MANUFACTURING PRODUCTIVITY

McKinsey
Global
Institute

with assistance from
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Washington, D.C.

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PREFACE

This report is an end product of a year-long project by the McKinsey Global Institute on manufacturing productivity in the leading economies of the world.

This project is a follow-on to the 1992 McKinsey Global Institute project on Service Sector Productivity.[1] That project placed particular emphasis on the service sector because it has been ignored historically relative to manufacturing and because productivity in the service sector has also been exceedingly difficult to measure. Yet, services make up the dominant share of all fully-developed economies. Thus, we felt that understanding service sector productivity would go a long way towards understanding differences in performance among the leading economies.

In the course of that project, however, we became aware of the recent work by Bart van Ark and Dirk Pilat at the University of Groningen, The Netherlands, on manufacturing productivity. That work and the results of others seem to contradict the conventional wisdom that manufacturing in the U.S. is in sharp decline and has fallen below manufacturing performance in Germany and Japan. The objective of our project has been to determine relative manufacturing performance and to explain whatever differences we found.

We focused again on productivity because it is the most fundamental measure of economic performance. Productivity is the ratio between the outputs of goods and services and the inputs of resources used to produce them. On the national level, productivity is an important indicator of the economic strength of a nation. For any level of employment, the higher the productivity, the higher the living standards. Increased productivity is the engine driving economic growth that provides society with additional goods and services for consumption and investment including public and social services.

This report consists of three chapters and an Executive Summary. Chapter 1 describes our objectives and approach for the project. Chapter 2 includes our nine manufacturing industry case studies. Each case study gives the results of our productivity calculations and discusses the reasons for the differences we found. Each case is preceded by a one-page summary of the results of the case. Readers more interested in our general results and less interested in the specifics of some or all of the cases may chose to read the summary rather than the entire case. Chapter 3 presents a synthesis of our findings including our overall conclusions and their implications for policy and for corporations.

The undertaking of this project is part of the fulfillment of the McKinsey Global Institute's mission to help business leaders: (1) understand global economic developments, (2) improve the performance of their corporations, and (3) work for better national and international policies. The working team for this project consisted of a core group of three McKinsey consultants transferred from their home offices to the Global Institute and a group of McKinsey sector experts. The Global Institute consultants and their areas of specialization were Hans Gersbach (Zürich) –

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[1] Service Sector Productivity, McKinsey Global Institute, Washington, D.C., October 1992.

cars, auto parts, food processing, beer, and soap and detergent; Tom Jansen (Toronto) – steel and metalworking; Koji Sakate (Tokyo) – computers and consumer electronics. Hans Gersbach was the day-to-day project manager. The sector experts were Craig Alexander (Boston) – soap and detergent; Leon Masiewicki (San Francisco) – beer; Glenn Mercer (Cleveland) – autos and auto parts; Mike Nevens (San Jose) – consumer electronics; Lou Schorsch (Chicago) – steel; Lothar Stein (Munich) – computers; Dorothea Velikonja (Brussels) – steel; and Steve Walleck (Cleveland) – metalworking. In addition, Kathy Huang, Omar Toulan, and Eric Zitzewitz provided analytical support, and Omar Toulan shared responsibility for the processed food case study. Administrative support was provided by Ronni Brownlee, Erika Kumoto and Rebecca Wright, and the graphic production team was led by Ralph Romano (Washington).

We were fortunate to have the same Advisory Committee for this project that we had for the Service Sector Productivity Project. The Advisory Committee was chaired by Bob Solow, MIT and consisted in addition of Martin Baily, The Brookings Institution and The University of Maryland; Francis Bator, Harvard University; and Ted Hall, McKinsey. The working team had 4 all-day meetings with the Advisory Committee to review progress during the course of the project. Halfway through the project, Martin Baily joined the working team as a McKinsey Global Institute Fellow on a full-time sabbatical. As such, he shared the project direction responsibility with me. At the drafting stage of the report, Francis Bator dedicated time to reviewing the objectives and approach chapter, the synthesis chapter, and a prototype case study. He also contributed extensively to the drafting of the executive summary. Bob Solow and Ted Hall provided frequent comments throughout the effort including specific reviews of the synthesis chapter. Bart van Ark and Dirk Pilat participated in the Advisory Committee meetings and provided advice and analytical support in our use of the Census of Manufacturing, which was the database providing the starting point for our work. In addition, Fred Gluck, Managing Director, McKinsey & Company, Inc. and Heino Fassbender (McKinsey Germany) participated in the meetings with the Advisory Committee.

Throughout the conduct of this project we benefited from the unique worldwide perspective and knowledge of McKinsey consultants on economic performance in the manufacturing industries investigated in our case studies. McKinsey sector leaders provided inputs to our case studies and reviewed our results. Their names are given following this preface. In addition, we would like to recognize the contributions of McKinsey consulting teams worldwide who provided us with invaluable information on the structure, dynamics and performance of all the industries we studied, while at the same time, preserving the confidentiality of information about specific McKinsey clients.

Bill Lewis
Director of the McKinsey Global Institute
October 1993

McKINSEY SECTOR LEADERS CONTRIBUTING TO CASE STUDIES

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Herman de Bode – Brussels
Mark McGrath – Chicago
Tatsuo Ohbora – Tokyo
Andrew Parsons – New York
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Thomas Tochtermann – Stuttgart

Cars and auto parts
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Felix Brück – Munich
Tadaaki Chigusa – Tokyo
Raimund Diederichs – Munich
Lance Ealey – Cleveland
Günter Nikolaus Fuhry – Vienna
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EXECUTIVE SUMMARY

Recent labor productivity calculations for manufacturing taken *as a whole* show that the productivity of operations in the U.S. is higher than in Germany and Japan and that Germany and Japan are closely matched. The common perception, however, is that manufacturing productivity in the U.S. has fallen behind productivity in Germany and Japan.

To find out which view is correct and what the reasons are for productivity differences, the McKinsey Global Institute has made a study of labor productivity in nine manufacturing industries: autos, auto parts, metalworking, steel, computers, consumer electronics, soap and detergent, beer and processed food. Our principal findings are:

- Large differences in productivity exist at the industry level – generally not resulting from mere differences in capital.

- Absent governmental and private restraints on competition, corporate managers could significantly improve manufacturing productivity *in all three countries* by adopting "best practice" processes at home, and sending them abroad. Companies in all three of these countries have already accomplished substantial adoption and transfer of best practice; however, much remains to be done.

PRODUCTIVITY FINDINGS

Exhibit S-1 shows that:

- In metalworking and steel production, labor productivity in Germany has caught up with labor productivity in the U.S., but in the other seven industries we studied, productivity in Germany is still lower. These results include adjustments for differences in the business cycle and differences in product quality.

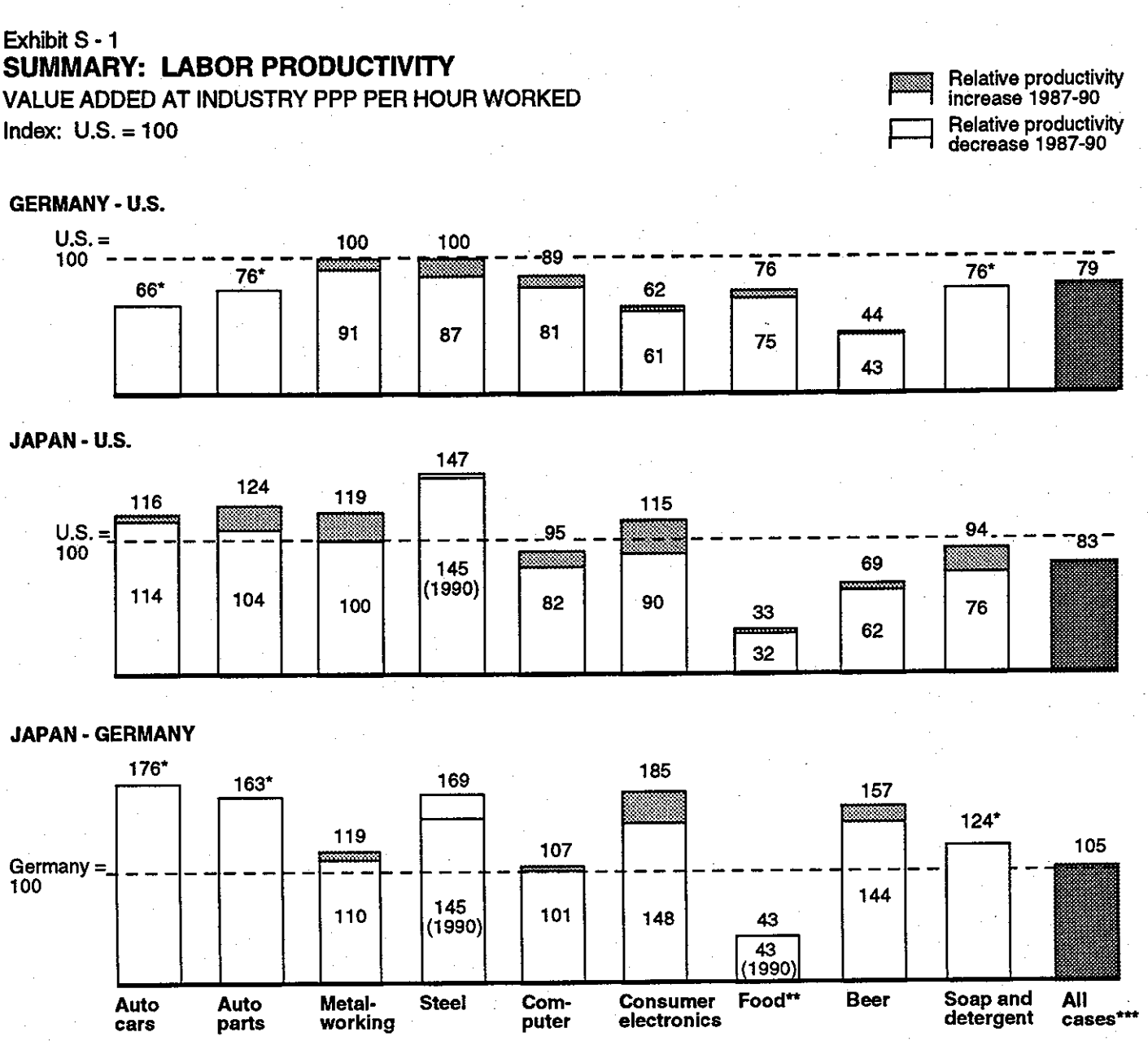
- In five of the case studies – autos, auto parts, metalworking, steel, and consumer electronics – labor productivity in Japan is significantly higher than in the U.S. (by 45 percent in steel in 1990). In the other four industries – computers, soap and detergent, beer, and food processing – Japan is behind, by large margins in beer and processed food. Because more Japanese are employed in producing food than in producing steel, cars, auto parts and metalworks combined, the weighted average of Japanese worker productivity in our nine case studies, taken together, is only 83 percent of that in the U.S., and only a little higher than in Germany.

Exhibit S - 1

SUMMARY: LABOR PRODUCTIVITY

VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED

Index: U.S. = 100



* Only 1990

** Based on shipment

*** Weighted by employment, only 1990

Source: McKinsey analysis

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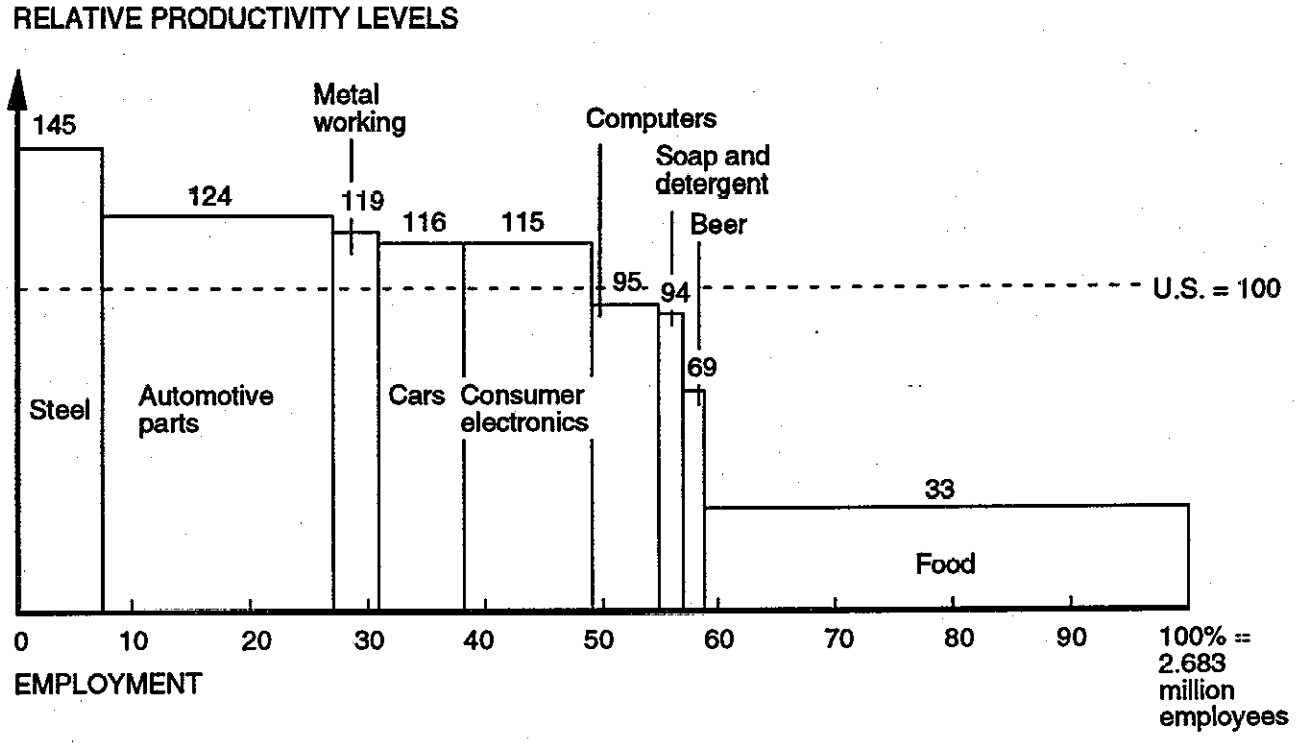
Exhibit S - 2

RELATIVE PRODUCTIVITY LEVELS AND EMPLOYMENT SHARE IN JAPAN 1990

NINE CASE STUDIES

Index: U.S. = 100



Source: McKinsey analysis

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¶ In five cases – autos, auto parts, steel, consumer electronics, and beer – labor productivity in Japan is much higher than in Germany. In the other four cases, productivity in Japan is higher in three – metalworking, computer, and soap and detergent – and significantly lower in food processing. Again, because of the large number of Japanese employed in food processing, the weighted average of labor productivity in Japan for our nine case studies is only slightly higher than in Germany.

Exhibit S-2 shows relative labor productivity in Japan compared to the U.S. in all nine of the industries we studied, with the width of the bars proportional to the number of Japanese workers employed in each. Evidently, Japanese manufacturing exhibits the attributes of a "dual economy," with state-of-the-art industrial processes and craft processes side by side. (Our case studies suggest no such dual economy for manufacturing in Germany since beer represents only 3 percent of employment in our case studies.)

* * *

With technological know-how and capital essentially fully mobile among Germany, Japan and the U.S., and with workers in those three market economies not significantly different in educational attainment and health, one would expect that by 1990 – 45 years after World War II – productivity in those three countries would be closely matched. To understand why that is not the case – and to discover whether the observed large differences in labor productivity within each of these industries offer opportunities for the followers to catch up – we have investigated the causes of productivity differences within each of our nine industries.

WHY PRODUCTIVITY DIFFERENCES PERSIST?

How much physical output a worker produces, on average, in an hour's work, depends on: (1) what the output is, (2) the worker's motivation and skill, (3) the technology, plant, and equipment in use, as well as the parts and raw materials, (4) the scale of production, (5) how easy the product is to manufacture, and (6) how the many tasks of production are organized in detail.

Exhibit S-3 summarizes our findings about what seems to matter in each of the nine industries we studied.

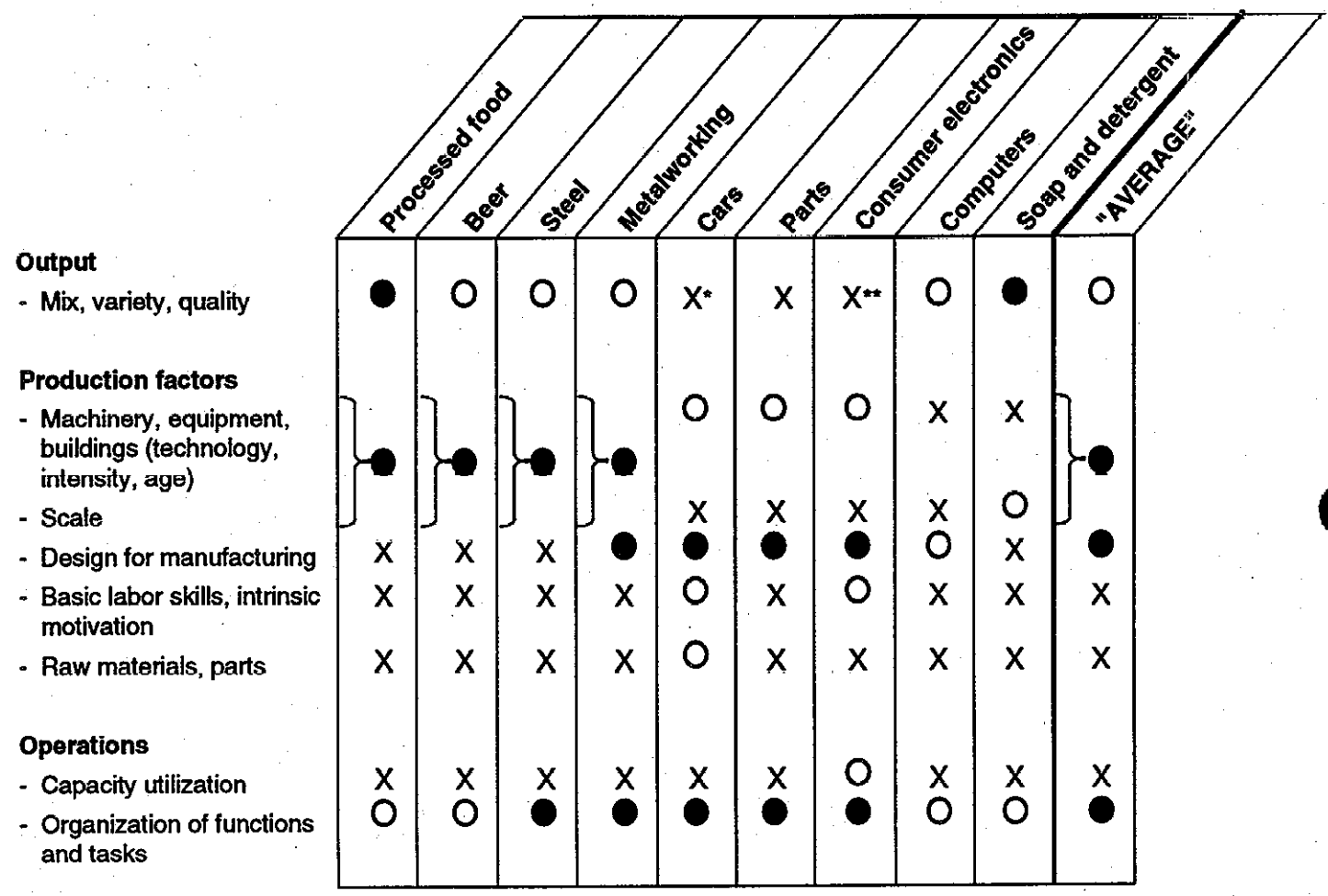
¶ We have seen the decisive role played by "design for manufacturing" and the "organization of functions and tasks" in the efficient production of autos and auto parts, and the important role they play in explaining productivity differences also in the consumer electronics and metalworking industries. How the work is organized in detail, and the manufacturability of the product, largely explain why workers in the Japanese auto industry are more productive than in the U.S., and much more productive than in Germany.

Exhibit S - 3

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES AT THE PRODUCTION PROCESS

SUMMARY

● High
○ Low
X Undifferentiated



* Adjustment for quality made to the productivity data
** Influence is high in the opposite direction

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¶ Technology, machinery and plant, and scale are important in metalworking and steel, and in a different way, in food processing in Japan and the production of beer in Germany. In the latter two industries, small scale, craft methods prevail. Consequently, labor productivity is very low.

¶ Among Germany, Japan, and the U.S., differences in workers' basic skills do not appear to play an important role in explaining differences in productivity in any of our nine industries. Leading edge producers have successfully transferred their home-based processes to production facilities in all three countries.

Most, if not all of the things that cause significant differences in productivity are subject to choice by managers. That is certainly the case when it comes to the manufacturability of the product ("design for manufacturing") and how the work place is organized. Yet great differences persist.

Why managers at the leading edge first adopt the methods they use, we have not attempted to explain in detail. However, we find that virtually all the leaders are now competing with the best external and internal producers and that they are continuing to improve their productivity at a rapid pace. We also find that in the computer, soap and detergent, food and beer industries, productivity leadership has not changed but has remained in the U.S. for a long time. However, in the other five cases (autos, auto parts, metalworking, steel and consumer electronics), operations in Japan overtook competitors in productivity within the last two decades. Prior to becoming productivity leaders, most of these industries in Japan were competing against their best external producers in Europe and the U.S. They became leaders by developing and implementing revolutionary innovations. Such innovation may have been triggered by exposure to the productivity leaders, but we cannot be sure of this point from our case studies.

Our case studies do throw light on why other manufacturers in other countries (or even at home) have failed quickly to follow the leaders. We find that the intensity of competition to which managers are exposed and, more specifically, the degree to which they are faced by direct competition from producers on the leading edge, matters a great deal.

To illustrate:

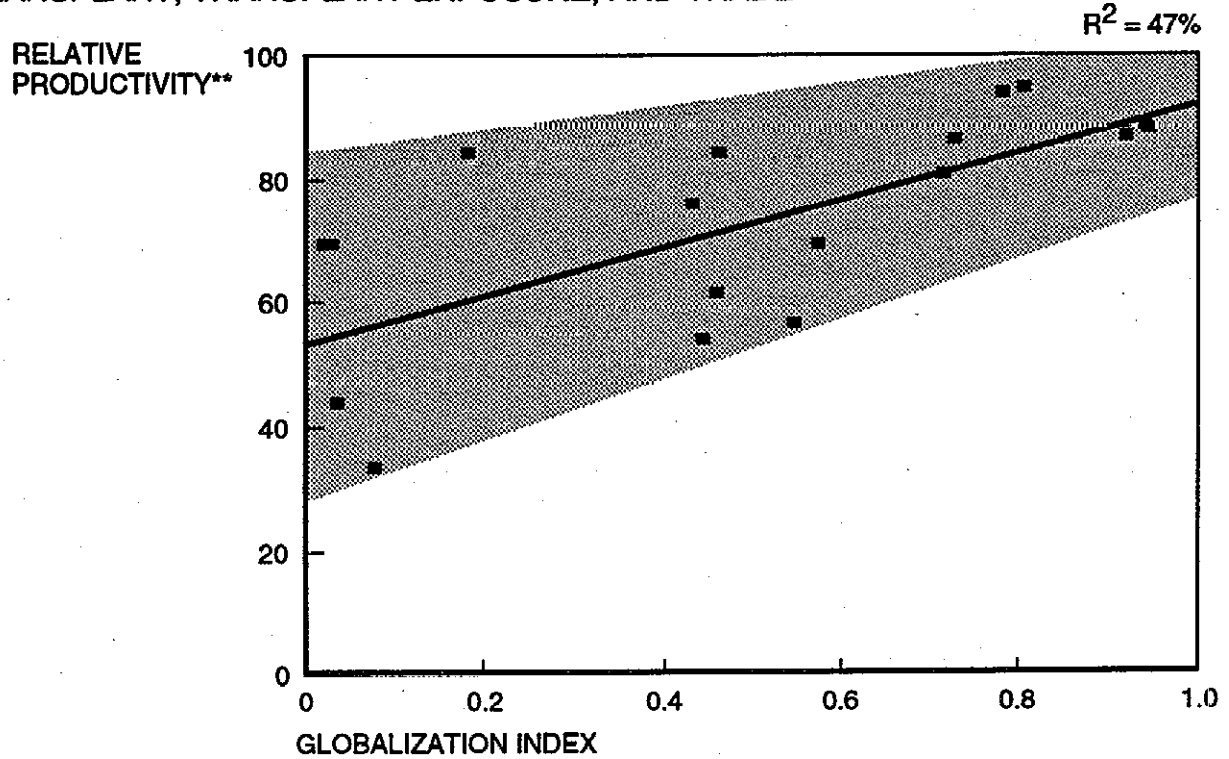
¶ Direct competition from leading edge auto producers in Japan has caused the exposed U.S. auto industry to respond in kind. The German auto industry, largely sheltered from Japanese competition, has not – productivity in the German industry is significantly lower than that in both Japan and the U.S.

¶ Food production in Japan, sheltered from leading edge producers abroad, has failed to modernize. Clearly domestic competition has not sufficed to

Exhibit S - 4

GLOBALIZATION vs. RELATIVE PRODUCTIVITY*

TRANSPLANT, TRANSPLANT EXPOSURE, AND TRADE



* Data points are nine case study industries in countries without productivity leading edge
** Relative to industry leader at 100

Source: McKinsey analysis

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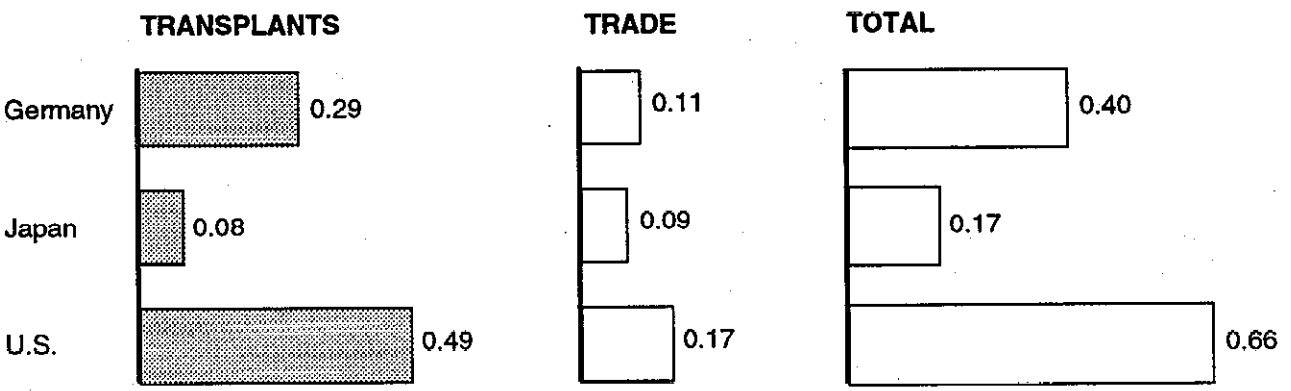
Exhibit S - 5

IMPACT OF TRANSPLANTS AND TRADE ON PRODUCTIVITY

Weight in Globalization Index



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force the consolidation that would be necessary to achieve high productivity.

¶ In contrast to autos and food, computer producers in all three countries (with the exception of a small segment in Germany) have been fully exposed to competition worldwide. The differences in labor productivity are small.

Exhibit S-4 plots relative productivity (relative to the industry leader) against an index of the degree to which a national industry which is a productivity follower is exposed to leading-edge competition worldwide (globalization index). The evidence supports the hypothesis that in stimulating productivity advance, global competition matters a lot.

IMPLICATIONS FOR POLICY

For manufacturers, exposure to competition worldwide depends on the laws and regulations that govern investment and trade. Our hypothesis that such global exposure profoundly affects the management decisions on which productivity depends implies, therefore, that barriers to trade and to foreign direct investment will profoundly affect productivity. Such barriers for autos are especially important because efforts to improve productivity in this industry spill over to auto parts, metalworking and steel.

Our analysis suggests that foreign direct investment (transplants) has been a more powerful way of improving productivity than trade has been, especially in Germany and the U.S. (Exhibit S-5). Transplants from leading edge producers: (1) directly contribute to higher levels of domestic productivity, (2) prove that leading edge productivity can be achieved with local labor and many local inputs, (3) put competitive pressure on other domestic producers, and (4) transfer knowledge of best practice to other domestic producers through the natural movement of personnel. Moreover, foreign direct investment has provoked less political opposition than trade because it creates jobs instead of destroying them. Thus, foreign direct investment is likely to grow faster than trade.

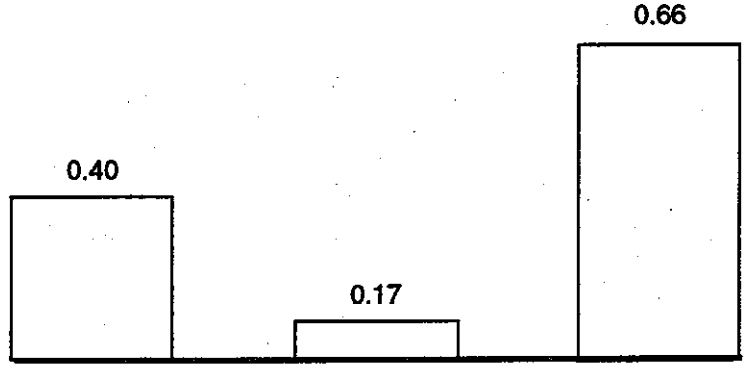
It is especially important that regulations and their interpretation and implementation not hinder the establishment of transplants. Also, the market for corporate control should allow the entry of productivity leaders through mergers, acquisitions, and joint ventures. We find the entry of productivity leaders to be easier in these respects in the U.S. than in Germany and Japan.

A question remains whether <u>temporary</u> protection from foreign competition might not have a positive effect on a domestic industry's performance by providing it with time to reform. In principle, the answer could go either way. But on the evidence we find that in only one industry in one country has trade protection led to improved productivity in existing facilities (car production in the United States).

Exhibit S - 6

GLOBALIZATION OF PRODUCTIVITY FOLLOWERS

Globalization index weighted by employment share for followers



	Germany	Japan	U.S.
	Autos Auto parts Metalworking Steel Computers Consumer Electronics Food Beer Soap and Detergent	Computers Food Beer Soap and Detergent	Autos Auto Parts Metalworking Steel Consumer Electronics
Productivity gap* of followers	34	59	20

* Weighted by employment with leader at 100

Source: McKinsey analysis

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The VRA on Japanese car imports in the United States did provide Chrysler and Ford with the time they needed to become competitive with Japan. We found no other recent example.

Granted, if one goes back far enough, there are others. The Japanese government's protection of its "infant" auto, computer, metalworking and consumer electronics industries very likely helped those industries develop to the point where they could compete on their own. Moreover, in knowledge-intensive industries like computers and metalworking, the Japanese government used the power of market access to require the transfer of technology to companies in Japan, thereby increasing domestic and eventually global competition. But, as a general rule, protection, once given, is hard to withdraw. Persisting inefficiency is its most likely result.

We do find evidence that transplants contribute to productivity improvement. To the degree that trade restrictions encouraged foreign companies to shift production to the United States – in metalworking, steel, cars and consumer electronics, the result was an improvement in American productivity. But in our opinion, the impact of these trade restrictions on corporate decisions was small.

As a rough indicator of the "global exposure" of the productivity followers in Germany, Japan and the United States, we sorted the data points on Exhibit S-4 by country and calculated the average for each country by weighting each industry by its employment (Exhibit S-6). Measured by that index for the nine industries, the followers in the U.S. appear to be the most exposed to global competition and consequently closest to the leader. On average, followers in Germany face considerably less exposure and Japan has very little. The result for Japan is heavily determined by food processing, which employs a lot of people but is not exposed at all. This result suggests that the most significant opportunities for policy changes leading to improved productivity are in Germany and Japan.

IMPLICATIONS FOR CORPORATIONS

We observed several cases of successful transfer or acquisition of best practices across the countries we studied. However, as long as there remain large international differences in productivity in an industry, as is the case in eight of our nine industries, further opportunities exist for leading-edge producers and followers. Leading edge producers could increase profits by raising labor productivity (and standards of living) in other countries by transferring their methods abroad. For the followers, the fact that they follow is both an opportunity and a threat: an opportunity because copying best practice is a lot easier than innovating; a threat, because government protection or even local customer loyalty, are not a reliable foundation for long term good health. What will happen to the

German auto industry when Japanese transplants in the U.K. start exporting cars in large numbers to continental Europe? Merely doing all right against current competition is not a sufficient test.

CHAPTER 1: OBJECTIVES AND APPROACH

In this chapter we describe our motivation, objectives and approach for studying manufacturing productivity and relate our work to the research we began almost 2 years ago on service sector productivity. Our objective for both studies has been to understand a fundamental measure of economic performance – productivity – and identify the reasons for differences in productivity across the Triad.

WHY MANUFACTURING PRODUCTIVITY?

Productivity is the ratio of the output of goods and services to the input of resources used to produce them. On the national level, productivity is an important indicator of economic strength; for any level of employment, the higher productivity, the higher the population's material living standards.

National Productivity

The best aggregate measure of the material living standard of a nation is gross domestic product (GDP) per capita. To compare GDP across countries, the OECD converts national currencies into a common currency using purchasing power parity exchange rates. The aggregate OECD data shows that 1990 GDP per capita in the U.S. was 14 percentage points greater than in West Germany, 18 percentage points greater than in Japan, 19 percentage points greater than in France, and 27 percentage points greater than in the U.K., when measured in units of equal purchasing power (Exhibit 1-1). These are somewhat surprising facts, partly because they contradict the commonly held view that the U.S. has fallen behind, and partly because in a world where technology and capital are fully mobile among advanced market economies, the common expectation has been that an almost perfect convergence of productivities would have occurred by now. In 1945, the U.S. GDP per capita was much higher than in Europe and Japan. However, even half a century later, most countries have not yet caught up. While rebuilding and matching best practices is easier than pushing out the frontier, it is still a long, slow process.

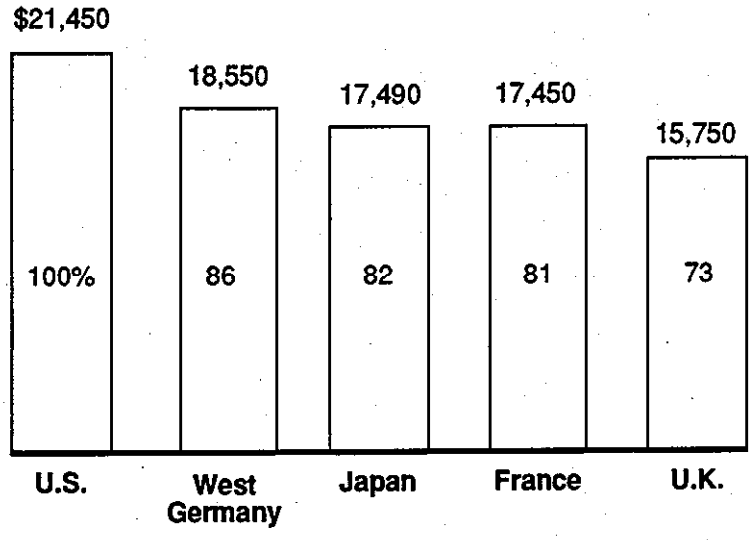
Exhibit 1-2 shows how per capita income has evolved since 1950. We see that although France, Germany, Japan, and the U.K. initially converged towards the U.S. level during this period, the convergence has slowed or stopped since 1980.

One reason for some of the remaining differences in per capita incomes is that more people work in the U.S. than in most other countries. The two-income family has become increasingly common in the U.S. but remains less so in Europe. Thus, the number of people employed as a fraction of the total population is higher

Exhibit 1 - 1

GDP PER CAPITA 1990

U.S. dollars, currencies converted at 1990
OECD Purchasing Power Parities (PPP*)



* Fisher Bilateral 1990 PPP

Source: OECD National Accounts Vol. 1, 1992; Eurostat

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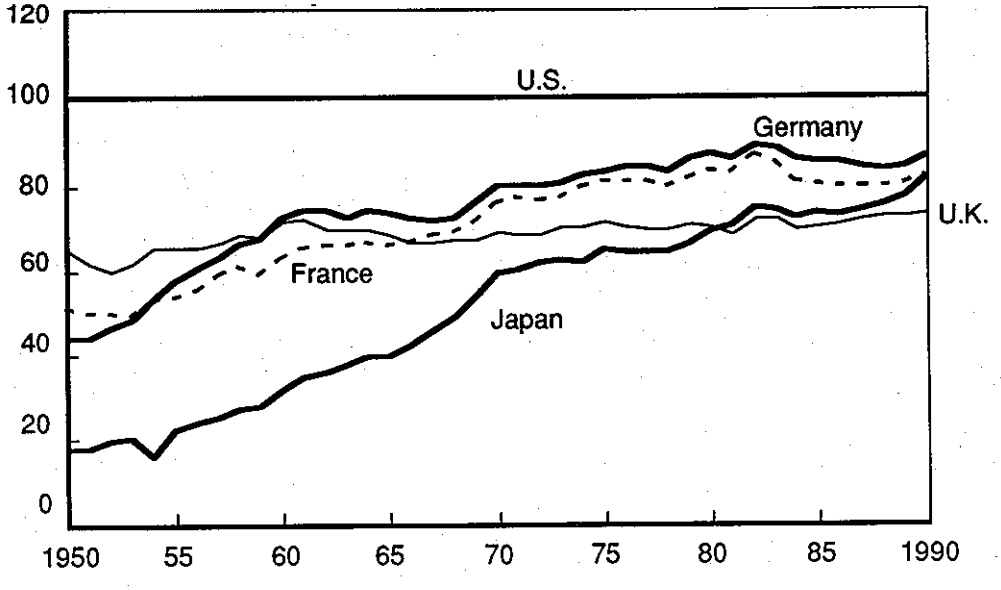
Exhibit 1 - 2

GDP PER CAPITA 1950-90

CURRENCIES CONVERTED AT 1990 OECD PPP*
Percent



* Fisher Bilateral 1990 PPP

Source: OECD National Accounts Vol. 1, 1992; Maddison, 1991

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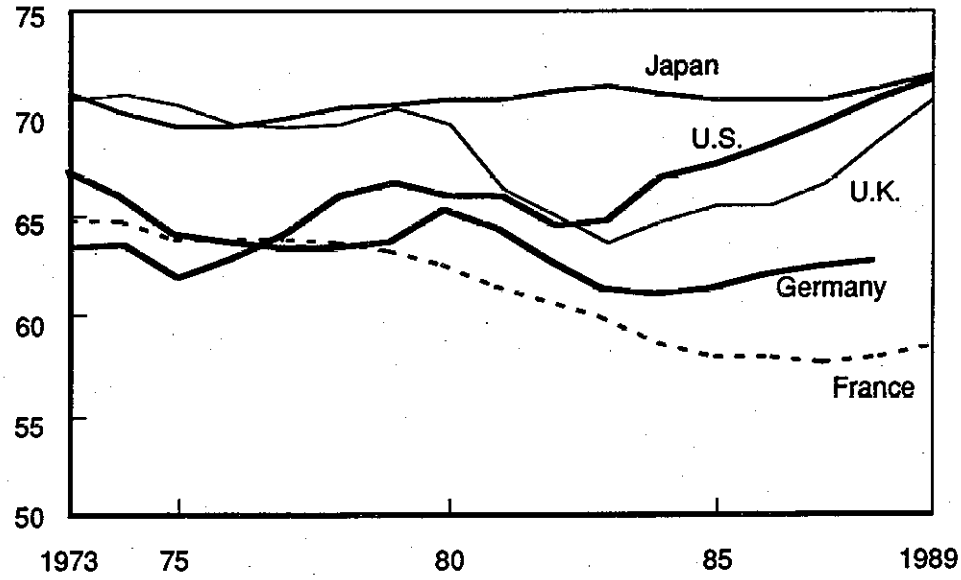
Exhibit 1 - 3

CIVILIAN EMPLOYMENT AS PERCENT OF WORKING AGE* POPULATION 1973-89

Percent



* Ages 15-64

Source: OECD Labor Force Survey

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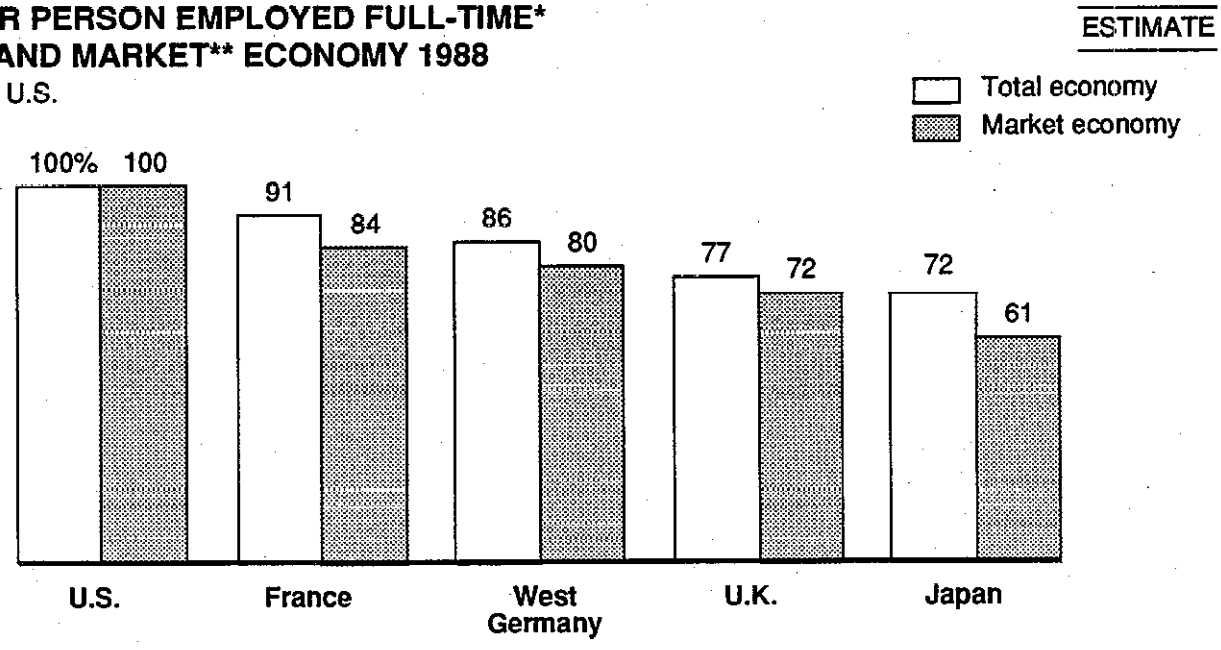
Exhibit 1 - 4

GDP PER PERSON EMPLOYED FULL-TIME* TOTAL AND MARKET** ECONOMY 1988

Percent of U.S.

ESTIMATE



* Part-time employees counted as 0.5 full-time employees

** Market economy excludes government, health services, education, real estate and nonprofit organizations

Source: OECD; Eurostat; BEA; McKinsey analysis

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in the U.S. than in Germany and France (Exhibit 1-3). The difference in incomes for these two countries and the U.S. remains significant, however, even if we look at output per employed person (Exhibit 1-4).

To get at the efficiency with which labor is used, a further adjustment can be made to take account of the fact that the length of the standard work week and vacations vary from country to country. Workers in Japan average more hours at work per year than those in the U.S., who in turn, generally have less vacation time than workers in Europe. In general, such an adjustment would further increase measured differences between Japan and the U.S. and reduce the difference between the U.S. and France or Germany. Because hours worked are not collected on a comparable basis across these economies, there remains some uncertainty over comparative national data in terms of output per hour. Moreover, we concluded that the measurement of output in the government, education, health and real estate sectors ("non-market sectors") was now virtually impossible. Thus, productivity measures which include these components were suspect. In trying to resolve this uncertainty, we narrowed our focus to just the market sectors and examined differences in productivity. Removing the nonmarket components, we estimated the relative productivities of France, Germany, Japan, the U.K. and the U.S. The resulting comparison for 1988, based on the 1990 PPP benchmark and full-time equivalent employment, is illustrated in Exhibit 1-4. In all cases the estimated relative productivities are lower for the market sectors than for the overall economies, with Japan showing the largest difference. After all these adjustments, the U.S. market sector remains the highest among the major industrial countries.

What explains the remaining differences? Dividing the economy into services and manufacturing, our first conjecture was that the answer could be found in the service sector, since services dominate both employment and output.

Service Sector Productivity

A clear picture of service sector performance could not be easily obtained from official sources. Therefore, we took a detailed, bottom-up look at the market part of the service sector. We followed a case study approach for five industries, using McKinsey information to make adjustments to existing data and to achieve consistency. The sample of five service industries, airlines, retail banking, restaurants, general merchandise retailing, and telecommunications, comprised 21 percent of market services (Exhibit 1-5). If we were going to find evidence that contradicted the differences suggested at the aggregate level, we would expect to find them in services. We found no such evidence.

Exhibit 1-6 summarizes the labor productivity results for the five service sector case studies and compares these results with the productivity results for the market part of the GDP. Our cases show that the U.S. has higher productivity in most sectors; the only exception to this general finding lies in the restaurant

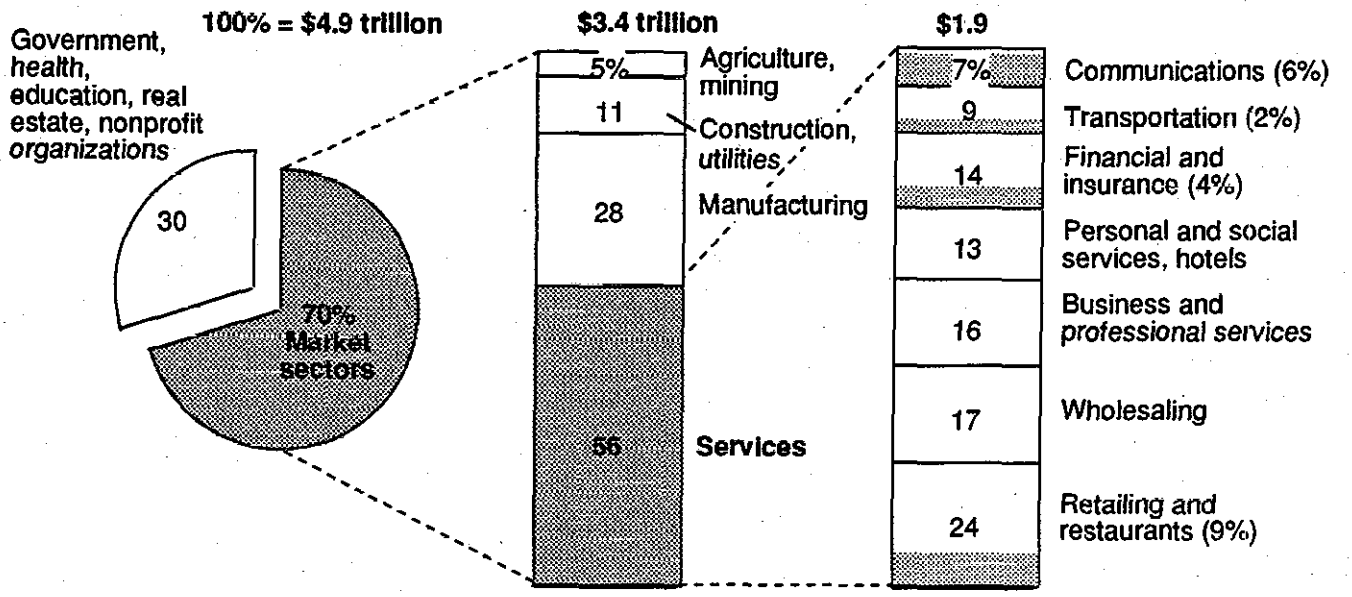
Exhibit 1 - 5

U.S. MARKET SECTORS GDP 1988

Percent

EXAMPLE

21% of market services covered in case studies



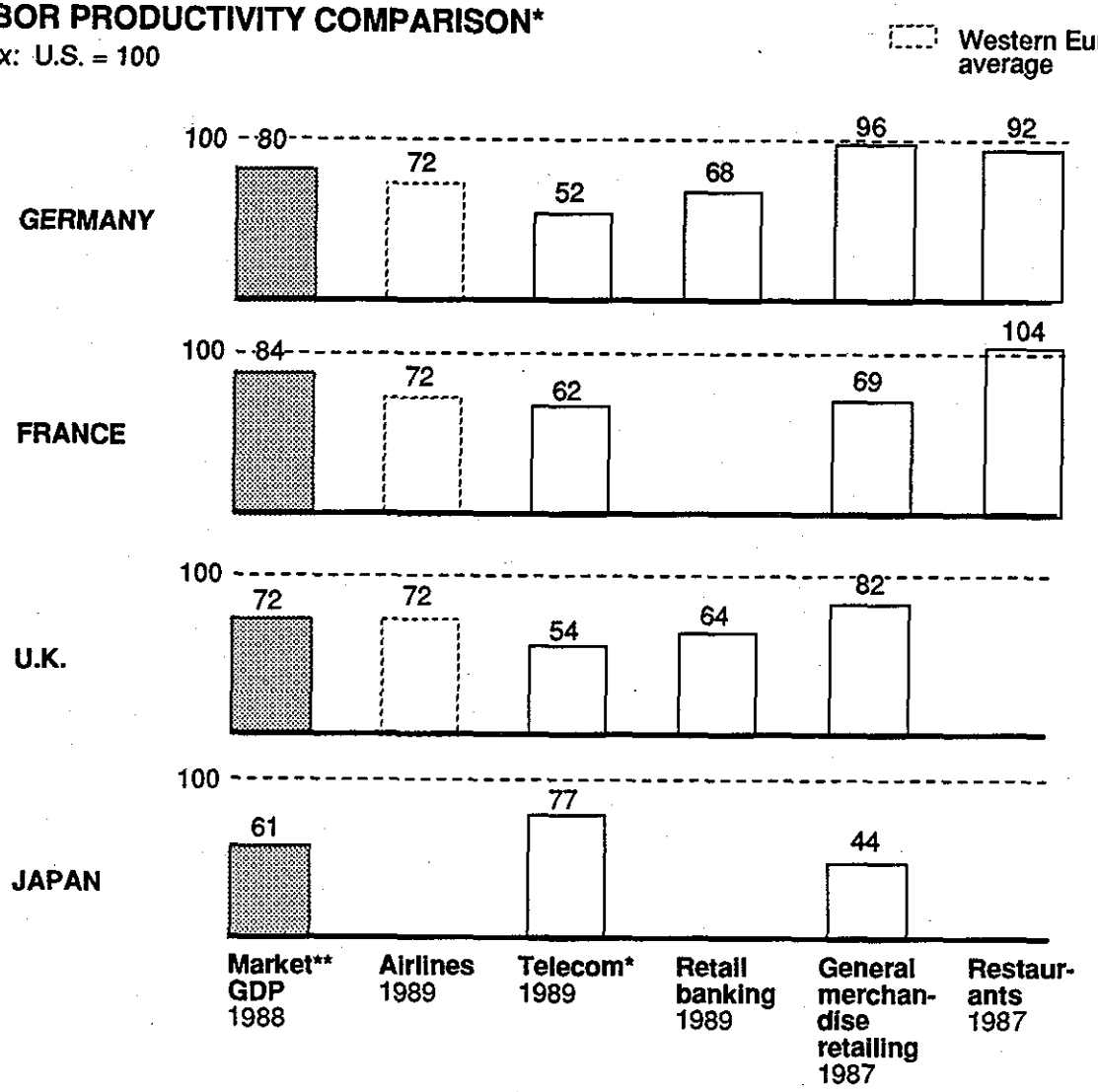
Source: Survey of Current Business

218M295D.ZXE

Exhibit 1 - 6

LABOR PRODUCTIVITY COMPARISON*

Index: U.S. = 100



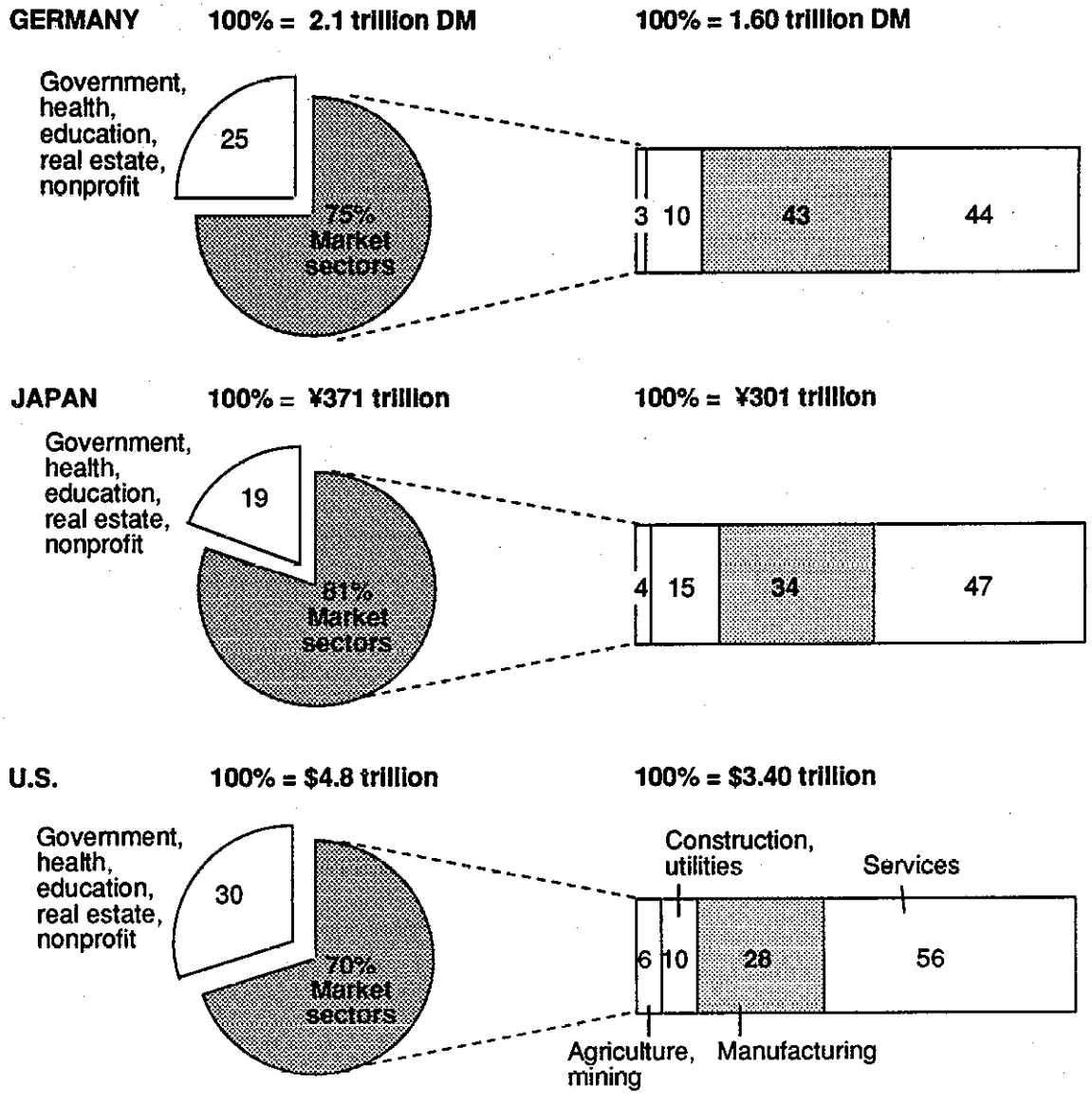
* Total factor productivity shown for telecommunications
** GDP excluding government, education, health, and real estate

834M295D.ZXE

Exhibit 1 - 7

VALUE ADDED BREAKDOWN 1988

Percent



Source: National Accounts data; McKinsey analysis

831aM295D.ZXE

industry. The magnitude of the differences implied by the sector and industry results is consistent with the differences at the market GDP level in each country.

To identify possible steps to improve productivity performance, we needed to better understand the reasons for the productivity differences in service industries. Labor productivity is a function of the available technology, the advantages and disadvantages of large scale, labor skill, capital intensity, output mix and how workers are combined with the other inputs to produce output. We call this last category the organization of functions and tasks. Many of the above determinants of productivity, especially the organization of functions and tasks, are the result of choices made by management.

By the process of elimination we concluded that at the level of the production process, the organization of labor was crucial in three of our cases. In contrast, differences in capital intensity and scale of operations played a surprisingly small role in explaining the productivity gaps. And differences in the mix of services provided by each industry had only limited explanatory power.

On higher levels of causality, we concluded that the most important differences across countries reflect how managers respond to the environment. Competitive intensity powerfully influences management behavior. Thus, in evaluating the reason for the higher U.S. productivity levels shown for the service industry case studies, we find the effect of competition on management behavior to be the likely principal cause. Competitive pressures on service companies operating in the U.S. are greater than in the other countries.

Lower competitive intensity in these five service industries in Europe and Japan is mainly the result of regulation and policy, particularly in the airline and telecommunications industries where state ownership prevails. Thus, we concluded that differences in labor productivity in these cases are ultimately caused by differences in economic policy and regulation, especially as these affect freedom of entry and pricing.

Manufacturing Productivity

The productivity results of the service sector case studies supported the differences suggested at the aggregate level. We then turned to the other substantial sector in the economy, manufacturing, which is frequently a topic of public debate, as some people believe this sector plays a disproportionate role in the development of innovations and strategic technologies.

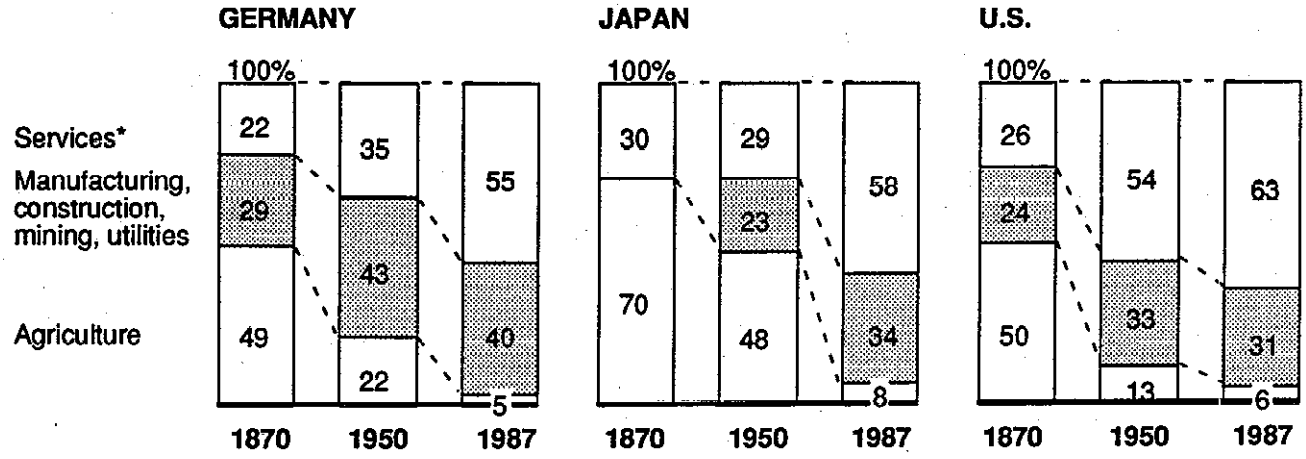
The Manufacturing Sector

The share of total employment and total value added in manufacturing is very different across countries. As Exhibit 1-7 shows, in the market sectors in the U.S., manufacturing accounts for only half of the value added of the service sector.

Exhibit 1 - 8

STRUCTURE OF EMPLOYMENT 1870, 1950, AND 1987

Percent



* Including government

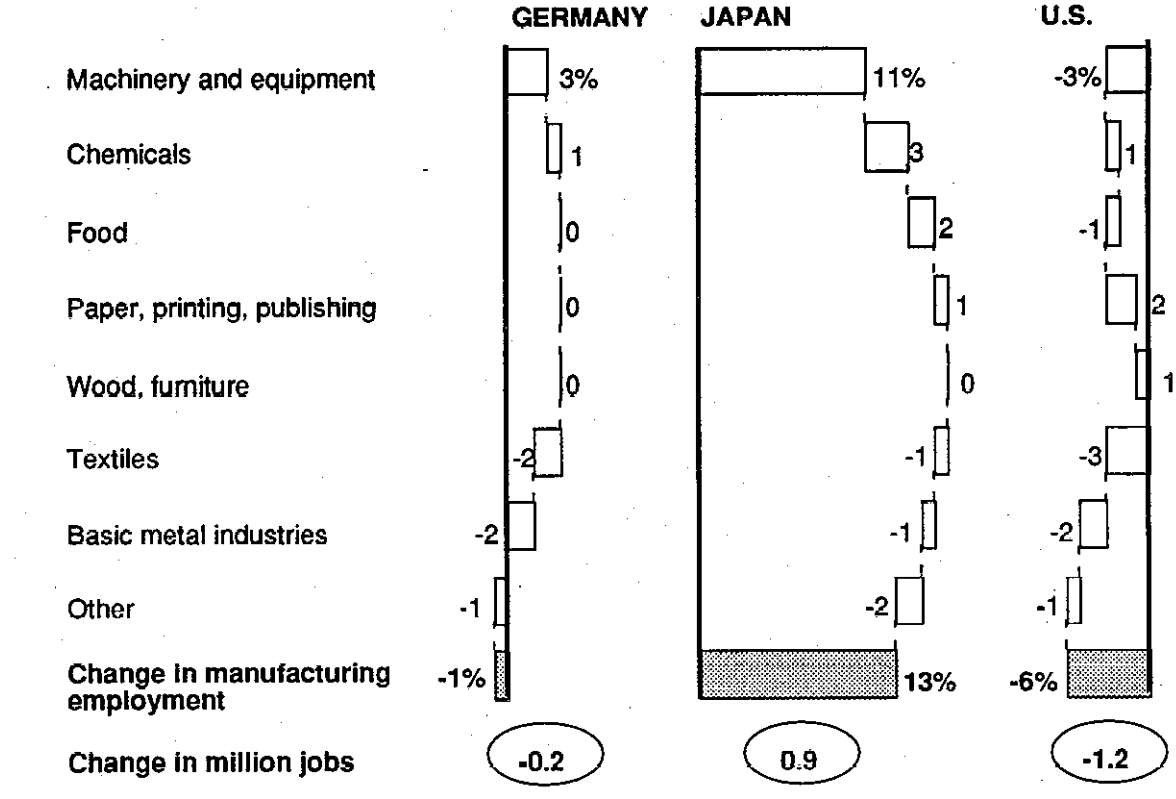
Source: Maddison 1991

809M295D.ZXE

Exhibit 1 - 9

SOURCES OF CHANGE IN MANUFACTURING EMPLOYMENT* 1980-90

Percent of manufacturing employment in 1980



* Wage earners and salaried employees only (excludes self-employed)

Source: OECD; Labor Force Statistic, 1992; McKinsey analysis

812M295D.ZXE

Both sectors contribute roughly the same amount in Germany, and Japan is in between.

The relative importance of manufacturing, construction, mining and utilities as sources of employment have declined slightly since the 1950s in the U.S. and Germany, but substantially increased in Japan (Exhibit 1-8). This development in the U.S. has come to be described as "de-industrialization," whereby traditional manufacturing is said to be gradually replaced by rapidly growing service industries. Looking at the branches within manufacturing, we see that job growth was largely stagnant or shrinking in most sectors in Germany and the U.S. (Exhibit 1-9). The substantial increase in employment in the machinery and equipment sector in Japan led to a 13 percent overall increase in its manufacturing employment. Changes in employment have otherwise been relatively small across branches in all three countries.

Manufactured goods account for the majority of exports and imports in Germany, Japan and the U.S. (well over 70 percent for the U.S.). However, focusing exclusively on traded goods, such as autos, can be misleading since much of the manufacturing sector is not traded. Exhibit 1-10, which presents the intensity of trade flows between Japan and the U.S. in manufacturing, illustrates this point. Very little trade occurs between the U.S. and Japan in the majority of manufacturing industries (labeled "other manufacturing").

Manufacturing sales include value added from services; the manufacturing sector buys a lot of its inputs from services, and the distribution of manufactured goods is also part of the activities counted in the service sector. Using the U.S. manufacturing sector as an example, we find that 47 percent of the value of sales of industrial goods (at point-of-sale) is created by services, due to both service inputs to manufacturing (e.g., design, software, etc.), and distribution (e.g., advertising, transportation, etc.) (Exhibit 1-11). This result shows that a large number of service sector jobs and activities depend upon the demand for manufacturing activities and vice versa.

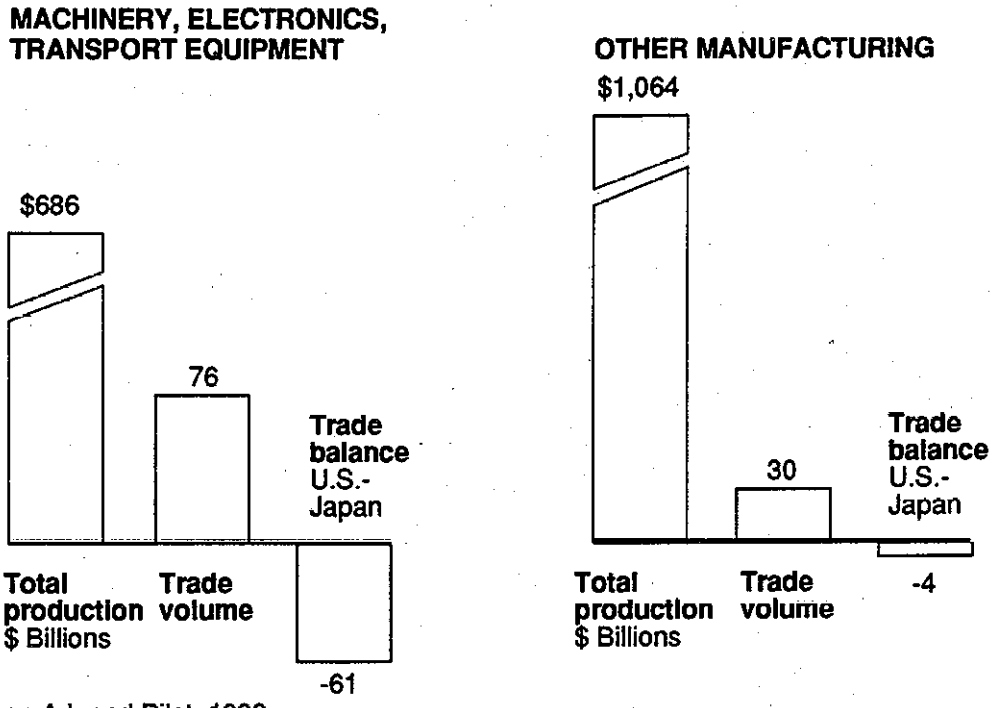
Productivity Studies Results

Since 1950, manufacturing productivity levels in Germany and Japan have converged toward that of the U.S., which is consistent with the classical catch-up hypothesis which says that aggregate productivity differences among industrialized countries should disappear over time (Exhibit 1-12). However, similar to the GDP per capita trends, Germany has not continued to gain on the productivity leader since 1980, and has had a lower productivity growth rate over this period.

There have been many international studies on manufacturing productivity and some insightful new work is becoming available. A sample of estimates from various cross-country comparisons agree on the rank order of manufacturing productivity levels for Germany, Japan and the U.S., but there is considerable disagreement over the magnitude of the gap (Exhibit 1-13). The van Ark/Pilat (1993)

Exhibit 1 - 10

TRADE PATTERNS AND PRODUCTIVITY DIFFERENCES IN MANUFACTURING FOR U.S. AND JAPAN 1987



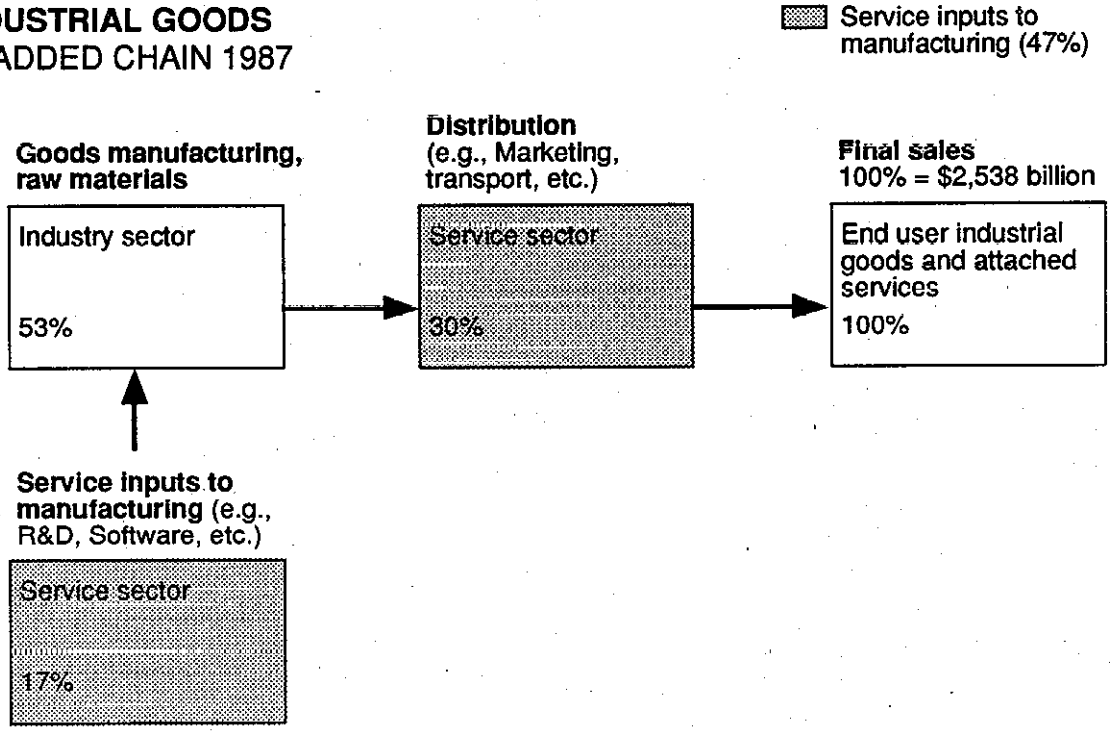
Source: van Ark and Pilat, 1993

067M295D.ZXE

Exhibit 1 - 11

U.S. INDUSTRIAL GOODS VALUE ADDED CHAIN 1987

Percent



Source: Survey of Current Business, BEA 1992; McKinsey estimate

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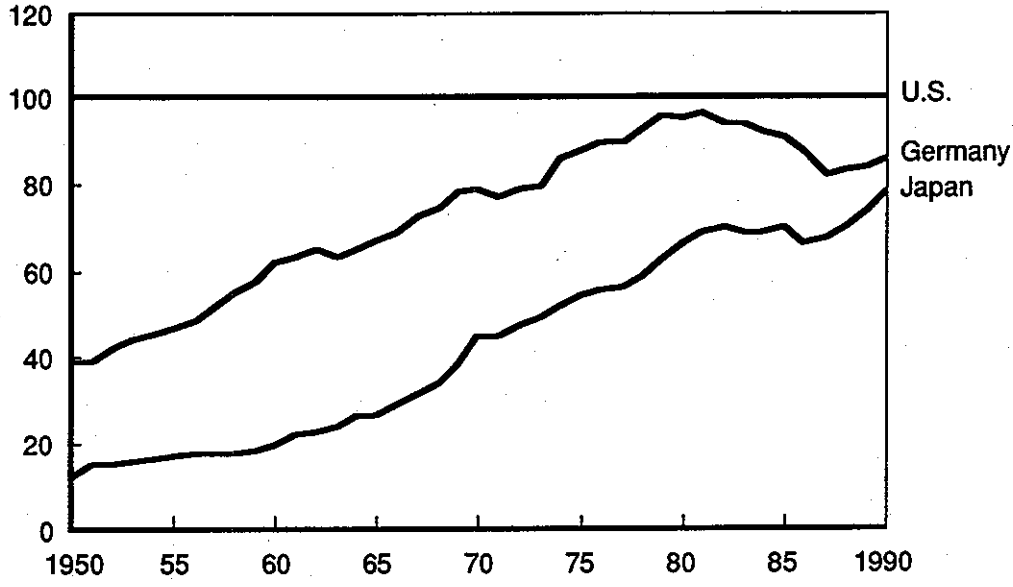
Exhibit 1 - 12

MANUFACTURING LABOR PRODUCTIVITY 1950-90

VALUE ADDED PER HOUR WORKED

Percent

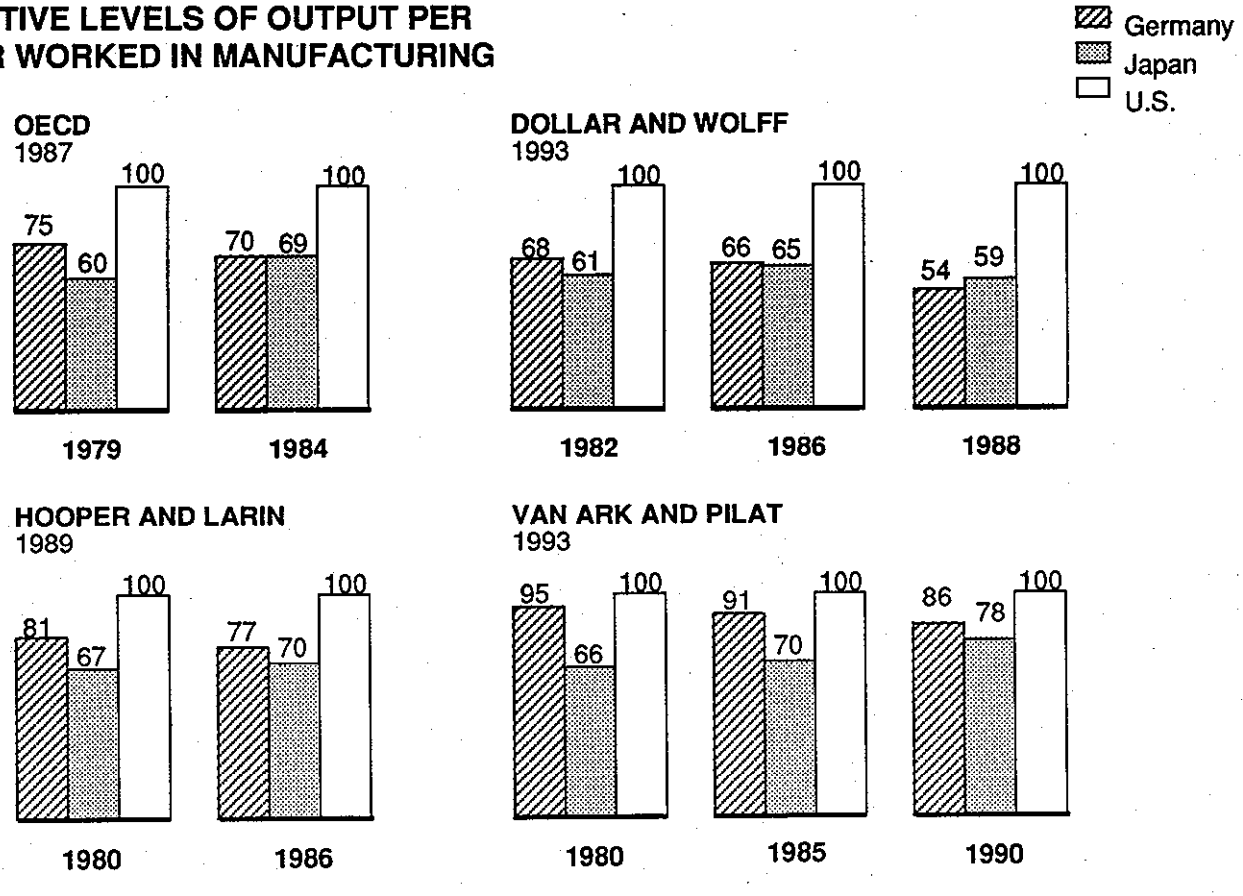


Source: van Ark and Pilat 1993

903M295D.ZXE

Exhibit 1 - 13

RELATIVE LEVELS OF OUTPUT PER HOUR WORKED IN MANUFACTURING



819M295D.ZXE

Exhibit 1 - 14

BASIC METHODS TO MEASURE MANUFACTURING LABOR PRODUCT

	Final expenditure PPP	Industry of origin approach
Description	Use ICP (OECD) PPP for currency conversion	Calculates PPP directly at the producer level from census data
	Different data set for value added and employment	Uses census data with consistent set of employment/value added
Major obstacles	Does not measure price relationship on the producer level (distorted by distribution, taxes, etc.)	Compares product categories for PPP with - Mix difference - Quality difference
	Includes import prices and not export prices	
	Inconsistency of value added with employment	

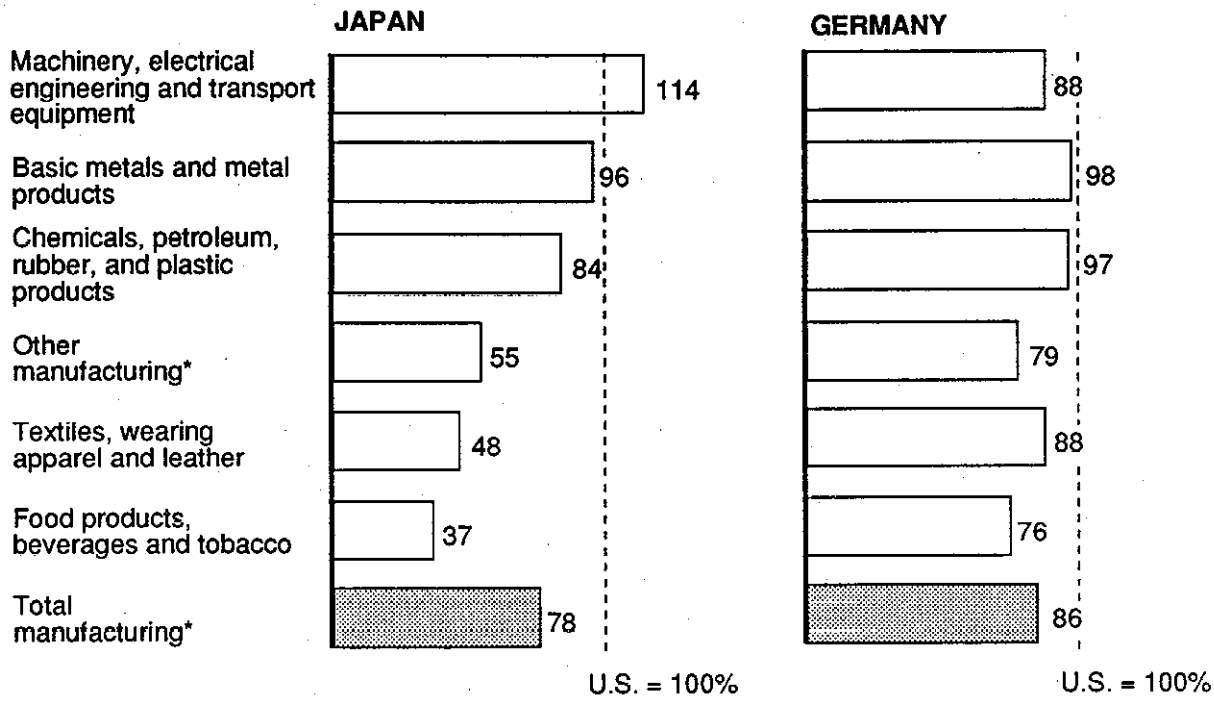
196M295D.ZXE

Exhibit 1 - 15

MANUFACTURING PRODUCTIVITY BY MAJOR BRANCHES 1990

Value added at industry PPP per hour worked

Index U.S. = 100



* Wood and paper products, furniture and fixtures, nonmetallic mineral products, other

Source: van Ark and Pilat 1993

808M295D.ZXE

result suggests that German operations are within 20 percent of the U.S. level, but a study by Dollar and Wolff (1993) reports that the same operations are only half as productive at the end of the 1980s. There is also no consistency as to whether Germany or Japan is closer to the U.S. in manufacturing productivity. Furthermore, the changes in relative productivity levels over time are not fully consistent. In some studies Japan shows some convergence towards the U.S., whereas other results suggest an almost constant gap. Although all results show that German productivity in manufacturing has slipped in the 1980s, the degree varies somewhat.

One explanation for the differing results is that the studies used two different approaches (Exhibit 1-14). The first approach converts currencies with (a selection of) purchasing power parities (PPPs) used for productivity comparisons of the overall economy or the market economy. This PPP is based on final expenditures, and therefore, on price comparisons for specified consumption goods, final services and investment. The approach is now widely used for international comparisons of per capita income and productivity, and was applied by the OECD, Hooper and Larin, and Dollar and Wolff for the manufacturing sector. However, this approach suffers from various shortcomings. First, expenditure prices include retail and distribution margins which may be different across countries and which are not part of manufacturing output. Second, expenditure PPPs fail to take into account differences in the prices of imports, raw materials, and parts and components, which in some industries form a substantial portion of manufacturing output. Third, exports are excluded and imports are included in expenditure PPPs.

The second approach, applied by van Ark and Pilat (1993)[1], is based on data from the Census of Manufactures of different countries. This data is used to construct PPP exchange rates for specific manufacturing industries "at the factory gate." This so-called "industry of origin" method creates a PPP which can be used to convert all of the output of an industry into a common currency. An industry of origin PPP, or more briefly, an industry PPP, represents the number of units of different currencies needed to purchase an equivalent amount of an industry's output. To obtain valid industry PPPs, however, one has to match products that are comparable in terms of quality and variety. This is not easy to do with publicly available data, since the Census carries only product groups such as "diesel engines," and diesel engines may differ considerably across countries because of variations in types and sizes.

Manufacturing Productivity
Results at the Branch Level

We looked at the van Ark and Pilat work on relative productivity levels for selected branches of manufacturing industries in 1990. As Exhibit 1-15

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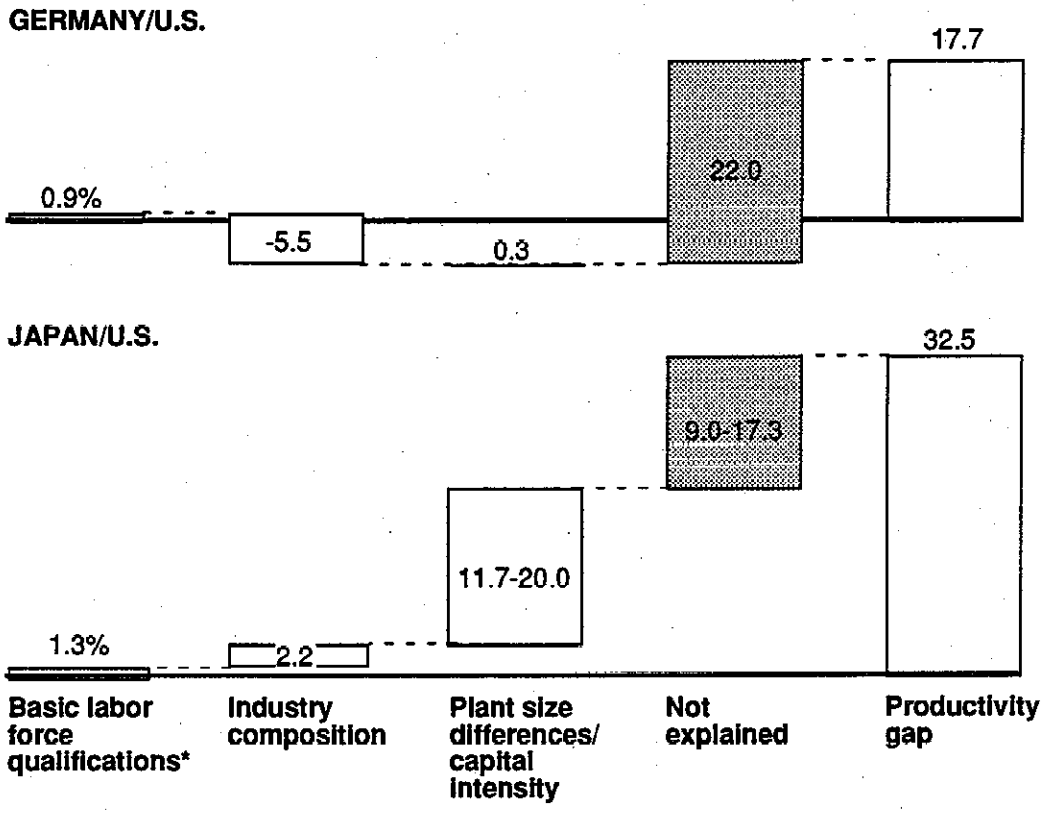
[1] van Ark, Bart and Dirk Pilat. "Cross Country Productivity Levels: Differences and Causes," *Brookings Papers on Economic Activity: Microeconomics, 2: 1993;* (forthcoming).

Exhibit 1 - 16

BREAKDOWN OF CAUSES OF PRODUCTIVITY DIFFERENCES 1987 BY VAN ARK AND PILAT

Percent



* Based on school degrees

Source: van Ark and Pilat 1993

820M295D.ZXE

demonstrates, their work indicates that the higher level of productivity for U.S. production does not apply uniformly to the individual industries within manufacturing. The level of productivity in several Japanese industry categories is similar to, or even higher than, that of the U.S. (e.g., the transport and machinery branch). The relative productivity levels of the manufacturing branches in Germany reveal a more uniform picture. Although aggregate manufacturing productivity levels may differ by modest amounts between Germany and Japan, Exhibit 1-15 suggests that aggregate numbers do not provide a very complete picture of these economies. With widely varying industry productivity levels, there are few industries in Japan close to the aggregate relative productivity level.

Causes of Manufacturing Productivity Differences

Van Ark and Pilat (1993) investigated the causes for the productivity differences they found by looking into four factors. Exhibit 1-16 presents their results and helps explain part of the productivity gap between Japan and the U.S. However, because capital intensity and plant size cannot be separated, we can only estimate a range for the amount of productivity gap that can be explained. Comparing Germany and the U.S., the four factors have no explanatory effect nor do they suggest reasons why the productivity gap should be as large as it is. (See Appendix I for a summary of some related economic studies on productivity.)

It was clear to us that further analysis at a more disaggregated level was required to explain the observed differences, particularly since these countries' industry-by-industry rank orderings are not uniform. Only at that level did we think we would find causes that could be helpful to policymakers and managers.

OBJECTIVES OF OUR STUDY

We chose Germany, Japan and the U.S. for our study because a very large share of manufacturing is located in these countries. The manufacturing sectors of these countries dominate worldwide production and international trade of manufactured goods, accounting for approximately 50 percent of the world's production and about one third of international trade in manufactured goods in 1988. However, one should not come away from this study with the impression that all leading edge manufacturing has originated in these three countries. Companies located in several other countries have contributed substantially to the development of the industries studied.

Since international productivity comparisons rely on the consistency of input and output data, and on the accuracy of the PPP, the large differences in national productivity estimates leave considerable uncertainty about the relative manufacturing productivity levels of Germany, Japan and the United States.

Therefore, to improve our understanding of relative productivities and to understand the reasons for the differences, we looked closely at specific industries.

We conducted nine case studies with three objectives in mind: (1) to understand the relative performance of manufacturing facilities located in Germany, Japan and the U.S.; (2) to identify the causes of the observed differences in the industries studied; and (3) to draw implications for policy and corporate strategy.

We used the case study method to both test existing studies on manufacturing productivity and develop our own understanding of the aggregate productivity differences. We focused exclusively on calculating the productivity of labor. However, labor productivity is not a complete measure of productivity; in the cases where capital productivity is important, we provide discussions on capital intensity and its impact on productivity.

Identifying Causes of Productivity Differences

There is a direct connection between the productivity of an economy and the living standards of the citizens that live and work in that economy. It is troubling, therefore, that the economics literature has not provided fully satisfactory explanations of why productivity grows over time within countries, or the related question of why productivity varies across countries at a point in time. Numerous economic studies have investigated the contributions to productivity that derive from capital, education, technology and other factors. Nevertheless, there is no consensus explanation of productivity differences in the literature and many economists regard both the sources of productivity growth over time and the reasons for different productivity levels as being, in large part, mysteries.

The focus of our productivity studies has been on differences in the levels of productivity within particular industries among operations in Germany, Japan and the U.S. Like others, we have found that large productivity differences persist across the Triad, which deepens the sense of mystery. With technological know-how and capital essentially fully mobile among Germany, Japan and the U.S., one would expect that by 1990, 45 years after World War II, productivity in these three countries would be closely matched. To understand why this is not the case, and to discover whether the observed large differences in labor productivity within each of these industries offer opportunities for followers to catch up, we have investigated the causes of productivity differences within each of the industries studied.

We did not expect to solve the productivity mystery in this project, but we hope to have made a contribution to its solution. In particular, we sought a better understanding of the role of technology, physical and intellectual capital, and the organization of functions and tasks in manufacturing productivity. On a higher level of causality we also analyzed how industry structure and conduct influences management decision-making. Our experience in the service sector study suggested

PRODUCTIVITY AND THE MEASUREMENT OF OUTPUT

Productivity reflects the efficiency with which resources are used to create value in the marketplace. It is measured by computing the ratio of output to input. For example, average labor productivity can be defined as the ratio of the output produced in a country or an industry to the number of hours worked to produce it. Difficulties in measuring productivity arise both from the output and input sides. As such, it is often necessary to use different variants of productivity, depending on the availability and accuracy of data.

With respect to output, there are three basic measurement approaches which can be taken: physical units, value added, and gross output. While physical output is the preferred measure, it is not always feasible to compare physical output due to product variety as well as differences in quality. This approach also requires that one have data from the same part of the value chain in every country; in some countries an industry may simply assemble products while in others it may produce them from raw materials. Physical measures would tend to overestimate the productivity of the former, as less labor would be required to produce the same amount of output. The only case in this study where this issue was not a problem was the beer industry – liters of beer were taken as the measure of output.

An alternative approach to physical output is to use value added. This is the approach taken in all of the case studies except beer and food. Here value added is defined roughly as factory-gate gross output less purchased materials and energy. The advantage of using value added is that it accounts for differences in vertical integration across countries. Furthermore, it accommodates quality differences between products, as higher quality goods normally receive a price premium which translates into higher value added. One complication arises from the fact that value added is not denominated in the same currency across countries. As a result, this approach requires a mechanism to convert value added to a common currency, a topic which will be discussed in a subsequent box.

The third approach, and the one which is applied in the food case study, is to use gross output. Using shipment values also requires that one look at the same part of the value chain across countries. Furthermore, as with value added, a mechanism for converting gross output to a common currency is needed. This approach is normally used when the first two are not feasible due to the lack of data, as was the case with the processed food study.

that the degree of competitive pressure helps explain productivity differences, and we suspected that the same is true in the manufacturing sector. Finally, we believe that some of the explanations for differences in productivity relate back to the external environment in which industries operate. Governments everywhere are concerned with creating the right environment for business success and economic performance and finding the proper balance between market forces and government regulation, and between consumer interests and producer interests.

Drawing Implications for Policy and Corporate Strategy

We set two objectives when drawing our conclusions and implications. The first dealt with the implications for policy: What are the productivity losses and gains associated with certain policies (e.g., trade, specific regulations, investment rules, etc.)? Our second objective was to draw out implications for corporations by answering the question: How can companies profitably take advantage of productivity differences by acquiring or transferring best practices?

OUR APPROACH

To calculate productivity levels, we began with the methodology van Ark and Pilat (1993) used to derive industry PPPs from the Census of Manufactures in Germany, Japan and the U.S. The measurement of labor productivity requires consistent output and input data and a way to transfer value added from one currency into another. (See boxes on Output, Input and Currency Conversion for more detail). Value added in a single currency should reflect measurable quality differences for which customers are willing to pay a price premium (see box entitled "Productivity and the Measurement of Quality").

We focused on labor as our input measure, and other input factors which influence labor productivity were treated as causal factors. The reasons for singling out labor are as follows. First, labor is the most important input factor in terms of share of output; second, labor productivity is closely connected to living standards; third, measures of productivity which include other factors, such as total factor productivity, are very hard to estimate.

Sources of Data

After starting our project, we realized that we would need to considerably improve the census data. The industry PPPs derived by van Ark and Pilat from the Census of Manufactures were not sufficient for productivity comparisons at the industry level because of quality and mix differences within product groups. Moreover, the employment and value-added data for these three countries are not fully consistent. Two basic steps, described further in Appendix II, were needed to

PRODUCTIVITY AND THE MEASUREMENT OF INPUTS

Output per unit of labor is a commonly used measure of productivity, and it is the method we adopted in this report. There are two basic ways to do this. The first is to measure output per employee. While this is normally the easiest method, it has a number of drawbacks, the major ones being that it does not account for differences in part-time labor or for differences in hours worked by full-time labor. As such, the alternative was used here: output per hour worked. In addition to avoiding the above problems, it better reflects the cost structure of manufacturing where most labor is paid on an hourly basis as opposed to a salary.

Another issue in labor input measurement is whether to incorporate skill differences directly. Sometimes in productivity analysis a skilled or educated worker is counted as being equivalent to more than one unskilled worker. We have not followed this approach, preferring to see skill differences as a possible cause of productivity differences. We followed the same approach with other inputs to the production process.

Average labor productivity is common in the literature of productivity analysis, because labor is the primary factor in value added in most industries and for GDP as a whole. The compensation of labor represents about two-thirds of GDP. Labor is immobile relative to capital and is associated with geography, thus making it a key factor in the choice of production sites. But not all productivity analysis focuses on labor productivity. A different measure of productivity is total factor productivity (also called multifactor productivity). This is computed as the ratio of output to an index of both capital and labor inputs rather than just labor alone. Its advantage is that it explicitly incorporates the contribution of capital to the production of output, where capital is the stock of machinery and structures, and in some cases, the stock of R&D and human skill capital, too. Its disadvantage is that it is much harder to compute than average labor productivity. Finding consistent data on capital and its contribution to output for several countries is tricky.

Although we chose to use labor productivity rather than total factor productivity for our analyses, we did not ignore the contribution of other inputs to production. We realize that labor productivity can increase because of increases in the amount of capital used by each worker, improvements in technology, management and organization, or advances in the skills of the work force. We have included these aspects of the production process in our causality framework for explaining productivity differences. Average labor productivity is our productivity measure, but we recognize the contributions of other inputs as causal factors in our discussion of the results.

CURRENCY CONVERSION
(INDUSTRY PURCHASING POWER PARITY)

One way to compare output values in different countries is simply to convert them to a common currency using market exchange rates. To compare the output of the German and U.S. steel industries in 1990, for example, the average exchange rate in 1990 between the dollar and the German DM can be used to convert German output in DM to dollars, or vice versa. If this procedure is used, however, comparisons of output will be biased by fluctuations in the exchange rate. In 1985, when the dollar was very high, U.S. output would have looked particularly large. In 1987, however, the dollar tumbled and using exchange rates would have produced the opposite result. This problem makes the use of exchange rates questionable. A better method of conversion is to use purchasing power parities (PPPs). Ideally, one would like to have a specific PPP for the industry under examination, called an industry PPP, which compares the unit prices at the factory gate of comparable products across countries in an industry.

We used comparable products produced by the manufacturing operations of the given industry in all three countries, such as a personal computer with certain attributes or a ton of steel of a certain type, for example. Suppose the factory gate price of a computer in the U.S. was $6,000, while the price of the same computer in Germany was 12,000 DM. The PPP in this case would be 2 DM per 1 U.S. $. The price of the standard item in DM in relation to the price in dollars gives a PPP exchange rate for the industry for the U.S.-Germany comparison and similarly for the Japan-U.S. comparison. Where we had several standard products in the same industry, we weighted the individual product PPPs to construct an average PPP exchange rate for the industry as a whole.

Industry PPPs are often very different from market exchange rates, even though one might expect them to be similar. After all, if unequal, someone can buy a product in the U.S., take it to Germany and sell it, then change the money into dollars and end up with more dollars than the product cost. A person could, in principle, make a profit by exploiting the discrepancy between PPP rates and currency rates. This suggests that international trade should force market exchange rates to equal PPP rates.

One reason this does not happen is that exchange rates reflect not only flows of traded goods, but also capital flows. The reason that the U.S. dollar was so high in 1985 was that high interest rates attracted a huge inflow of capital that drove the dollar up as foreign investors purchased dollars to invest in the U.S. A second reason for potential differences between PPPs and the exchange rate has to do with relative pricing differences across countries. While the exchange rate essentially is an average price level for the whole economy, relative prices between countries can differ dramatically across industries. In Japan the price of food relative to the price of cars is much higher than in the U.S.

A third reason for the divergence between market exchange rates and industry PPP rates is that many countries have taxes, tariffs or nontariff barriers. A 20 percent difference in price for the same goods in two different countries can simply reflect the fact that one of the countries has a 20 percent value-added tax and the other does not. A final reason for the disparity between exchange rates and PPP rates is that not all items are traded. A substantial portion of manufactured goods is usually not traded, and even tradable goods face obstacles in the form of tariffs, transportation costs and other restrictions on trade, all of which serve to prevent full price equalization.

PRODUCTIVITY AND THE MEASUREMENT OF QUALITY

In order to make meaningful productivity comparisons across countries, adjustments must be made for differences in quality. Our procedure accomplishes this in the following way. First we try to construct the industry PPPs by comparing products where quality differences are not significant. *We compare like products to like products* for that part of industry output where this was possible. For example, we looked at the producer prices of a given type of steel in the three countries (see the Currency Conversion box in this chapter for details of the PPP construction).

The first issue of quality then arises for these comparable items. Are they really of the same quality when we compare across countries? We decided to assume quality was the same across countries unless there are differences that meet the following two-part test. The differences in quality are: 1) recognized by consumers and such that they are willing to pay a price premium; and 2) are a result of differences in the production process, and not of advertising, tradition, nationalism, differences in information, etc. We adjust our comparable products for quality only if the product differences meet these two conditions; other notions of "quality" are regarded as consumer preference differences and treated as explanatory factors for productivity differences.

To give examples: We assumed that German beer and U.S. beer were of the same quality even though many observers believe that German beer tastes better. This is because our experts told us that in most cases U.S. or German breweries could mass produce beer in Germany that tastes like existing German beer. Thus this "quality" difference failed the second part of the two part test. In contrast, we assumed that Japanese autos were of higher quality than U.S. autos of similar size because we had evidence that U.S. consumers with ready access to all models were willing to pay a premium for the Japanese autos; the quality differences also involved production process differences.

The second step in accounting for quality differences across countries arises with products that are not comparable. We argue that, provided the PPP has been correctly estimated for the standard products of the industry, there is no further adjustment necessary to take account of specialty products that are either higher or lower in quality than the standard products. The basis for this is that specialty products will command a higher or lower price in the market than the standard industry products and will consequently add more or less to value added per unit than the standard industry products. The price system in market economies automatically provides a quality adjustment because it reflects value as perceived by customers.

Our procedure is based upon an idea similar to that of hedonic prices, which rely on the market to reveal the value of products attributes to consumers. It works properly only if the products made in an industry are close substitutes for each other, the markets are competitive and customers have unrestricted access to the entire product set. These conditions will not be satisfied completely, but using the price system does give us our best available information and we note in our causal analysis where we think the conditions may be violated.

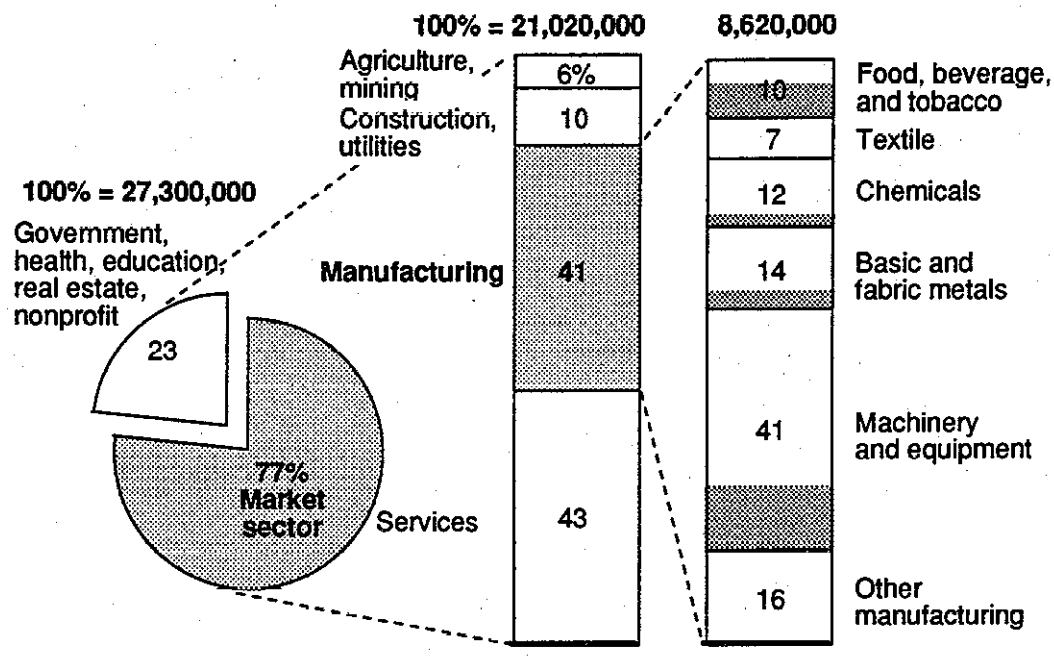
We recognize also that customers may value products differently simply because they perceive and experience products in diverse ways, even though these distinctions are not based on measurable product differences. These are generally due to differences in taste, advertising, brand image, tradition or custom, and information. Product differences of this type can differ substantially across countries and are frequently important in consumer goods, where consumer perceptions and brand image are major buying factors. Product differentiation based upon these differences in preferences can also provide value to customers, but these differences were treated as causal factors at the external factors level of the framework. These preferences can change rapidly as new information becomes available or as new products are introduced and are often the result of advertising and less of the production process.

Exhibit 1 - 17

EMPLOYMENT BREAKDOWN 1988

GERMANY

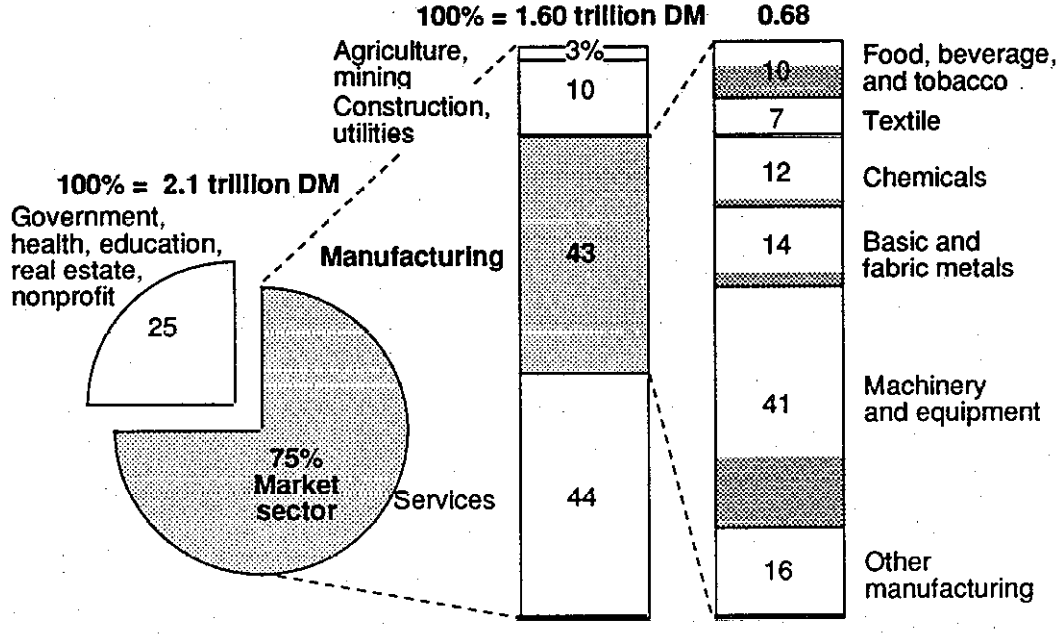
Percent



Case studies
Percent of sectors

Processed food	42%
Beer	7
Soap and detergent	5%
Steel	16%
Cars and parts	21%
Computer	2
Consumer electronics	2
Metalworking	4
Percentage of total manufacturing	**20%**

VALUE ADDED BREAKDOWN 1988



Case studies
Percent of sectors

Processed food	37%
Beer	9
Soap and detergent	5%
Steel	17%
Cars and parts	22%
Computer	3
Consumer electronics	2
Metalworking	3
Percentage of total manufacturing	**20%**

Source: National Accounts data; Census of Manufactures; McKinsey analysis

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remedy these problems. First, we adjusted the Census of Manufactures data in detail to make employment and value-added comparisons across countries consistent. Second, we changed or constructed industry PPPs based on McKinsey expertise and publicly available information.

Coverage of the Manufacturing Sector

A sample of nine industries was selected that comprise between 15 and 20 percent of employment and between 17 and 22 percent of value added of the manufacturing sector in the three countries (Exhibits 1-17 to 1-19). The case studies were selected on the basis of the following criteria. First, we tried to cover the entire range of the manufacturing sector as broadly as possible. Second, we wanted to include different types of manufacturing production methods, including assembly and process industries. Third, we only undertook case studies where McKinsey has sufficient knowledge to understand and determine the causality of productivity differences.

Framework for Explaining Manufacturing Productivity Differences

In order to identify and explain the causes of observed productivity differences, we developed a framework that captures all major possible causes and reflects their relationships to each other within a given hierarchy. This framework proved useful and applicable in studying each of our nine industries and in structuring our discussion of causality.

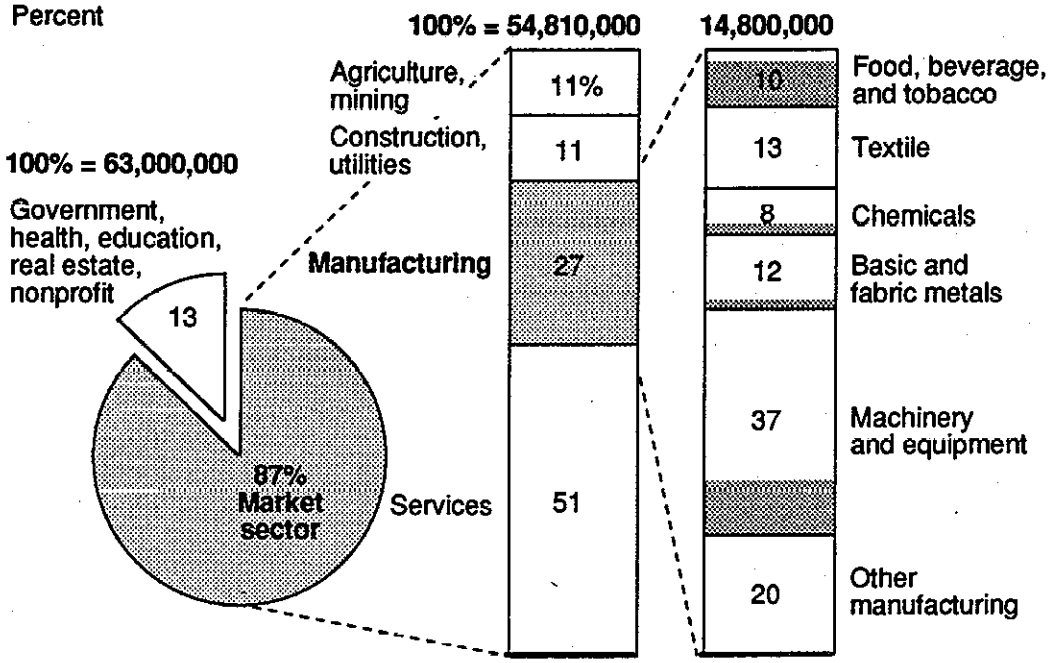
In constructing this framework, we distinguished three hierarchical levels of causality (Exhibit 1-20). First, we concluded that the observed productivity differences must have some proximate causes, meaning that operations in Germany, for example, must do something different that makes output per hour worked higher or lower relative to their counterparts in Japan or the U.S. (Exhibit 1-21). The production process, which has the most immediate and direct impact on labor productivity, includes the output (mix, variety and quality), the production factors (capital, scale, design for manufacturing, basic skill of labor and raw materials and parts), and the way in which the production factors are put together in operations (capacity utilization and the organization of functions and tasks). Second, we concluded that the differences at the production process level were the result of past and present industry structure and behavior which is captured under the nature of competition. Third, we judged that competition and the behavior of managers are heavily influenced by the external forces confronting and constraining managers, in both the market and policy environment. We call this third layer of causality "external factors."

Exhibit 1 - 18

EMPLOYMENT BREAKDOWN 1988

JAPAN

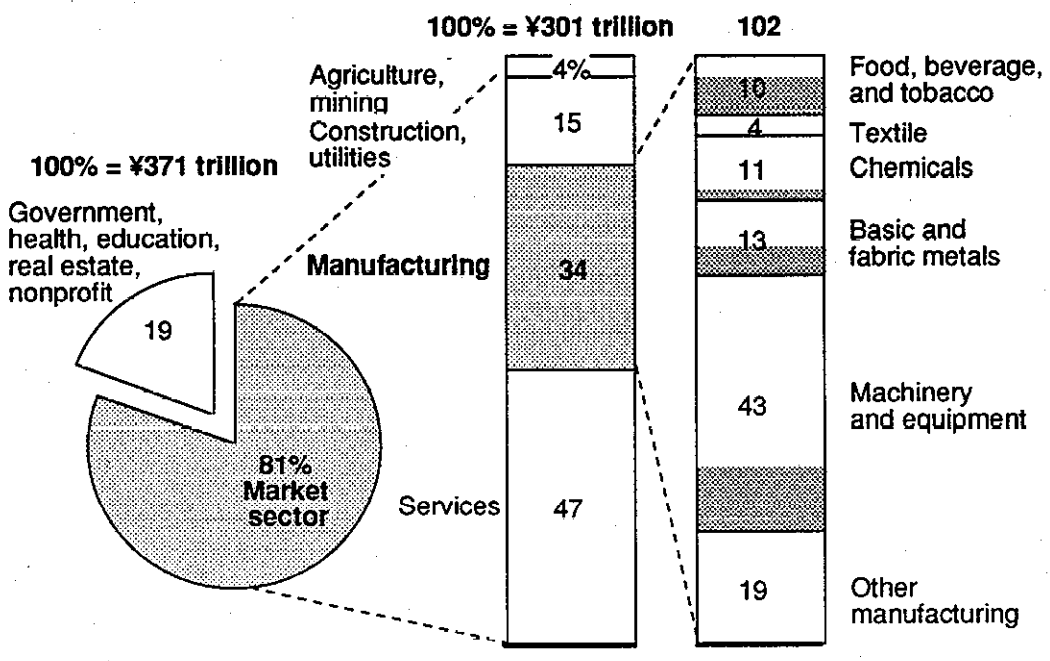
Percent



Case studies
Percent of sectors

Processed food	86%
Beer	1
Soap and detergent	1%
Steel	13%
Cars	4%
Auto parts	10
Computer	3
Consumer electronics	6
Metalworking	4
Percentage of total manufacturing	**20%**

VALUE ADDED BREAKDOWN 1988



Case studies
Percent of sectors

Processed food	63%
Beer	2
Soap and detergent	2%
Steel	25%
Cars	7%
Auto parts	9
Computer	4
Consumer electronics	5
Metalworking	3
Percentage of total manufacturing	**22%**

Source: National accounts data; Census of Manufactures; McKinsey analysis

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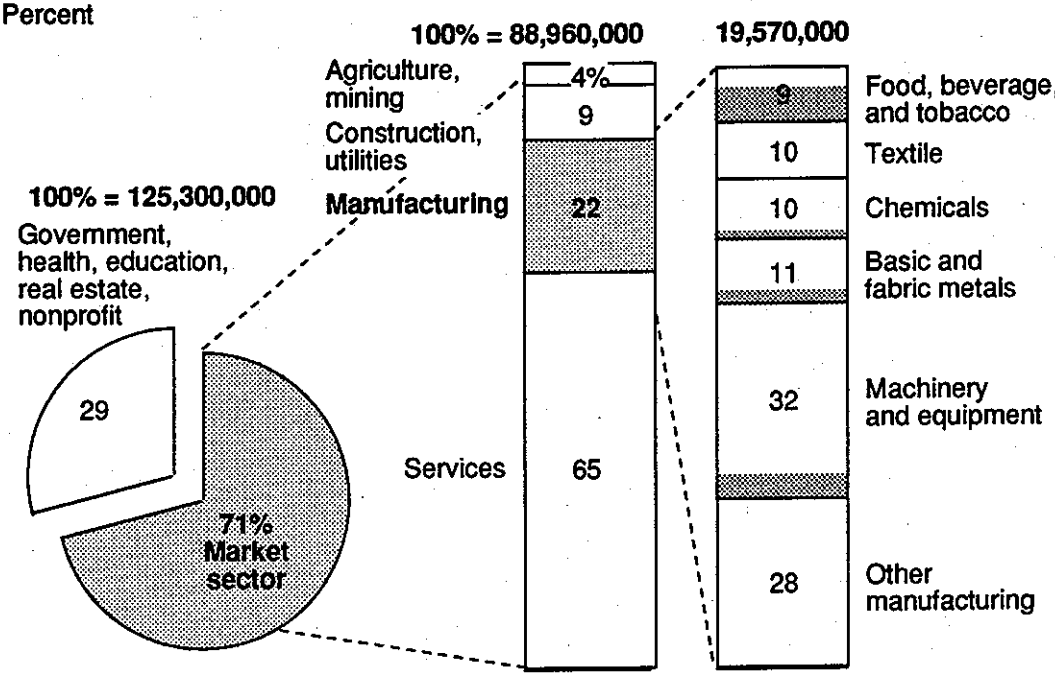
Exhibit 1 - 19

EMPLOYMENT BREAKDOWN 1988

U.S.

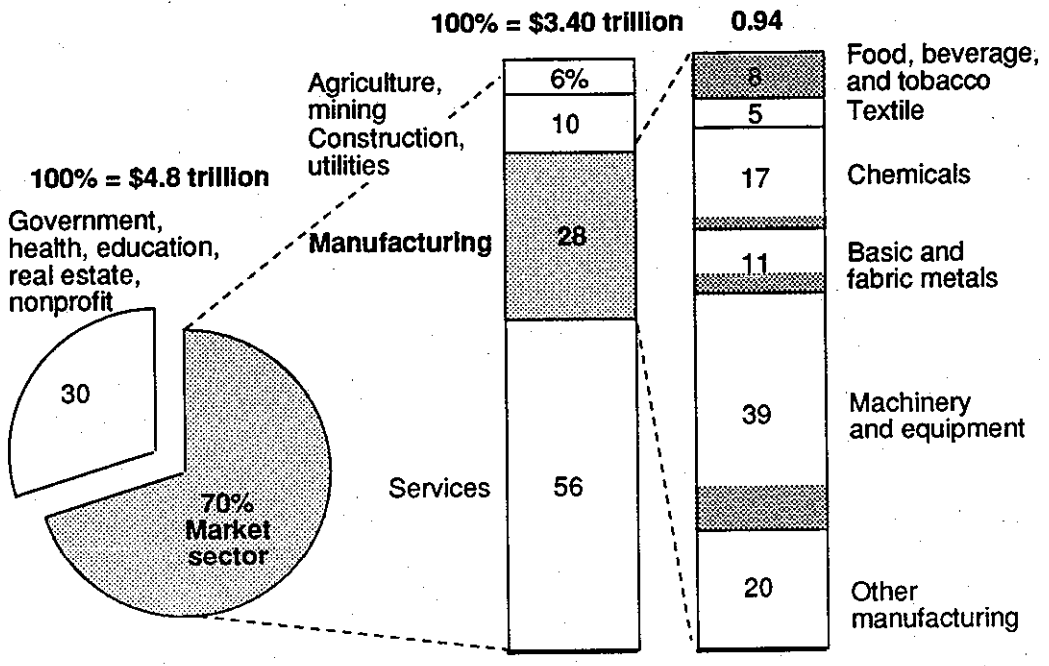
Percent



Case studies
Percent of sectors

Processed food	80%
Beer	2
Soap and detergent	2%
Steel	10%
Cars	4%
Auto parts	7
Computer	4
Consumer electronics	<1
Metalworking	2
Percentage of total manufacturing	**15%**

VALUE ADDED BREAKDOWN 1988



Case studies
Percent of sectors

Processed food	82%
Beer	6
Soap and detergent	3%
Steel	12%
Cars	7%
Auto parts	6
Computer	6
Consumer electronics	<1
Metalworking	1
Percentage of total manufacturing	**17%**

Source: National accounts data; Census of Manufactures; McKinsey analysis

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Exhibit 1 - 20

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES

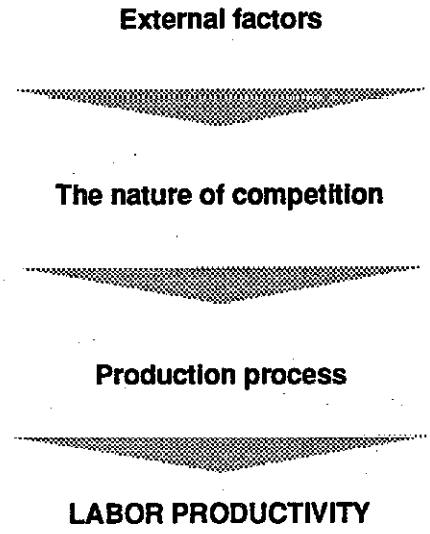

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Exhibit 1 - 21

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES

External factors

Market conditions
- Demand factors
- Relative input prices/factor availability
- Other industries

Policy and regulation
- Macroeconomic condition
- Competition rules and concentration rules
- Corporate governance rules
- Labor rules and unionism
- Other regulations (tariffs, nontariffs)

Nature of competition

Production process

Output
- Mix, variety, quality

Production factors
- Capital (intensity, vintage, technology)
- Scale
- Design for manufacturing
- Basic skill of labor, intrinsic motivation
- Raw materials, parts

Operations
- Capacity utilization
- Organization of functions and tasks

LABOR PRODUCTIVITY

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The external factors include those elements which indirectly influence productivity: market conditions (demand factors, relative input prices/factor availability and other industries) and policy and regulation (macroeconomic condition, competition rules and concentration rules, corporate governance rules, labor rules and unionism, and other regulations). The framework is further explained in Appendix III.

Generating and Testing Hypotheses

The calculations starting from census data give the productivity differences to be explained; then we asked McKinsey experts who work in the industries studied to suggest explanations for these productivity differences. Economic analysis provided the basis for organizing the alternative hypotheses about productivity differences, determining how these alternatives are interrelated and testing the hypotheses. However, our approach was based much more on the microeconomics of competition among firms than most of the economics literature.

Testing and revising our hypotheses and assessing the relative importance of the different causal factors were done through benchmarking studies, plant visits, and multiple rounds of interviews with McKinsey consultants and active industry managers. Through meetings and discussions and repeated reviews and revisions of the case studies, we have tried to resolve differences in points of view and to bring in additional data or evidence from the business and economics literatures. Although the focus of this report was productivity, we also took note of the financial performance of the factories and companies we studied.

We recognize that we are not the first to combine business experts and economists in an attempt to understand productivity differences; studies at leading business schools have been made of various industries, especially the auto industry. And we have made use of the insights these studies have provided. However, we believe this project is broader than prior, similar work in that we studied nine industries in three countries and utilized the experience and data generated by McKinsey's worldwide practice. The productivity data from census sources have also provided valuable discipline when making comparisons of industry performance.

The benchmarking studies that have been used in assessing hypotheses consist of the following key elements: (1) identifying the manufacturing and managerial processes that need to be assessed, (2) selecting facilities for comparison (these usually include smaller operations as well as the industry leaders), (3) observing and measuring in detail how well these processes – and specific tasks within processes – are performed, and (4) interpreting results. Prior McKinsey work provided some benchmarking results for this study, and in some cases, the project team members conducted small-scale benchmarking studies of their own, geared to productivity differences.

Based on the benchmarking studies, plant visits, interviews with industry experts and Advisory Committee reviews, we have been able to make an assessment of the causes of productivity differences in manufacturing operations in these industries across the three countries. In most case studies, the breakdown of the overall difference is made qualitatively; we can distinguish the elements of the framework which are the most important sources of difference from those less important or unimportant. Although quantitative information at the company level was frequently available to support our conclusions, we were able to show the quantitative measures in only a few cases in order to preserve confidentiality. Despite the fact that we cannot be sure that all potential biases have been eliminated, our methodology involving independent sources and an iterative review process does try both to check whether our results are correct or not and to ensure consistency.

APPENDIX I

SOME PRIOR PRODUCTIVITY STUDIES

In recent years, there have been some attempts to isolate and analyze the factors that account for observed productivity differences among countries in a given year. A study by Davies and Caves (1987) attempted to analyze the manufacturing productivity gap between Britain and the United States during the 1970s on the basis of an estimated production function, using census-based productivity estimates for 74 manufacturing industries in 1967 to 1968 and for 94 industries in 1977. They found that disrupted labor relations and low management skills account for a large part of the British/American productivity gap. More recently, Caves et al. (1992) carried out various studies comparing six countries by estimating the degree of technical inefficiency (i.e., the amount of inputs over the minimum required) as distinguished from allocative inefficiency (i.e., the wrong combination of inputs given their relative prices). The estimates were again derived through regression analysis from estimated production functions. Most of them refer to comparisons of changes in technical efficiency at the national level.

Dale Jorgenson with various co-authors have produced a range of papers on the technology gap among Germany, Japan, and the U.S. They also make use of production functions, but instead of using regression techniques, Jorgenson makes use of highly-disaggregated data on output and on input of labor, capital, and intermediate goods. According to one of their most recent publications, Jorgenson and Kuroda (1992) found that the technology gap, which is the difference between the productivity level in the U.S. and Japan after correction for the use of labor, capital and intermediate inputs, was just over 10 percent in 1980. However, it increased to over 50 percentage points in 1985. Although Japanese performance continued to improve in some industries, it remained behind the U.S. in others. Conrad (1992) found that Germany's technology performance deteriorated from an advantage over the U.S. of 4 percentage points in 1980 to a disadvantage of 4 percentage points in 1986. (A selected bibliography for this report, as well as for the case studies, is available upon request.)

STATISTICAL SOURCES FOR COMPARISONS OF MANUFACTURING PRODUCTIVITY

We used the following statistical sources as a starting point for our productivity measurements:

Germany: We obtained value added and employment from *Kostenstruktur der Uneternehmen 1987* and *1990* (Statistisches Bundesamt). Working hours were provided by the Institut für Arbeitsmarkt und Berufsforschung (Nürnberg). Unit values for 1987 were obtained from *Produktion im Produzierenden Gewerbe* (Statistisches Bundesamt) and extrapolated to other years with producer price indexes from *Preise und Preisindizes für gewerbliche Produkte* (Statistisches Bundesamt).

Japan: Value added and employment were taken from the *Census of Manufactures 1987* and *1990 Report by Industries* (MITI). The information on prices was obtained from the corresponding *Report by Commodities* for 1987, and extrapolated to other years with weighted domestic and export producer price indexes from *Price Index Annual 1991* (Bank of Japan). Working hours were calculated from the *Yearbook of Labor Statistics 1987* and extrapolated to other years with the *Monthly Labor Review* (Ministry of Labor).

U.S.: Industry valued added, employment and price information for the U.S. was taken from the *1987 Census of Manufactures* (U.S. Department of Commerce). For 1990, value added and employment were obtained from the *1990 Annual Survey of Manufactures.* Hours worked were obtained from the Bureau of Labor Statistics (BLS), and price indexes were taken from *Producer Price Indexes* (BLS).

APPENDIX II

DATA ADJUSTMENTS

In order to get output, input and currency conversion data for our study, we used data from the Census of Manufactures (see box entitled "Statistical Sources for Comparisons of Manufacturing Productivity" for sources of specific data). We then modified the data in two different ways.

Consistency of Input and Output Data Across Countries

For industry input and output, for example, we relied on the statistical data gathered by the Census of Manufactures in each of the countries studied. The only exceptions were the soap and detergent industry and the German automotive assembly and parts industries, where we used McKinsey data. Then, to make input and output data comparable across countries, we made a series of adjustments.

- The data from the Japanese Census of Manufactures was available in a similar format to that of the U.S. (i.e., establishments of all sizes), therefore the only consistency issue was to make sure that the same definition of value added was applied. Most of the necessary adjustments was for the data from Germany.

- The German data was only available for legal units with 20 or more employees and included auxiliary employees (i.e., head office); consequently, we created a comparable set of data for the U.S. that included auxiliary employees, but not establishments with fewer than 20 employees.

- No direct comparison between Japan and Germany was possible because of differences in the reporting of auxiliary units. (It was impossible to net them out of the German figures and we were not able to add them consistently to the Japanese figures.)

- In some cases, labor input was adjusted to include or exclude apprentices, part-time work, etc. (e.g., steel).

Derivation of Industry PPPs

We used five basic principles to check and modify the industry PPPs as they were calculated by the Groningen research group.

¶ Improving existing product category matches. The census data provided us with an industry PPP on the assumption that all products are similar (i.e., a diesel engine is a diesel engine or a car is a car). To correct for the difference in products, we undertook two steps. First, we adjusted for differences in the product mix. For instance, the composition of cars in Japan is different than in the U.S. in terms of size and basic features. Therefore, the industry PPP has to be corrected for differences in the mix of products. Second, even with similar basic features, cars can differ with respect to reliability, functionality, etc. We called this difference quality differences. Quality differences are defined by the price differential an average consumer is willing to pay for a content-equivalent car, based on his/her perception of tangible differences in the product.

¶ Adding new product matches. Another way to derive industry PPPs is to look for new product matches from other public sources or from McKinsey data. These new matches can be combined with existing product matches from the census or they can serve as the base for a totally new industry PPP.

¶ Using exports and domestic sales PPPs. A third way to calculate the industry PPP is to use the PPP for exports and domestic sales and weight them according to the share of exports and domestic sales in total production. The export PPP is usually close to the current exchange rate, adjusted for distribution or discount differences. The PPP for domestic sales can be calculated in a few ways. For instance, by gathering information about price differentials between export and domestic sales one can derive the data. In one case, we could derive the price differential from cost and profit comparisons of companies producing similar products.

¶ Using final expenditure PPPs. A fourth way to obtain factory-gate, processed food PPPs was to calculate them from final expenditure (ICP) PPPs. This was done because it was impossible to make the usual quality adjustments to PPPs derived from census data matches. Deriving factory-gate PPPs from final-expenditure PPPs required two adjustments. The final expenditure PPPs reflect the price ratios at the retail level, and these may be different from those at the factory gate because of differences in the relative margins of the distribution channels as well as in included sales or value-added taxes. Thus, we took out the distribution margins and the taxes. In addition, we controlled for the fact that final expenditure PPPs reflect final prices which exclude exports but include imports.

¶ Accounting for "double deflation". In addition to modification of PPPs based in gross output, some industries in particular countries (consumer electronics, computer and steel in Germany and Japan) exhibited different input and output PPPs. For instance, inputs in some industries are traded

more freely than output and thus priced at world market rates. In such cases we calculated a separate Input PPP and applied the Output PPP only to gross output and the Input PPP to inputs.

In every case study we applied each of these principles depending on the availability and reliability of data. The industry PPPs were extrapolated from 1987 to 1990 with time series analysis, and the details of the each industry's calculation are explained in the case studies.

Exhibit 1 - 22

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES

External factors

Market conditions
- Demand factors
- Relative input prices/factor availability
- Other industries

Policy and regulation
- Macroeconomic condition
- Competition rules and concentration rules
- Corporate governance rules
- Labor rules and unionism
- Other regulations (tariffs, nontariffs)

Nature of competition

Production process

Output
- Mix, variety, quality

Production factors
- Capital (intensity, vintage, technology)
- Scale
- Design for manufacturing
- Basic skill of labor, intrinsic motivation
- Raw materials, parts

Operations
- Capacity utilization
- Organization of functions and tasks

LABOR PRODUCTIVITY

APPENDIX III

THE FRAMEWORK FOR EXPLAINING CAUSALITY

In order to identify and explain the causes of the productivity differences we found, we developed a framework that captures all major possible causes and reflects their relationship to each other within a given hierarchy. However, since the framework was designed to analyze differences in labor productivity at a given point in time, additional elements were required to help explain the intertemporal aspects of technological and industry evolution, such as the shortening of product life cycles or the fragmentation of industry structure.

As mentioned earlier, we identified three levels of causal explanations: the production process, the nature of competition, and external factors (Exhibit 1-20).

The Production Process

On the level of the production process, there are three basic elements that explain possible differences in productivity. First, the estimates of labor productivity can differ because of output differences as seen from the buyer's perspective. We call this first basic element "output." Second, labor productivity differences can be caused by differences in the mix of basic inputs, such as capital, the way products are designed, labor, raw materials and parts. We call this second element, "mix of production factors." The third element which can cause differences in labor productivity is caused by the way the basic inputs are combined. We call this category "operations" (Exhibit 1-22).

¶ Output. Two industries in different countries never produce exactly the same output as seen from the buyers perspective. Differences in output can influence labor productivity in three different ways:

- Output mix. The output of industries can differ in terms of the mix of products. Differences show up in the output of finished products (e.g., liquid versus powdered detergents), the output of finished goods and parts (e.g., TV versus electronic parts), and product life cycle differences (e.g., mix of new and old products).

- Output quality. Even if two industries produce essentially the same sort of products, there may still be tangible features that differ for which consumers are willing to pay price differences.

- Output variety. Plant-by-plant comparisons may produce a different range of brands or products than company comparisons. This may happen even if the overall industry output mix is the same.

Differences in the number or variety of products may cause differences in labor productivity because the production process is more or less complicated (e.g., higher variety leads to more set-up time).

¶ Mix of production factors. The choice of inputs can greatly influence productivity in a number of ways:

- Capital. We use capital in the sense of physical assets (not land) and their embodied processes (e.g., machines, equipment, plant and buildings, and the hardware in information systems). Capital can influence labor productivity in three different ways:

  - Capital intensity. If an industry works with a higher capital intensity (i.e., uses more capital in combination with each unit of labor), we expect that this industry would show a higher labor productivity.

  - Capital vintage. A similar effect can happen if there are differences in the vintage or age of capital, especially if one industry applies a more modern stock of capital (e.g., newer tools or computers).

  - Capital technology. The age of capital cannot always explain differences arising from the use of different equipment. It is often more appropriate to talk broadly about capital technology differences whenever different equipment is used which causes productivity differences.

- Economies of scale. We use the term "economies of scale" or "scale effects" to describe the situation in which a firm can increase its value added (or output) with less than a proportional increase of all inputs; "diseconomies of scale" refers to the opposite relationship between output and input. If scale economies exist, a larger establishment is more productive than a smaller one. If one industry consists of larger firms than another, and the production process exhibits economies of scale, this causality factor would explain resulting differences. Two kinds of economies of scale can be distinguished:

  - Economies of scale on the plant level exist if plants exhibit economies of scale, e.g., fixed plant overhead may be spread over a larger output or relative material use declines with larger output.

  - Economies of scale on the company level are found if the whole legal entity shows economies of scale, e.g., overhead labor as marketing, research and development, etc., are spread over a larger output.

- Design for manufacturing. Labor productivity differences can arise when firms in an industry use different ways to design products for manufacturing which are otherwise equivalent in the eyes of the customer. Design for manufacturing describes techniques used to increase the ease of fabrication and assembly, e.g., the standardization of components, the minimization of the number of parts and screws, tools used, and production steps, etc.

- Basic skills of labor/intrinsic motivation. Another possible cause of productivity differences is the skill of non-managerial labor. If employees in one industry are more skilled in the art of production stemming from their basic education, they may be able to produce either more or better quality output in a given period of time within a given organization than employees in another. Thus, the skill factor tries to capture differences in the quality of labor input, excluding those things influenced by management (i.e., training, etc.).

  The residual factor we are left with very often is the intrinsic motivation of the labor force (i.e., the motivation of workers stemming solely from their social environment and history/culture, but not those things that management controls). Higher motivation can result in less idle time, higher speed or quality of individual work, or more efforts to support colleagues.

- Raw material and parts. Labor productivity may be higher because of special attributes in the raw materials or parts used as inputs. This may also stem from special relationships with suppliers. For example, a car company may be able to influence the design and production of parts in a way that does not increase cost, but requires less labor to assemble.

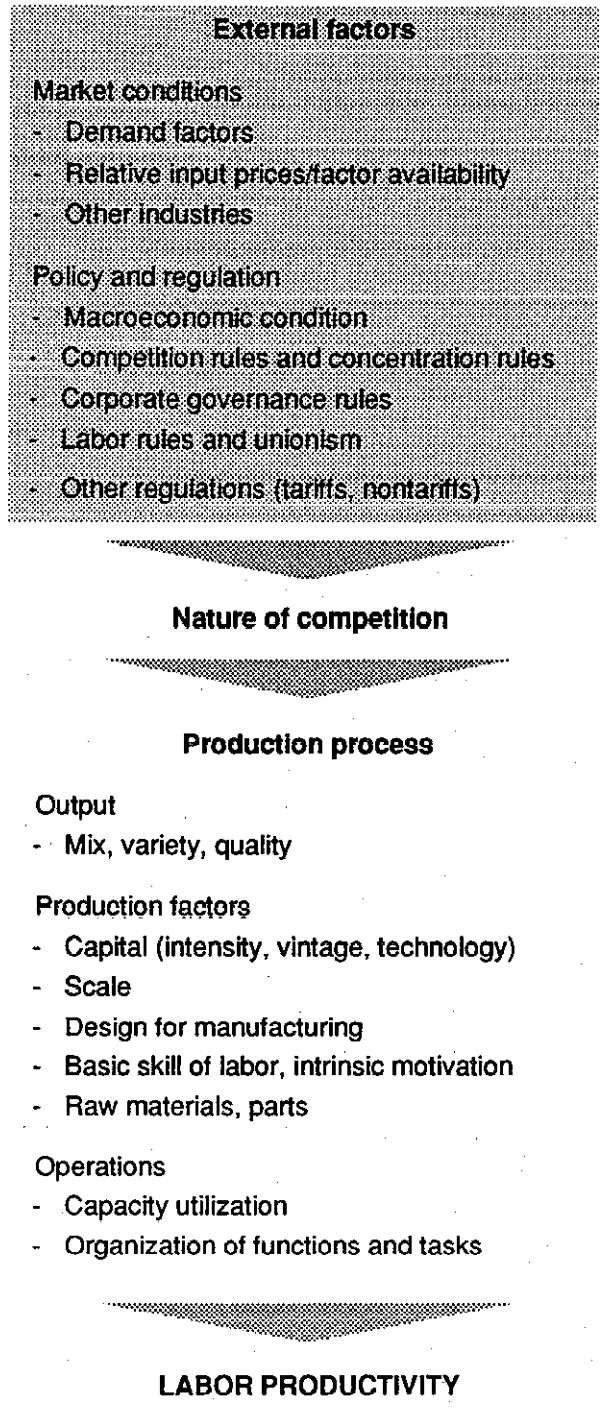
¶ Operations

- Capacity utilization. Given similar inputs and scale, labor productivity across markets may differ simply because of differences in the demand cycle and the utilization of labor inputs. Here we are only concerned with the utilization of inputs; the way that inputs are mixed together is captured under the next entry. Note that cyclical adjustments have been made for those industries greatly affected by business cycles (autos and metalworking).

- Organization of functions and tasks. This category describes the effectiveness and efficiency with which labor and other inputs are brought together in the production process. The causal factor captures differences in the organizational structure and core processes of companies, which determine the division of labor, the processes to improve the organization, centralization versus decentralization, etc.

Exhibit 1 - 23

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES



It also captures the way in which companies organize internal communications and design incentive systems to maximize output.

The way industries organize their functions and tasks has an impact on the motivation of workers. For instance, under different working environments and leadership styles, employees may be more or less willing to work efficiently. In this sense, the aspects of motivation that are related to incentives are included under the organization of functions and tasks.

The Nature of Competition

At the level of industry structure and management behavior (or management decision-making), we can distinguish between two basic sets of evidence. First, the results of past management behavior often play a role in today's decision-making. Past behavior may have influenced such things as the structure of the industry or the history and culture of companies, which determines behavior today. Second, the nature of competition resulting from present behavior or conduct of companies in the marketplace also influences management. For instance, one can identify differences in how companies in an industry compete through such things as product differentiation, product variety, price, advertising and new product development. In addition, the nature of competition can also be determined to a great extent by the level of international competition (trade) and foreign direct investment, and the nature of vertical relationships between suppliers and distributors (i.e., in terms of time, exclusivity, etc.).

External Factors

Observing that there are differences in the way industries and managers behave, raises the next question. Why does management decide to manufacture products using a particular production process that is more or less productive than some other process? The answer to this question lies on the third level of causality. To understand the different behavior of managers and of industries in various countries, we must explore the external forces that managers face. We grouped the external factors affecting management behavior into eight categories (Exhibit 1-23). They are related to differences in consumer tastes, relative factor prices and factor availability, and other industries which can affect industries. In addition, short-run macroeconomic conditions, policy and regulation governing competition, labor rules and unionism, corporate governance rules and other regulatory constraints are external forces that constrain managers.

¶ Market conditions

- Demand factors. Customer preferences for final products may influence managers' choice of the mix of products they provide.

Customers in particular regions or countries may choose products from industries producing in their region or country over products from foreign sources, even if there are no substantive differences among the products supplied.

- Relative input prices/factor availability. Differences in relative input prices, especially the relative cost of labor, capital, energy, raw materials and parts, can create different incentives for managers to substitute, for example, labor for capital, or to utilize more or less labor-intensive production processes. In addition, suppliers may be restricted in their ability to supply other countries, inhibiting others from producing similar products.

- Other industries. Other industries, such as intermediate customers (OEM) and distributors, can affect management behavior by enlarging or decreasing strategic freedom and influencing the production process. Therefore, they can indirectly have a significant impact on labor productivity.

¶ Policy and regulation

- Short-run macroeconomic conditions and management. Short-run macroeconomic conditions can have various influences on the constraints and incentives of managers. The most prominent example is the influence of overall swings in aggregate demand which can affect demand in a particular industry. Another example is that large swings in the exchange rate can have an effect similar to price increases or decreases, which induce management reactions that might not have occurred under more stable conditions.

- Competition and concentration rules. Different competitive environments may cause different management behavior. If there is an appropriately designed antitrust law, enabling free entry and punishing collusion, the resulting competitive intensity may be high and managers are likely to behave differently than if the competitive intensity were low. These different patterns of behavior may cause the creation of more or less productive production processes in different industries.

- Labor rules and unionism. While the relative prices of basic inputs determine management behavior, other features of these markets are also relevant. In the labor market, the balance of power between management and labor may vary among industries due to different individual and collective rights of labor (e.g., workers councils, unions). In addition, the work rules and compensation schemes supported by national laws may increase or decrease the possibility to put in place certain types of production processes. Thus, these

differences may generate different constraints and incentives for managers to consider when they decide on the elements of the production process.

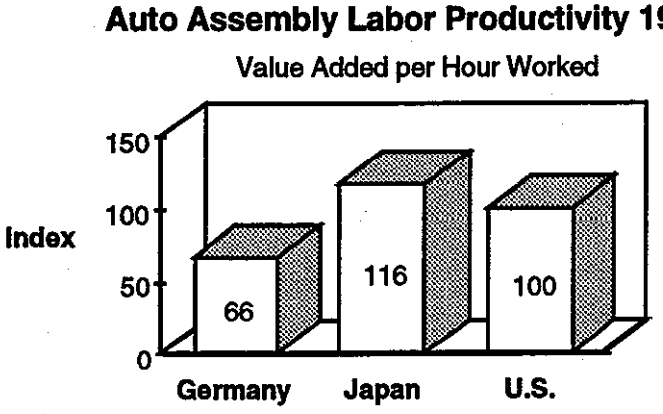
- Corporate governance rules (market for corporate control). Similar to the labor inputs, there are substantial elements apart from the capital costs which play a role in explaining the set of constraints and incentives for managers. There are three elements to consider here. First, there can be differences in the rules governing companies (e.g., board rules, rules for shareholders, banks and other stakeholders to influence company decision-making). Second, we observe differences in the rules governing the interactions among companies (e.g., takeover and disclosure laws). Third, differences along both of these dimensions can result in totally different corporate governance systems which give very different incentive schemes for managers to improve labor productivity.

- Other regulatory constraints. In addition to the constraints embodied in the items above, there can be many additional international (e.g., tariffs or trade rules) or domestic (e.g., health and safety requirements) regulatory constraints for an industry.

* * *

We applied this framework to each of the case studies. The framework is dynamic in two respects. First, the framework, especially on the levels of industry structure & management behavior and external factors, is a mixture of the past and present industry situation. History is brought into the picture if it can explain the labor productivity differences observed in 1990. Second, although our framework lacks explicit dynamic elements, such as product life cycles, the exhaustive list of reasons for causality differences at the production process level includes such elements (e.g., differences in the product life cycle are treated as differences in the product mix). We will point out the dynamic nature of the framework in our causality discussion.

AUTO ASSEMBLY CASE STUDY SUMMARY



Organization of labor and design for manufacturing, not high tech factories or worker skills, are key factors of productivity. Intense competition with best practices in the Triad drives management to improve productivity.

The auto assembly industry shows that modern, mass production can enjoy high productivity growth, despite enormous product complexity and continuous product innovation. Japan made 13 million cars and light trucks in 1990, the U.S. 10 million and Germany just over 4 million cars.

Why is Japan so productive? Two factors appear to be fundamental. First, the way companies organize their processes, labor, and communication within their plants and with their suppliers is important. Organizational principles such as integration, continuous improvement, and supplier management are methods by which higher labor productivity is achieved. Second, the way products are designed for ease of manufacturability and assembly affects productivity. All of these traits are epitomized in Toyota, which is 40 percent more productive than any other automotive assembler in Japan, and which also holds roughly 40 percent of its home market.

Why has the U.S. drawn close? First, the U.S. benefits from substantial Japanese transplant production. Second, as demonstrated by operations such as Ford's in Atlanta, automakers in the U.S. have greatly improved their productivity and overcome the legacy of the lower competitive intensity of the "Big Three" era. In fact, U.S. automotive assemblers now are, on average, equally as productive as most Japanese operations, with the exception of industry leader Toyota.

Why does Germany lag? The automotive industry in Germany illustrates how the lack of exposure to international productivity leaders has impeded labor productivity growth. Complexity in design for manufacturing and problems in the organization of labor are the major reasons German operations are lagging. Furthermore, automakers in Germany are burdened by a complex, highly specialized and inflexible job classification system, and a lack of incentives from stakeholders to improve productivity. Manufacturers in Germany are now attempting to bring about rapid productivity improvement through joint ventures and major cost cutting. The necessary commitment to improve appears to have finally arrived as a result of the recession and increasing competitive intensity in Europe.

PRODUCTIVITY IN THE AUTOMOTIVE ASSEMBLY INDUSTRY

In all the world's leading economies the automotive industry, and in particular, vehicle assembly is considered one of the core manufacturing sectors. The significance of the automotive assembly industry stems not only from its share of employment, but also from its central role as a consumer of a wide range of mechanical and electronic parts, machine tools, and steel. The automotive assembly companies vary widely in the number of components they produce in-house, with General Motors at one end with about 70 percent vertical integration, and Chrysler and the vehicle producers in Japan at the other end of the spectrum with 30 percent. The automotive assembly industry also serves as a locus for many leading technological innovations in both products and processes. As such, changes in the automotive assembly industry affect a significant part of the manufacturing sector and, in turn, the overall economy.

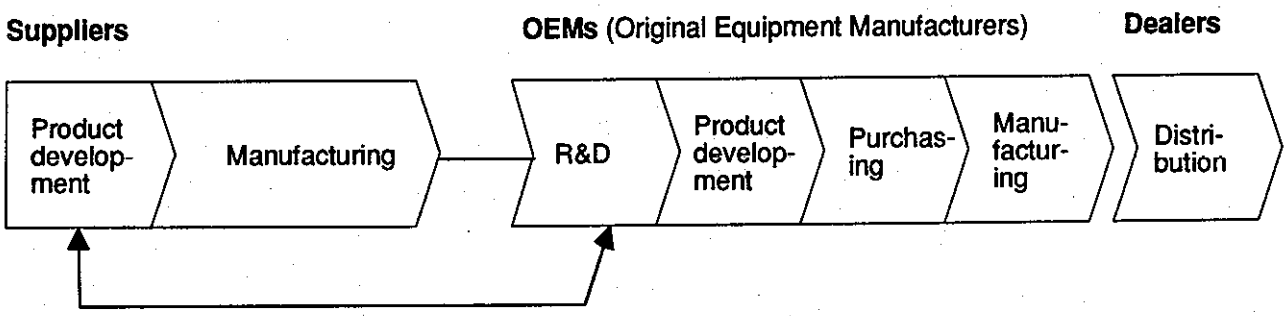
The automotive industry is also among the most discussed and debated of industries, often in connection with government involvement. The recent initiation of car import deregulation in Europe, as well as the more general issue of global trade restrictions, are high on the list of discussion topics, along with environmental, safety, and fuel efficiency regulation. These issues promise to remain important in the future as well, especially since Europe, North America, and Japan are unlikely to eliminate all restrictions to trade and foreign direct investment.

We think that an understanding of the relative performance of the world's major automotive assembly industries would provide a better understanding of the issues behind these debates. In addition, the automotive industry continues to become more and more international. A sound point of view on the relative performance of the industries in different countries, as well as an understanding of the causes of any differences, becomes increasingly important for developing corporate strategy or designing industrial policy. Much analytical work has already been done on this industry, but surprisingly we did not find a value-added-based analysis of labor productivity which deals satisfactorily with the issue of currency conversion, and thus, achieves comparable output for the entire industry. Given our belief that the importance of understanding international productivity differences, we believe it vital to attempt to derive a more satisfactory measure.

We believe this case study contributes to the discussion in four ways:

- First, our measures of labor productivity for the automotive assembly industries in Germany, Japan, and the U.S. give a top-level insight into the performance of the three industries. They show that during the 1985 to 1990 period (the period for which the latest reliable data is available) Japan was leading the race, with the U.S. somewhat behind, and Germany

Exhibit A - 1
BUSINESS SYSTEM



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a distant third. There were wide variations in productivity for firms within each national grouping.

¶ Second, our time series analysis of relative performance shows how the operations based in each of the three countries have reacted to changes in the global competitive environment. It highlights how the industry in the U.S. responded to intense competition with Japan throughout the period.

¶ Third, our causality analysis suggests that differences in design for manufacturing, and in the organization of functions and tasks, appear to be driving a large proportion of the differences in labor productivity at the level of the company production process itself.

¶ Fourth, our causality analysis on higher levels explains how and why different national competitive environments in Germany, Japan, and the U.S. have contributed to the current situation. Whereas, the industry in the U.S. during this period is recovering from its earlier, less competitive stance (after a costly transition), the industry in Germany is still threatened by severe productivity shortfalls. The resulting policy issues challenge two fundamental aspects of the German economic system, namely its market for corporate control, and the micro structure of the German labor market.

Overall, the automotive assembly case illustrates how modern mass production in large markets can generate high labor productivity growth, despite high levels of product complexity. It also shows how large productivity differences within countries, as well as between countries, can persist for a long time, which has its own implications for public policy.

We start our analysis with a brief description of the automotive assembly industry. In the first section we measure productivity differences in 1990 as well as in previous years. This section is followed by an analysis of the causal factors explaining the measured productivity gaps. Finally, conclusions are drawn about causality and the policy issues arising from these.

THE AUTOMOTIVE ASSEMBLY INDUSTRY

The Business System And Production Process

As Exhibit A-1 illustrates, there are three main types of players in the overall automotive industry: materials and parts suppliers, vehicle assemblers (original equipment manufacturers – OEMs), and distribution networks of car dealerships. The first link in the chain, the supplier, tends to be highly fragmented, with thousands of legal entities in each country performing primarily engineering and

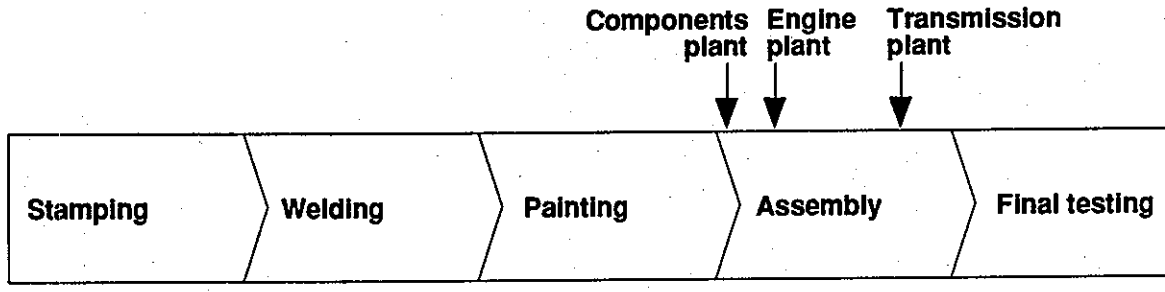
Exhibit A - 2

AUTOMOTIVE ASSEMBLY PRODUCTION PROCESS

OEMs

TYPICAL ASSEMBLY PLAN

→ Supplier plant inp



	Stamping	Welding	Painting	Assembly	Final testing
Labor content	Low - Highly automated heavy presses	Low - Highly automated complex welding machines and robots	Low - Painting robots - Automated materials handling	High - The bulk of a typical plant's work force	Low (Japan) Higher (Germany

Source: McKinsey Automotive Practice

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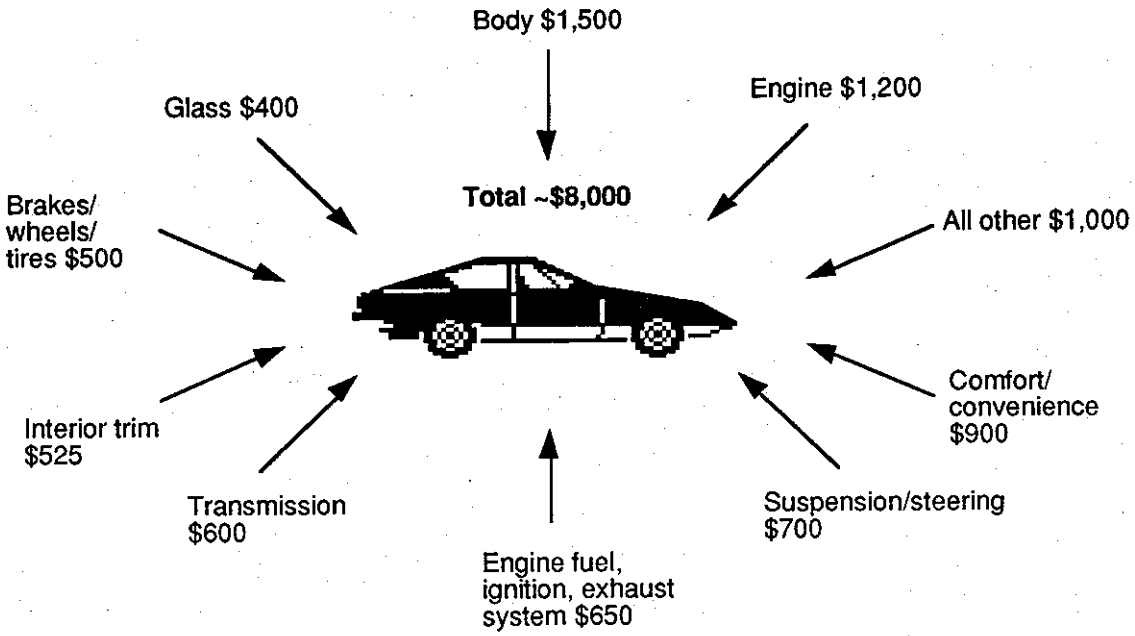
Exhibit A - 3

CAR COST BREAKDOWN

ACCORD/TAURUS RANGE IN 1990

TYPICAL OEM COST



Source: McKinsey Automotive Practice; University of Michigan

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manufacturing tasks. The OEMs, by contrast, are much more concentrated, with only slightly more than a dozen major firms around the world. The composition of these firms also differs substantially from one country to another. Some are also heavily involved in component manufacturing. General Motors is about 70 percent vertically integrated, the same figure for Chrysler or a typical firm headquartered in Japan is only 30 percent, while Germany averages 50 percent. One thing which all the OEMs have in common, however, is a high level of R&D expenditures, usually around 5 percent of sales. This level is due in part to the highly technical nature of the modern car and its production process, and to the complex web of product regulations that each vehicle must meet. (However, compared to industries such as machine tools or electronics, R&D expenditure as a percent of sales is lower.) The last link of the chain, the dealership network, serves as the primary commercial distribution channel. Dealers tend to be, for the most part, OEM subsidiaries or legally independent franchises, and thus are separate from the OEMs in terms of productivity reporting. These are not addressed in this report.

The focus of this case study is the production process of assembly by the OEMs (a second case study examines the supplier industry in more detail). As Exhibit A-2 shows, there are essentially four steps in the assembly of a car, each with varying levels of labor intensity. In general, the first three (stamping, welding, and painting) tend to be heavily automated, often consuming less than 20 percent of a plant's labor force. The remaining 80 percent of the plant's workers are involved in the final assembly of the car, which involves incorporating the engine and transmission as well as other components into the body and chassis of the car.

Because the equipment used in these assembly plants tends to be specialized, OEM facilities generally produce exclusively cars or trucks, and usually just a few models of each.

Inputs

The raw materials used in a car are fairly straightforward. Nearly 70 percent of the weight of a car is composed of steel and iron. Plastic, aluminum, rubber, and glass comprise another 20 percent, and the remainder is comprised of items such as cloth for seat covers.

As Exhibit A-3 illustrates, no one item dominates in the value of a car. The production costs are fairly evenly distributed across different areas, with no one part accounting for more than 20 percent of the total value.

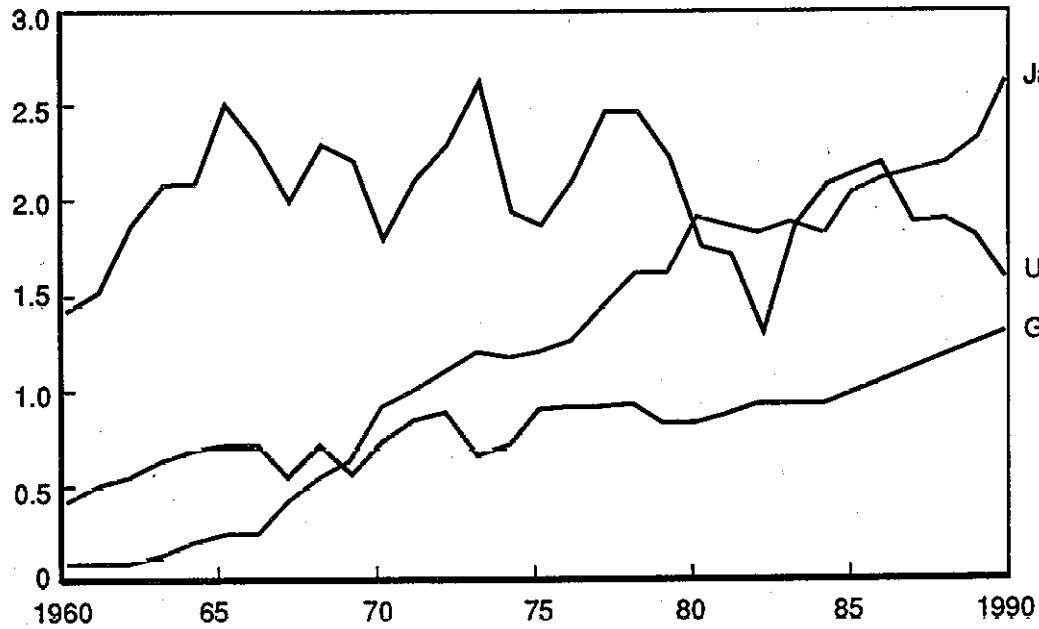
Industry Size

The automotive industries in Germany and Japan have enjoyed steady rates of growth in production since the mid-1960s (Exhibit A-4). The same was not true in the U.S., however, where the industry was exposed to severe downturns in 1982 and

Exhibit A - 4

CAR PRODUCTION IN UNITS 1960-90

Index: Japan 1971 = 1.0



* Excluding former East Germany

Source: MVMA

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ADJUSTMENTS

Industry Coverage and Vertical Integration Adjustments

The German industry definition of automotive assembly contains a very substantial portion of the automotive parts industry as well. As such, we were only able to derive directly from the census data productivity figures for the total German automotive industry. Productivity figures for the two individual segments of the industry were obtained from proprietary McKinsey benchmarking studies. These studies provided us with the relative performances of the assembly and parts industries in Germany vis-à-vis their foreign counterparts. In addition, it was necessary to perform an adjustment in industry coverage to account for the fact that the U.S. industry also contains personal-use light trucks, counted elsewhere as commercial vehicles and not included in the "automotive" industry as traditionally defined.

Purchasing Power Parities (PPP) Adjustments

- Product mix. The raw census data provided us with an industry PPP based primarily on the assumption that "a car is a car," everywhere. This is obviously not true. To correct for this, we undertook two adjustments. First, we adjusted for product mix by asking the following question: How much would the average price of a Japanese or German car change if that country had the same product mix as the U.S.? "Same product mix" is defined here according to the European ABCDE market segmentation, which classifies cars according to size and basic features. This standard is normally employed only in Europe, but it provides a worldwide yardstick against which other countries' cars can be evaluated. After classifying cars in Japan and the U.S. according to the ABCDE standard, and applying value weights to each of the market segments, we were able to derive the appropriate mix adjustment (Exhibit A-6). The results showed that Japanese cars are on average "lighter" than those in the U.S. and the mix adjustment was substantial. Towards 1990, this adjustment becomes smaller, reflecting the move of Japanese producers into larger luxury cars. Surprisingly, the results showed a similar but smaller adjustment for Germany. The well-known reputation of Germany in the luxury cars market hides the fact that a large portion of German cars are in smaller car segments.

- Quality differences. Product mix alone is not a fully satisfactory adjustment. Since there are substantial differences in reliability, functionality, and basic quality among cars in a particular market segment, we made another adjustment for these differences. We used, as described in Exhibit A-7, different methods in Germany and Japan for determining differences in quality with the U.S. as a reference. Quality differences are defined as price differentials a consumer with unrestricted access to foreign products would be willing to pay for a content-equivalent car, based on his/her perception of tangible differences (e.g., reliability, functionality, etc.). This definition requires us to separate consumer preferences into one part related to tangible product differences, and another part related to differences based on intangible, nationalistic preferences.

Capacity Utilization Adjustments

The benchmarking year, 1990, as in most other years, has the characteristic of seeing the three countries at different stages of the business cycle. The fact that the U.S. was already in a slow-down led to substantial decreases in capacity utilization as compared to previous years. Japan, however, was at the top of its business cycle. We estimated the effect on labor productivity of these changes in capacity utilization to be roughly 8 to 12 percentage points against the U.S. However, part of the low capacity utilization in the U.S. could also be seen as an inability to downsize operations, which relates once again to management's organizational skills. (The same effect appears to be occurring in Japan in 1992 to 1993, as production volume drops without large reductions in employment)

again in the late 1980s. Japan has surpassed the U.S. in production volume, with almost 10 million cars produced in 1990 compared to 6 million for the U.S. Until 1990, continued growth in Germany allowed it reach a level of more than 4 million cars. (Note that when light truck production is included in these figures, Japanese and U.S. production in 1990 rise significantly higher, to 13.5 million and 9.8 million, respectively. Light trucks have less impact on the German figure, adding only about 300,000 units in 1990. "Light trucks" in the U.S., and to a lesser extent in Japan, include pick-up trucks, minivans, and sport-utility vehicles (SUVs), such as Jeeps, many of which are employed for personal use as "car-like" vehicles. While we focus in this report on car production, for purposes of data comparability, readers should be aware of the major impact on the OEMs of light truck production, especially in the U.S., where there is significant sharing of product and process technology between cars and light trucks.

While the three countries have considerable differences in output, the levels of employment in each industry are roughly the same, ranging from 700,000 to 800,000 for the automotive industry as a whole (Exhibit A-5). Roughly one-third of that amount is devoted to vehicle assembly and related OEM functions.

PRODUCTIVITY RESULTS

Adjustments

The diversity of output in the automotive assembly industry, and the differing degrees of vertical integration make it impossible to use direct physical comparisons to measure productivity. Therefore, measures of value added were used in this study. The data for value added and other measures, including employment and hours worked, were obtained from national industrial census records. By combining these data with industry-specific purchasing power parities (PPPs), we were able to derive labor productivity levels by country.

However, before comparing the productivity of the industries in Germany, Japan, and the U.S., we had to make a number of adjustments reflecting differences in products, levels of vertical integration, capacity utilization, and reporting methods used by the three countries (see box entitled "Adjustments").

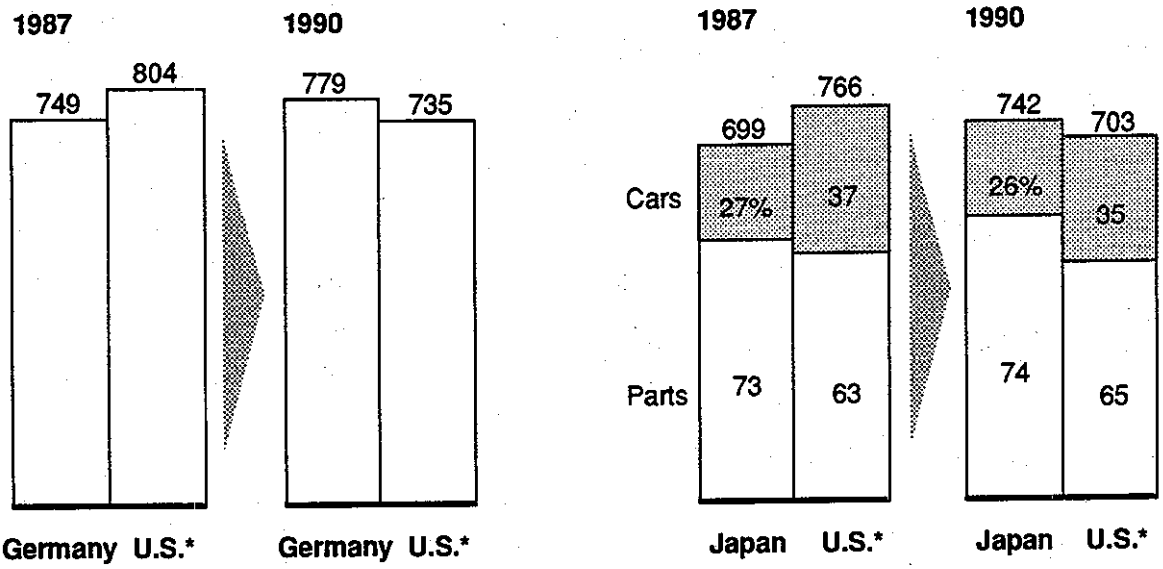
Labor Productivity Results

After making the adjustments described above, the aggregate results of our analysis show that the automotive assembly industry in Japan was roughly 16 percent more productive than the industry in the U.S. in 1990. By contrast, productivity in Germany was two-thirds that of the U.S. (Exhibit A-8). Although experienced observers would expect to see lower labor productivity in Germany, the magnitude of the gap is somewhat surprising.

Exhibit A - 5

AUTOMOTIVE EMPLOYMENT IN ASSEMBLY AND PARTS

Thousands



* U.S. numbers different because U.S./Germany comparison includes auxiliary units but excludes companies with fewer than 20 employees

Source: Census of Manufactures; McKinsey analysis

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Exhibit A - 6

PRODUCT MIX ADJUSTMENT

Size categories used in mix weighting

Segment code	Example	Value weights
A	Fiat Panda	5
B	Ford Fiesta	7
C	VW Jetta	10
D	Honda Accord	15
E	All Mercedes, all sports cars	30

Resulting mix adjustments
U.S. 1987 = 100

	1987	1989	1990
Germany	90	89	90
Japan	73	79	76
U.S.	100	98	98

Source: AID; DRI; JAMA; Ward's; McKinsey analysis

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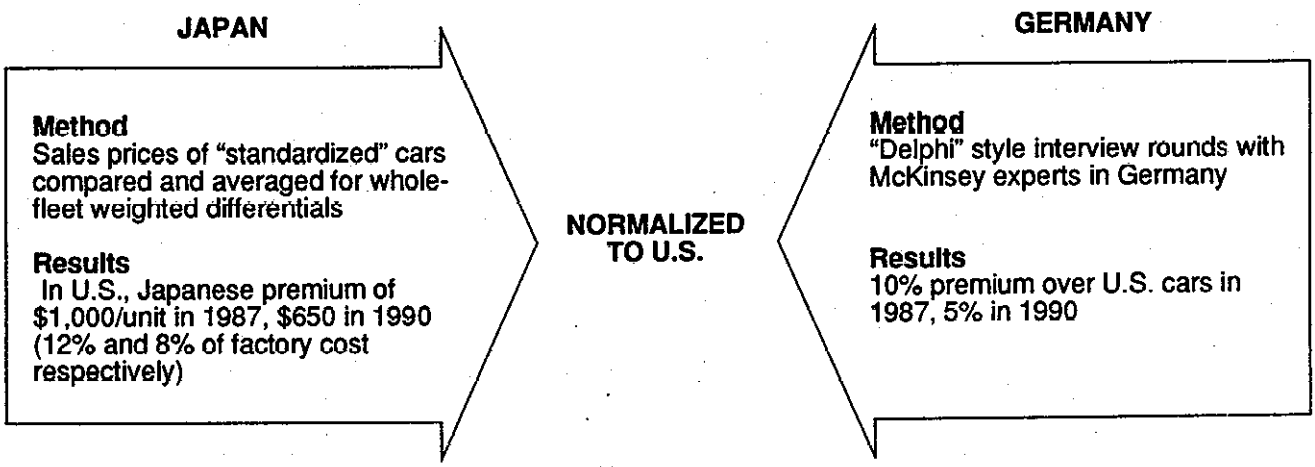
Exhibit A - 7

PRODUCT QUALITY ADJUSTMENT



Source: McKinsey Automotive Practice

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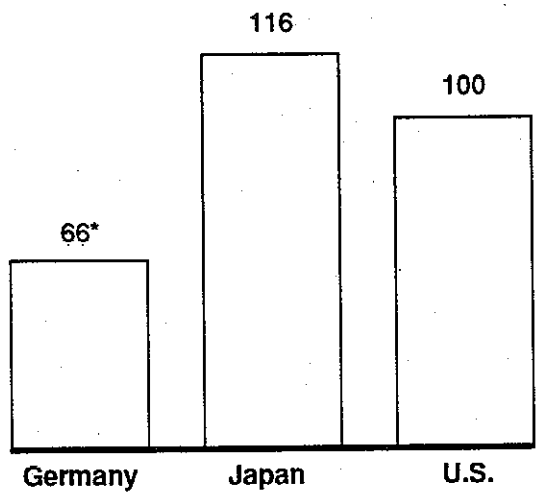
Exhibit A - 8

AUTOMOTIVE ASSEMBLY LABOR PRODUCTIVITY 1990

VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED

Index: U.S. = 100



* Estimated from McKinsey data

Source: Census of Manufactures; McKinsey analysis

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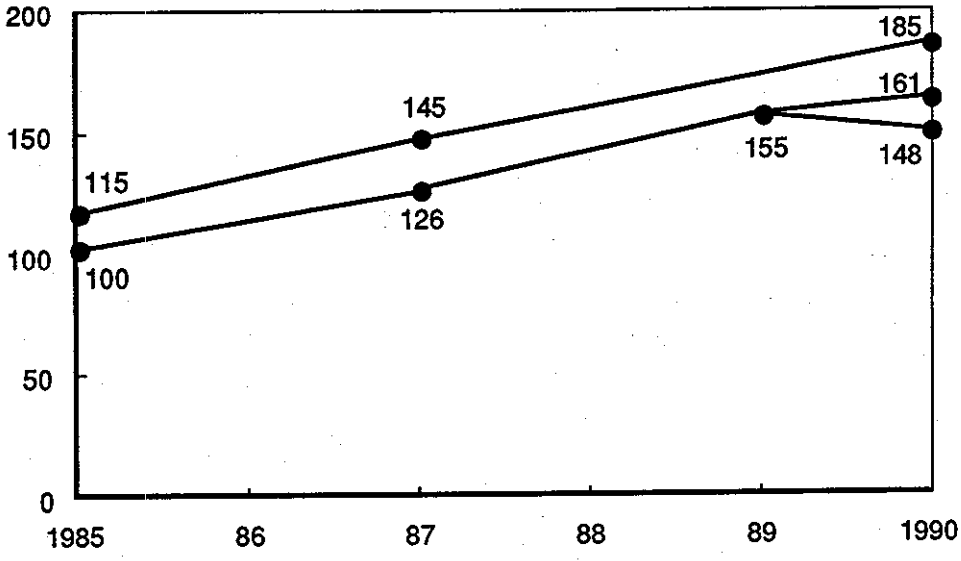
Exhibit A - 9

REAL LABOR PRODUCTIVITY CHANGE 1985-90

AUTOMOTIVE ASSEMBLY INDUSTRY

Index: U.S. 1985 = 100



Real annual productivity change 1985-90	
Japan	10%
U.S.	10
U.S.*	8

* Without capacity utilization adjustment

Source: McKinsey analysis

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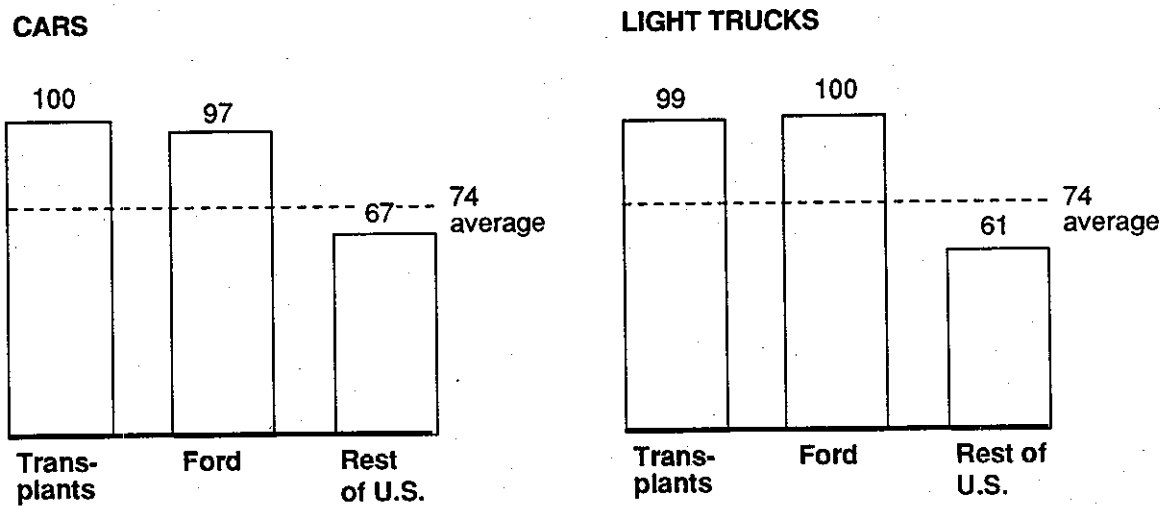
Exhibit A - 10

U.S. ASSEMBLY PLANT LABOR PRODUCTIVITY VARIANCE 1990

Index of cars per worker-day



Note: Assembly plant productivity is not the same as, but is probably a good surrogate for, productivity of an assembly company as a whole

Source: Harbour Report

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Because of the nature of the data on the industry in Germany, we could construct a time series analysis only for the Japan/U.S. comparison. The results shown in Exhibit A-9 reveal that from 1985 to 1990, both the U.S. and Japan experienced substantial productivity gains. The industry in the U.S. was able to remain close to that of Japan in absolute terms for most of the time period (and to substantially catch up in relative terms), although in 1990, productivity fell slightly, due to the recession in the U.S. and the resulting decline in capacity utilization. When we adjust for capacity utilization, the U.S. remains close to Japan in productivity growth during this time period.

In an industry with only a few large players in each country, one key question is whether firms within a country also have large differences in labor productivity. Indeed, we do see large physical productivity differences in the U.S. among the U.S. companies, and among U.S. operations of OEMs originating in Japan, known as transplants (Exhibit A-10). This result shows quite dramatically that large productivity differences are present even within a country. Turning to Japan, we find an even more striking picture. In 1987 (as well as throughout the 1980s we believe), Toyota showed a productivity advantage of roughly 40 percent over other major OEMs in Japan (Exhibit A-11). Toyota gained its edge roughly 10 to 15 years ago and has been able to sustain it over time.

CAUSES OF PRODUCTIVITY DIFFERENCES

Exhibit A-12 summarizes our views on the causes of the demonstrated productivity differences among the three automotive assembly industries. Two fundamental forces appear to differentiate the industries and companies in those industries on the production process level: the way companies organize their processes and labor around production within their plants and with their suppliers and the way companies design their products. On a higher level of causality, we observe large differences in the competitive behavior of these industries, which also helps explain a substantial part of the differences in companies' production processes.

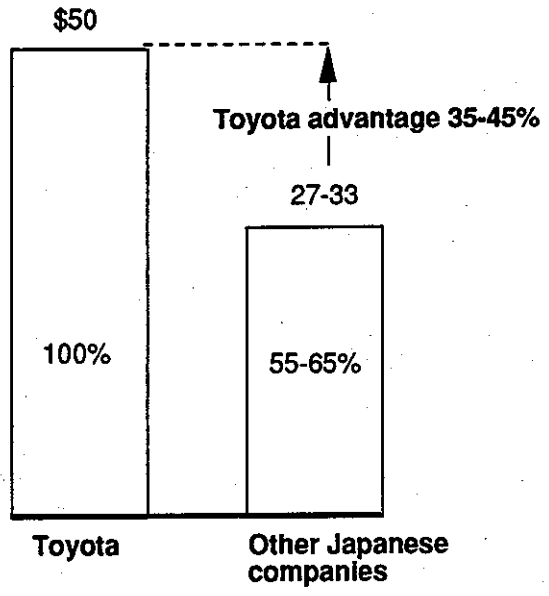
For example, the U.S. is much more exposed to the international productivity leaders from Japan than is Germany. Moreover, the competitive pressure arising from the decision of OEMs to compete on the multiple dimensions of product price, range, and development is much higher in Japan than in Germany where competitive initiatives are more circumscribed. Furthermore, the way managers compete and behave can also be substantially explained by external factors. For instance, in Germany the labor market and the market for corporate control, together with high consumer loyalty and implicit and explicit regulations, provide a set of conditions and incentives which do not encourage managers to work for quantum leap productivity improvements as vigorously as do their competitors . In the U.S., the legacy from the previous "Big Three" era was still having productivity-dampening effects in the late 1980s, although its influence was diminishing year-by-year in the face of intense competition from Japan.

Exhibit A - 11

JAPANESE OEM LABOR PRODUCTIVITY 1987

OEM VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED

1985 dollars



Source: Lieberman, Lav, Williams, 1988; McKinsey analysis

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Exhibit A - 12

CAUSES OF PRODUCTIVITY DIFFERENCES 1990

AUTOMOTIVE ASSEMBLY INDUSTRY

External factors	Nature of competition	Production process	Labor productivity
Strong customer preference for domestic products in Germany and Japan Labor and corporate governance rules in Germany reduce incentives to increase productivity Tariff and VRA regulations in the U.S. and Europe tried to limit Japanese competition, but transplants, especially in the U.S., have reduced importance of these constraints	**Germany:** Competition based primarily on product differentiation Less exposure to global competition than U.S. **Japan:** Fierce competition focusing on price as well as on product range, differentiation and development **U.S.:** Price and product range the basis for competition Almost fully exposed to global competition	Organization of functions and continuous improvement in Japan within plants and with suppliers Product design in Japan emphasizes manufacturability and ease of assembly, as compared with overcomplexity in Germany	Large productivity gap between Japan and Germany - Japan = 116% - U.S. = 100% - Germany = 66%

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In the following discussion we will use this general framework to explain in more detail the reasons for the observed differences in productivity. First, we will discuss the way companies organize themselves internally to do business, then analyze to what extent the differences have been determined by industry conduct, and then other external factors. In each case, we will examine all the commonly cited reasons for productivity differences, dividing them into groups of factors that either did, or did not, actually influence our results. Finally, we will look at major developments in these factors since 1990.

Causality at the Production Process Level

¶ Organization of functions and tasks as a causal factor. We found that the organization of functions and tasks – essentially a management decision – is the main causal factor in explaining productivity differences in this case study. We will discuss some of the key organizational principles which seem to be crucial for achieving high labor productivity.

- Specialization versus integration. One of the sharpest differences between the German and Japanese labor systems is the emphasis on specialization by the former and integration by the latter. The German system has high numbers of job classifications which compartmentalize workers and prevent them from assuming broader roles. Japanese management, on the other hand, stresses integration over specialization. This emphasis is reflected in high levels of teamwork and front-line empowerment, as well as group coordination, rather than craft-based individual excellence. The U.S. lies somewhere between Germany and Japan on this spectrum, but is moving closer to the latter. The benefits of doing so can be seen, for example, in Ford's highly productive Atlanta plant, which achieved large increases in productivity by substantially reducing restrictive work rules (within a unionized context) in conjunction with redesigning the product for easy assembly. In Germany, the focus on specialization has led to excessively high complexity in the production process.

- Continuous improvement. Central to the well known Japanese concept of continuous improvement is the employee involvement systems employed in many firms in Japan. This system, along with front-line empowerment to implement suggested improvements, helps firms continuously refine their processes at the margin. Over time this system yields significant productivity improvements. Improvements take the form both of reduced labor requirements and lower defect rates, which of course, further reduce labor requirements. Toyota, for example, was able to reduce its employment in one paint shop from 8 to 3 employees over the course of 4 years simply by following employee suggestions with regard to cutting down worker

walking distances. One of the reasons this system works is that many of the workers involved do not fear losing their jobs as productivity grows, due to lifetime employment guarantees by firms. However, this guarantee may not be sustainable without the ever-growing vehicle output volumes characteristic of Japan from 1950 to 1990. Since the 1980s, OEMs in Japan have not guaranteed lifetime employment to all employees.

- Supplier management. Another key organizational element is the way in which an OEM manages its suppliers. The benefits which can result from good management in this arena take the form of reduced labor needs and improved product quality. These benefits are achieved through at least two mechanisms: reduced complexity and shared quality control. The former is the result of fewer direct suppliers to the OEM (see data in the automotive parts case study). Whereas, in Germany and the U.S. an OEM may have thousands of direct suppliers, the comparable figure in Japan would be in the hundreds. Furthermore, these suppliers provide more standardized parts. The OEM is able to save labor both in the management of supplier relations as well in the handling of material parts. In addition, effective supplier relations allow the OEM to shift most aspects of component design and quality management to the supplier, once again reducing OEM labor needs.

- Effective use of capital. A typical example of how OEMs in Japan use capital most effectively is the care they take to make sure that their machinery and equipment is of similar quality throughout a production line. This ensures better process control and, thus, reaps the full benefits of each piece of machinery. This condition is further enhanced by spreading investment out evenly over time rather than by investing in large "crash" programs. In addition, key equipment, such as presses, are often developed jointly by the OEM and the parts supplier, adjusting the machine until it can be operated by a highly-skilled small team.

  Additionally, only the best OEMs in Japan have been able to design one production line for producing radically different models simultaneously. This is a particularly effective use of capital, however, it requires year-long worker training.

Please note that we did not address other Japanese management concepts commonly discussed, such as "just-in-time" and "autonomation," and the host of tools which go along with these concepts (*kanban* cards, production smoothing techniques, etc.). Instead, we have tried to stress what we believe are the underlying organizational foundations of these principles and systems.

Also note that partially as a result of such organizational principles, work intensity and individual task speed have been shown to be considerably higher in Japan than, for instance, in Germany. As discussed later, a fraction of these differences could also be explained by higher intrinsic motivation of workers.

A final point is that lower employee turnover rates in Japan have generated substantial savings in terms of recruiting and training costs. Furthermore, lower turnover preserves the tacit knowledge of the firm, which is quite valuable, but difficult to transmit to new hires. The value of this aspect of labor is made clear by the example of the transplants in the U.S., where it is estimated that higher turnover rates in the U.S. versus Japan burden facilities with a 5 percentage point labor productivity disadvantage as compared to similar plants back in Japan.

All of the characteristics of the Japanese management system described above are epitomized by Toyota, which serves as a model of labor productivity both inside and outside Japan for the automotive as well as other industries. In fact, more is to be learned from studying Toyota as a company, than by studying Japan as a country with regard to labor productivity in the automotive assembly industry.

Our hypothesis that management's organization of employee functions and tasks, and design for manufacturing are the major causes of the observed differences in productivity is further supported by a McKinsey benchmarking study carried out through reverse engineering as well as comparisons at factory locations.

¶ Design for manufacturing (ease of assembly and low complexity) as a causal factor. Differences in design for manufacturing is another primary factor explaining the differences in labor productivity between OEMs in Japan and others. In designing products, firms in Japan remain very conscious of how such designs affect the manufacturing function, and attempt to specify them so that they are easy to produce and assemble. This joint product/process design system, including the OEM and its supplier partners, involves both standardizing parts so that they can be used in multiple models and reducing the overall number of parts in the car. The result is a reduction in the amount of time needed to assemble a car, and thus lower labor costs as well as less time and money spent in the product development process itself.

¶ Less important causal factors

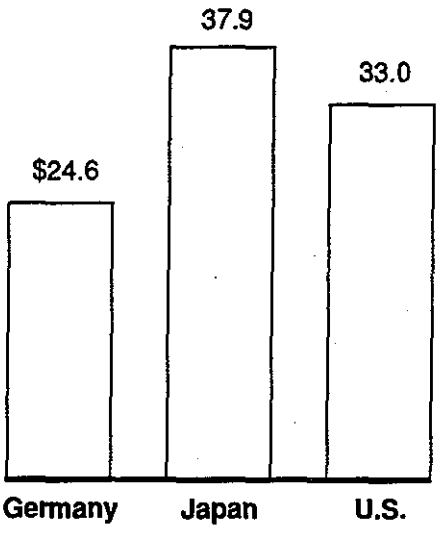
- Raw materials and parts. The previous discussion leads naturally to the point that when the design and production of car parts are also executed along the same lines as that of the overall car, the parts are especially well suited for assembly. The assemblers then have an

Exhibit A - 13

TOTAL AUTOMOTIVE ACCUMULATED INVESTMENT 1987-90

ASSEMBLY AND PARTS

1990 $ Thousands per employee



Source: Census of Manufactures

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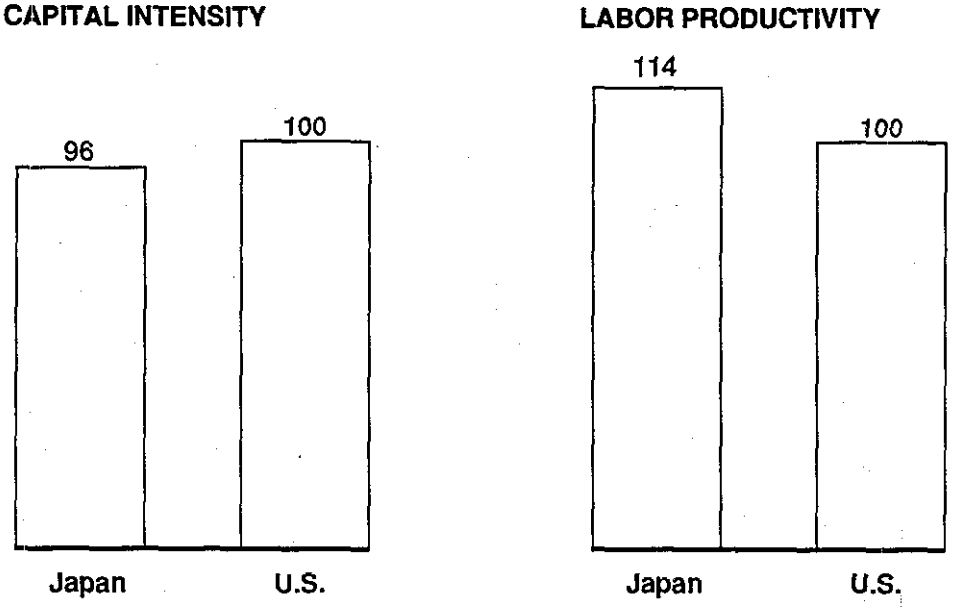
Exhibit A - 14

CAPITAL INTENSITY 1987

AUTOMOTIVE ASSEMBLY INDUSTRY

CAPITAL STOCK PER EMPLOYEE, LABOR PRODUCTIVITY

Index: U.S. = 100



Source: van Ark 1993; *national investment statistics*

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advantage in labor productivity. This factor is highly dependent on the relationship between the OEM and the supplier, and on how well the OEM can take advantage of the specialized skills of the supplier. We observed that this additional factor plays a role, but a somewhat less important one, than overall design for manufacturing.

- Intrinsic motivation. While not a major causal factor, worker motivation can be important in certain cases. Toyota's system, for example, requires high employee commitment. This commitment can be sustained best with a young and intrinsically highly motivated work force. In general, intrinsic motivation gives a small additional advantage in terms of labor productivity. In Japan, for instance, employees are willing to discuss work and make improvement suggestions outside their paid working time, which can account for as much as an additional 5 percent of hours worked. This type of effort has been far less common in the U.S. and Germany.

- Capital intensity Germany/Japan. Based on investment data from the 1980s, one observes that capital intensity in OEMs was higher in Japan than in Germany. There has also been less investment in new equipment in Germany than in Japan in recent years (Exhibit A-13). However, note that our next observation implies that these capital differences do not explain the major part of the productivity gap.

Having discussed the major and the less important causal factors, we will now turn our attention to the non-differentiating factors.

¶ Non-differentiating causal factors

- Capital intensity U.S./Japan. The existence of advanced laborsaving technologies would imply that a substantial part of labor productivity differences could be explained by differences in the amount of such capital put into place. Surprisingly, the data and analysis do not suggest such a relationship (Exhibit A-14). In fact, the total capital intensity of the OEM industry in Japan is slightly lower than that of the U.S., even though it did increase its rate of investment at the end of the 1980s. In general, the three industries have by now adopted similar investment levels. This lack of correlation holds not only in cross-border comparisons but also within a given country. In Japan, for instance, even though Toyota holds a 40 percent productivity lead over its competitors, its capital intensity is roughly the same as the others'. (Exhibit A-15).

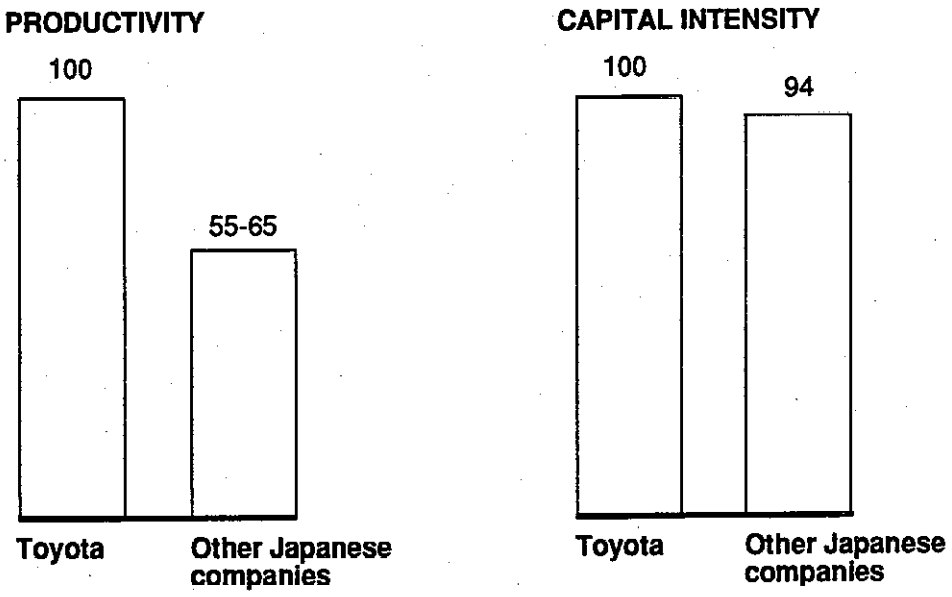
- Scale. In the automotive assembly industry, the achievement of critical scale for plants, as well as for companies, is obviously crucial for success. Today, critical scale is often cited at about 200,000 to 250,000 units per year at the assembly level. However, as Exhibit A-16

Exhibit A - 15

CAPITAL INTENSITY IN JAPAN 1987

AUTOMOTIVE ASSEMBLY INDUSTRY

Index: Toyota = 100



Source: Lieberman, Lav, Williams, 1988; McKinsey analysis

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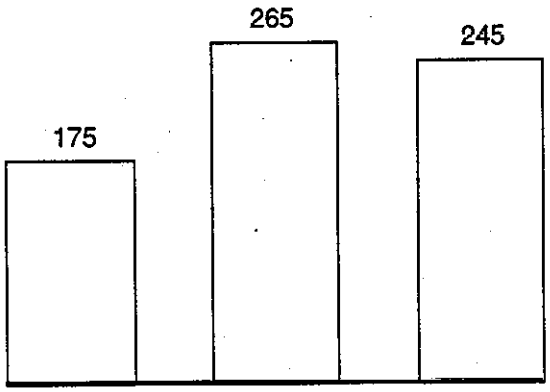
Exhibit A - 16

PLANT SCALE AND LABOR PRODUCTIVITY

U.S. ASSEMBLY EXAMPL

AVERAGE NORTH AMERICAN ASSEMBLY PLANT CAPACITIES

Thousand vehicles per year



	Transplants	Ford	Rest of U.S.
Largest	330	330	500
Smallest	100	170	85
Average productivity*	100	97	67

* Transplants = 100

Source: Volpe Transportation Center; Habour Report

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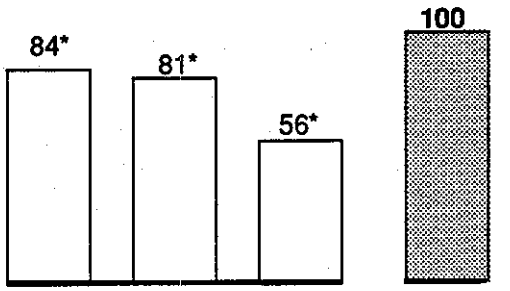
Exhibit A - 17

LABOR PRODUCTIVITY LINKAGES TO HUMAN CAPITAL AND MOTIVATION

FORD ATLANTA PLANT

PLANT PRODUCTIVITY
CAR PER WORKER DAY
Index: Ford Atlanta = 100



Human capital status

- UAW plant
- Average age in mid-40s
- Average seniority about 15-20 years
- No formal team structure

Observation

High productivity is possible with "old," unionized, existing work force

* Average
Note: Ford ascribes much of Atlanta's success to excellent Taurus design for assembly, design for manufacturability
Source: Harbour Report; Ward's; Automotive Industries
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Exhibit A - 18

NATURE AND INTENSITY OF COMPETITION

HYPOTHESES

● = Primary
◑ = Secondary
○ = Tertiary

Base of competition	Germany	Japan	U.S.	Impact on competitive intensity
Price	○	◑	●	High
Advertising/share	◑	●	●	Medium
Product differentiation				
- Horizontal (e.g., color, style)	◑	◑	◑	Low/medium
- Vertical (e.g., functions)	●	●	◑	Medium/low
Product Development (e.g., new products, fast refreshes)	◑	●	◑	High
Product range/breadth	○	●	●	High
Summary of competitive intensity	Low Narrow competition on features and technology	High Numerous models quickly renewed and technologically changing	High Share and price-driven	

Source: Interviews; McKinsey Automotive Practice
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illustrates, using the North American example, scale is not a differentiating factor for labor productivity. There are even signs that some companies have overdone it, with their plants showing slight diseconomies of scale.

- Basic skill differences. One of the most discussed and debated issues in this field is whether the edge enjoyed by companies originating in Japan in terms of labor productivity is due to superior work force skills. In tackling this question, one has to first recognize that the skills workers use and apply have different effects when the management or organization of their tasks differs. What we are addressing here, however, is the question of whether one could, for example, achieve Japanese levels of productivity with U.S. workers, provided those workers were given similar training as in Japan. The evidence from U.S. transplant data suggests that differences in worker skills are not a significant source of national productivity differences. The Japanese transplants are able to achieve similar productivity in the U.S. as in Japan using newly recruited and carefully screened and trained workers, although such plants are usually able to "skim the cream" from the local labor pool, accepting perhaps one job applicant in ten. However, reorganized plants in the U.S. using existing (even unionized) work forces, such as Ford's Atlanta plant, can also achieve comparably high labor productivity (Exhibit A-17).

The Nature of Competition

Why have the automakers in Japan been able to sustain a high level of labor productivity growth over time? Why has the industry in the U.S., in general, begun to close to the gap with the industry in Japan, while the industry in Germany has not? Our next analysis in trying to answer these questions lies in the behavior of the automotive industry as a whole at the national scale.

¶ The nature of competition – 1990. Exhibit A-18 summarizes the type and degree of competition in each of the three countries, based on the strategic variables automotive companies can manipulate. The industry in Japan exhibits competition on the basis of price, but also on product range, differentiation, and development. All of these dimensions greatly increase the pressure on other companies to improve productivity, either by threatening them through supplying the same products or by displacing competitor products with superior ones.

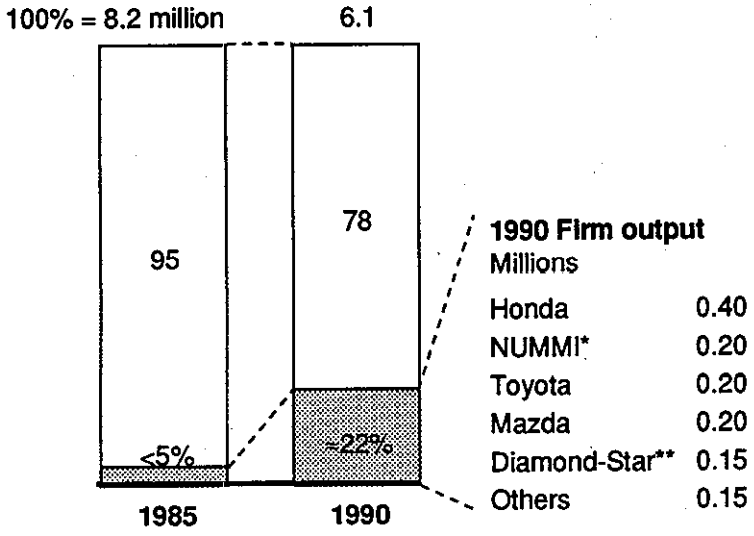
Today, the industry in the U.S. exhibits substantial competitive intensity, in which price and product range tend to be the leading elements. The emergence of the transplants and the high levels of exports from Japan have also made product development a key competitive variable in the U.S. (Exhibit A-19). Thus, the industry in the U.S. now shows a degree of

Exhibit A - 19

IMPACT OF JAPANESE COMPETITION IN U.S.

TRANSPLANT SHARE OF U.S. CAR PRODUCTION

Units



TRADE BALANCE

Billions

	1987	1990
All merchandise	-$152	-109
Automotive portion	-61	-53
Japanese automotive portion	-33	-31

(Negative number indicates Japanese favor)

* GM/Toyota joint venture
** Chrysler/Mitsubishi joint venture

Source: Automotive News; U.S. International Trade Commission

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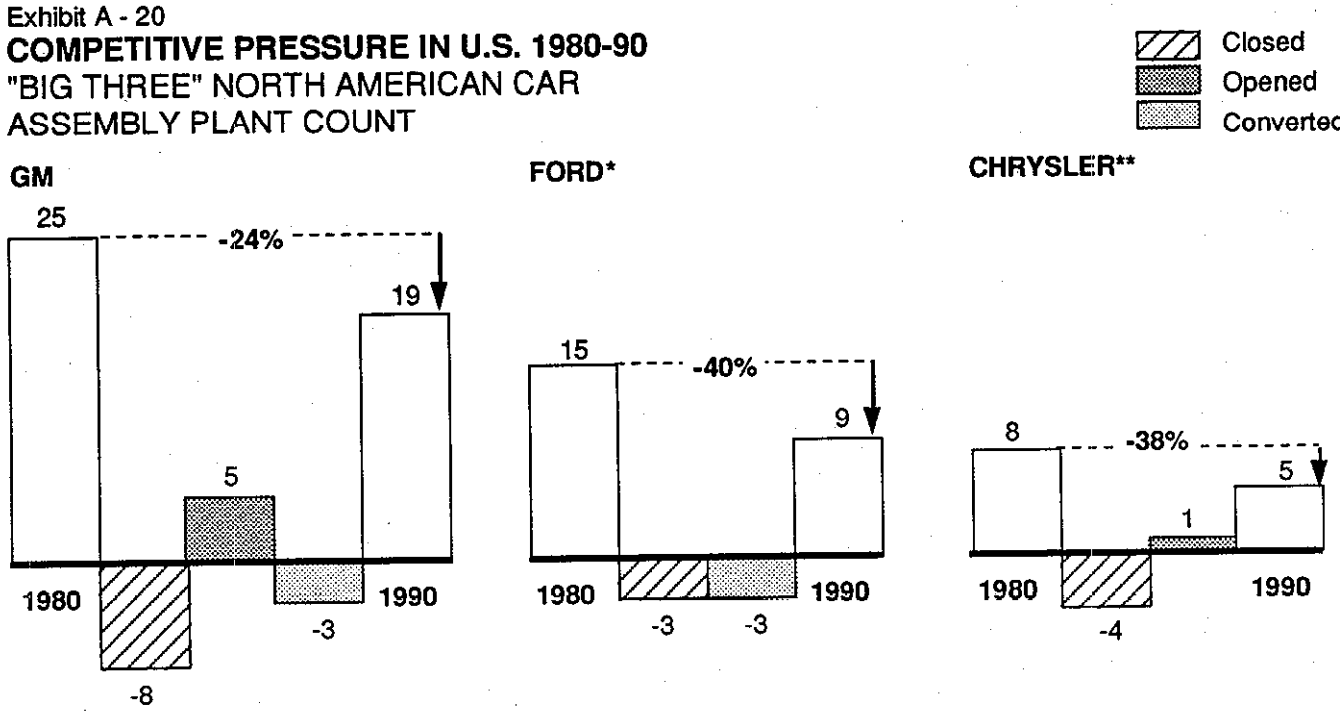
Exhibit A - 20

COMPETITIVE PRESSURE IN U.S. 1980-90

"BIG THREE" NORTH AMERICAN CAR ASSEMBLY PLANT COUNT



* Excluding Flat Rock
** Including AMC, excluding Diamond-Star

Source: Ward's; Harbour Associates; Integrated Automotive Resources; McKinsey analysis

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competitive intensity similar to its counterpart in Japan. The industry's response can be seen in the massive 1980s restructuring undertaken by the "Big Three." As Exhibit A-20 illustrates, the competitive threat to the car manufacturers originating in the U.S. has led to substantial plant restructuring. The driving force was exposure to the productivity leaders from Japan.

In contrast, the primary basis for competition in Germany is product differentiation, through adding new features to existing cars. This factor does not strongly encourage productivity increases. Furthermore, firms in Germany tend to be much more narrowly focused on particular market segments and therefore, do not face the broader competitive pressures of the market. In addition, in Germany we observe that earlier foreign direct investments (FDI) by the OEMs in the U.S. have begun to behave more like other companies headquartered in Germany. For this reason, they have not served as international "converging mechanisms," as is typically the case with FDI. (This behavior is changing as both GM and Ford in Europe have introduced major improvement plans since 1990.) Until recently the threat from Japanese imports has been relatively weak in Germany, due to protectionist measures at the level of the EC (which we discuss later) and to Japanese manufacturers' preoccupation with the U.S. and their own domestic markets.

¶ The nature of competition – 1980s. Differences in the prior competitive behavior of industries can have long-lasting effects on their current relative performance. The automotive assembly industry in the U.S. demonstrates this. While the picture we observe in 1990 concerning the nature of competition was also the picture throughout the second half of the 1980s, prior to that competition in the U.S. was significantly different. The industry exhibited relatively low competitive intensity until the early 1980s (Exhibit A-21). This supply structure helped to temper the use of key competitive variables such as price and product development. This removed much of the pressure and incentive for managers to improve productivity. In addition, the high profits some U.S. companies earned during this period of low competitive intensity made them slow to respond to emerging threats from Japan. In the late 1980s we still see the legacy of this situation as the U.S. strives to catch up with Japan.

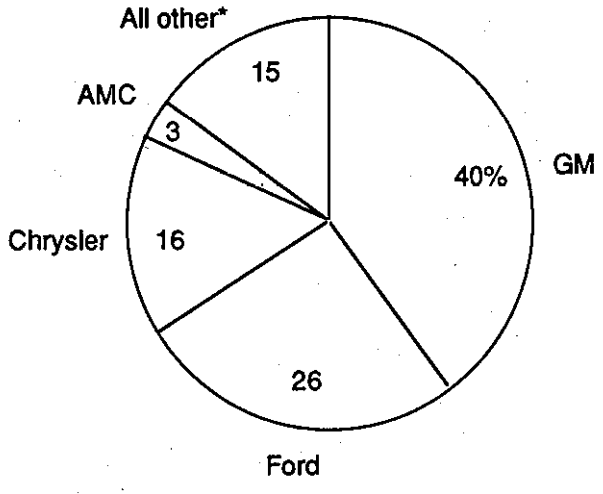
¶ Mechanisms for productivity improvement. The partial convergence of U.S. and Japanese productivity levels, as well as recent attempts by the industry in Germany to get closer to world productivity standards, are the result of three related factors. First, exports from Japan led to an immediate increase in the pressure to improve performance in the U.S., and helped eliminate legacies from the earlier environment. Second, the strong growth of highly productive Japanese and Japanese-American transplants helped increase U.S. productivity, in part because they are now

Exhibit A - 21

U.S. INDUSTRY HISTORIC CONCENTRATION

OEM MARKET SHARES 1970

Percent



Early/mid 1980s behavior

New models once per year, same time each year

One price change per year

No rebates

Standardized segments

* Other imports: VW 7%, all Japanese 4%, captives 2%, others 2%, total = 15%

Source: Ward's; McKinsey Automotive Practice

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embedded in the U.S. productivity figures, and in part because of the competitive pressure they put on other plants in the U.S. to perform. Thirdly, the emergence of transplant joint ventures with domestic producers especially increased the transfer of knowledge to the U.S. firms. Similar attempts at joint ventures are also occurring in Europe for the same reason. However, as of 1990 they had not led to major improvements in productivity.

External Factors

When it comes to the general business environment, Germany, Japan, and the U.S. exhibit substantial differences. The following section discusses how the industries differ in these external factors, which affect management behavior and the nature of competition, and ultimately, productivity.

¶ Important external factors

- Customer demand. Customers around the world value certain luxury cars beyond the tangible advantages they provide, or are willing to pay a substantial price premium for marginal safety or comfort differences. For example, the sale of Mercedes, BMWs, and more recently, Toyota's Lexus line, in any place where wealthy people live attests to the fact that cars are often used as signaling devices for social status. Furthermore, U.S. customers have relatively lower preferences for domestically-produced cars, but German and Japanese customers have a strong bias for domestic products. However, while in Japan local preferences acts as a "bonus" for the manufacturers, in Germany they are essential conditions for the survival of the industry.

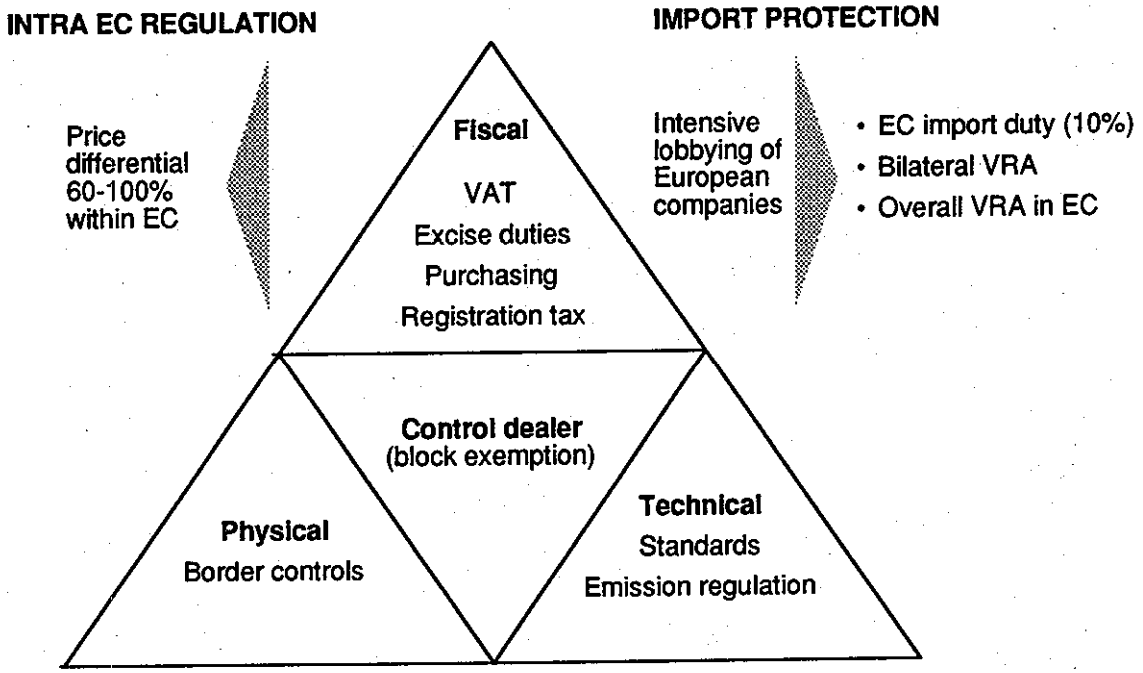
  We found that consumer preferences in Germany, other than the tangible quality adjustment we discussed earlier, can offset basic labor productivity differences of even 10 to 20 percent. This effect is significantly smaller in most other European countries. Preference for nationally produced cars is based on custom and tradition, and on the high-speed environment "autobahn" in Germany, as well as on preferences for national labels and brand image. Regardless of its source, this preference which may erode as borders throughout the OECD erode, has been important to the success of the German OEMs.

- Labor rules, unionism, and corporate governance rules. We believe that a connection between the labor market and national corporate governance rules creates a set of incentives for German managers which results in lower productivity.

  On the labor market side, three main obstacles create disincentives for managers to forcefully try to increase productivity. First, work rules

Exhibit A - 22

PROTECTIONIST MEASURES IN EUROPE 1987-90



Source: McKinsey analysis

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and job classifications make it much harder for managers to introduce state-of-the-art Japanese or U.S. elements of the organization of functions and tasks described earlier. Second, the high cost of laying off surplus labor in Germany creates disincentives to reduce unneeded parts of the work force. Third, anecdotal evidence suggests that the German piece-rate worker compensation system results in lower productivity than other forms of incentives.

As for the market for corporate control, we observed in Germany that the probability is very low that managers could be threatened by dissatisfied current or future asset holders. This is reinforced by the fact that the boards of companies originating in Germany include, to a large degree, representatives of the work force. The other potential "incentive aligners", the large industrial banks, have also not provided an impetus for labor productivity improvements, partially because their boards are often intertwined with those of their clients. The market for corporate control, thus, does not seem to force industrial operations in Germany to accelerate its race for increased productivity.

Obviously, the main argument against the hypotheses stated above is the counter-example of Japan, where the market for corporate control is also not driven by shareholder action, and the labor market has its own rigidities in terms of lifetime employment. However, as long as one is competing on the product market side with the productivity-leading companies, as the industry in Japan is, any lack of enforcing mechanisms from other sectors becomes less important. Since the industry in Germany is not competing directly and fully with the leading edge firms, the effects of the market for corporate control become more important.

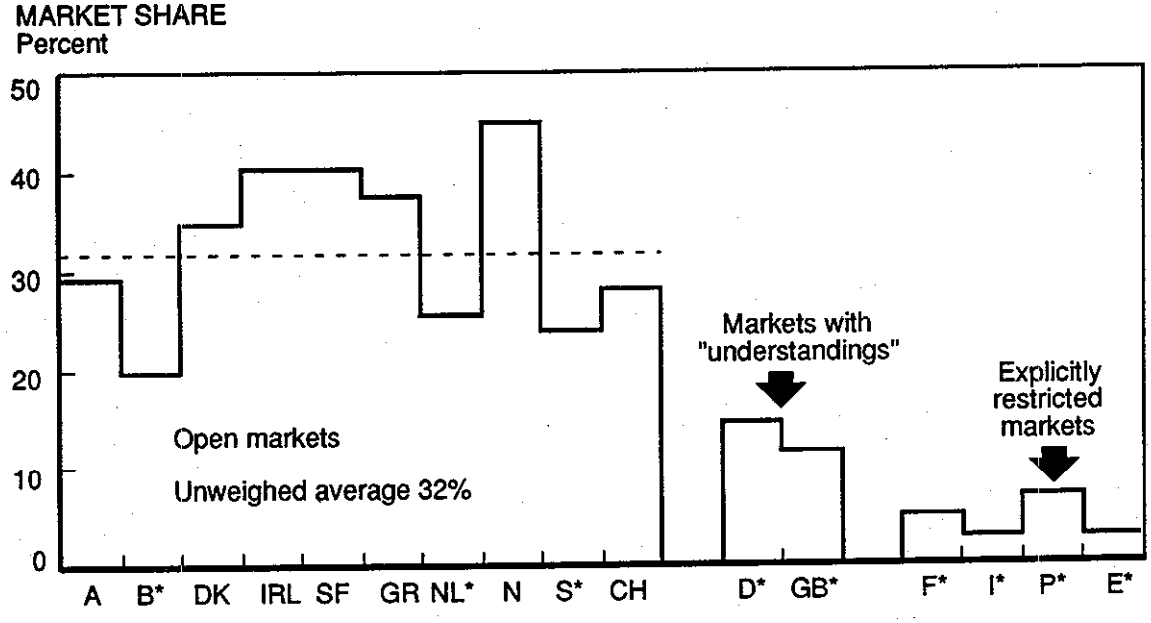
- Other regulations (tariff and nontariff). Still present in the U.S. in 1990 was the prohibitive tariff on imported light trucks of 25 percent, which gave considerable relief to threatened U.S. companies especially as this tariff in many cases had been extended to the highly profitable truck-based sport utility ("Jeep") segment as well. Furthermore, Japan has since the early 1980s, followed a Voluntary Restraint Agreement (VRA) on cars due to intense American political pressure. In 1990, the VRA had however, lost much of its importance, partly because of the emergence of the transplants, and partly because of the regained competitive base of part of industrial operations in the U.S.

  In Europe, four major sources of regulation serve as barriers for non-European produced products to reach Germany (Exhibit A-22). First, EC borders provide an initial barrier. On the tariff side there is a 10 percent import duty on cars, and even higher rates for light trucks. In addition, there exists an EC-wide VRA on Japanese imports. Furthermore, the

Exhibit A - 23

EUROPEAN IMPORT RESTRICTIONS ON JAPANESE VEHICLES

JAPANESE AUTOMAKERS' MARKET SHARES IN EUROPE 1990



* Nations with significant production capability

Source: AID

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Exhibit A - 24

AUTOMOTIVE INDUSTRY REGULATION TODAY

	Environmental	Efficiency	Safety	Trade	Labor
Germany	• Emissions standards catching up to U.S. and Japan • Clean plants • Recycling law	• Maintained via high fuel prices	• Equivalent to U.S.	• Implicit market share cap on Japanese* exports to Germany	• High safety standards • Highest mandated benefits (e.g., vacation) • Strong unions throughout
Japan	• Emissions standards track U.S.'s	• Maintained via high fuel prices and tax breaks	• Catching up to U.S.	• Nontariff barriers (e.g., inspections) a challenge to all	
U.S.	• Strict emissions standards • California standards lead the world • Clean plants	• CAFE (Corporate Average Fuel Economy) rules • Gas guzzler tax • Luxury tax	• Strict roll-over collision, restraint standards	• 25% tariff on 2-door trucks • VRAs • Local content labels • Activist OEMs	• High safety standards (OSHA • Strong unions at OEMs
Overall	• Little differential impact as standards converge	• Germany and Japan advantaged in high-MPG car know-how	• Similar across all three	• U.S. may have replaced Japan as most protected market	• Germany disadvantaged relative to the others

* Often debated point, our source here is the European Commission

Source: Interviews; McKinsey Automotive Practice

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number of cars produced by Japanese transplants in Europe has been capped at 1.2 million (although the Japanese do not acknowledge this limit). In addition, there may be an implicit understanding of a potential ceiling on Japanese imports into Germany. There is no supporting documentation on this issue, although, as the import data strongly suggest, an implicit contract could exist (Exhibit A-23). However, one has to recognize that other European countries, e.g. France and Italy, have much higher import restrictions than Germany.

As for Japan, while in 1990 various informal barriers to automotive imports may have remained (such as the high cost of buying land for an importer's dealership network), the market was at least formally quite open. Of the three nations, Japan was the only one that had no automotive import tariffs of any kind. Arguers to the contrary should take note that at least, the European OEMs had penetrated "closed" Japan to the same extent as the "open" U.S. market, holding about a 4.5 percent share of both markets in 1990.

Obviously, there are many other regulations affecting the automotive industry worldwide (Exhibit A-24). However, their impact on labor productivity can be viewed as minimal, mainly because of substantial convergence of these regulations in each country.

¶ Less important external factors

- Macroeconomic conditions. A familiar theme in the discussion of the automotive assembly industry is the role which yen appreciation has played. For example, the dramatic appreciation of the yen (¥) from over ¥200/$ in 1985 to an average of about ¥144/$ in 1987 increased drastically the price pressure which Japanese exports felt in the U.S. In a sense, this appreciation worked as would a price decrease by U.S. competitors, and substantially increased incentives to improve productivity on the part of the Japanese. However, one should not overstate the influence of the exchange rate movement on labor productivity. First of all, industrial operations in Japan were already clearly leading in productivity when the appreciation began. Secondly, Japanese productivity growth seemed to only slightly increase after the appreciation of the yen began.

- Competition and concentration rules. As mentioned earlier, the legacy of the prior U.S. market structure probably still had some effect on the level of U.S. labor productivity in 1990. Until the early 1980s, GM held a market share, which, if any bigger, might have triggered intervention by antitrust authorities. This condition created a stable situation in which GM had no incentive to push ahead because of potential antitrust intervention. Most of the players enjoyed highly successful financial results. The failure of antitrust laws to influence the largest

U.S. player to increase productivity faster may have had a role in the relative decline of the industry in the U.S.

In discussing each of these external factors, one might get the impression that they are independent of each other. This impression would be misleading, as the essential features of the social market economy in Germany, for example, are based on the combination of labor market rules and the way corporate governance rules are designed. In addition, if a nation's labor productivity is much lower than that of global competitors, it can only survive and sustain its employment level if such a productivity disadvantage is offset by a combination of demand and informal/formal barriers.

OUTLOOK

Unsustainability of High Growth in Japan

During the period 1985 to 1990, Japan experienced extremely high rates of growth in productivity. Since 1990, however, this trend has slowed substantially. Part of this has to do with structural changes taking place in the country. For instance, it is unlikely that the automotive industry in Japan will be able to preserve its lifetime employment guarantee now that domestic demand growth has retreated to replacement rate levels. Consequently, worker incentives for continuous improvement may be threatened. Lower demand due to recession across the Triad has also affected operations in Japan in the early nineties. Finally, after years of *kaizen* effort and the implementation of literally millions of worker improvement suggestions, additional productivity improvements have become increasingly hard to attain. While it not expected that these changes will cause the industry in Japan to fall behind that of the other two countries in the Triad, it is likely that its rate of productivity growth will be difficult to sustain.

The U.S. and Germany Close the Gap

The productivity gap between the U.S. and Japan will probably not be completely eliminated in the near future. However, it should become narrower as the U.S. reaps the benefits of its restructuring. In addition, as productivity in both countries improves, the relative importance of any gap declines. Once a given car can be made in 18 or 22 hours with very low defect rates, as it can be in the better plants of Japan and the U.S., the basis of competition begins to shift to design and marketing differentiation, with the few hours of labor gap becoming less significant.

The future of the industry in Germany is not so certain, however. The OEMs there are attempting to face the challenge of increased global competition through joint ventures, major cost cutting, and benchmarking programs. The gap which they must overcome, though, is much larger than that of the U.S., and the obstacles

Exhibit A - 25

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES

AUTOMOTIVE ASSEMBLY INDUSTRY

● Important
○ Secondary
X Undifferentiating

External factors

- Market conditions
  - Demand factors ●
  - Relative input prices/factor availability X
  - Other industries X
- Policy and regulation
  - Macroeconomic conditions ○
  - Competition rules and concentration rules ○
  - Corporate governance rules ●
  - Labor rules and unionism
  - Other regulations (tariffs, nontariffs) ●

Nature of competition ●

Production process

- Output
  - Mix, variety, quality X
- Production factors
  - Capital (intensity, vintage, technology) ○
  - Scale X
  - Design for manufacturing ●
  - Basic skill of labor, intrinsic motivation ○
  - Raw materials, parts ○
- Operations
  - Capacity utilization X
  - Organization of functions and tasks ●

LABOR PRODUCTIVITY

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which stand in the way are also more formidable. However, the necessary commitment to truly improve has apparently finally arrived.

Various factors have combined to create this commitment. On the one hand, customer loyalty for domestically produced cars is continuing to decrease in Germany and Europe . On the other hand, the still small but rapidly growing share of transplants in the EC, especially in the U.K., is imposing even more pressure on the rest of the European industry. Also, U.S. companies operating in Germany have learned how to become more competitive, partly based on the transfer of experience from their sister divisions in the U.S.

Furthermore, the increasing competitive threat is sharpened by the current trend in the EC to continue to ease restrictive regulations. Not only has there been a weakening in the administrative and technical borders within the EC, but the EC has adopted a plan to further lower import restrictions, especially with regards to Japanese producers (although this process is being bitterly debated and reviewed in the current recessionary period).

The necessity to improve productivity in Germany, however, will inevitably clash with other external factors such as corporate governance rules, labor regulations and unionism, which we addressed previously. However, if the industry is to survive in a global marketplace, these obstacles must be overcome.

SUMMARY AND POLICY ISSUES

We have discussed the car assembly industry as a case example of a core manufacturing industry. We have found large productivity gaps between Germany and the U.S. and, to a lesser extent, between the U.S. and Japan. As summarized in Exhibit A-25, the organization of functions and tasks and design for manufacturing and the complexity associated with them are the key differentiating factors on the level of the production process. The availability of parts which are easy to assemble, capacity utilization, and intrinsic motivation also contribute to the productivity gap. On a higher level, the observed productivity differences can be traced back to differences in the nature of competition in 1990, and to some extent even earlier. The major causes of productivity differences on the level of external factors include customer preferences, regulatory constraints, the joint effect of corporate governance rules and labor rules, and unionism. Macroeconomic conditions and competitive and concentration rules play a more minor role.

From this study we reach the fundamental conclusion that external factors, upon which governments most often focus their policy efforts, can result in a substantial hobbling of a country's ability to "force" an industry to leading productivity levels. This conclusion was true of the industry in the U.S. before about 1980, and is still applicable to Germany. In the German case, the automotive industry represents the most dramatic example of how originally very beneficial

elements of the "social market economy" have begun to hinder productivity growth.

We will discuss policy issues first in terms of Germany, where the productivity issue is most salient. Germany has three options. First, it could try to replace its vanishing protective borders with new ones against imports, and against the emerging transplants in the U.K. and Spain. This move would most likely place the current EC institutional set-up at risk, since it would make necessary limits at the German border which violate fundamental principles of the EC. Second, Germany could follow a passive approach by leaving all activity to the industry and to other agents who have a stake in the automotive industry. However, Germany's best hope is probably to adopt a third way: a policy agenda designed to ease the transition of the automotive industry to higher labor productivity. This agenda could entail deregulating the labor markets on the one hand (e.g., reducing work rules, redesigning incentive systems, etc.), and introducing more competitive elements into the market for corporate control on the other (e.g., permitting or even encouraging the merger of weaker firms by stronger ones), while retraining workers to adopt to more productive practices, or to enter other occupations. The recent substantial restructuring efforts in the automotive industry in Germany raises hopes that in the future these operations will come close to the productivity leaders in the world.

As for American policy, we can observe that exposure to competition in the late 1980s has helped reduce the productivity gap, and that any action now to decrease such exposure through protectionist measures would most likely be counter-productive. The U.S. is well on track to virtual parity with the Japanese OEMs, and probably would do best to simply continue its present course.

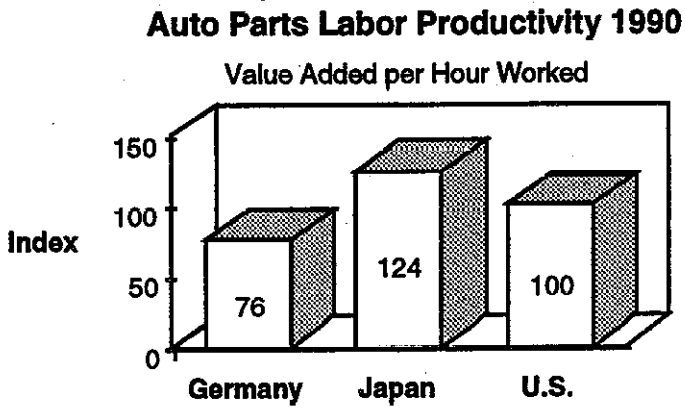
Germany and the U.S. must recall, however, the limited impact of government action on free markets. The fact that Toyota leads the world in productivity, but is itself atypical within Japan, demonstrates that the best a state can do is create conditions favorable for the emergence of a Toyota. It cannot legislate such a company into existence.

As for Japan, the policy issues in the high-growth 1980s are only now emerging, as the OEMs are crippled by slowing demand at home and abroad. Continued success for the Japanese OEMs will depend on how well and quickly they adapt to a low-growth/high yen environment. Steps already being taken in this direction, including increased overseas output, some reduction in domestic capacity, renewed efforts to cut product complexity, etc., may already be having positive effects. If this is indeed the case, the U.S., and especially Germany would be well-advised to redouble their efforts to further increase productivity levels, since a Japanese automotive industry that can successfully survive its current problems will likely re-emerge as an even more formidable competitor in the mid-1990s.

In summary, competition appears to be good for the automotive assembly industry wherever it is located, although it may bring with it short-term, painful dislocations

in employment, as companies strive to respond and improve. Policy efforts are therefore best focused on encouraging conditions that favor open competition, and encouraging companies of any nationality to invest freely (e.g., in transplant operations), as the market dictates. After these basic conditions are set in place, governments and countries should step aside, permitting the best companies to move ahead. This path is most likely to lead to sustainably strong industries around the world.

AUTO PARTS INDUSTRY CASE STUDY SUMMARY



Balance of pressure and cooperation between OEMs and suppliers drive improvements in productivity.

The high productivity of the auto parts industry in Japan can, in part, be traced to the same factors which make the Japanese automotive assembly industry highly productive. State-of-the-art manufacturing techniques are transferred from automakers to their suppliers. Given the close-knit relationships between parts suppliers and the auto assembly companies, innovative techniques originating in one are easily transferred to the other. Design for manufacturing and the organization of labor are critical in explaining the productivity advantage of the Japanese auto parts industry, while the use of technology and inherent worker skills have less explanatory power.

On a higher level, the differences in productivity across the three countries are rooted in differences in industry structure. **Japan has a tiered structure of suppliers, while in Germany and the U.S. there is a flatter structure in which both large and small suppliers interact with the original equipment manufacturer (OEM).** The result of this difference in organization is that, in Japan, the number of direct suppliers to the OEMs is much less than in Germany or the U.S. However, because the division of labor in Japan is more pronounced, there are more parts producers in total in Japan than in Germany or the U.S. This tiered structure helps the entire auto industry and its suppliers reduce the level of operational complexity, and thus cost.

This industry structure in Japan and the resulting low number of supplier-OEM contacts have also affected the way these relationships are managed on a day-to-day basis. In Japan, auto parts companies have relationships with OEMs which are characterized by a **balance between cooperation and pressure from the OEMs.** In the U.S., most contracts between automakers and parts companies have been short term, and in this relationship, most of the bargaining power lies with the automaker. If suppliers increase productivity, most of the economic benefit flows to the automaker in the form of lower prices. In Germany, the arms-length relationship between auto assembly companies and their suppliers is also a barrier to productivity improvement. As a result, U.S. and German parts suppliers have less incentive to become more productive. In Japan, the automakers' relationship with its parts suppliers is far more cooperative, but at the same time intense. This is reflected in the payment system which attempts to guarantee the parts supplier a reasonable margin, while at the same time providing strong incentives for productivity improvement.

PRODUCTIVITY IN THE AUTOMOTIVE PARTS INDUSTRY

The automotive parts industry in Japan has overtaken its U.S. counterpart in terms of labor productivity, and remains well ahead of the industry in Germany. The differing nature of relationships between assemblers and their suppliers across the three countries is at the root of these differences in productivity, and manifests itself in the varying methods of production organization and design for manufacturing.

The automotive industry as a whole plays an important part in the health of most industrialized economies. While this fact normally draws attention to the vehicle assemblers (e.g., Ford or Fiat), the truth is that more people are employed, and more value added is created, by automotive parts suppliers. In fact, this segment of the industry is the largest supplier industry in the world. As discussed in the cars case, the parts industry obviously plays a crucial role in the success or failure of the automotive assembly industry it supports.

While the parts industry is linked in partnership with the assembly industry, the two are actually very different on a number of fronts. First of all, there are relatively few assemblers, but many parts suppliers; there are slightly more than a dozen or so major assembly players worldwide, but thousands of parts suppliers in each of the leading economies. Thus, parts suppliers are, on average, very small compared to the assemblers. In Germany, for instance, auto suppliers have become the epitome of the medium-sized firm. However, while the vast majority are small firms, suppliers such as Bosch in Germany and Nippon Denso in Japan have sales of over $10 billion. Other major suppliers include TRW and Allied-Signal in the U.S., Aisin Seiki in Japan, and Mannesmann and Siemens in Germany.

The automotive supplier industry has come into the spotlight of public discussion as a result of the potential impact of this industry's restructuring (triggered by original equipment manufacturer – OEM – restructuring) on future employment in all three countries. Our goal for this case study is to contribute to the current discussion in three ways:

- First, our measures for labor productivity – based on value added, industry purchasing power parities (PPPs), and capital intensities – of the auto parts industries in Germany, Japan and the U.S., give a top-level insight into the performance of the three industries. They show, as of 1990, that operations in Japan have the highest productivity, with the U.S. substantially behind, and operations in Germany at an even lower level.

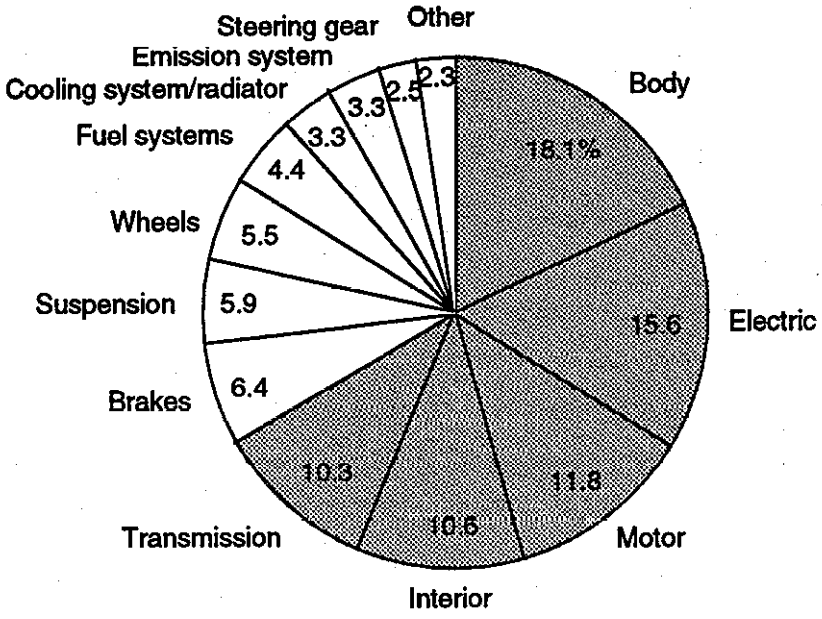
- Second, our time series analysis of relative performance shows how the automotive parts suppliers in Japan reacted to changes in the automotive assembly industry during the second half of the 1980s. They increased

Exhibit B - 1

EXAMPLE: EC

PRODUCTION SEGMENTS OF CAR PARTS SUPPLY INDUSTRY

Percent of production value



Source: Panorama of the European Community, 1991-92

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Exhibit B - 2

BUSINESS SYSTEM OF AUTOMOTIVE PARTS SUPPLIERS

	R&D	Componentry	Subsystems	Systems
Example	• Fuel combustion science	• Fuel injectors • Fasteners	• Speedometers • Door locks	• Car seats • Fuel systems
Production process	• n/a	• Mechanical • Cells, transfer lines	• Assembly (manual or automated)	• Mechanical and assembly • Significant electronics production
Supplier type	• Concentrated in larger firms	• Very small to very large	• Mid sized	• Very large, mid sized

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their productivity significantly, whereas in the U.S. productivity seemed not to grow during this time.

¶ Third, we focus on the nature of the relationship between suppliers and OEMs as a key determinant influencing the labor productivity of suppliers. We also illustrate how competition among OEMs influences suppliers through these relationships.

Our report is divided into three sections, the first of which overviews the automotive parts industry in the three countries analyzed. This section is followed by a discussion of the methods employed to measure output and productivity. The last section explores the causes of labor productivity differences among the three countries, and the implications these differences have for the future of each industry.

THE AUTOMOTIVE PARTS INDUSTRY

Industry Definition

The term "automotive parts" covers a wide array of products. A typical car may have 20,000 parts, depending on how far subassemblies are broken down. These parts range from large stamped body panels, to machined transmissions, to electro-mechanical fuel systems, each with varying degrees of importance to the industry. As Exhibit B-1 illustrates, five major classifications of parts account for about two-thirds of value added in the industry. In the United States these products fall under the heading "Motor Vehicle Parts and Accessories" (SIC 3714, 3592, 3694). The comparable industry code in Japan is 3113 while in Germany they are combined with cars under 3311 and 3314. As with all census data, we only capture those companies whose primary business is in automotive parts.

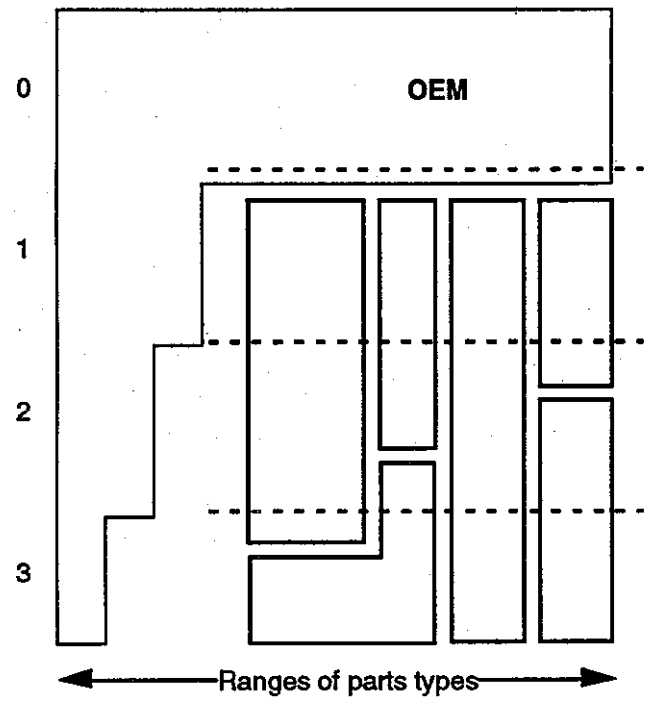
The Business System And the Production Process

As mentioned in our auto assembly industry case study, parts suppliers, vehicle assemblers, and car dealerships are the three main players in the overall automotive industry. The parts suppliers form the first link of this value chain. In turn, the supplier segment has its own value chain. As Exhibit B-2 shows, in addition to R&D, there are three stages of production: components, subsystems, and entire systems. The last two stages involve assembly of parts from the previous stages. In general, production becomes more automated and plants become larger as one moves from components to entire systems.

While the above paragraph describes the different stages of the production process, it does not necessarily reveal anything about the legal borders of the firm. Some firms and some plants are involved in all three stages, while others tend to

Exhibit B - 3

MODES OF PARTICIPATION OF LEGAL UNIT IN U.S. AUTOMOTIVE SUPPLY



Description	Typical operating margins in U.S. Percent
Vehicle integration	5-10%
Vehicle systems	0-10
Subsystems	10-15
Componentry	10-20

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specialize in one or two (Exhibit B-3). The former paradigm is more characteristic of the U.S. and Germany while the latter is common in Japan, where a three-tiered system results most often in highly-specialized plants.

The production equipment used in these plants tends to be dedicated to automotive parts, which is one reason why parts suppliers tend to serve the automotive industry exclusively.

Industry Size

As mentioned earlier, the automotive parts industry is, in fact, larger than the assembly industry, both in terms of employment and value added. As Exhibit B-4 shows, the parts industry in Japan employed more people than the industry in the U.S. in 1990. The trends in the two countries are not the same, however. While employment in the U.S. fell between 1987 and 1990, employment in Japan increased.

With respect to production, Japan increased its output during the same 3 years by about 50 percent, reaching a level of output more than double that of the U.S. (Exhibit B-5). Similarly, Japan dramatically improved its level of value added during this period. Part of this gain was due to increased exports to newly-built Japanese assembly transplants around the world.

Role of the Automotive Parts Industry

The parts industry is important to the assembly industry for a number of reasons. First of all, it can contribute approximately a third of the value-added of the factory price of a car. Second, parts suppliers can have a strong impact on the level of final customer satisfaction. Aside from obvious quality factors, serviceability and availability of parts are also important; after the design of the car itself, these factors rank highest in importance to consumers.

A third factor which accentuates the importance of suppliers to assemblers is the role they play in incorporating technological innovations in the car. The clearest example is the growing use of automotive electronics and computerization in everything from instruments and anti-lock brake systems (ABS), to passive restraint systems (airbags). In addition to helping integrate these systems into the car, the suppliers often serve as the source for technological innovations in such products.

PRODUCTIVITY RESULTS

Adjustments

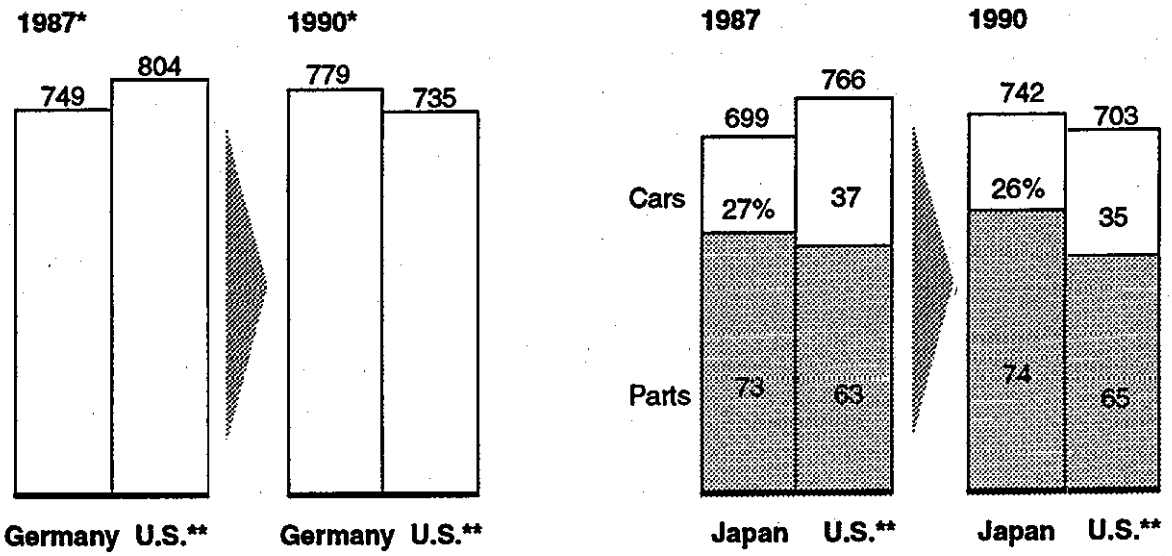
The enormous diversity of output in the automotive parts industry as well as the different degrees of vertical integration of parts companies, makes it impossible to measure physical productivity directly. Thus, at the heart of our productivity

Exhibit B - 4

AUTOMOTIVE EMPLOYMENT IN ASSEMBLY AND PARTS

Thousands

Case study focus



* Cars and Parts combined

** U.S. numbers different because U.S./Germany comparison includes only companies with more than 20 employees and also includes auxiliary units

Source: Census of Manufactures; McKinsey analysis

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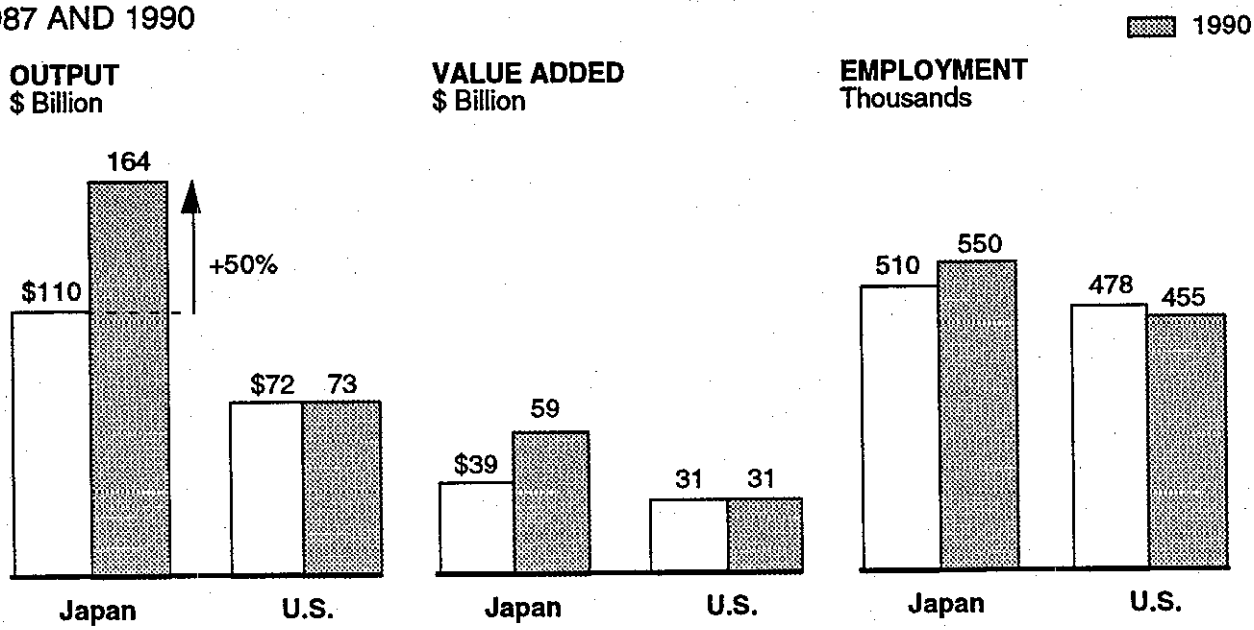
Exhibit B - 5

AUTOMOTIVE PARTS INDUSTRY

1987 AND 1990

1987
1990



Note: 1987 PPP = 120 ¥/$; 1990 PPP = 111 ¥/$

Source: Census of Manufactures; McKinsey analysis

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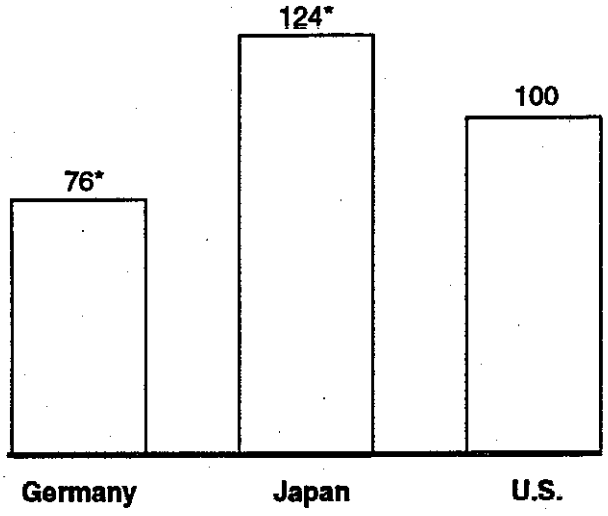
Exhibit B - 6

AUTOMOTIVE PARTS LABOR PRODUCTIVITY 1990

VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED

Index: U.S. = 100



* Estimated from McKinsey analysis dividing parts from cars

Note: Adjusted for capacity utilization differences

Source: Census of Manufactures; McKinsey analysis

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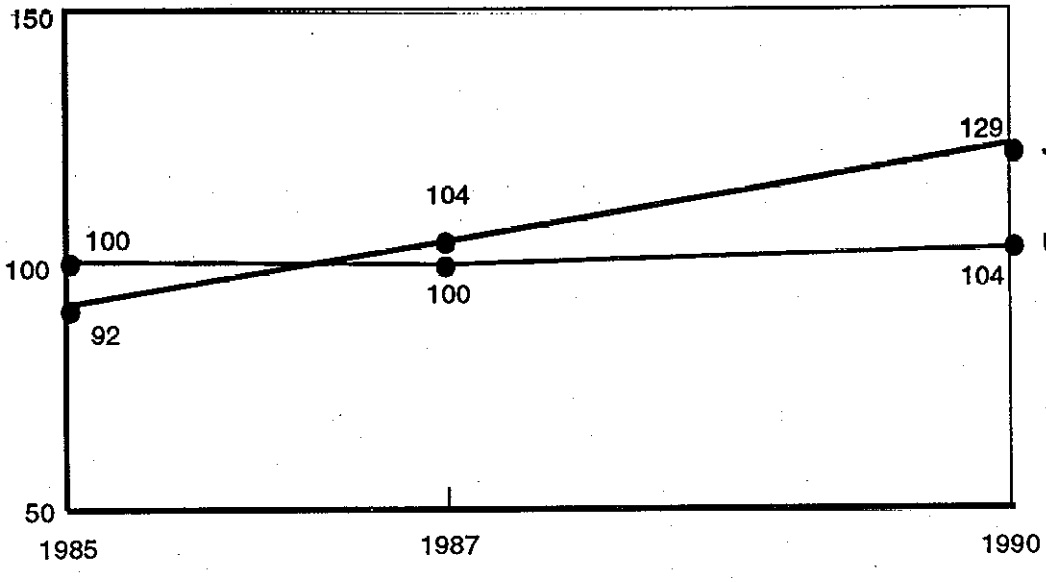
Exhibit B - 7

REAL LABOR PRODUCTIVITY CHANGE 1985-90

AUTOMOTIVE PARTS INDUSTRY

VALUE-ADDED AT INDUSTRY PPP PER HOUR WORKED

Index: U.S. 1985 = 100*



* Adjusted for capacity utilization

Source: Census of Manufactures; McKinsey analysis

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measurements are data on value added, employment, hours worked, and industry PPPs.

However, before comparing the productivity of the automotive parts industries in Germany, Japan, and the U.S., we had to go through a process very similar to that employed in the automotive assembly case, in order to deal with the issues of industry coverage, reporting methods, and product mix adjustments. As with automotive assembly, capacity utilization differences lowered U.S. productivity in the automotive parts industry by roughly 10 percent in 1990.

Labor Productivity

After making the needed adjustments, the aggregate results of our analysis show that the automotive parts industry in Japan in 1990 was 24 percent more productive per hour worked than the industry of the U.S. By contrast, productivity in Germany was three-quarters of that of the U.S. (Exhibit B-6). As in the automotive assembly case, productivity in Germany had to be derived indirectly from McKinsey data. However, cars and parts taken together were compared with the overall automotive productivity figures derived from census data, and the results correlated well.

Because of the nature of the German data, we could conduct a time series analysis only for the Japan/U.S. comparison. The results shown in Exhibit B-7 reveal that, whereas in 1985 the industry in Japan was less productive than that of the U.S., by 1987 the two had reached parity. Furthermore, the industry in Japan continued to improve from 1987 to 1990 by over 20 percent, but productivity increased only slightly during the same time period in the U.S. This minimal improvement was due, in part, to the slowdown in the U.S. economy and the resulting drop in new car sales, which, in turn, lowered factory capacity utilization. In contrast, the OEMs in the U.S. were able to remain relatively close to OEM productivity growth rates in Japan.

This rather striking increase in auto parts manufacture labor productivity in Japan, in contrast to the U.S. case, is fairly well corroborated, if only indirectly, by an independent empirical study performed by Cusumano and Takeishi, over a similar time period (1987 to 1990). Their study compared OEM/supplier interactions for four different parts families (shock absorbers, instrument panels, meter clusters, and front seat assemblies) in both Japan and the U.S. The results (Exhibit B-8) show traditional U.S. suppliers passing on annual price increases to their OEM customers even as their Japanese counterparts achieved regular price savings, indicating at least directionally the persistence of the productivity gap. The Japanese transplants in the U.S., working with a mixture of Japanese and U.S. parts, achieved a middle-ground level of performance, all the more impressive since all of these plants were still in a start-up phase at this time, but thereby demonstrating the "portability" of Japanese techniques for labor productivity maximization.

Exhibit B - 8

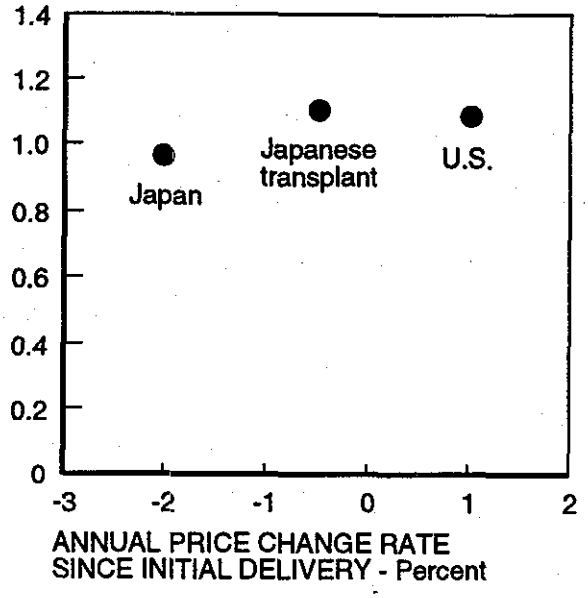
DIFFERENTIAL PRICE AND QUALITY PERFORMANCE OF PARTS SUPPLIERS 1987-90

U.S., JAPAN, AND JAPANESE TRANSPLANTS IN THE U.S.

4 PRODUCT LINES

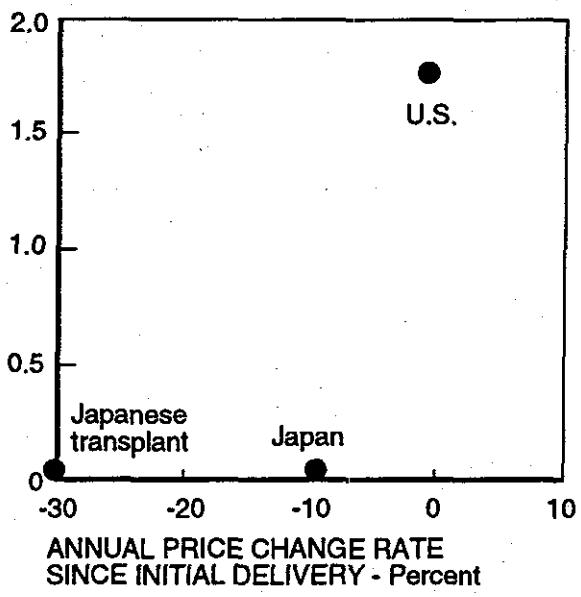
PRICE TO OEM

INITIAL/TARGET PRICE



PART DEFECT RATE

INITIAL DEFECT RATE- Percent



Note: Price ratio is actual price at production start compared to OEM's original target price; Japan = Japanese suppliers in Japan; U.S. = American suppliers in U.S.; Japanese transplants = any supplier selling to a transplant in the U.S.

Source: Cusumano and Takeishi survey of 10 OEMs, 1991

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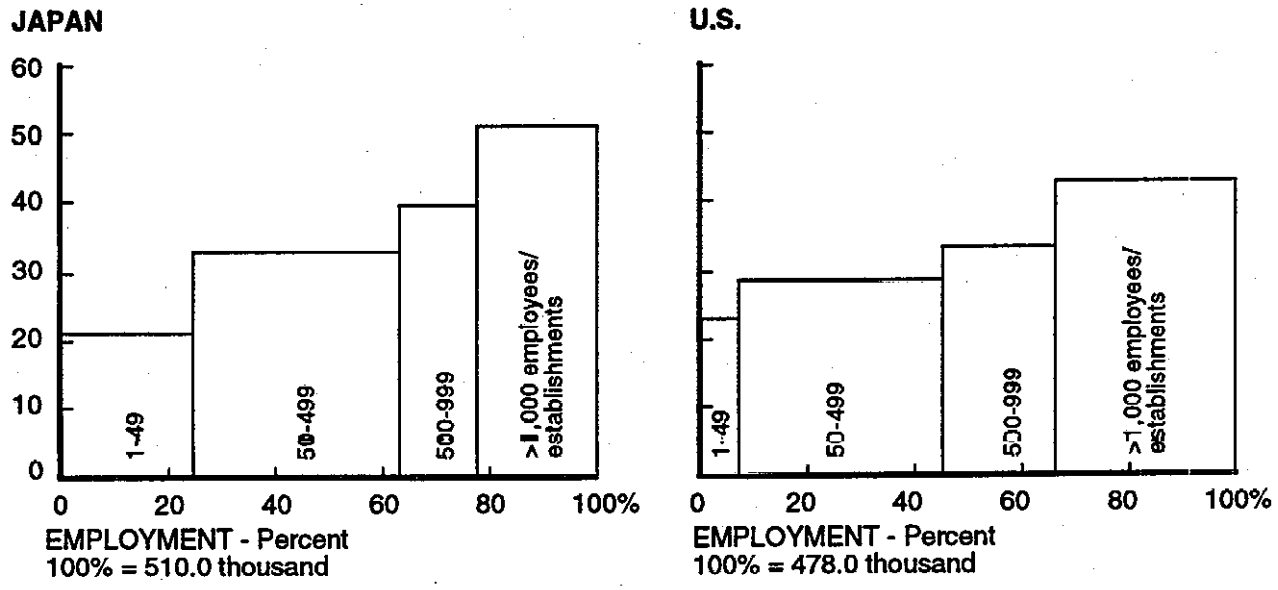
Exhibit B - 9

LABOR PRODUCTIVITY DIFFERENCES BY ESTABLISHMENT SIZE 1987

AUTO PARTS

VALUE ADDED PER HOUR WORKED

U.S. dollars



Source: National Employment Census data

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Exhibit B - 10

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES 1990

AUTOMOTIVE PARTS

External factors	Nature of competition	Production process	Labor productivity
Differing competitive intensities among auto assembly companies Management focus in U.S. is on assembly sector	**Germany:** Long-term, but passive, relationship; few improvement incentives **Japan:** Balance between pressure and incentives Active transfer of product design and assembly knowledge from OEM to supplier **U.S.:** Mainly price "squeezes" Significant switching behavior	Advantages of Japanese suppliers in product design and organization of functions and tasks Minor differences due to capacity utilization	Large productivity advantage of Japan vs. U.S. - Japan = 124% - U.S. = 100% - Germany = 76%

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Note that the benefits accruing to the OEMs in Japan from their strong supply base extended beyond price reductions. While cutting prices, suppliers in Japan were also improving on already very low defect rates, saving their OEM customers significant inspection and rework costs. The U.S. base was also improving, but at a slower rate and from a much higher initial defect level. Again, the transplants occupied the middle ground, starting from a defect rate higher than in Japan, but cutting it down at a very fast rate.

The productivity figures stated above are averages for all establishment sizes. As Exhibit B-9 shows, however, there are wide differences in relative productivities across plant sizes. In both Japan and the U.S., there appear to be significant economies associated with larger plants. The disparity is especially striking in the case of Japan, where there are differences of almost 150 percent between the largest and smallest plants. This phenomena reflects the so-called "dual economy" in Japan. The automotive parts industry here takes the form of a three-tiered system of suppliers, in which third-tier suppliers build simple components, which are then assembled into subsystems by the second tier, which, in turn, go to the first-tier suppliers for final assembly into systems and cans. The components producers tend to be both smaller and relatively less automated, requiring more labor per unit of output.

CAUSES OF PRODUCTIVITY DIFFERENCES

We will examine the reasons for the observed differences in productivity at three levels (Exhibit B-10). The first is causality at the production process or firm level, that is, the way companies organize themselves to do business. This level includes the degree to which companies take advantage of technology, as well as their level of efficiency in utilizing resources. While this level of analysis explains the most immediate sources of productivity differences among the three industries, the second and third levels attempt to explain why the production process is set up as it is in the first place. Here we look at differences in the structure and competitive behavior of the industry, along with external factors which can influence the production process.

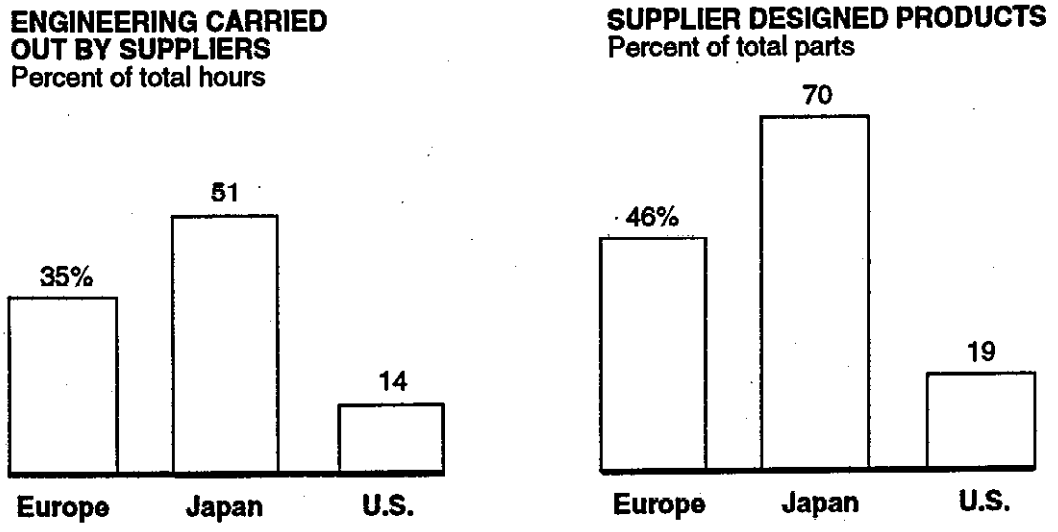
Causality at the Production Process Level

The productivity gaps which exist between Germany, the U.S., and Japan are explained by two differences in the production processes across the three countries: the organization of firm functions and tasks, and the nature of product design.

¶ Organization of functions and tasks as a causal factor. Primary among the reasons why parts suppliers in Japan are so highly productive is the way in which they organize themselves. The advantages in this area come in large part from their close relationship with the OEMs. Many of the

Exhibit B - 11

PRODUCT DEVELOPMENT



Source: "The Machine That Changed The World," MIT Press

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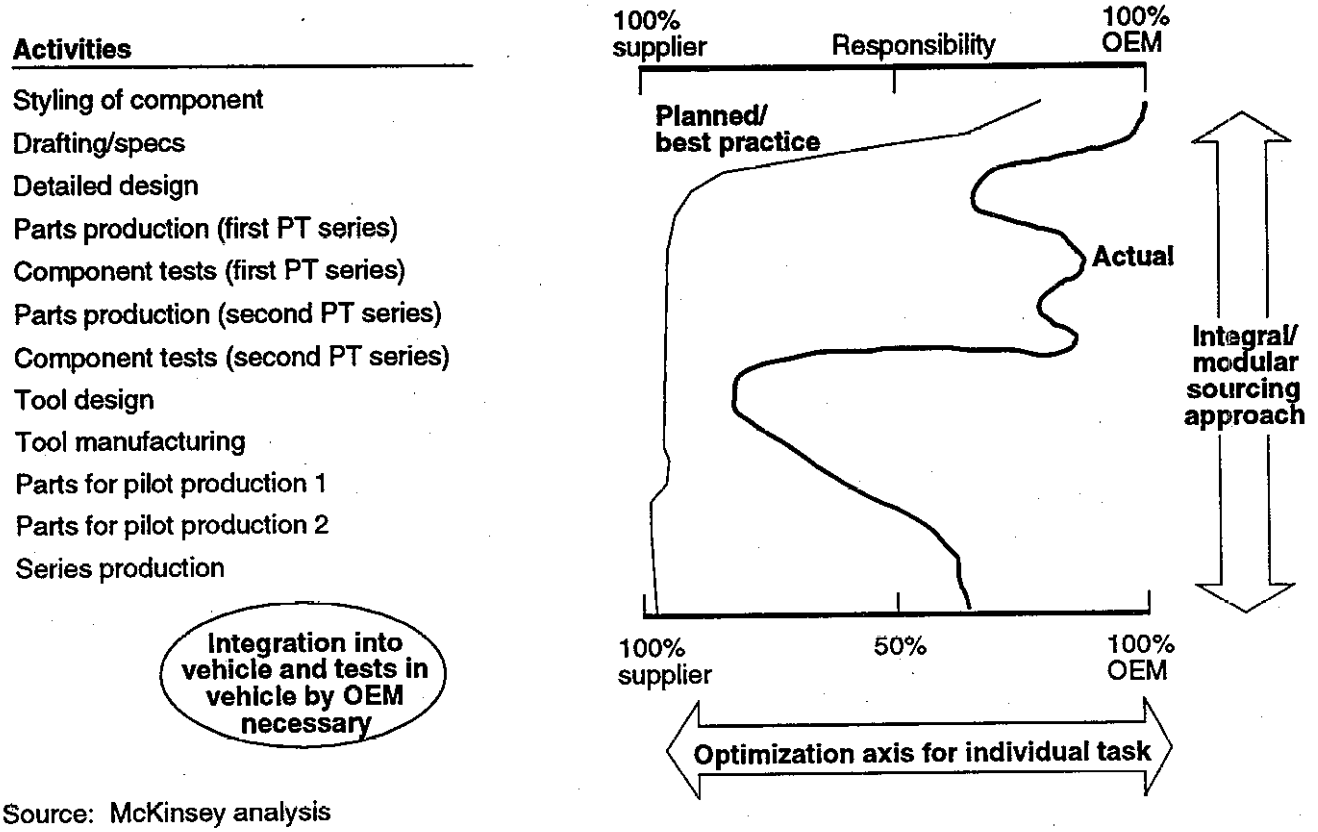
Exhibit B - 12

EXAMPLE: INTEGRATION OF SUPPLIERS IN GERMANY WITH OEM

OEM/SUPPLIER TASK SHARING FOR A TYPICAL MODULE



Source: McKinsey analysis

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techniques of lean production first adopted by the assemblers were later transferred to the parts suppliers. Therefore, many of the organizational principles are similar to those mentioned in the automotive assembly case. They include integration versus specialization of labor, and continuous improvement through suggestion systems and front-line empowerment. OEMs further help suppliers by getting them involved in the vehicle design process early, working together on standardizing parts for ease in production and assembly.

¶ Design for manufacturing and complexity as a causal factor. As with the assembly industry, design for manufacturing can have a significant impact on productivity in the parts business. In Japan, OEMs have made major efforts to design products for manufacturability and ease of assembly, thus allowing both themselves and their suppliers to cut costs. Furthermore, suppliers in Japan are given much more responsibility for designing products (Exhibit B-11), allowing them to make improvements more easily and frequently. In contrast, many of these responsibilities are retained by the OEM in Europe, presumably including Germany (Exhibit B-12). In addition, there are fewer dedicated factories in Germany, and many more highly specialized factories for particular parts and components in Japan.

Costs of the suppliers at all tiers can be further reduced by designing primary components for easy assembly and subassembly. These benefits are enhanced by the standardization of parts across car models. The major outcome of design for manufacturability is that suppliers need to make fewer parts, and those that are needed can be produced in fewer steps with far less labor.

Nippon Denso and other major Toyota suppliers have most closely followed the above principles, inspired by Toyota, and have achieved especially high productivity levels as a result.

Having discussed the two major causal factors, we now turn our attention to factors that appear to be of minor importance, or non-differentiating.

¶ Capital intensity and technology as a minor causal factor. The existence of advanced labor saving technologies would imply that a substantial part of labor productivity differences can be explained by differences in the amount and kind of capital put in place. Surprisingly, the data and analyses do not suggest such a relationship (Exhibits B-13 and B-14). We do not find evidence to support a claim of correlation between capital intensity and labor productivity in this industry. Although investment in recent years has been higher in Japan than in the U.S., Japan was building up an existing capital stock which was 17 percent lower than that in the U.S. However, the same is not true for Germany; capital investment per labor hour lagged behind that in Japan and even the U.S. The renewal of

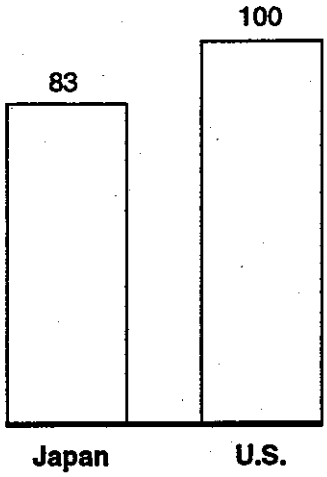
Exhibit B - 13

CAPITAL INTENSITY

AUTOMOTIVE PARTS INDUSTRY

1987 CAPITAL STOCK $ PER EMPLOYEE PERCENT

Index: U.S. = 100



Source: Census of Manufactures; national investment statistics; McKinsey analysis

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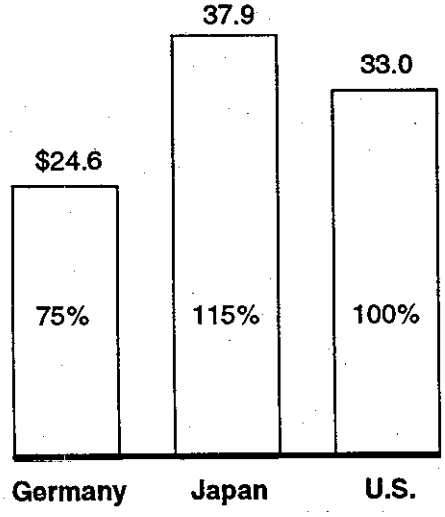
Exhibit B - 14

ACCUMULATED INVESTMENT 1987-90

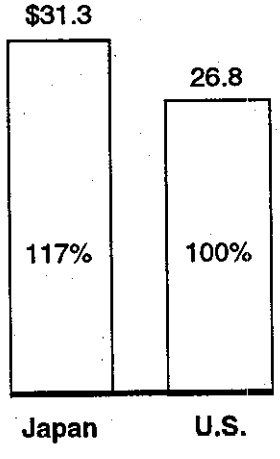
1987 $ THOUSANDS PER EMPLOYEE

Index: U.S. = 100

TOTAL AUTOMOTIVE
ASSEMBLY AND PARTS



AUTOMOTIVE PARTS



Source: Census of Manufactures; McKinsey analysis

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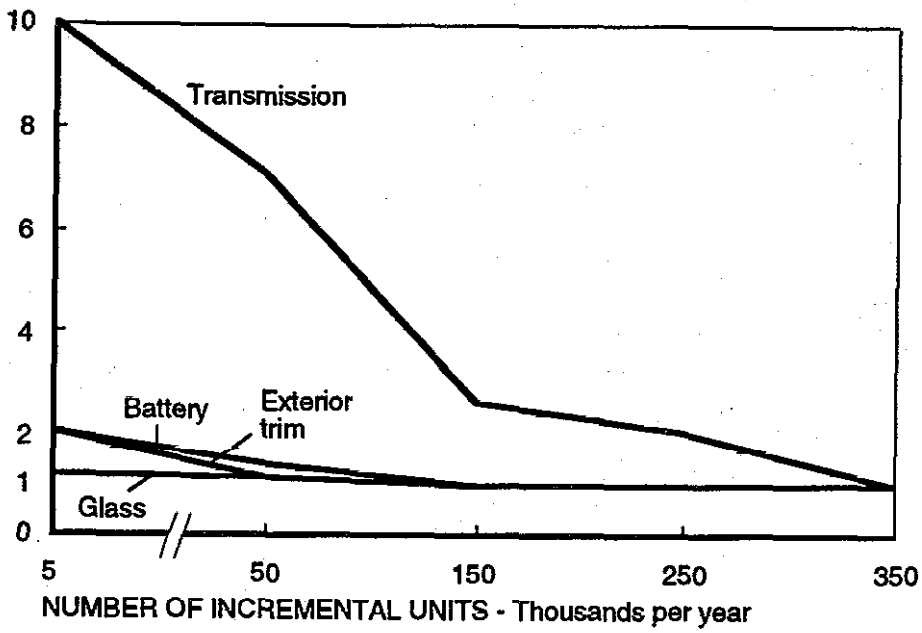
Exhibit B - 15

CRITICAL SCALE FOR AUTOMOTIVE PARTS

RATIO OF COST DISADVANTAGE COMPARED TO OPTIMAL SCALE

Optimal scale = 1

EXAMPLE



Source: McKinsey analysis

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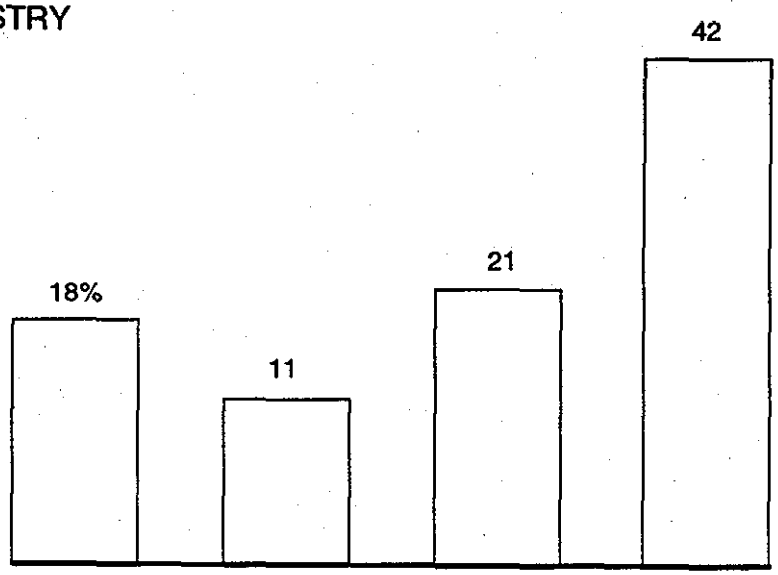
Exhibit B - 16

LABOR PRODUCTIVITY GROWTH IN JAPAN BY SIZE OF ESTABLISHMENT 1987-90

AUTO PARTS INDUSTRY

Percentage change



Source: Census of Manufactures; McKinsey analysis

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factories and the introduction of new production techniques in Germany were not pursued in a manner similar to that of the larger Japanese parts operations.

¶ Scale as a non-differentiating factor. Productivity in the U.S. is lower than in Japan even though there are more larger plants in the U.S. As Exhibit B-15 illustrates, however, many parts reach critical incremental production scale relatively quickly; hence, scale does not play as important a role as it does in the assembly industry. (Note that many parts for which scale is very critical, such as engines and transmissions, are manufactured in-house by the OEMs.) Only a few parts require very high output volumes to reach critical scale for production at the margin.

¶ Basic skill differences as a non-differentiating factor. One of the most discussed and debated issues in this field is whether the edge enjoyed by Japanese companies in terms of labor productivity is due to inherently superior work force skills. In tackling this question, we begin by recognizing that the skills workers use and apply obviously have different impacts if the organization of tasks, as set up by management, differs. The question to answer is whether, companies could achieve Japanese levels of productivity with U.S. workers, provided those workers are given similar training to that received in Japan. The experience of Japanese automotive supplier transplants in the U.S. suggests that achieving similar levels of productivity with U.S. workers is quite possible.

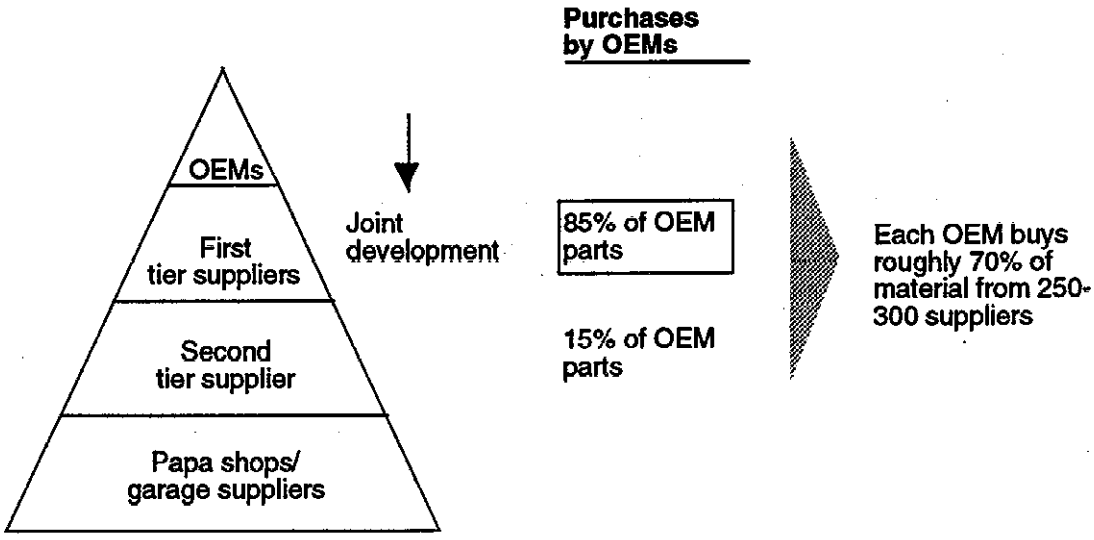
The distribution of skills within the industries in Japan, Germany and the U.S., however, is not the same. In the U.S., skills are distributed more uniformly across plants, while in Japan there is a strong correlation between the size of the plant and the skills of the work force. While overall skill levels average out across the countries, the higher-skilled workers in Japan seem to be much more concentrated in the largest plants. The situation in Germany is very different, with basic skill levels being high across the board. However, this high skill level has not been translated into high productivity.

Interestingly, a remaining issue is how the dramatic productivity growth achieved in Japan in the latter half of the 1980s was distributed. As Exhibit B-16 shows, this growth was heavily concentrated in the largest plants, which is indicative of the penetration of good manufacturing techniques into suppliers in the first and even second tiers. As expected, the most productive plants also gained market share. During this time, the automotive parts industry in Japan also embarked on a substantial investment campaign. Overall, capital intensity in 1990 almost reached the level of the U.S. industry, whereas Germany lagged behind. This implies that the lower labor productivity of Germany is, to some extent, offset by lower capital intensity when one considers total factor productivity.

Exhibit B - 17

STRUCTURE OF PARTS INDUSTRY

JAPAN



Source: McKinsey analysis

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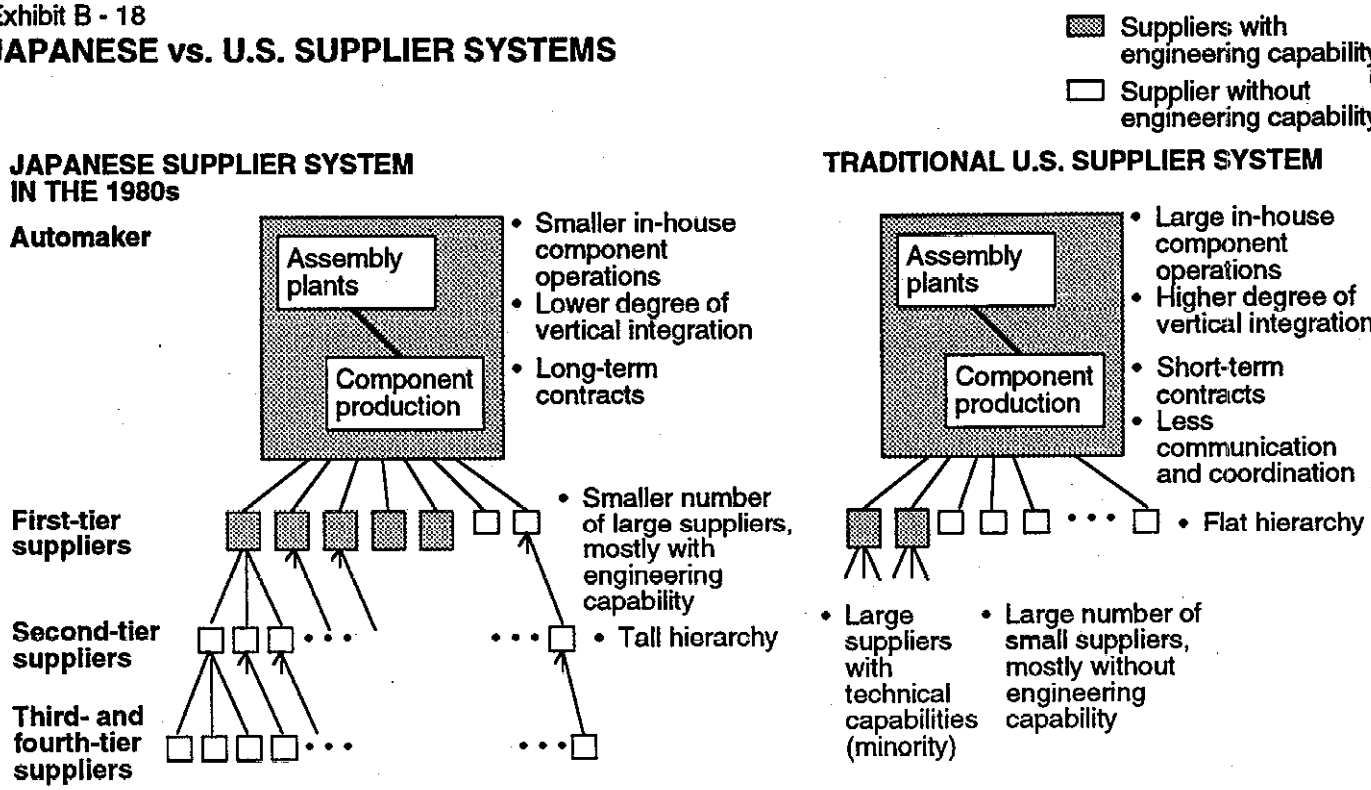
Exhibit B - 18

JAPANESE vs. U.S. SUPPLIER SYSTEMS



Note: This diagram illustrates ideal types of supplier systems rather than reality. The size and number of suppliers in the diagram do not reflect actual data. Only one assembler is assumed in each case.

Source: Product Development Performance

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External Factors and Industry Behavior

Why is it that plants in Japan have been able to sustain such a long period of productivity growth? Why has the industry in the U.S., on average, not been able to follow the productivity improvements in automotive parts plants in Japan. Why is the German parts supplier industry so far behind?

Our analysis of these questions in terms of the nature of competition and other external issues boils down to one determining factor: the relationship of the supplier to the OEM. Industry experts judge a good relationship to be a necessary condition for achieving leading-edge industry performance levels. This issue has two facets which deserve particular elaboration. On the one hand, there are structural differences in the automotive industries of the three countries which define the general relationship between the supplier and the OEM. On the other, there are differences in the way those relationships are managed on a day-to-day basis within the existing structure.

¶ Differences in industry structure. The primary difference in industry structure in Japan relative to the U.S. or Germany is the tiered system of suppliers (Exhibit B-17). By contrast, Germany and the U.S. possess a flatter industry structure in which both large and small suppliers interact directly with the OEM (Exhibit B-18). The result of this difference in organization is that in Japan the number of direct suppliers to the OEM is much less than in Germany or the U.S., which helps to reduce the level of purchasing complexity, and the need to manage numerous direct contacts with suppliers (Exhibit B-19). This relationship is true, not only at the company, but also at the plant level. Smaller span of control by players in each layer makes the subassembly process more efficient. However, because of the tier division of labor within the industry in Japan, Japan still has a greater total of parts producers than the other two nations.

Industry structure also comes into play in terms of vertical integration, which may explain part of the difficulty the U.S. supplier base had in improving labor productivity in the late 1980s. Parts manufacturers vertically integrated into vehicle OEMs make up over one-third of the U.S. parts industry's total sales, in contrast to the Japanese industry, where despite high levels of "affiliation" between OEMs and suppliers (e.g., through management exchanges, minority shareholdings, etc.), OEMs tend to retain little in-house parts production beyond the – admittedly very significant – categories of drivetrain components and body panels.

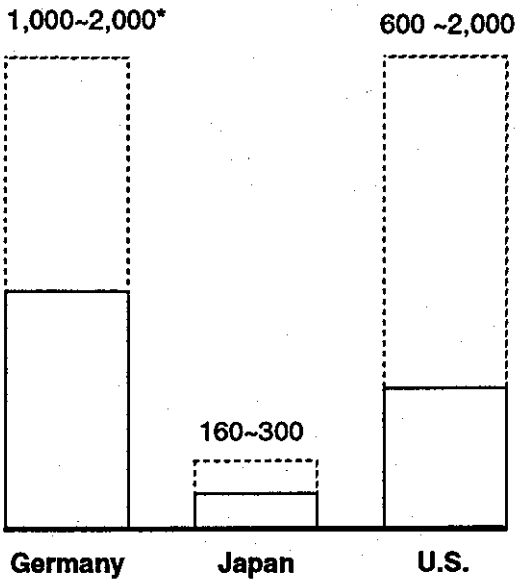
As a result, to the extent that captive parts suppliers exerted a great influence on the overall U.S. parts industry's productivity figures, the unique constraints on these in-house facilities tended to slow the entire industry's progress. These constraints on productivity included parts plants wage rates linked to traditionally high OEM assembly plant levels, limited management flexibility to shift production tasks among workers

Exhibit B - 19

EXTENT OF DIRECT LINKS
BETWEEN OEMs AND SUPPLIERS

DIRECT OEM/SUPPLIER CONTACTS

Per OEM



* Includes contacts to suppliers outside Germany

Source: Census of Manufactures; McKinsey analysis

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Exhibit B - 20

JAPANESE AUTOMOTIVE SUBCONTRACTING SYSTEM FEATURES

Principles and actions	Impact on productivity	Tools for execution
Maximize benefits		
- Leverage supplier skills in development and production	- Less duplication of work - Efforts focused	- Close down OEM capability to do the work
Minimize cost and risk		
- Tier supplier	- Fewer interfaces to manage	- Single point of sales contact - Streamline engineering and manufacturing relations
- Develop close relations		
• Long-term	- Supplier encouraged to invest in labor training and specialized capital	- Long-term contracts - Equity holdings, etc. - Alternative work in downturns - Geographic proximity - Finance weak suppliers - Supplier councils
• Short/mid-term	- Allows rapid response to changing conditions	- Exchanges of managers - Standard "formula" contracts - Supplier cost transparency - Process-step cost focus - Supplier grading - Supplier certification - Profit-sharing rules - JIT penalty/bonus system
Continuously improve	- (Self-evident)	- Market price target-costing method - Exchange productivity tools

Source: Mishiguchi; Smitka; interviews

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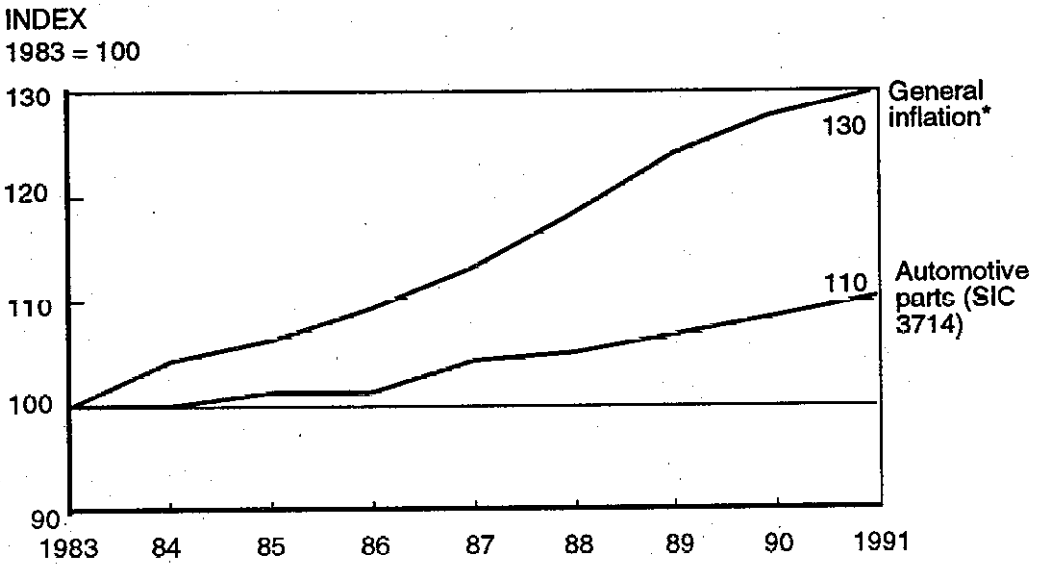
Exhibit B - 21

U.S. AUTOMOTIVE PARTS PRICE INDEX



* GNP Deflator

Source: U.S. Department of Commerce; McKinsey analysis

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and plants (due to similar OEM contract linkages), and the natural tendency of the OEM corporate structure to favor in-house supply despite its often less competitive price levels. The German industry faced similar challenges in enhancing the productivity of in-house supply, especially in very large vehicle assembly "cities," where labor/management dynamics were such that outsourcing of supply to more specialized independent vendors proved difficult to accomplish.

¶ Differences in design and management of relationships. Not only are the structures of the three industries different, but also the ways in which specific suppliers and OEMs interact. Usually this issue is discussed in the context of the Japanese *keiretsu* system. Here, however, we concentrate on some key principles which are applicable to other countries as well. Exhibit B-20 goes into this issue in detail.

- Differences in the incentive systems. In the U.S., most supply contracts have traditionally been short term in nature, as well as often using multiple suppliers rather than sourcing from a single supplier for one type of part, and, consequently, hold the threat that the OEM will switch suppliers once the expire. This fact helps explain why suppliers seem to have given away much of their value surplus in order to retain the OEM's business (Exhibit B-21). A consequence of this "squeeze" of suppliers is that they have little incentive to increase productivity, since the benefits may be captured by the OEM, while the suppliers are saddled with the costs of the improvement. This asymmetrical relationship has been the norm in the U.S. As a result of the nature of these relationships, there have been few successful joint efforts at development. A similar story holds true in Germany, where the OEM often sends a supplier a blueprint for parts and does not expect or necessarily desire any feedback with regards to potential improvements. Although negotiations are based on cost competitive bidding, the complexity of products and features have prevented significant increases in productivity. (As competitive pressures have intensified, however, both these countries have adopted more "Japanese" approaches.)

  By contrast, in Japan the OEM's relationship with first tier suppliers has been a balanced array of incentives to cooperate. Suppliers are encouraged to invest in labor training and specialized capital by exchanging members of management, receiving OEM financing, and employing interlocking equity holdings, among other means. Furthermore, while pricing in the U.S. is dominated by competitive bidding which tends to reduce supplier surpluses to zero, suppliers in Japan have often been guaranteed a minimum gross margin rate (Exhibit B-22) with negotiated reductions in cost over time, forcing productivity improvements. Japanese OEMs know cost components of

Exhibit B - 22

JAPANESE AUTO PARTS PRICING MECHANISMS

Price build-up*

	Factor cost increase rules
Extra compensation	Based on actual performance
Gross margin	Set once for each supplier
Tooling adjustments	Amortized over volume
Direct manufacturing costs	Reduced semiannually for productivity improvement - Labor costs are **not** negotiable
Purchases - Parts - Processing	Negotiable
Raw materials	Negotiable

* Height of bar reflects fraction in sales price

Source: Asunama (various studies); McKinsey Automotive Practice

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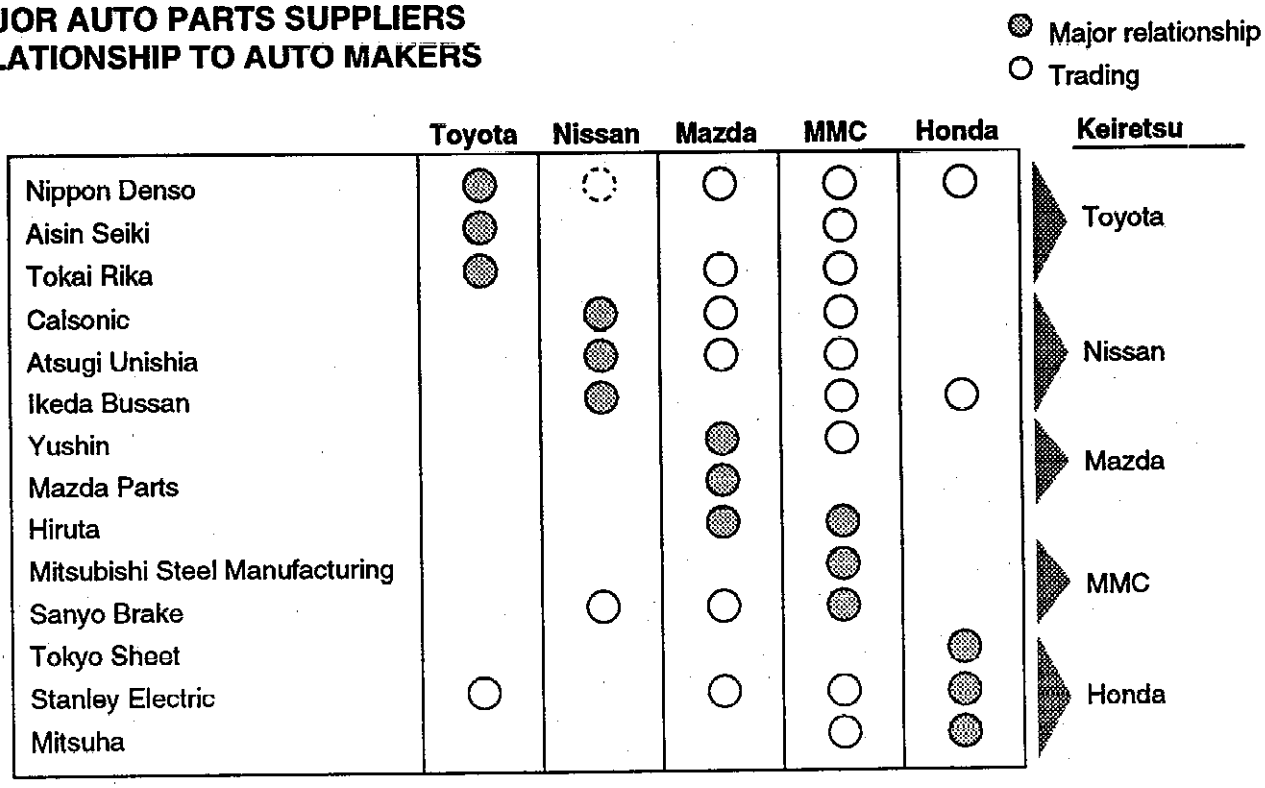
Exhibit B - 23

MAJOR AUTO PARTS SUPPLIERS RELATIONSHIP TO AUTO MAKERS



Source: Yano Data Bank; Financial report

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parts suppliers in detail through joint development and design process of parts. Japanese OEMs delegate the design of parts to first- and second-tier suppliers, while many suppliers in the U.S. are depending on the blueprints from the OEMs. When Japanese OEMs negotiate the prices of parts, they have a standard procedure to estimate manufacturing costs by assessing machineries, raw materials used, manufacturing steps, and production time. Japanese OEMs and suppliers work jointly on improvements in every production task (value analysis). The gains are distributed depending on who suggested the idea. The same procedure is replicated in the relationship between first- and second-tier parts suppliers. This system provides high incentives for productivity improvement on the part of the supplier. The overall result is higher productivity for the suppliers, and lower parts prices for the OEMs.

- Differences in knowledge transfer. In addition to indirect incentives to improve productivity, the OEM also provides the supplier with direct help in the form of consulting services to help improve its business functions and engineer exchanges to help improve its production functions. This practice has spread to the U.S., where Ford, and most of the Japanese transplants, have established supplier "institutes" to accomplish their purposes. Recently, in Japan, but also to some extent elsewhere, OEMs and major suppliers, including cast die manufacturers, are networked to computer aided design (CAD) and computer aided manufacturing (CAM) which are able to transfer design and significantly reduce the development time for new car models.

- Exclusivity of relationships. Part of the reason why the industry in Japan has been successful at integrating the functions of the first-tier suppliers and their OEMs is because of the exclusivity of relationships as laid out in the well-known *keiretsu* system. In order to have better designs for manufacturing, OEMs must have better designed parts with lower defect rates. The companies in Japan follow the concept of building quality into the parts rather than tightening inspection of assembled cars and reworking them when problems arise. In this process, cooperation of and improvement by parts suppliers are crucial. This system not only increases the level of trust, but also improves the ability of the supplier to effectively serve the OEM. For a variety of reasons, including suppliers' desires to grow their business globally, the exclusivity of these links is ebbing, however, and it will be interesting to see what effect this change has on the productivity of suppliers (Exhibit B-23). In the short term there could be improvements based on increased scale, but success in the long run will require standardization of parts across OEMs.

Having discussed the major external factors, and the relationships among the supplier and the OEM, we will not address other less important ones as they are similar to those in the automotive assembly case, and are propagated to this industry through its relationship with the OEMs.

OUTLOOK

The automotive parts industries are undergoing substantial change in all three of the countries analyzed. The one which will undergo the most dramatic changes in the future is the industry in Germany, which is beginning to feel strong pressure to improve performance as a result of the downturn in that country's assembly industry. These firms will also face increasing competition from automotive suppliers in other parts of Europe, as assemblers respond to the "Europe 1992" phenomenon and continue to source more regionally, and less nationally. At the same time, we expect to see the structure of relationships with the OEMs in Germany gravitate toward a tiered structure like that in Japan. OEMs in Germany are trying to simplify their procurement process by reducing their number of direct suppliers. In addition, the relationships they do retain will most likely resemble those in Japan more than the current ones in Germany. This change, is in part, because OEMs are seeking to reduce the development time needed for new products, and suppliers can play a key role in trying to meet this goal, but only if they are assured of the benefits of fuller participation. A new design in the relationship between the two should become the norm in the future. However, overcoming the old paradigm – arm's length at best and adversarial at worst – will not be easy. Regardless, external pressures are expected to result in dramatic changes for the industry in Germany.

As for the U.S., productivity is expected to improve. This outcome, is likely in large part, because the changes predicted to occur in Germany are already well underway in the U.S., especially with respect to improving relationships between OEMs and parts suppliers. This improvement has largely occurred because parts suppliers in the U.S. faced economic pressures earlier than those in Germany, both from the OEMs and from more than 400 Japanese automotive parts transplants that entered the U.S. during the 1980s. The result has been a shake-up in the U.S. parts supplier industry, in which the more productive firms are benefiting from closer relations with the OEMs, while the less productive firms are being forced to either improve, or exit, or drop to a lower tier position.

While Germany and the U.S. are moving closer to Japan in terms of having fewer but closer direct contacts between suppliers and OEMs, Japan is moving closer to the other two in the sense that the exclusivity of relationships is breaking down. This change is due partly to an attempt by the suppliers to increase profits and partly to OEMs trying to achieve greater parts commonality. Whether this trend accelerates, and whether this lack of exclusivity reduces the OEM's willingness to invest in its suppliers, is as yet unknown. (Furthermore, parts plants in Japan will

Exhibit B - 24

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES
AUTOMOTIVE PARTS INDUSTRY

● Important
O Secondary
X Undifferentiating

External factors

- Market conditions
  - Demand factors — X
  - Relative input prices/factor availability — X
  - Other industries — ●
- Policy and regulation
  - Macroeconomic conditions — O
  - Competition rules and concentration rules — X
  - Corporate governance rules — X
  - Labor rules and unionism — O
  - Other regulations (tariffs, nontariffs) — X

Nature of competition — ●

Production process

- Output
  - Mix, variety, quality — X
- Production factors
  - Capital (intensity, vintage, technology) — O
  - Scale — X
  - Design for manufacturing — ●
  - Basic skill of labor, intrinsic motivation — X
  - Raw materials, parts — X
- Operations
  - Capacity utilization — X
  - Organization of functions and tasks — ●

LABOR PRODUCTIVITY

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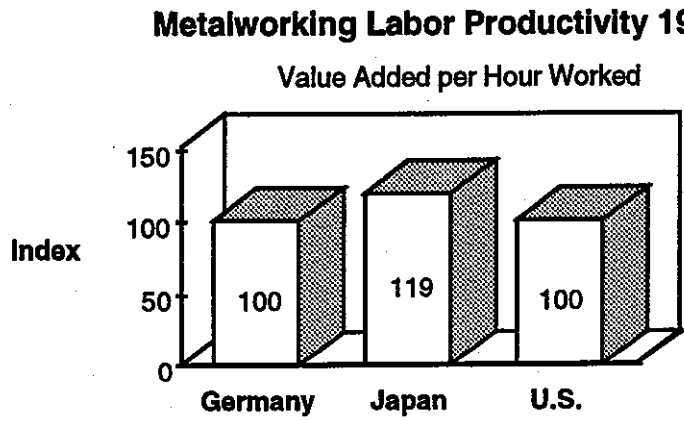
encounter slower growth in demand as assembly transplants overseas begin to source more and more locally.)

SUMMARY AND POLICY ISSUES

As mentioned earlier, the automotive parts industry was chosen as a case study because of its leading role as a supplier industry, and its impact downstream on the assembly sector. We have shown that rapid productivity growth in the latter half of the 1980s in Japan allowed that country to overtake the U.S. as the productivity leader, so that operations in Japan now hold a 24 percentage point advantage. The gap with Germany is even larger. As Exhibit B-24 summarizes, we believe there are two main factors at the production process level which help explain this gap: the organization of functions and tasks, and differences in design for manufacturing. The advantages of Japan with regard to these two factors is, in large part, the result of the cooperative, but nonetheless, demanding relationship between suppliers and OEMs. This case serves as a classic example of the effect the links to other industries can have on another industry's productivity.

The implications for government policy in the automotive parts industry are similar to those in the assembly industry. Germany is, again, the country which faces the most dramatic changes in the future. One way or another, the industry will be forced to become more productive, through large layoffs, the adoption of new management techniques, and the consolidation and merger of weaker firms with stronger ones. Whatever government actions can be taken to support and accelerate these trends (while mitigating short-term displacement suffering as much as possible, for example, through retraining) will strengthen the industry in the long run, and will establish again a strong automotive supplier industry in Europe. Continuing "squeezes" on suppliers without assisting the necessary restructuring could lead to a decline in the industry, as was seen in the U.K. auto parts and assembly industries in the 1970s. It is especially important not to neglect the auto parts industry at the expense of the more visible assembly industry, since, as even industry leader, Toyota, has affirmed, "the strength of our company derives from the strength of our suppliers."

METALWORKING CASE STUDY SUMMARY



Standard parts and products plus factory automation give metalworking companies in Japan a productivity advantage. Industry consolidation and the switch to laborsaving designs, equipment, and organization drive revolution in productivity.

The metalworking industry makes machine tools, machining centers, and automated manufacturing systems, such as robots and transfer lines. During the 1980s, the leading metalworking operations in Japan switched **from craft processes**, which stress skills in mechanical design and manual operations, **to a predominantly modern industrial process,** which requires the integration of software and electronics, the ability to automate production and standardize parts and products, and the ability to design for manufacturing. The industrial process approach means that metalworking firms in Japan have longer production runs, economies of scale, and hence, greater productivity than metalworking operations in Germany and the U.S. which have been slow to make this transition.

In the first three decades after the second world war, government policy in Japan encouraged standardization and consolidation through R&D funding, technology import/export licenses, and other policies. The government played a very active role in the evolution of the industry. The legacy of this early involvement remains salient today.

In part because of the growing share of Japanese transplants, **U.S. firms are beginning to modernize their production facilities** and should expect a relative improvement in productivity over the next few years. Metalworking firms in Germany, which once got a 30 percent price premium for their products in Europe because of their high quality, have been slow to upgrade their production practices. Today, German firms face stiff competition from high quality, low cost imports.

The use of one productivity figure for the metalworking industry in Japan masks the fact that the industry structure is different than in Germany and the U.S., and that an averaging effect is taking place. A small number of large, highly productive companies operate alongside much smaller establishments that have low productivity, but provide low-priced services and inputs to boost productivity at the big plants. The small players are, by and large, less productive than most metalworking companies in the U.S. and Germany.

PRODUCTIVITY IN THE METALWORKING INDUSTRY

The metalworking industry produces the equipment and tooling which other industries use to cut, form and manipulate parts. Because improvements in the production processes of these other industries usually requires the introduction of different and better machinery, metalworking is often an important source of manufacturing innovation.

While the makers of machine tools in Germany, Japan, and the U.S. enjoyed stable and growing demand from the end of the Korean War to the first energy crisis, the past two decades have been characterized by slow growth and high cyclicality. Throughout this period, the level of competition increased as players entered what were rapidly becoming global markets for increasingly standardized and automated metalworking products. The national competitiveness of metalworking industries became a source of political controversy, especially in the U.S., where some domestic manufacturers were facing elimination as a result of import competition.

Before the 1980s, successful companies only required skills in mechanical design and production. By 1982, however, success in metalworking manufacturing required additional skills in four main areas: (1) the integration of electronics and mechanics, (2) the ability to standardize and design for manufacture, (3) the application of automation technologies to their own production process, and (4) the integration of customer's innovations into their own product line. Metalworking companies were then required to bring together basic machines with sophisticated computers and software, and become knowledgeable in disciplines ranging from materials technology and mechanics to software design and factory automation. The success of industrial operations in Japan and the relative decline of those in Germany and the U.S. is the story of this transition. The metalworking case illustrates how reducing complexity through product and process standardization can lead to longer production runs, economies of scale, and factory automation, which combine to greatly improve productivity.

The report is organized into four parts. First, we will define the metalworking industry, then we will discuss the measurement of output and labor productivity. In the last two sections, we will discuss the causes of significant differences in productivity, and the resulting implications and outlook for the three metalworking industries.

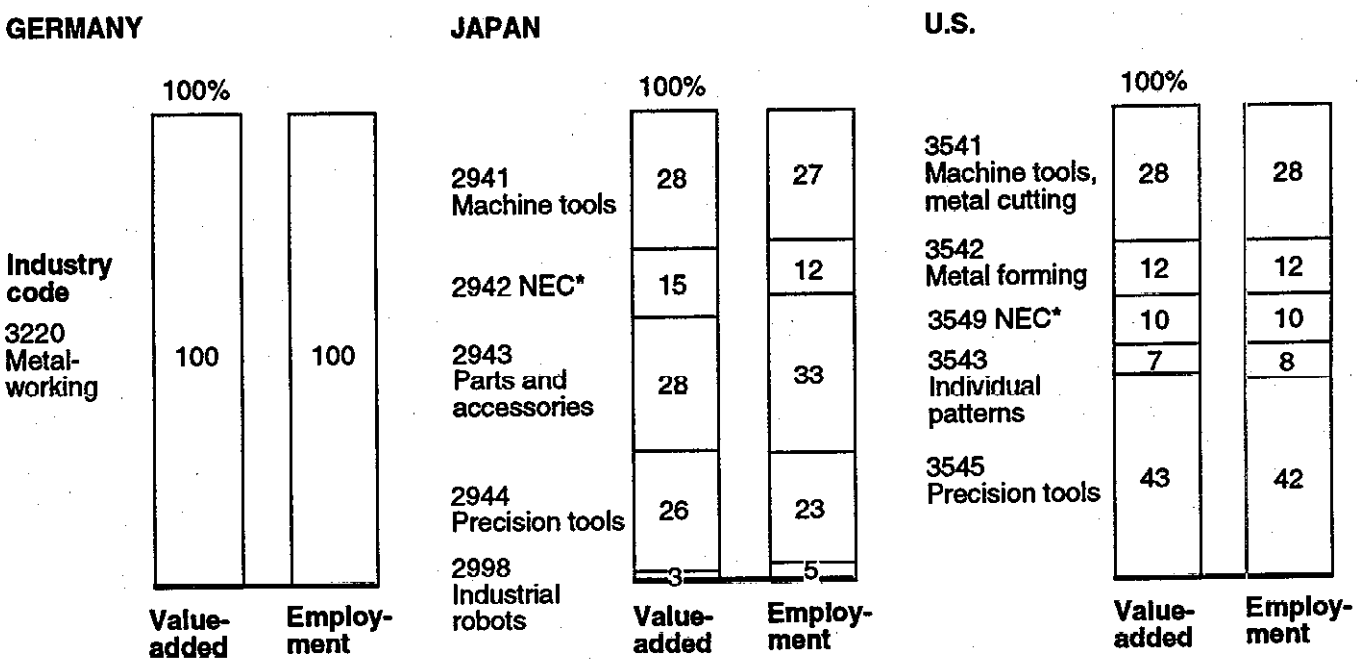
THE METALWORKING INDUSTRY

The metalworking industry is made up of a variety of activities and end products (Exhibit C-1). In our study, we have captured the fabrication of parts and the assembly of standard machine tools (e.g., saws, lathes, milling machines, etc.),

Exhibit C - 1

METALWORKING INDUSTRIES 1990

Percent



* Machine tools not elsewhere classified

Source: Census of Manufactures; McKinsey analysis

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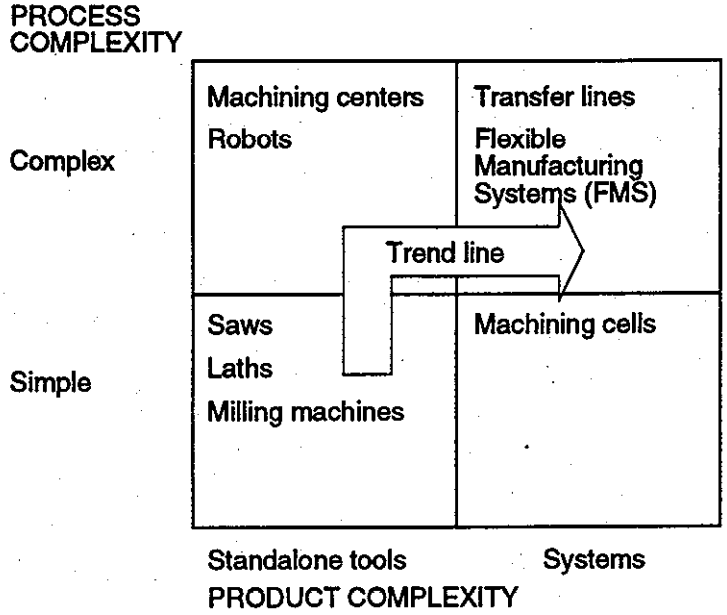
Exhibit C - 2

METALWORKING PRODUCTS AND PROCESSES



Industries included

Machine tool: metal cutting, metal forming

Cutting tools, machine tool accessories, precision instruments and tools

Industrial robots and manufacturing systems

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Exhibit C - 3

METALWORKING PROCESS FLOWS

	Designing and programming	**Casting of parts**	**Milling and machining**	**Assembly/run-off**
Craft/ customized activities	Each product and its parts designed independently Emphasis on drawings	Made in-house	Many single task stations Organized by function Manual material handling Large WIP inventory	Parts pulled from inventory Secondary machining required (rework)
Industrial/ standardized activities	Products designed using standard parts and standard modules Computer-aided design directly programs machining centers (no drawings)	Outsourced	Few multiple task stations Linear process flow Automated material handling Little WIP inventory	Parts pulled from production

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machining centers, and automated manufacturing systems (e.g., machine cells, robots, and transfer lines) (Exhibit C-2). The trend over the years has been a movement away from manual or hard-programmed, single-purpose, stand-alone tools, toward automated, flexible, multipurpose ones (e.g., machining centers) networked or linked together with automated material-handling equipment. While this shift has occurred in all three markets, industrial operations in Japan have participated to a much greater degree in product standardization and factory automation.

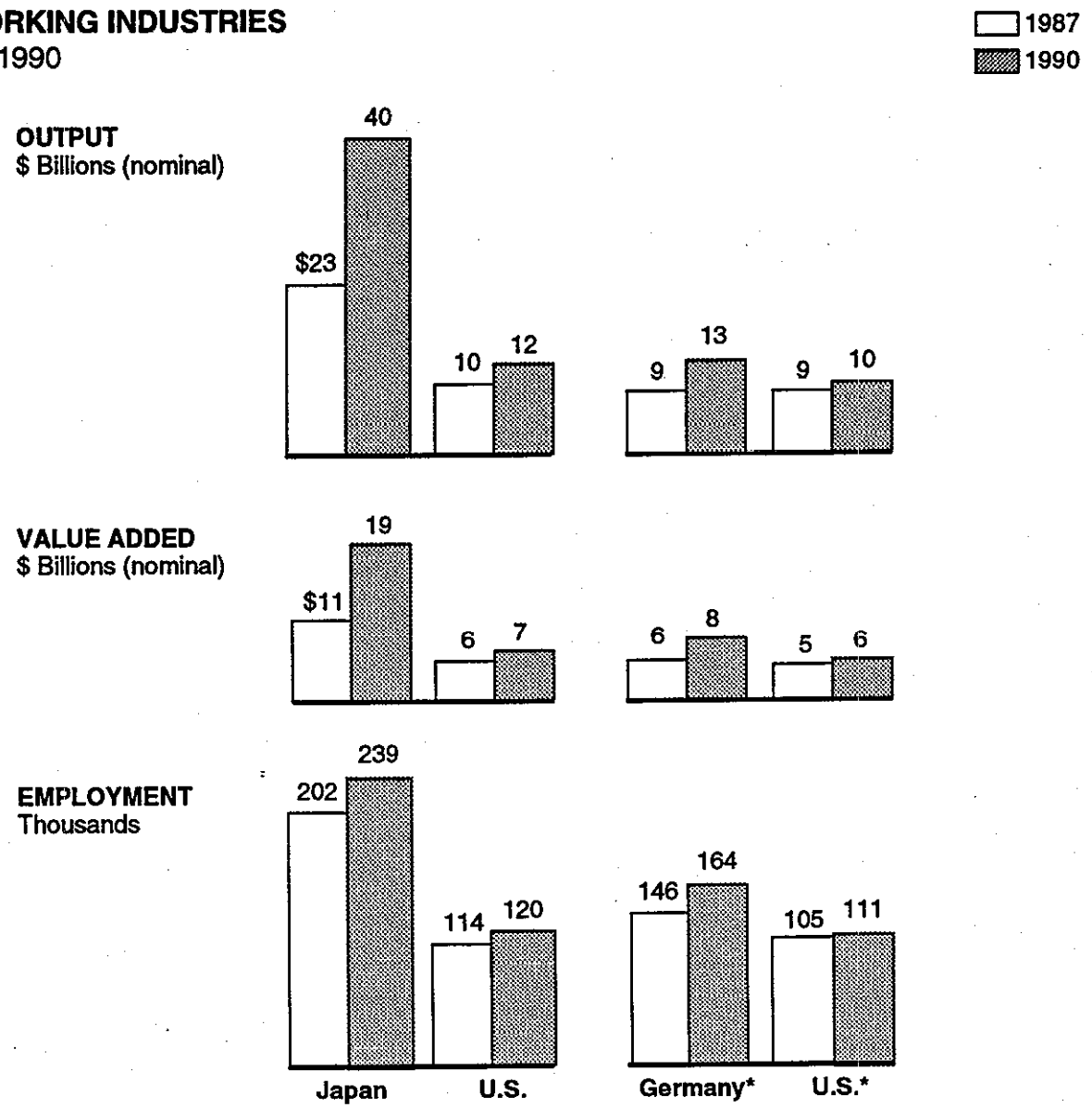
The shift in products is mirrored by a similar shift in production processes within the metalworking industry itself. The traditional craft or custom manufacturing process, developed at the beginning of the century for work on stand-alone tools, has been phased out slowly. Due to the complex nature of the products, the large number of process steps required, and the manual operation of equipment, craft shops using stand-alone tools have proven much less productive than metalworking operations using modern technologies (Exhibit C-3). There remains a significant number of factories in Germany and the U.S. which operate along craft lines, and even some in Japan. However, many of these older operations are unprofitable. Since the early 1980s, most factories in Japan have been redesigned for standardized unit production, whereby the parts, products, and production processes are simplified, designed for commonalty, and automated. Products have also been redesigned to be assembled from standard parts and components that are either purchased complete from low-cost suppliers, or are machined in-house by flexible, multiple-task machining centers and handled by automated moving and storage systems. These technical innovations were paralleled by organizational concepts that resulted in revolutionary increases in productivity.

The output of the metalworking industry is hard to estimate and compare in physical terms or on a unit basis because of great differences in product mix. The best approximation, therefore, is the value of output (Exhibit C-4). We derived a metalworking industry purchasing power parity (PPP) exchange rate to convert domestic industry values into U.S. dollars (see box entitled "Adjustments"). Using this exchange rate, the output of each industry in 1990 was the following: Japan, $40.0 billion; Germany, $12.9 billion; and the U.S., $11.6 billion ($10.3 billion in the German/U.S. comparison). Although industrial operations in Japan generally perform fewer activities in-house (value added as a percentage of output in Japan was only 47 percent in 1990 as opposed to 59 percent in Germany and the U.S.) value added in each industry in 1990 shows a pattern similar to output. Operations in Japan had the largest value added at 18.9 billion. Those in Germany were next at $7.6 billion, and those in the U.S. had $6.9 billion (or $6.1 billion in the German/U.S. comparison).

Metalworking operations in Japan employed 239,250 people in 1990, while those in Germany employed 163,630, and those in the U.S. employed 119,900 (the U.S. employment for the German comparison was 110,960). The hours worked per

Exhibit C - 4

METALWORKING INDUSTRIES
1987 AND 1990



* Excluding legal units with less than 20 employees

Source: Census of Manufactures; McKinsey analysis

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ADJUSTMENTS

PPP Calculation

The output and value-added figures for operations in Germany and Japan were converted to U.S. dollars using a PPP exchange rate. The PPP conversion rate was calculated using two methods: first, by improving existing category matches in the census data, and second by deriving a weighted average PPP for exports and domestic sales. The export PPP is usually close to the exchange rate, but is adjusted for distribution or discount differences. The domestic PPP was calculated by deriving the price differential from cost and profit comparisons of companies producing similar products.

The German PPP was similar using both methods. For Japan, however, it proved impossible to make useful matches using the census data. As a result, the Japanese PPP was calculated using only the first method. The PPPs calculated for 1990 were 2.18 DM/$ and 138 ¥/$. For 1987, the PPPs calculated were 2.28 DM/$ and 140 ¥/$.

Double Deflation

In the case of Germany, a small adjustment was made for double deflation. Because the German PPP was somewhat higher than the exchange rate, we had to adjust for the higher price of domestically sourced inputs relative to the world price of outputs. The impact of this adjustment was to lower German productivity by less than 5 percent.

The Japanese PPP was so close to the exchange rate that no adjustment was necessary.

Cyclical Adjustment

The time period of our study, from 1987 to 1990, covers a number of unique circumstances in the Japanese economy. Over this period, the metalworking industry experienced both a bust and a boom. After the signing of the Plaza Accord in 1985, the value of the Japanese yen rose at an unprecedented rate, and export oriented industries witnessed a drop in output and production. For the metalworking industry, this resulted in a dramatic drop in orders which caused operating rates to fall to an all time low in 1987. By 1990, however, metalworking operations were again booming, as the result of strong domestic and overseas demand. To minimize the effect of this swing, we have adjusted the productivity of the Japanese industry to an average operating rate (calculated over the 10-year period preceding 1990). The impact of this adjustment was to raise 1987 productivity by 7 percent, and reduce 1990 productivity by 3 percent.

employee in 1990 were the following in each industry: Japan, 2,197 hours; Germany, 1,604 hours; and the U.S., 1,963 hours.

The size of these industrial operations does not indicate the relative consumption of machine tools, however. Germany and Japan are net exporters of metalworking products while the U.S. is a net importer and has been since the 1970s. Since 1985, over 40 percent of new machine tools sales in the U.S. (by value) have been imported (over 50 percent by units). Approximately 50 percent of these imports came from Japan while approximately 15 percent came from Germany.

PRODUCTIVITY RESULTS

Comparing the value added per hour worked in 1990 using a PPP exchange rate, and adjusting for double deflation and changes in the business cycle (see box entitled "Adjustments"), the productivity level of metalworking operations in Japan was 19 percent higher on average than those in Germany or the U.S. (see Exhibit C-5). In some segments, such as machine tools, the average productivity of operations in Japan was as much as 35 percent higher than operations in the U.S. (operations in Germany are not broken down in that level of detail in the census, see Exhibit C-1).

As Exhibit C-6 demonstrates, the productivity of metalworking operations in the U.S. and Germany were, on average, higher than that of Japan prior to 1987. Since 1987, however, operations in Japan have become much more productive. This rapid productivity growth was caused by the revolutionary transition of operations in Japan to automated production processes in the 1980s and the redesign of many products to be made from standard parts, components and modules. These changes resulted in a phenomenal increase in output that had little impact on the amount of labor required. For example, the actual physical output of machine tools (e.g., number of units) increased by 16 percent per year over this period, while the input of labor increased by only 6 percent per year. This resulted in real productivity growth of 8.5 percent per year (as measured by value added per hour worked).

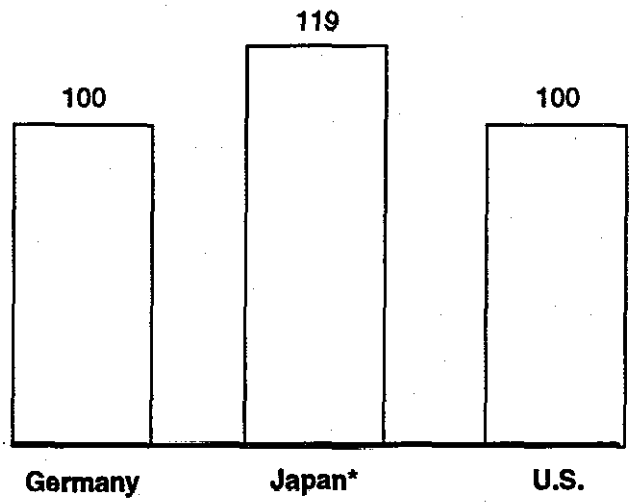
What these productivity comparisons do not reveal, however, is that before 1987 many individual companies located in Japan were already more productive than those located in Germany and the U.S. Breaking the industry down by establishment size, industrial operations in Japan demonstrate a distinctive pattern (Exhibit C-7). While the average productivity of operations in Japan in 1987 is approximately equal to those in Germany and the U.S., establishments in Japan with more than 500 employees were far more productive than smaller ones. By contrast, establishments in Germany and the U.S. were all much closer to the industry average, regardless of size, and were at a significant disadvantage compared to large establishments in Japan. The rapid productivity growth of the metalworking industry in Japan is reflected in improved productivity across establishment sizes (and especially in larger ones in such areas as metalworking), and the growing share of workers employed in larger establishments (Exhibit C-8).

Exhibit C - 5

LABOR PRODUCTIVITY IN METALWORKING INDUSTRIES 1990

VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED

Index: U.S. = 100



* Adjusted for cyclicality

Source: Census of Manufactures; McKinsey analysis

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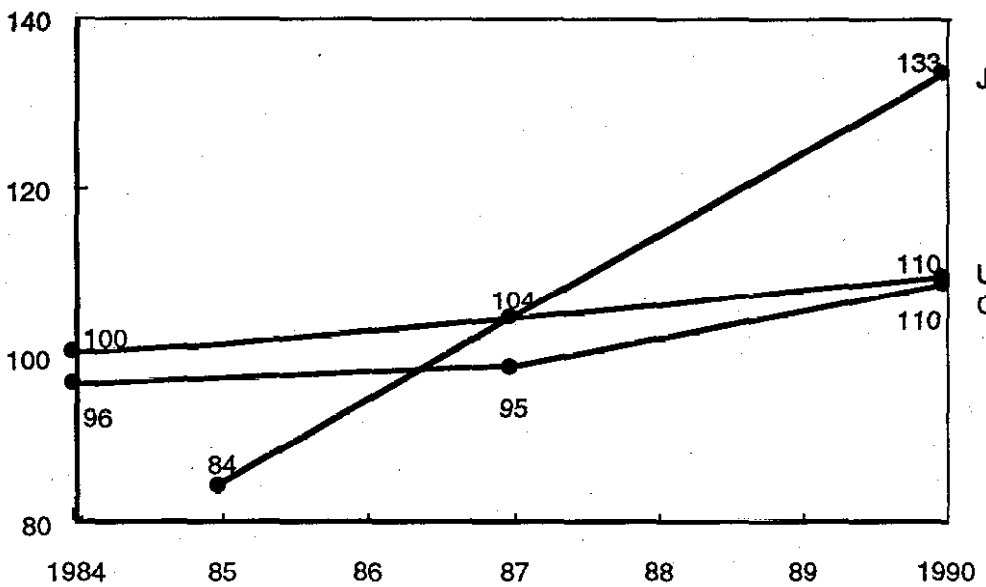
Exhibit C - 6

REAL PRODUCTIVITY GROWTH IN METALWORKING INDUSTRIES 1984-90

BASED ON VALUE ADDED PER HOUR WORKED

Index: U.S. 1984 = 100*



	Real annual productivity change 1987-90
Japan**	8.5%
U.S.	1.9
Germany	5.0

* Reference for Japan in 1985 is based on U.S. at 100 for 1985

** Adjusted for cyclicality

Source: McKinsey analysis

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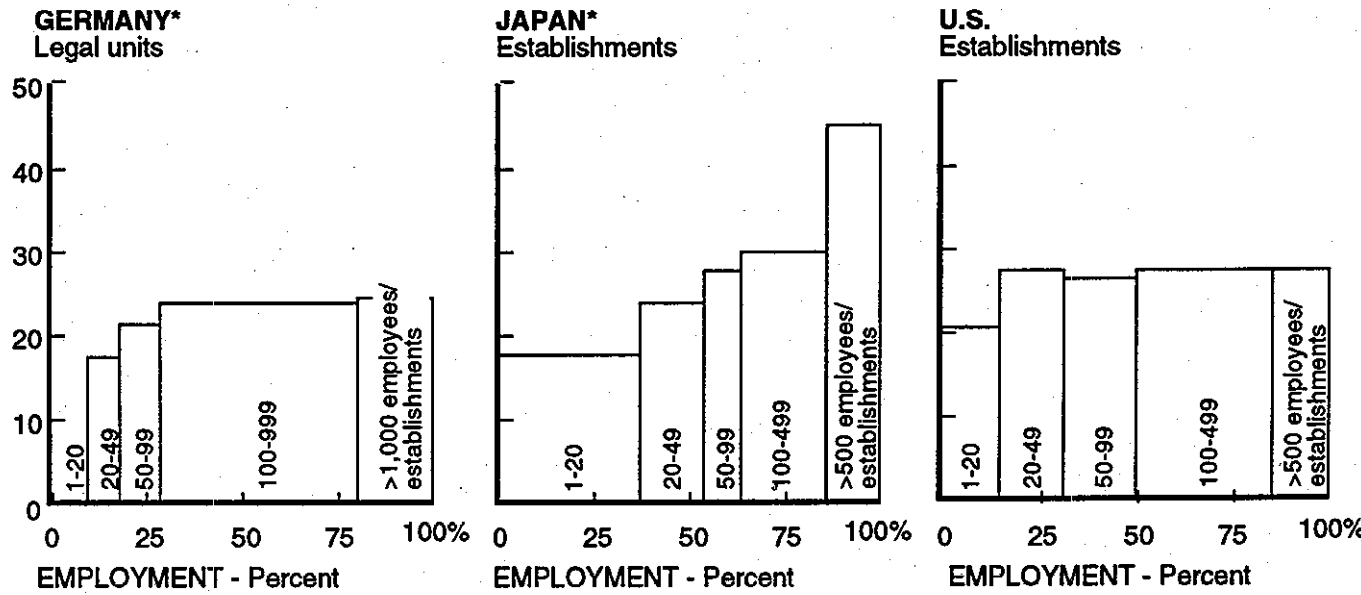
Exhibit C - 7

LABOR PRODUCTIVITY DIFFERENCES BY ESTABLISHMENT SIZE 1987

METALWORKING INDUSTRIES

VALUE ADDED PER HOUR WORKED

U.S. dollars



* Adjusted for cyclycality

Note: German figures are based on legal units and do not include legal units with less than 20 people

Source: Census of Manufactures; McKinsey analysis

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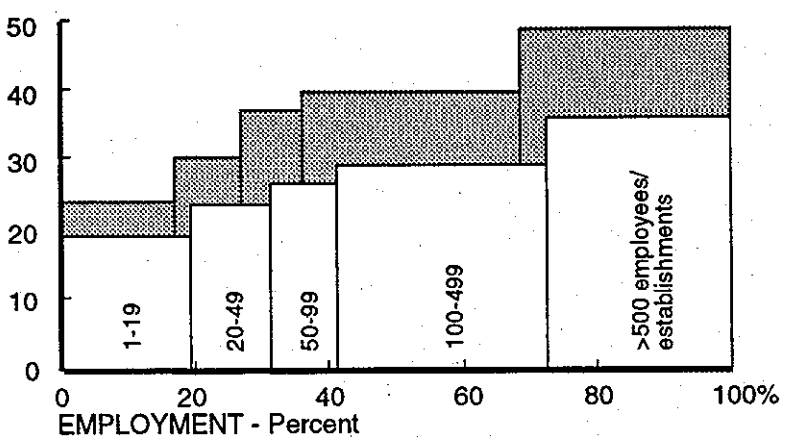
Exhibit C - 8

LABOR PRODUCTIVITY GROWTH IN MACHINE TOOL OPERATIONS IN JAPAN BY ESTABLISHMENT SIZE 1987-90

VALUE ADDED PER HOUR WORKED IN 1987 $ U.S.

Adjusted for cyclicality



Real productivity change	21%	25	37	35	36

Source: McKinsey analysis

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Exhibit C - 9

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES 1990
METALWORKING INDUSTRY

External factors	Industry structure and behaviors	Production process	Labor productivity
Germany: Demand for customized and specialized products; protective barriers at EC level	Highly fragmented and specialized production; active trade within Europe, little outside	Customized production; limited automation; unique products; complex operations	100%
Japan: Legacy of government intervention to consolidate industry and standardize output; influence of auto industry	Fewer major players, but competing with similar products; export-oriented, globally-competitive industry; vertical integration of key components	Standardized production; high degree of automation; products designed for manufacturability; simple, linear operations	119%
U.S.: Protective barriers	Highly fragmented and specialized production; growing share of transplant production	Customized production; limited automation; unique products; complex operations	100%

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Exhibit C - 10

REASONS FOR ADVANTAGE JAPAN OF METALWORKING OPERATIONS ON THE PRODUCTION PROCESS LEVEL

Scale/capital	Product design	Integration of functions and tasks	Product mix
High unit volumes and flexible automation employed to raise productivity	Standardization of components and inputs Higher degree of outsourcing of parts and components; emphasis on assembly Standardization of electronics	Linear process flow Relationships with suppliers pushes low-value activities out of company	Initial focus on low-end, standardized machine tools Gradual movement to higher value-added activities using standardization and specialization

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The higher value added per hour worked at the larger establishments was a factor of their outsourcing more activities both outside their industry and within their industry, (i.e., leaving the fabrication of parts and components to smaller establishments). While the first instance is a matter of cross industry organization, the second is an aspect of the "dual economy," which we have observed in other industries. Essentially, smaller establishments provide services and inputs to the assembly operations of large plants, at lower wages and at lower prices than the industry average. This arrangement gives larger companies a competitive advantage, especially in overseas markets. These large, highly productive companies also tend to be the ones driving exports and foreign direct investment. (See the synthesis chapter for a more complete discussion of the production process differences for large and small plants.)

CAUSES OF PRODUCTIVITY DIFFERENCES

Using the general framework of this study, we examine the reasons for the observed differences in productivity at three levels. First, at the level of the production process, then at the level of the industry structure and behavior, and finally at the external factors that also influence management decision-making (Exhibit C-9).

Causality at the Production Process Level

The relative productivity advantage enjoyed by metalworking operations in Japan in 1990 is largely explained at the production process level by differences in scale and capital, product design, the integration of functions and tasks, and, to a lesser degree, product mix (Exhibit C-10). During the 1980s, metalworking operations in Japan had redesigned their parts, products, and production processes, to a higher degree of standardization than the majority of companies in Germany and the U.S. As a result, many manufacturers in Japan achieved sufficient scale to justify large-scale investments needed for automated manufacturing, material handling, and assembly systems. These new technologies facilitated better ways of organizing functions and tasks, both within the operation and with suppliers. In 1990, these advantages were not captured by the majority of producers in Germany and the U.S.

- ¶ Capital and scale as causal factors. Whereas metalworking production in Germany and the U.S. was largely based on low volumes of highly specialized products (as it had been since the beginning of the century), production in Japan was characterized by high volumes of standardized products. This type of production in Japan was made possible by a higher degree of industry consolidation and concentration. For example, most machine tools makers operating in the U.S. and Germany during the 1980s produced only five or six units of a given machine in 1 year. Many

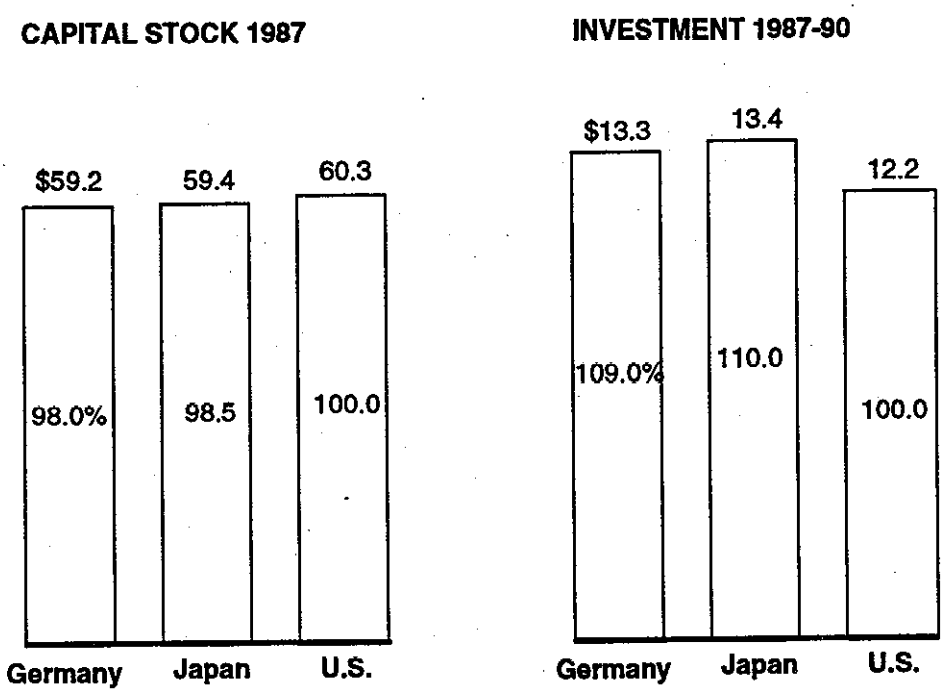
Exhibit C - 11

CAPITAL STOCK AND INVESTMENT

METALWORKING INDUSTRY

$ THOUSANDS/EMPLOYEE

Index: U.S. = 100



Source: Census of Manufactures; McKinsey analysis

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companies operating in Japan, however, were able to produce ten times that in a single month.

Over time, higher unit volumes allowed companies operating in Japan to simplify product designs for manufacturing with standard parts and components. In addition, higher volumes permitted them to justify heavy investments in industrial manufacturing systems and automation equipment. For example, metalworking operations in Japan were the first to develop and apply flexible manufacturing systems (FMS) to their operations throughout the 1980s. FMS allowed many of them to achieve economies of scale at even lower volumes, and to develop more customized products. The result of these labor-saving technologies was a rapid increase in productivity.

Based on these observations, we would expect that metalworking operations in Japan would have much higher levels of capital intensity and investment than those in Germany and the U.S. In measuring capital stock, however, we found that capital intensity in each of the three industries was similar in 1987, although operations in Japan and Germany did invest more in the years leading up to 1990 (Exhibit C-11). Part of the reason why we find lower than expected capital intensity figures in Japan is that operations in Japan do fewer activities in-house (e.g., value added is only 48 percent of the industry gross output, as opposed to 60 percent in Germany and the U.S.). As a result, less capital is required and the machinery in place tends to be only that which is regularly and productively put to use. For example, most machine tool producers in Germany or the U.S. either make their own castings, or buy them and do all of the rough machining themselves. In Japan, metalworking operations often buy high quality, pre-machined castings from the foundry, eliminating the need for labor and equipment to do rough finishing.

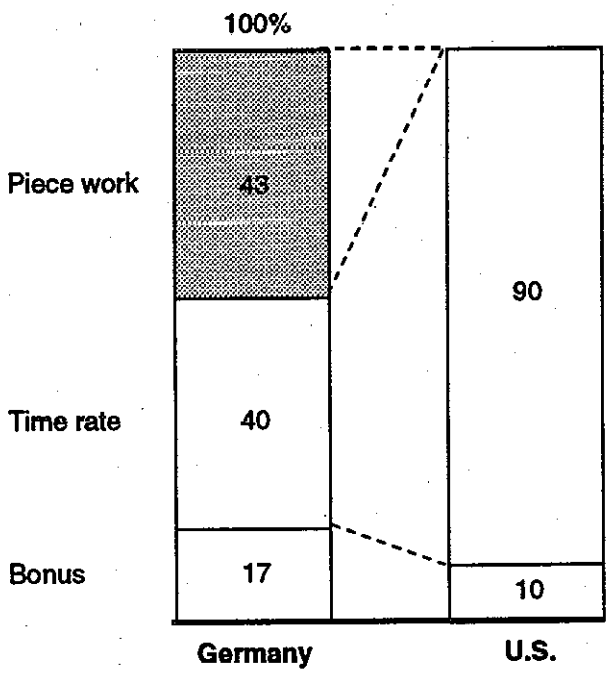
¶ Design for manufacturing as a causal factor. Metalworking operations in Japan are characterized by a greater degree of standard parts, products and processes that result in high productivity. The design for manufacturing and the simple, linear process layouts in most Japanese operations require less labor but produce higher levels of output. Operations in Germany and the U.S., on the other hand, are characterized to a greater degree by product and process complexity resulting from their relatively low levels of product and process standardization and their lower product volumes.

Based on factory tours and interviews in Germany, Japan and the U.S., we estimate that the number of parts (e.g., ball bearings) and tools (e.g., drills) being used in best practices for standardized machine tool production had been reduced to one-tenth of what was originally required in craft production. This reduction had been achieved by designing or redesigning

Exhibit C - 12

COMPENSATION SYSTEMS

Percent of wage earned



Source: McKinsey analysis

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products so that they could be produced using standardized parts and components and automated equipment. For example, the most modern factories use three-dimensional computerized design (CAD) equipment to program a series of machining centers to work on standard parts and components that are moved from station to station using automated material handling and storage systems. This greatly reduces the amount of parts, tools and labor required for the manufacturing of standard machine tools, while at the same time greatly increasing output. Many of the companies operating in Japan have completed this transition, and have successfully integrated their electronic and mechanical technologies with the design process. Similar product and process redesigns are underway in leading machine tool manufacturers in Germany and the U.S., but weakened financial and market positions slow their efforts to catch up.

The overall impact of product and production simplicity is lower costs, shorter lead times, better quality and, consequently, better productivity.

¶ Organization of functions and tasks as a causal factor. A recent McKinsey survey of 39 machine tool companies in Germany found that the organization of functions and tasks was a key driver of corporate success in this industry (success was defined by ROS, ROE, and the growth of sales and profits). At the heart of this success was simplicity. Compared with their less successful rivals, the best machine tool companies had fewer customers, fewer products, fewer suppliers, shorter lines of communication, and better trained workers (they spent up to four times more on in-house training).

As a result of more simple product designs and process layout, management in metalworking operations in Japan in 1990 had a better opportunity than in Germany and the U.S. to optimize the definition and allocation of tasks. Operations in Japan gave workers higher levels of responsibility, empowering them to perform and redefine their tasks, and instilling in them a desire to continuously increase the rate of operating improvements.

The simple, linear process, used by many factories operating in Japan, emphasizes the pull of customer orders (i.e., parts and components are ordered and fabricated only for the machine being worked on, not built for stock). This practice results in lower work-in-progress inventories and fewer people dedicated to material handling. In addition, companies operating in Japan rely to a much greater degree on supplier relationships to replace labor in low productivity operations.

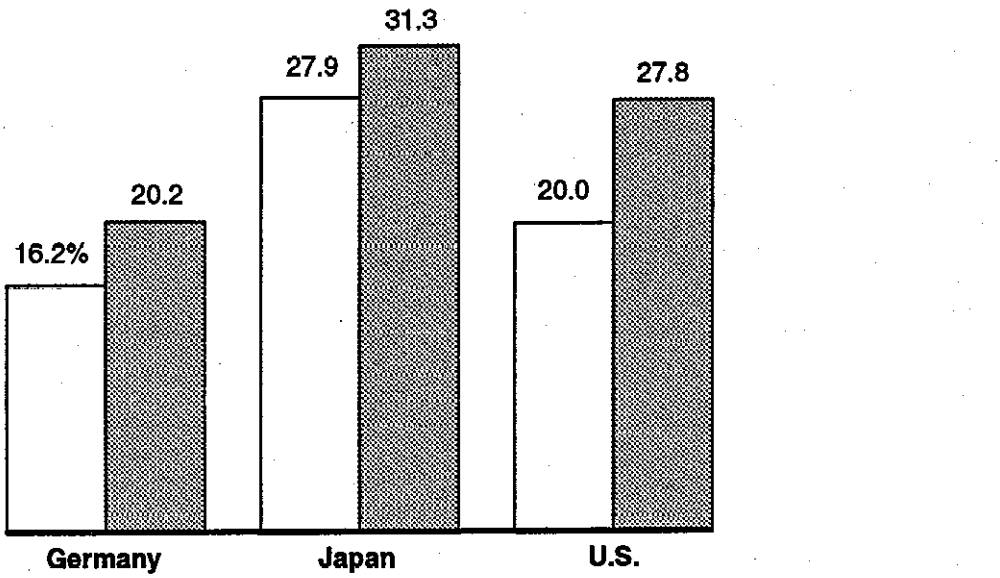
The piece-rate compensation system, used by industrial operations in Germany (Exhibit C-12) is an example of how the organization of functions and tasks may negatively influence productivity. The piece-rate

Exhibit C - 13

AUTOMATED MACHINE TOOLS AND SYSTEMS

PRODUCTION SHARE BY VALUE

Percent



Source: AMT; VDW; MOF; McKinsey analysis

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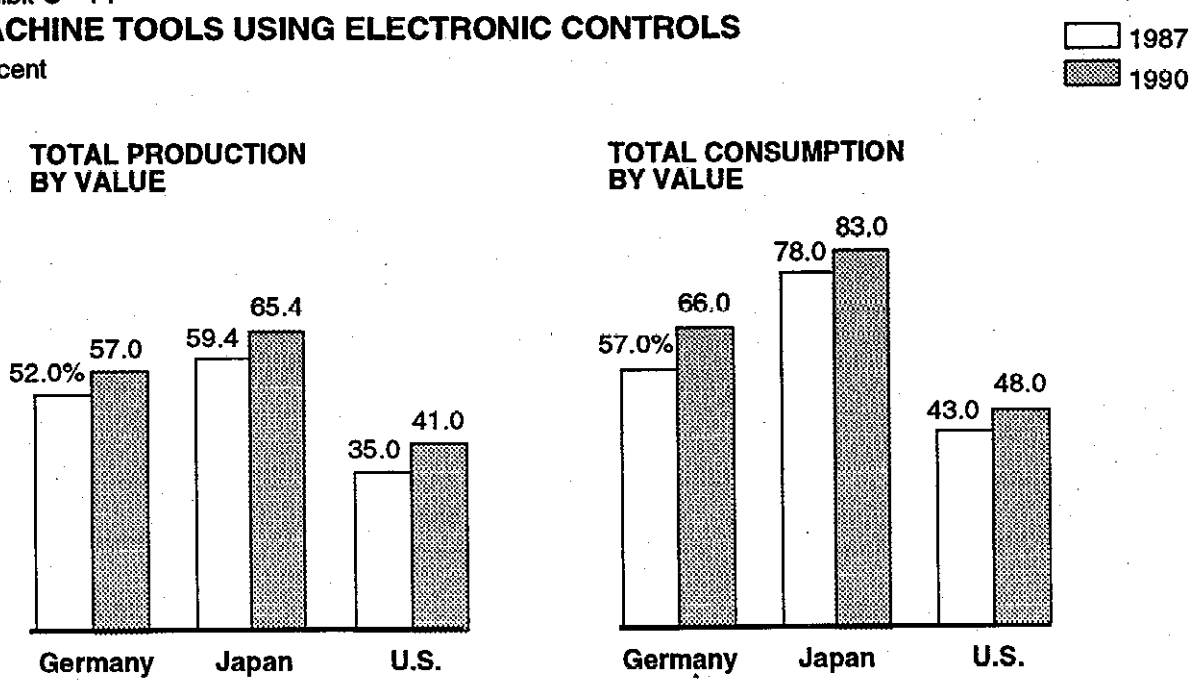
Exhibit C - 14

MACHINE TOOLS USING ELECTRONIC CONTROLS

Percent



Source: AMT; VDW; JMTBA; McKinsey estimate

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system reduces the flexibility of workers in an operation. Any attempt by management to increase output is often seen by labor as an attempt to speed up operations, and often becomes an area of dispute. Because labor in Germany has a voice in the running of companies, management is often discouraged from seeking higher output. While the impact of the piece-rate system is hard to measure, anecdotal evidence suggests that German productivity could be substantially higher if new incentives could be designed.

¶ Product mix as a causal factor. Product mix is a somewhat less important factor in explaining productivity differences in 1990. Because of their design for manufacturing, metalworking operations in Japan had a higher share of production of standard, off-the-shelf machine tools. In addition, they produced a higher share of automated manufacturing systems, such as machining centers and station-type machine tools (Exhibit C-13). Metalworking operations in Germany, although similar to those in Japan in terms of scope (e.g., making both off-the-shelf tools and customized products), could be characterized as being more focused in niche mechanical markets, and less on systems. Those in the U.S., on the other hand, had largely abandoned the standard tool market, but maintained a relatively high level of production in systems and in complex, highly capable equipment for the aerospace industry. Finally, the integration of electronic technologies with machine tools was also at different levels: operations in Japan had a higher share of sales in numerically controlled products in 1990 than those in Germany or the U.S. (Exhibit C-14).

The effects of this product mix difference are difficult to quantify. Producers in Japan reduced the price of many products through their efforts to standardize and commoditize production, but also increased the productivity of their operations and gained market share (e.g., Fanuc had almost 50 percent of the global market in numerical controls in 1990). Producers in Germany were somewhat immune to the commoditization of many standard products. Few Japanese-made products had yet entered the German market and many customers preferred customized products. As a result, prices in Europe were still very high in 1990. Producers in the U.S., on the other hand, had lost market share to import competition and were largely pushed out of many standard tool markets. What production remained in the U.S. was focused, to some extent, on higher value, niche markets, and in those protected from foreign competition.

In summary (Exhibit C-15), the higher productivity of metalworking operations in Japan was largely the result of greater standardization of parts, products and processes, larger volumes of automated production, and superior organization of functions and tasks. Raw materials, labor skills, and intrinsic motivation, although important to the performance of individual companies, were non-differentiating factors across the countries studied.

Exhibit C - 15

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES ON THE PRODUCTION PROCESS LEVEL 1990

Factor	Germany	Japan	U.S.	Impact on productivity
Product				
Variety	Customized, niche products	Standardized products	Customized, niche products	Operations in Japan are able to achieve higher productivity through industrialized production of high-volume, standardized products
Production factors				
Scale economies	Low-unit volumes	High-unit/module volumes	Low-unit volumes	
Machinery and equipment	Manual and mechanical process	Automated process	Manual and mechanical processes	
Organization of functions and tasks	Functional layout	Linear layout	Functional layout	

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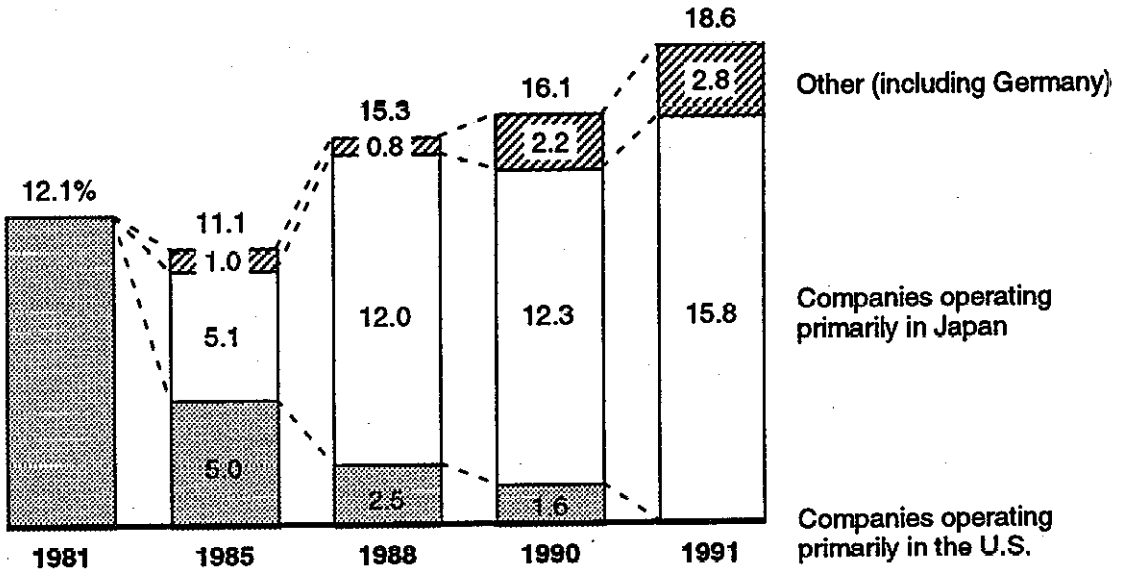
Exhibit C - 16

MACHINE TOOL INDUSTRY

Percent of world machine tool sales by top 10 producers



Source: *American Machinist*, August 1987, August 1988, August 1991; *The Economic Handbook of the Machine Tool Industry*, 1982-83, 1986-87, 1991-92

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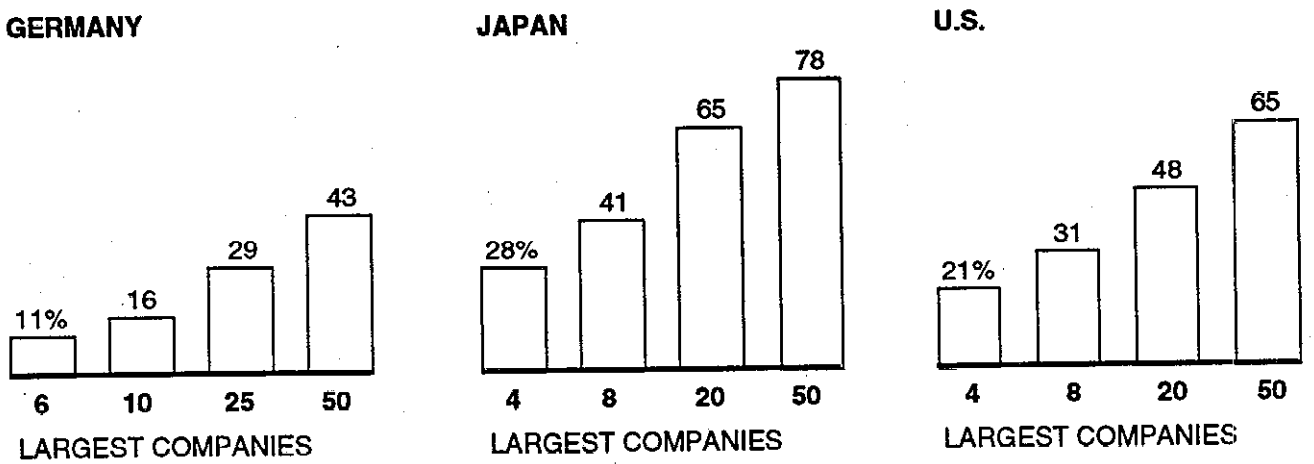
Exhibit C - 17

CONCENTRATION IN THE METALWORKING INDUSTRY 1987

Market share of output accounted for by size



Source: Census of Manufactures; McKinsey analysis

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External Factors and Industry Behavior

Why have metalworking operations in Japan been more successful at standardizing products and at automating production than those of Germany and the U.S.? Why have companies operating primarily in Japan been more successful at integrating electronic and mechanical skills? The answer to these questions is the story of convergence and crossover resulting from the dramatic consolidation, standardization, and automation of metalworking operations in Japan, and the relatively slow evolution of those in the U.S. and the German industries.

¶ The nature of competition. The nature of competition in the three countries under study has a number of dimensions. First, concentration has played a substantial role in allowing operations in Japan to make innovations at the production process level. Second, the higher level of competition in Japan, especially as it relates to international exposure (e.g., exports and foreign direct investment), has also provided stimulus for productivity improvement. And finally, the greater reliance on vertical relationships has permitted the removal of low productivity activities to other industries.

- The metalworking industry in Japan is characterized by fewer players with higher market shares than operations in either Germany or the U.S. Exhibit C-16 illustrates this point. Ten years ago, the ten largest machine tool companies in the world were located primarily in the U.S., today most are located primarily in Japan.

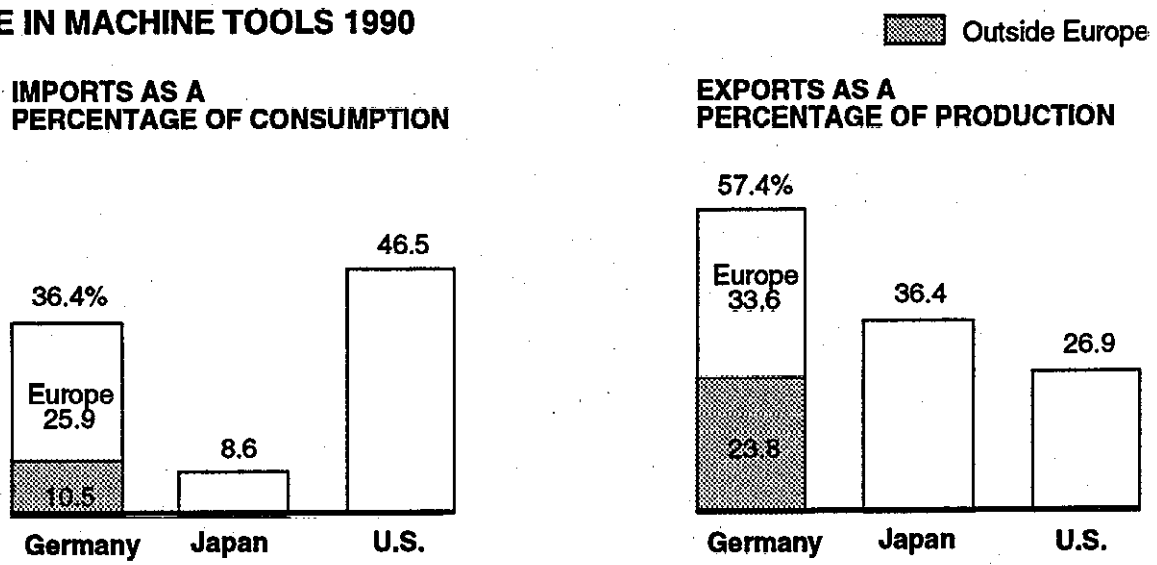
  Because of the higher level of product standardization, however, the number of companies in Japan selling *similar* products is higher than in Germany and the U.S. Over the past few decades, this situation has provided higher levels of domestic competition that has resulted in higher productivity in 1990. Metalworking companies in Japan compete fiercely for sales of standardized products through price reduction and product innovation. The fragmentation of metalworking operations in Germany and the U.S., on the other hand, has put them at a relative disadvantage (Exhibit C-17). Few players in those markets had sufficient scale in the 1980s to justify investments in laborsaving devices such as multiple-function machining centers and factory automation. As a result, operations in the U.S. and Germany were relatively more specialized in 1990, and competition in similar products was much lower. In the case of the U.S., the low level of competition was characterized by lead times between orders and deliveries of up to 2 years in the early 1980s (providing a significant opportunity for imports).

- International competition has also played a role in spurring productivity growth in companies located primarily in Japan. While no official restrictions prevent entry into the Japanese market, buyers

Exhibit C - 18

TRADE IN MACHINE TOOLS 1990

Percent



Source: *American Machinist;* AMT; McKinsey analysis

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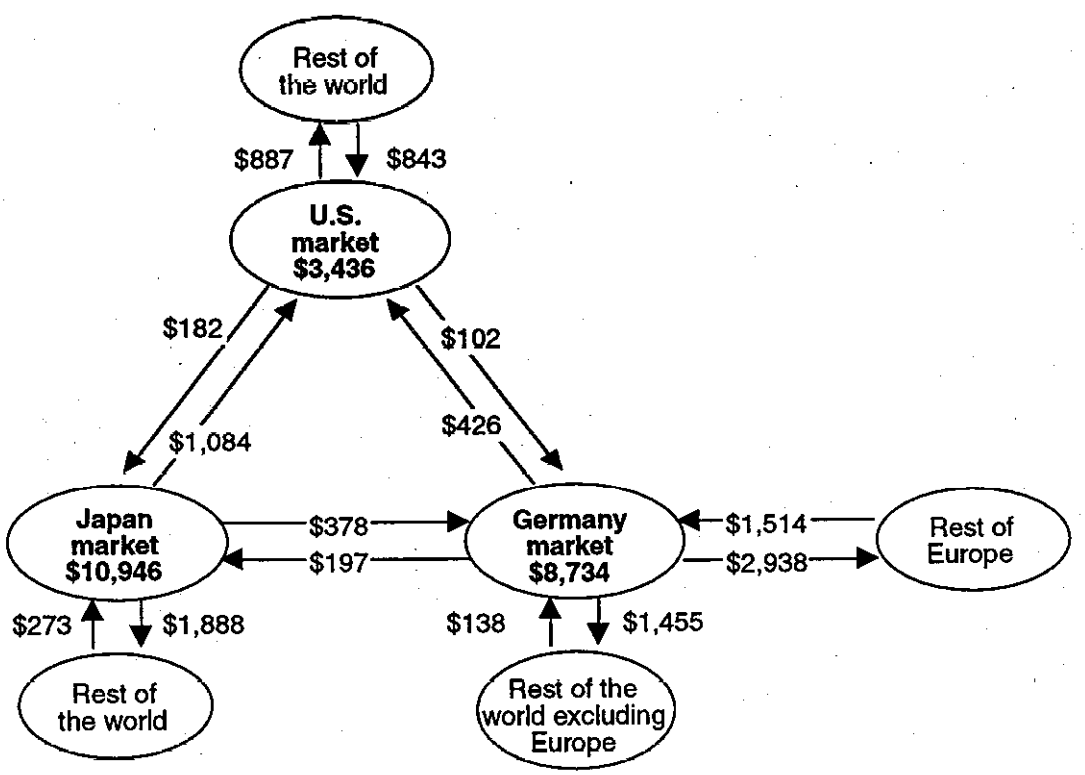
Exhibit C - 19

TRADE FLOW OF MACHINE TOOLS*

1990 $ Millions



* Metal cutting and metal forming

Source: AMT; McKinsey analysis

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often express a preference for locally-produced machine tools. The imported products found in Japan (Exhibit C-18) are either low value-added machines from Asia, or highly specialized ones from Europe and the U.S. The low levels of imports are not surprising in light of the much higher productivity of operations in Japan. (However, operations in Japan have not always been the most productive. Companies located in Japan imported much of the technology used to make machine tools from the 1950s to the late 1970s.) In terms of exports, companies located in Japan sent 36 percent of their production offshore (Exhibit C-19), much of it at the leading edge of technology or competing head-to-head with the technology leader. In some markets (e.g., numerical controls), companies located in Japan control a substantial share of the global market. In addition, many are making significant foreign direct investments in Asia, North America, and Europe (East and West). This spurs productivity growth by exposing the greater part of the industry in Japan to global competition.

The metalworking market in Germany has traditionally been trade-oriented but the nature of its competition is mostly regional. Even though it is a net exporter of machine tools, well over half of its exports go to other European countries (Exhibit C-18). In addition, many of its overseas markets are in specialty products and custom machine tools where it currently faces little international competition. In 1990, import exposure was limited to production from other European countries (70 percent of imports), with little coming from world-class exporters (i.e., Japan) (Exhibit C-19). The makers of standard machine tools were thus protected from global competition by EC legislation (VRAs), antidumping cases, and a preference for German products, both in Germany and in the rest of the European Community. These factors combined effectively to keep Asian products out of the market and to maintain the regional nature of European competition. Since 1990, these factors have begun to break down.

In general, metalworking operations in the U.S. have largely focused on the domestic market, although exports as a percentage of production is not far behind operations in Japan, especially the non-European exports of operations in Germany (Exhibit C-18). As in Germany, many of the products exported from the U.S. in 1990 were highly specialized or customized tools, which faced relatively less international competition. Nevertheless, operations in the U.S. were openly exposed to import competition until 1987 (when the federal government negotiated a voluntary restraint agreement with a number of trading partners). In 1990, however, the U.S. imported 46.5 percent of machine tools consumed. In addition, transplants (primarily of companies operating in Japan) account for as much as 10 to 15 percent of domestic sales in the U.S. Many people in the industry expect this share to grow.

Exhibit C - 20

GOVERNMENT EFFORTS TO RATIONALIZE AND STANDARDIZE METALWORKING OPERATIONS IN JAPAN 1945-75*

Subsidies

R&D (long term)
- MITI Research Labs

Tax incentives
- MOF

Export Assistance
- MITI

Subsidized credit
- MITI (1956 Law on Temporary Measures)

Technology acquisition
- Foreign Exchange and Foreign Trade Control Law, 1949
- Foreign Capital Law, 1950
- Tariffs and duties

Directives

JNR contracts in 1940s and 1950s

1956 Law on Temporary Measures for Development of Machinery Industry
- Economies of specialization
- Standardization
- Collaborative research

1968 Law on Temporary Measures . . .
- Guidelines on minimum lot sizes (e.g., "discontinue production if <5% market share and < 20% of company output")
- Rules for mergers

1971 notification of new products
- Letter of intent required by JMTBA

1971 Law on Temporary Measures . . .
- Increase specialization and share of world NC market

* Most government programs were scaled down or eliminated in the 1970s
Source: Martin Fransman, *Machinery and Economic Development;* McKinsey analysis

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The growth of transplants, combined with the large import share of the U.S. market, should significantly raise U.S. productivity in coming years by exposing the largest part of the industry to global competition.

- As stated above, the use of vendors and affiliates to provide parts, components and services is much more prevalent in metalworking operations in Japan than in those of the U.S. or Germany. This outsourcing allows producers in Japan to push some of their lower productivity activities into other industries or into smaller, affiliated companies. (See the synthesis chapter for a more complete discussion of the production process differences for large and small plants.)

¶ Government intervention and the regulatory environment. Metalworking is the only case we studied where government intervention played a positive role in productivity improvement. The degree of government intervention and regulation, although similar across all three countries by 1990, was historically important for industry development and productivity improvement of the Japanese industry. The legacy of past government policies helps explain the productivity convergence and crossover of the metalworking operations in Japan in the 1980s, and the large productivity advantage enjoyed in 1990. In addition, it helps explain the unique vulnerability of operations in the U.S. in the 1980s and, perhaps, the potential vulnerability of those in Germany today. While government intervention helped in this instance, we would like to point out that the policies put in place increased the level of competition in both domestic and global markets.

- Prior to the 1960s, Japan had numerous small producers with highly differentiated products and markets (much as Germany and the U.S. had in 1990). Beginning in the 1950s and continuing well into the 1970s, the Japanese government encouraged industry consolidation and product standardization in a number of ways (Exhibit C-20).

  First, the government used its buying power to deliver the message of consolidation to the industry, both through procurement policies and through state companies. For example, the Japan National Railway (JNR) announced that it would only work with a limited number of large size companies. Companies that did not meet this criteria were encouraged to merge with larger players or close. Because of its unique buying power after the devastation of World War II, the government was able to use this tool effectively until the 1960s, when it then switched to more activist policies.

  Second, companies were encouraged to produce minimum lot sizes for specific products based on MITI guidelines. From 1957 until the 1970s, the government published these guidelines which were increasingly used in the allocation of R&D funding, subsidies and export support.

Companies which did not meet these criteria were again encouraged to merge or exit.

Finally, R&D funding, technology import licenses, and other subsidies for new product development were only available to a few producers. This method essentially allowed the government to allocate a potential new market to a limited group of players (while other players were encouraged and funded to develop other markets). This allocation helped set industry standards and, along with standardization and consolidation, resulted in rising economies of scale and increased competition in similar products. A good example of this process was the development of numerical controls. The government provided opportunities to a number of electronics companies to develop these new products. Fujitsu-Fanuc focused on the development of numerical control (NC) technologies and on providing machine tool builders with standard, flexible, multipurpose controls. As a result of its success, Fanuc was able to obtain and maintain a large share of the NC market, which helped establish industry standards both in the control industry and in the machine tool industry, which had to adapt machines to suit the standard controls. The end result was a higher level of competition in both the control and metalworking industries, despite relatively fewer players and larger market shares than in Germany or the U.S.

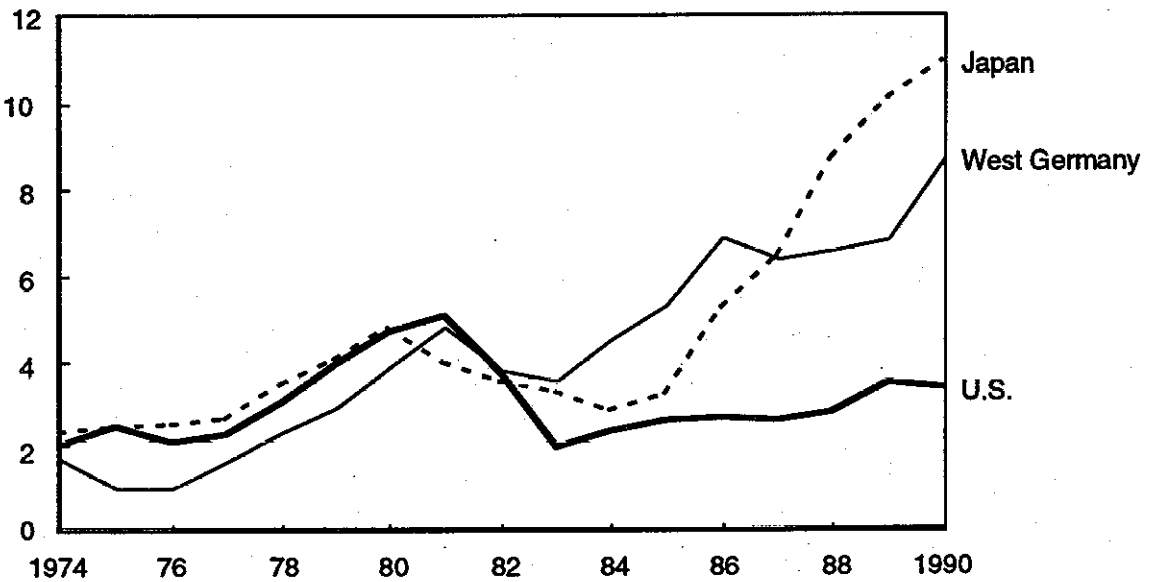
- Metalworking operations in Germany and the U.S. did not evolve along the same lines as those in Japan, but remained characterized by numerous, small producers with highly differentiated products. In both countries, pressure to consolidate or standardize production was insufficient, either from outside or within. Within the industry, individual producers had no incentive to build standard tools because they believed this change would destroy much of the value in their custom products in terms of after sales support. In addition, they may have feared government intervention or competitive reprisal. As a result, the industry had little incentive to push through standardization. Outside of the industry, no single buyer was large enough or under sufficient pressure to take it upon themselves to improve metalworking productivity (although automakers tried half-heartedly in the 1980s). More important, governments did not see that the majority of customized tool makers had local or product monopolies. As a result, they were not philosophically inclined to intervene in what seemed a healthy, vibrant and competitive market.

  The development of numerical controls is a good example of how companies in Germany and the U.S. evolved differently. Computer numerical control (CNC) as a technology was originally developed and applied in the U.S. In both Germany and the U.S., a large number of

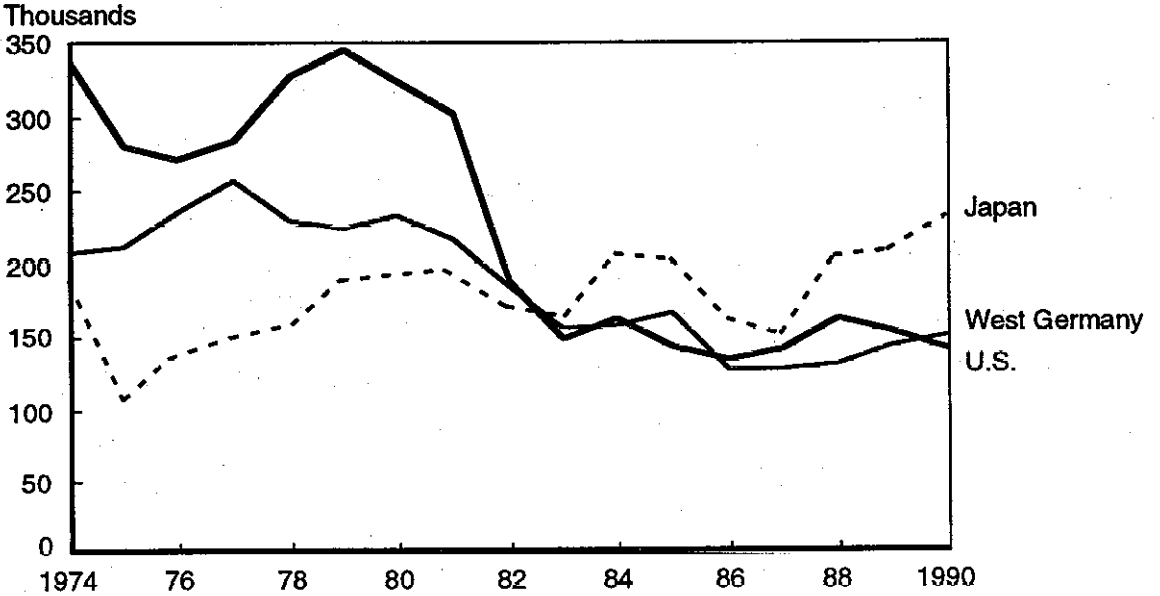
Exhibit C - 21

SIZE OF DOMESTIC MACHINE TOOL INDUSTRIES

VALUE OF PRODUCTION
$ Billions (Nominal dollars, market exchange rates)



SHIPMENTS OF UNITS
Thousands



Source: *The Economic Handbook of the Machine Tool Industry*, 1991-92

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players began producing highly customized computer controls for use on their machine tools. In the U.S., in particular, producers initially focused on complex designs (for defense and aerospace industries) that proved costly and complicated. Many companies designed controls thinking that, because they had mastered the mechanics of machine tool making, they could easily master the electronics as well. They used existing facilities and people to develop controls that, for end users, remained expensive, limited to specific machines, and difficult to program and reprogram. Thus, the movement to numerical controls in Germany and the U.S. was very slow and provided little additional competition between machine tool companies. In addition, these markets became vulnerable to the more flexible designs of producers from Japan.

¶ Market conditions. Three issues under market conditions must be addressed. First, the macroeconomic environment had a profound impact on product demand in the metalworking industry. Second, the cyclical nature of demand influenced the way in which management made decisions. Third, local preference is often a significant element of demand in Germany and Japan. Finally, the role of other industries was also an important factor in promoting productivity in metalworking.

- The metalworking industry is highly sensitive to the overall economic climate. In 1990, Japan was experiencing what is now referred to as the "bubble economy," an unprecedented burst of economic activity that resulted in record levels of investment and speculation (Exhibit C-21). In Germany, the euphoria over German unification and the movement to a single market in Europe by 1992 also resulted in record levels of economic output and growth. The booms in Japan and Germany resulted in unprecedented demand surges in 1990. In the U.S., on the other hand, growth had already slowed and machine tool companies had witnessed a drop in orders.

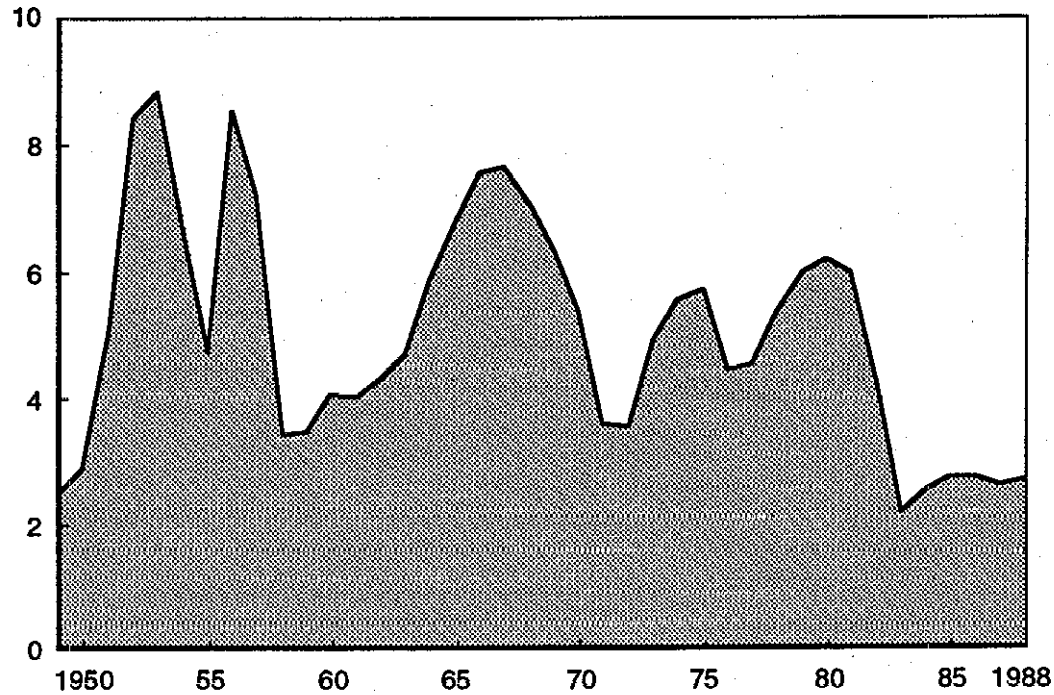
- The cyclical nature of the industry had different effects on productivity. In Japan, down cycles were rare in the 1970s and 1980s. Because they were growing rapidly, often into export markets, operations in Japan needed new production capacity to meet growing demand. Hence, they enjoyed more frequent opportunities to experiment with new production processes and organizational approaches. Even when external shocks slowed the domestic market, the export market (up to 40 percent of production is exported) took up the slack. The German and the U.S. metalworking markets, on the other hand, were proving to be a roller coaster (Exhibit C-22). Because of the product and industry specific nature of the majority of the companies' output, annual meetings of industry associations would often focus on forecasting demand, with little emphasis on issues relating to productivity. As a

Exhibit C - 22

METAL CUTTING AND METAL FORMING MACHINE TOOL SALES IN THE U.S.

1987 $ Billions

EXAMPLE



Source: *The Economic Handbook of the Machine Tool Industry*, 1991-92

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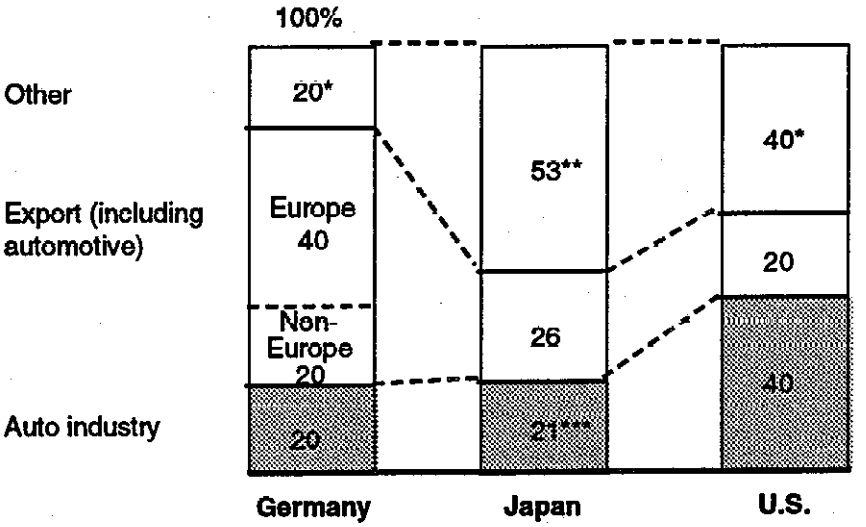
Exhibit C - 23

PURCHASERS OF MACHINE TOOLS 1990

Percent



* Machine tool industry, aerospace, farm equipment, etc.
** Auto parts, machine tool industry, aerospace, farm equipment, etc.
*** Assembly only

Source: Commerce Department; Japan Machine Tool Builders' Association; McKinsey estimates

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Exhibit C - 24

STRUCTURE AND BEHAVIOR LEADING TO DECLINE OF MACHINE TOOL OPERATIONS IN THE U.S.

Factor	Impact	Outcome
Extreme cyclicality	• Volatility of cash flows and profits • Strategy to backlog customer orders (manage order book through the cycle)	**Extremely vulnerable to import competition** • Boom and bust mentality with less attention to productivity enhancement • Low levels of new investment • Low customer loyalty • Low workforce loyalty • Low innovation • Low attraction and retention of talented engineers
Low competitive intensity and low innovation by users*	• No reward for new technologies • Declining user sophistication • Low emphasis on mechanical engineering in universities • Slow to move to numerical controls	
Ownership/ concentration	• Small, family run businesses • Highly fragmented • Under capitalized at company level • Lack of industry standards • Lack of skills in new technologies (e.g., electronics)	

* The most dynamic users were defense and aerospace companies (extremely low production volume)

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result, managers spend most of their time trying to predict the demand cycle and manage their capacity, and too little time on improving operations.

- In each of these countries, local preference has been an issue. In Germany and Japan in particular, domestic manufacturers demonstrate a preference for relationships with local suppliers, including machine tool makers. The best example of this preference is found in Japan, where many players in the auto industry have developed their own, in-house, machine tool manufacturers. They have vertically integrated both to develop proprietary tools and to help other suppliers customize their products for their unique requirements. Meanwhile, manufacturers in the U.S. have demonstrated a preference for imported machine tools since the 1980s.

- Finally, the role of other industries plays a significant part in productivity improvement. Over 25 percent of the industries' output is absorbed by the auto industry (and often as much as 40 percent) (Exhibit C-23). The auto industry can, thus, play an important role in disciplining and encouraging development in metalworking. In Japan, for example, auto assembly companies have worked in cooperation with machine tool builders to make improvements and innovations in their products and in their productivity (costs). In Germany and the U.S., this role never fully developed. Moreover, machine tool companies in Japan were more closely tied to large customers through long-term contracts. Since demand was more predictable, they could design a simplified, linear process that made the most of technological and organizational innovations. In the U.S., most customers sought competitive bids for new business. This created an environment of uncertainty and prohibited investments in technological and organizational improvements.

  In Germany and the U.S., government contracts (e.g., defense) have, at times, played an important role, especially in the introduction of new technologies, but not to the extent of providing market discipline or pressure to improve productivity.

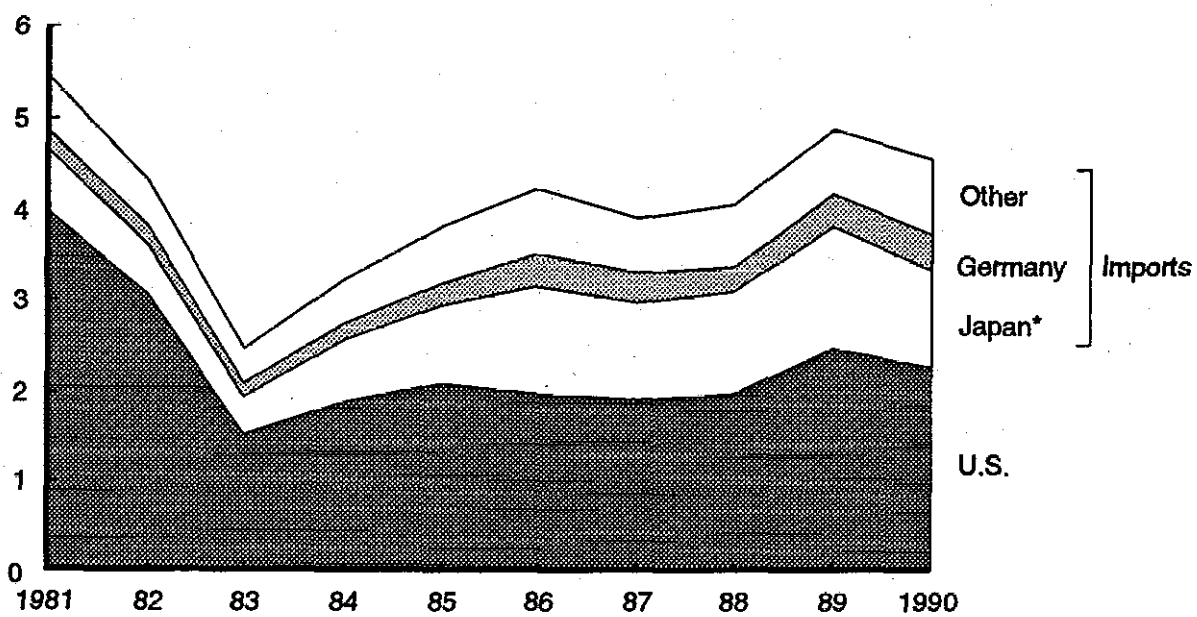
¶ Industry dynamics relating to the decline of the U.S. and vulnerability of the German industries. The profound differences in industry structure and behavior, combined with external factors, set the stage for a collision between metalworking operations in Japan and the U.S. in the early 1980s (Exhibit C-24). These same conditions have important implications for operations in Germany today.

- The economic turmoil of the 1970s provided the metalworking industry with a roller coaster of rising and crashing demand. In the late 1970s and early 1980s, machine tool orders in the U.S. were at very

Exhibit C - 25

ORIGINS OF U.S. MACHINE TOOL CONSUMPTION

$ Billions



* Imports only – not transplants

Source: *The Economic Handbook of the Machine Tool Industry*, 1991-92

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Exhibit C - 26

ELECTRONICS AND MACHINE TOOLS

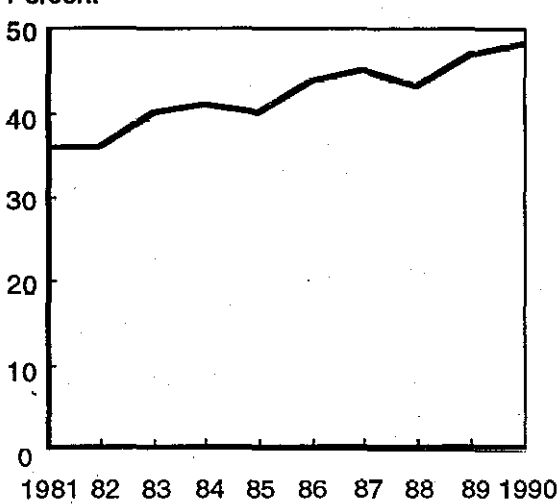
U.S.

EXAMPLE

Import share

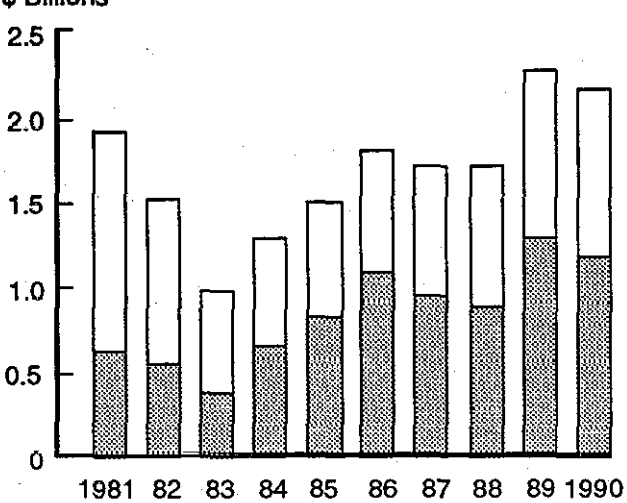
IMPORTED NC TOOLS AS A PERCENTAGE OF TOTAL U.S. CONSUMPTION

Percent



CONSUMPTION OF NC MACHINE TOOLS

$ Billions



Source: AMT

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high levels. These high levels were the result of many industries retooling to make smaller, more energy efficient products. Large corporate buyers, such as the auto industry, got preferential treatment during the resulting boom, while many smaller customers, such as job shops, were left with long lead times. Small buyers, due to the contract nature of their work, are less able to wait for tools and less interested in longevity (beyond the specific job). As a result, they began to buy what was then viewed as lower quality, off-the-shelf products from Japan, Taiwan, and Korea.

- Operations in Japan were able to provide rapid delivery and installation of standard products, and guaranteed rapid service to make up for lower quality. Beginning with the lathe market, they moved to vertical machining centers, and finally to horizontal machining centers. Over the years, the quality of both products and service improved, as did relationships with the job shops. In 1982/1983, when big buyers stopped buying machine tools, many metalworking companies in the U.S. found they could not get back into the low-margin market which they traditionally turned to in down cycles. Imports had captured the only growing part of the market, and were able to grow their share in other parts as they recovered (Exhibit C-25).

- As a result, many companies operating in the U.S. decided to exit low value-added markets, such as standard, numerically-controlled commodity tools (Exhibit C-26), preferring to source them from Japan in order to fill out their product lines. Then these so-called high-value markets suddenly came under pressure on two fronts. First, high-value markets such as station-type tools (including transfer lines) were highly cyclical (Exhibit C-27) and became very unattractive when domestic players tried to increase sales. Second, the machining centers, which were now largely imported, were able to do more of the activities traditionally reserved to highly customized station-type tools. As a result, companies operating primarily in the U.S. were competing in shrinking parts of the market (e.g., transfer lines) while the growing parts were dominated by non-U.S. producers (e.g., machining centers) (Exhibit C-27).

OUTLOOK

The outlook for each of these industries will be different in the next few years. The German industry has the most to gain in terms of productivity improvement. Although it was at par with the U.S. in 1990, we suspect that its productivity may erode in the coming years as a result of the current recession and the growing flow of non-European imports, which will eventually undermine the market power traditionally enjoyed by German products. As in the auto industry, companies in Japan are now making tools capable of dislodging both the standard tool makers and

Exhibit C - 27

EXAMPLE

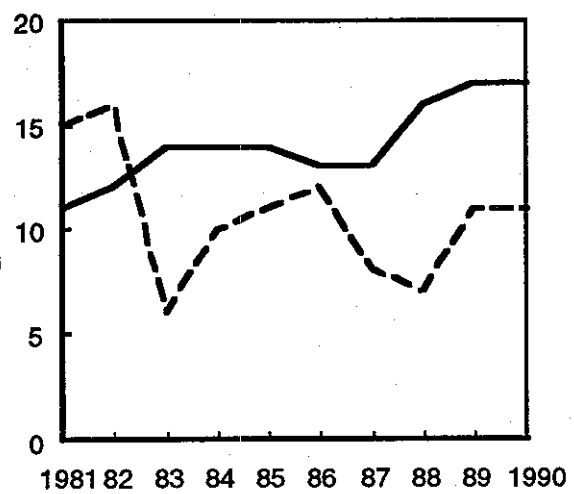
AUTOMATION AND MACHINE TOOLS

U.S.

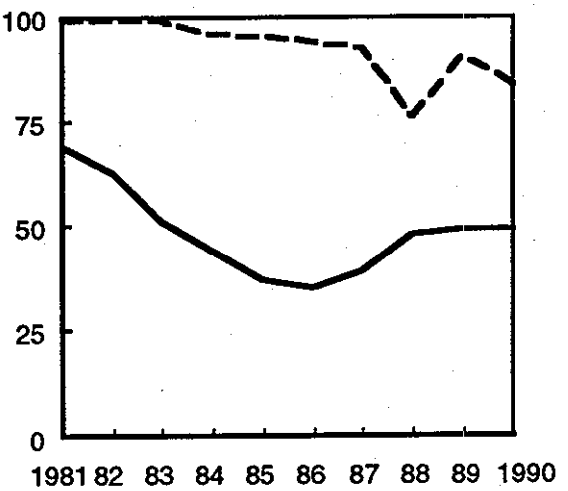
— Machining centers

– – Station-type tools (e.g., transfer lines)

SHARE OF TOTAL MACHINE TOOL CONSUMPTION



DOMESTIC SHIPMENTS AS PERCENTAGE OF CONSUMPTION



Source: AMT

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Exhibit C - 28

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES
METALWORKING INDUSTRY

● Important
○ Secondary
X Undifferentiating

External factors

• Market conditions	
- Demand factors	●
- Relative input prices/factor availability	X
- Other industries	X
• Policy and regulation	
- Macroeconomic conditions	X
- Competition rules and concentration rules	X
- Corporate governance rules	X
- Labor rules and unionism	○
- Other regulations (tariffs, nontariffs)	●

Nature of competition ●

Production process

• Output	
- Mix, variety, quality	○
• Production factors	
- Capital (intensity, vintage, technology)	●
- Scale	●
- Design for manufacturing	●
- Basic skill of labor, intrinsic motivation	X
- Raw materials, parts	X
• Operations	
- Capacity utilization (adjusted)	X
- Organization of functions and tasks	●

LABOR PRODUCTIVITY

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the specialty tools producers that previously enjoyed significant price premiums. While operations in the U.S. have spent the past decade restructuring, those in Germany are only now facing this challenge. As a result, productivity in domestic operations should improve in the long run. In the short run, however, the necessary restructuring will result in the shake-out of weaker players and the loss of many jobs (as happened in the U.S.). Nevertheless, governments should ensure that metalworking operations remain exposed to international competition to maintain their long-term viability.

While the dominant position of metalworking operations in Japan is yet unchallenged, they face a stream of cheaper exports from operations in such countries as Southeast Asia, Brazil, and India (many from their own transplants). As with the U.S. in earlier years, this evolution has forced the industry to abandon some low value markets at home and abroad, and to focus on higher value ones. More important, the opportunities to increase productivity through growth are largely exhausted. Growth opportunities are limited in the domestic market, and export markets are becoming more competitive. Moreover, financing for large scale investments will not be as cheap or as easy to obtain in the 1990s. Future productivity gains, therefore, are more likely to come in the form of better integration of functions and tasks and laying off redundant workers.

The U.S. industry is now reviving from its near demise in the 1980s, and the productivity outlook seems quite strong for the 1990s. Some new companies have started up in recent years and all indications suggest that these and many older companies will continue to do well when the VRA is dropped in 1994. Other players who have been lingering may finally be pushed out. In addition, multinational companies originating in Japan have made significant investments in transplant operations in the U.S. in recent years, some of which are now considered to be among the best plants in the industry. These trends should significantly improve U.S. productivity, perhaps narrowing the gap with operations in Japan substantially. In short, the U.S. industry has begun its process of restructuring and is now well positioned to compete in the global market. However, additional efforts will be required to rebuild overseas sales and distribution networks.

SUMMARY AND POLICY ISSUES

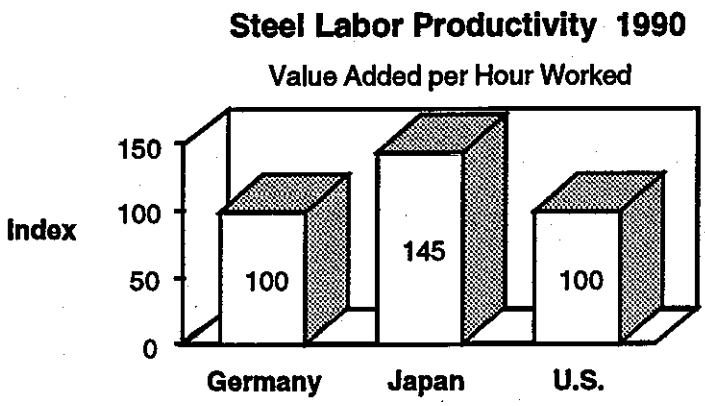
We have discussed the metalworking case as an example of how redesigning production to increase standardization can lead to an increase in the volume of those standardized parts and products, which, in turn, can provide opportunities for reorganization and automation (Exhibit C-28). The ultimate outcome of this process was a dramatic increase in productivity in metalworking operations in Japan that, over time, allowed them to catch up to operations in Germany and the U.S. during the second half of the 1980s, and to surpass them by 1990. The pivotal role played by the Japanese government in this process needs to be recognized. While the objectives of MITI are not well understood, the outcome of two decades of

encouraging consolidation and standardization was a domestic industry with fewer players, but higher levels of competition in similar products.

The relative complacency of companies operating primarily in Germany and the U.S. was not obvious at the time. With hindsight, it is easy to say that the German and U.S. governments should or could have played a similar role. But this was unlikely. Even today, German metalworking products are widely considered to be the best in terms of precision, accuracy and longevity. Many people still wonder why companies operating in Germany should worry about these new manufacturing innovations in Japan.

Metalworking companies in Germany should be more concerned about the productivity of their competitors in Japan. While metalworking operations in the U.S. have undergone restructuring as a result of a decade of import competition and foreign direct investment from Japan, operations in Germany have yet to face the current situation. In some ways, however, they are in a much better position than operations in the U.S. were during the 1980s, especially in terms of their perceived high quality and niche-market dominance. Even these advantages will eventually erode, unless the industry is encouraged to remain competitive in the international market.

STEEL INDUSTRY CASE STUDY SUMMARY



Older integrated plants in the U.S. and a lack of minimills in Germany lower steel productivity. Organization as well as technology makes the difference.

The average steel productivity numbers do not tell the whole story for this industry. German and U.S. productivity are equal in 1990, but how each country arrives at the those numbers is entirely different. There are two distinct ways of producing steel: traditional integrated mills and minimills. Because of their organizational flexibility, use of technology, and lean management structures, **minimills are roughly twice as productive.** Productivity of minimills does not vary much from country to country, but the prevalence of minimills does. Japan and the U.S. have approximately the same percentage of minimills. **Only 6 percent of German production comes from this highly productive format.**

The dominance of integrated mills and the lack of minimills in Germany explains much of Germany's productivity gap with Japan. **Why are there so few minimills in Germany?** Productivity improvements and new technologies mean layoffs in the steel, ore and coal industries. Government policies discourage laying off employees. Therefore, Germany is burdened with labor-intensive capacity, leaving little room for the entry of minimills. Despite its higher share of minimills, the U.S. is only even with Germany. U.S. productivity has been undermined by financial restructuring, often reinforced by labor and supplier concessions as well as local government subsidies, that have allowed unproductive, integrated mills to continue producing steel despite their poor economics. In some cases, this outcome has been encouraged by relatively lenient U.S. bankruptcy laws.

Much of the productivity difference among integrated mills in the U.S., Japan and Germany is due to the **age of the mills.** Newer plants take advantage of new high-productivity technologies and have adopted new approaches to organization. Although it has been upgraded, more of the U.S. integrated steel-making capacity dates from before World War II. Germany's capacity was added during the 1950s and has since been upgraded. Japanese facilities are newer, dating from the 1960s and 1970s. In addition, from 1970 to 1987 Japan invested over 20 percent more in steel making than the U.S. Ultimately, however, these integrated mills are facing challenges from more productive and more flexible formats (e.g., minimills), and cheaper imports and substitutes.

Outlook: The steel industry in Japan has lost ground to Germany and especially the U.S. since 1990. An estimate of labor productivity for 1992 places Japan only 20 to 25 percent ahead of the U.S. and 30 to 40 percent ahead of Germany. Even adjusting for the drop in capacity utilization following the bursting of the bubble economy, the U.S. has gained ground relative to Japan and Germany. Unlike the U.S. industry, which is relatively far along in the restructuring process, the Japanese and German industries face significant challenges. Given the higher returns to investors, higher productivity, and greater flexibility of minimills, the large, modern integrated facilities of the Japanese and German plants are proving to be underutilized and costly.

PRODUCTIVITY IN THE STEEL INDUSTRY

Steel holds a special place in economic history. It was the backbone of industrial development throughout much of Europe, Asia and North America. Through much of this century, steel companies operating in Germany, Japan, and the U.S. maintained positions of prestige and influence. Even today, although the relative importance of steel has declined, the steel industry gets a disproportionately large amount of attention in the press and in the halls of government. Deep-seated emotions are evoked by perceived internal and external threats to domestic steel production and employment.

Since the 1970s, steel has also become a synonym for a mature or declining industry, and, in the case of operations in Germany and the U.S., for regional de-industrialization or "rust belts." Even operations in Japan, which had been able to maintain high levels of performance within a deteriorating global environment, have been profoundly shaken by the collapse of the "bubble economy" in the early 1990s. In each of these industries, shrinking domestic demand, rising imports, and the loss of traditional export markets has resulted in the need for substantial capacity reduction. Over the same period, however, high levels of capital investment were required to maintain and upgrade remaining facilities. While this situation was somewhat similar across Germany, Japan and the U.S., the governments and steel producers of these countries started with very different assets and operating practices, and subsequently made very different decisions concerning capacity reduction and investment. The productivity differences we observe are largely the result of this combination of different starting points and different responses to market pressures.

THE STEEL INDUSTRY

Consistent with the rest of this document, our analysis focuses on the steel industry in Germany, Japan and the U.S. in 1990 and, to a lesser extent, in 1987. As a result, it does not take into account more recent developments that continue to alter the competitive landscape for this industry, particularly in Japan. These more recent developments are discussed in the section entitled "Outlook."

Our productivity comparisons are based on comparable data for products and industries using the censuses of manufacturing in Germany, Japan and the U.S. (Exhibit D-1). Using census definitions, we have captured the fabrication of steel products in both integrated facilities and minimills. These products include: semifinished products, such as billets and blooms; flat products, such as steel plate, steel sheet, and coated sheet; and long products, such as H-beams and rails. Steel tubes and pipes as well as specialty products (e.g., galvanized and aluminized sheet) are also included.

Exhibit D - 1

STEEL INDUSTRY DEFINITIONS

	SIC	Industry definition
Germany	2711	Blast furnace, steel and rolling mills
	2715	Manufactures of tubes and pipes
	2720	Manufactures of precision tubes
	3011	Cold rolling mills and cold finishing
Japan	261	Iron industries, with blast furnaces
	263	Manufacture of steel, with rolling facilities
	264	Manufacture of steel materials except smelting furnaces and steel wires with rolling facilities
	265	Manufacture of coated steel
U.S.	3312	Blast furnaces and steel mills
	3316	Cold finishing of steel
	3317	Steel pipes and tubes

Major products	
Long products	
Wire rods	Heavy sections
Bars	Rails
Light sections	Piling
Flat products	
Hot rolled –	Plates
	Hot wide strip and sheet
	Strip
Cold rolled –	Cold rolled sheet and coil
	Electric sheet
	Cold strip
	Tin plate
Coated –	Hot dip galvanized
	Electro galvanized
	Organic coated and painted sheet
	Aluminized sheet

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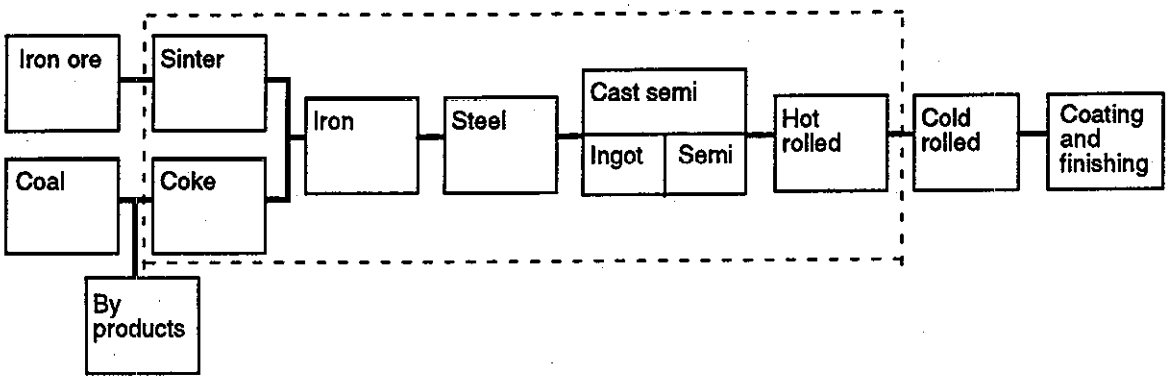
Exhibit D - 2

RUDIMENTARY STEELMAKING PROCESS FLOWS

INTEGRATED BAR PROCESS: 6-7 STEPS



MINIMILL BAR PROCESS: 3 STEPS

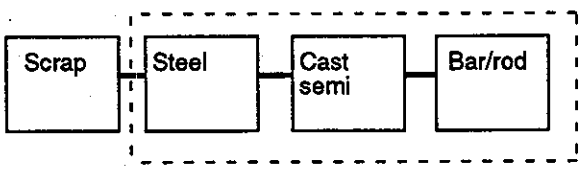


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Exhibit D - 3

MAIN TYPES OF PLAYERS

	Integrated mills	Mini-mills
Raw materials	Iron ore, coke	Scrap
Production/ capacity	2 to 10 million tons	100,000 to 1 million tons
Technology/ equipment	Complex production flow (Blast furnace → BOF → Ingot/continuous casting, hot rolling → cold rolling/finishing)	Single production line (EAF → continuous casting → hot rolling)
Product range	Wide variety in flat and long products including higher value added products	Limited product mix in commodity long products (wire rods, bars, sections, normally in common and lower quality steel grades); now penetrating flat-products in U.S.
Markets	Domestic and global markets	Mainly domestic and local markets
Investment level	Requires high investments (2-3 times per unit of capacity more than minimills)	Medium investments to install and maintain
Philosophy	Relatively risk adverse and hierarchical due to complexity and asset-intensity of process; typically inward focused	Entrepreneurial, non-hierarchical and typically market-focused

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Two main types of steel plants are used in the production of steel products: integrated production and minimill production (Exhibit D-2). The integrated process gets its name from the fact that it integrates both iron-making and steel-making activities, thereby covering production processes that run all the way from ore to finished products. In ironmaking, raw materials such as coal and iron ore are processed into coke and sinter/pellets. These materials are then combined in blast furnaces to produce pig iron. The iron is then sent to the steel mill where it is converted into steel in basic oxygen furnaces (BOF) and cast into ingots or semis (billets, blooms and slabs). Slabs are transformed into flat products in hot-rolling mills, where they are pressed into plate or long sheets and then cooled and coiled. This coil can then be cold rolled, coated, and finished. Some of the sheet will further be processed into tubes and pipes. Billets and blooms are transformed in structural mills into long products such as heavy sections, I-shapes, and rails; and in bar mills or wire-rod mills into such long products as bars, light sections and wire rods.

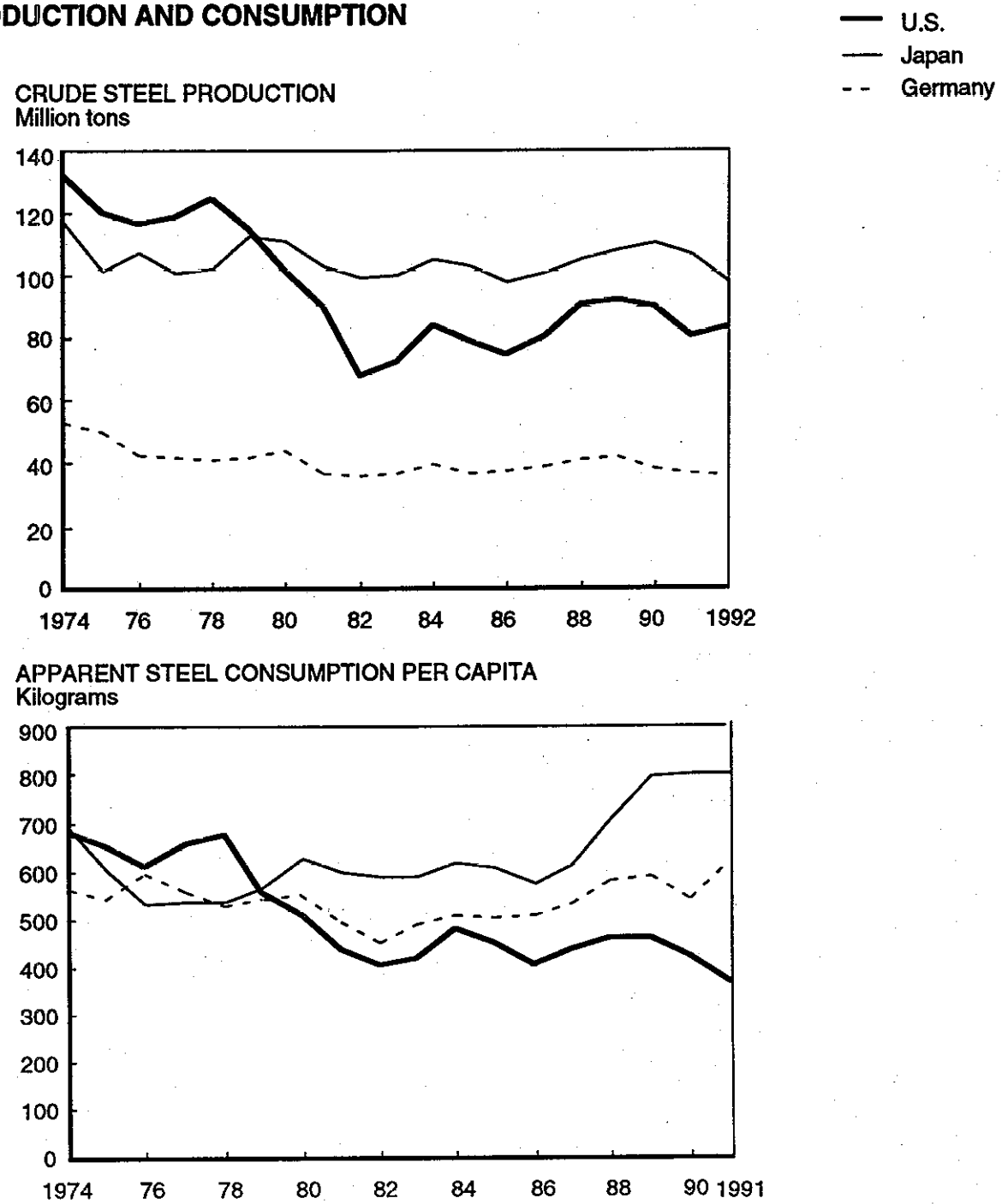
The minimill process gets its name from its small size. Whereas the capacity of integrated mills typically ranges from 2 million to 10 million tons per year, their minimum efficient economic scale is usually in the range of 3 to 4 million tons. Minimills, on the other hand can efficiently operate with a capacity as low as 100 thousand tons, although most are in the range of 300 to 600 thousand tons (Exhibit D-3). More important, we will see that the productivity of minimills (based on value added per hour worked) is roughly twice that of integrated producers. The smaller scale and higher productivity of minimills relative to integrated mills results from differences in technology, product complexity and organization.

In general, steel companies in all three countries sell directly to customers as well as through trading houses, brokers and distributors. However, distribution across the three countries varies somewhat, both in terms of structure of the system and the degree to which steel companies are vertically integrated in distribution activities. Steelmaking operations in Japan and Germany are tied to their distribution systems through ownership or cross holdings to a greater degree than operations in the U.S., which largely gave up distribution in the early 1980s to focus on steelmaking.

Estimates of crude steel production are useful to compare the output of each steel industry in physical terms (Exhibit D-4) but are not useful for calculating productivity. Crude steel production does not reflect differences in product mix, quality and value, and therefore cannot be divided by hours worked to derive robust productivity estimates. A better approach is the use of sales values. Using a PPP exchange rate derived for each industry by comparing price levels over a wide range of comparable products, the 1990 output of each industry was as follows (Exhibit D-5): operations in Germany were the smallest at $28.7 billion in sales; those in Japan had sales of $72.7 billion; and those in the U.S. had $56.8 billion in sales ($56.3 billion in the German/U.S. comparison).

Exhibit D - 4

STEEL PRODUCTION AND CONSUMPTION



Source: McKinsey steel data base

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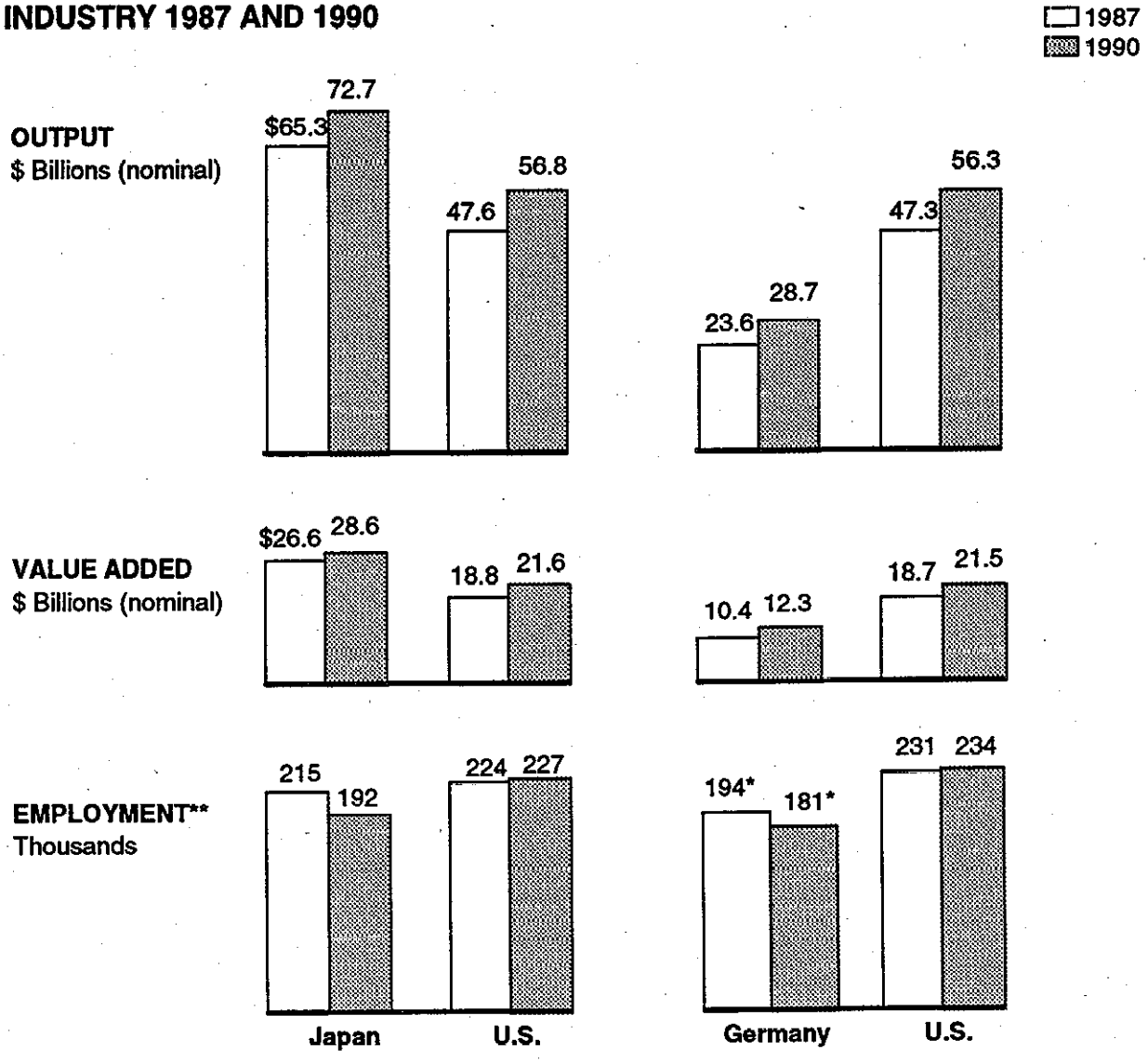
Exhibit D - 5

STEEL INDUSTRY 1987 AND 1990



* Excluding "Azubis" (apprentices) (1987: 12,000; 1990: 10,000)
** Including all leased and subcontracted labor

Source: Census of Manufactures; McKinsey analysis

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ADJUSTMENTS

Industry PPPs

The purchasing power parity (PPP) exchange rates for the steel industry were derived from numerous product matches across all grades of products found in the 1987 Census of Manufactures for Germany, Japan and the U.S. The basic method used was to improve these product category matches when necessary. A weighted average of these product PPPs was then calculated, resulting in the industry PPPs used in this study. The PPPs for 1990 (and other years) were arrived at by inflating (or deflating) 1987 prices by the producer price indices of the two countries being compared. New PPPs were then calculated from the inflated/deflated data. A slight adjustment was made in the case of Japan for the shift in demand in long products resulting from the construction boom associated with the "bubble economy" of 1990. The resulting PPP for Germany in 1990 was 1.90 DM/$ (1.88 DM/$ in 1987); the PPP for Japan in 1990 was 170 ¥/$ (149 ¥/$ in 1987).

Employment

Employment numbers for operations in Germany were adjusted to exclude apprentices or "azubis" because they do not contribute to the production of steel or do productive activities in the mill. Azubis numbered approximately 10,000 in 1990.

Double Deflation

There was no adjustment made for double deflation. Two tests assured us that there were no distortions resulting from differences in the price level of inputs and outputs. First, we observed that the PPP for both Japan and Germany was very close to the exchange rate in 1987 (our benchmark year). Second, we calculated an input PPP and compared it to the output PPP. We did this because we were concerned that price level differences in such key inputs as iron ore, and coal (for integrated producers), and scrap and electricity (for minimills) would have a distorting effect on output prices. By calculating an input PPP based on the prices of inputs, weighted by products and technology (e.g., integrated versus minimills), we found that the input PPP matched the output PPPs of both Japan and Germany. In 1990, the input PPPs were 188DM/$ and 173¥/$.

The value added in each industry in 1990 had a similar pattern as output: operations in Germany were the smallest, with $12.3 billion of value added; operations in Japan produced $28.6 billion of value added; and operations in the U.S. created $21.6 billion value added (or $21.5 billion in the German/U.S. comparison). Differences in input prices – although significant in some areas (e.g., scrap) – have only a minimal effect on aggregate value added and productivity. As a result, such differences are not reflected in our estimates (see box entitled "Adjustments").

Steel operations in Germany employed around 181,000 people in 1990, while those in Japan employed 192,000 people and those in the U.S., 227,000 (234,000 in the German/U.S. comparison). This includes subcontractors, who frequently represent a large proportion of the total labor force, particularly in Japan and particularly at newer plants. During that same year, the hours worked per employee were the following in each industry: Japan, 2,177 hours; Germany, 1,495 hours; and the U.S., 2,018 hours. The accuracy of these numbers is important, as our productivity comparisons relate to hours of labor input, not to total employment.

PRODUCTIVITY RESULTS

In 1990, the productivity level of steel operations in Japan, measured in terms of value added per hour worked, was 45 percent higher than the productivity of operations in Germany and the U.S. (Exhibit D-6). In earlier years, the operations in Japan were at an even greater advantage to those of Germany and the U.S. (Exhibit D-7). Between 1987 and 1990, the productivity lead of operations in Japan decreased – a trend that has continued through the early 1990s.

According to census data, the productivity gap between steel operations in the U.S. and Germany in 1987 was approximately 13 percent and had been closed by 1990. We believe that this result reflects uncertainty in capacity utilization rather than a clear cut productivity difference. We have not adjusted the productivity of the U.S. or Germany to reflect the business cycle (See box entitled "Adjustments"). Our suspicion is that the relative productivity difference in 1987 was fairly similar to that existing in 1990 (i.e., both had about the same productivity).

CAUSES OF PRODUCTIVITY DIFFERENCES

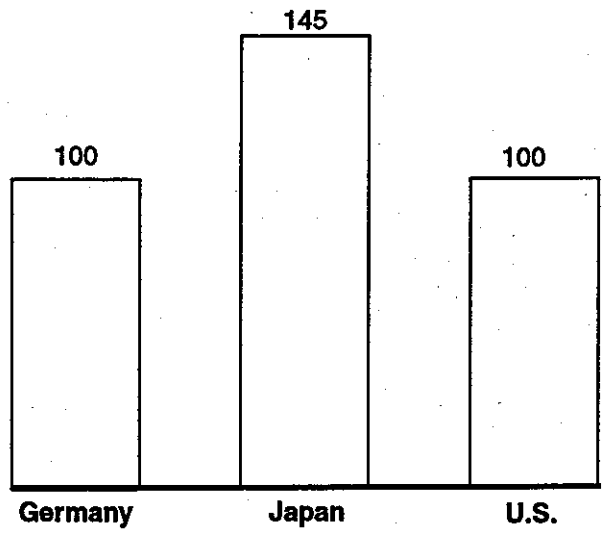
Using the general framework of this study, we will examine the reasons for the observed differences in productivity at three levels (Exhibit D-8). The first level is the way companies organize themselves to do business, that is, their scale, their efficiency in the utilization of resources, and their ability to take advantage of the best technologies. This level describes the entire observed productivity difference at the production process level. Then we ask why the production processes in these countries are organized differently, and offer explanations on the second and third levels. The second level looks at the differences in the structure and competitive

Exhibit D - 6

STEEL LABOR PRODUCTIVITY 1990

VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED

Index: U.S. = 100



Source: Census of Manufactures; McKinsey analysis

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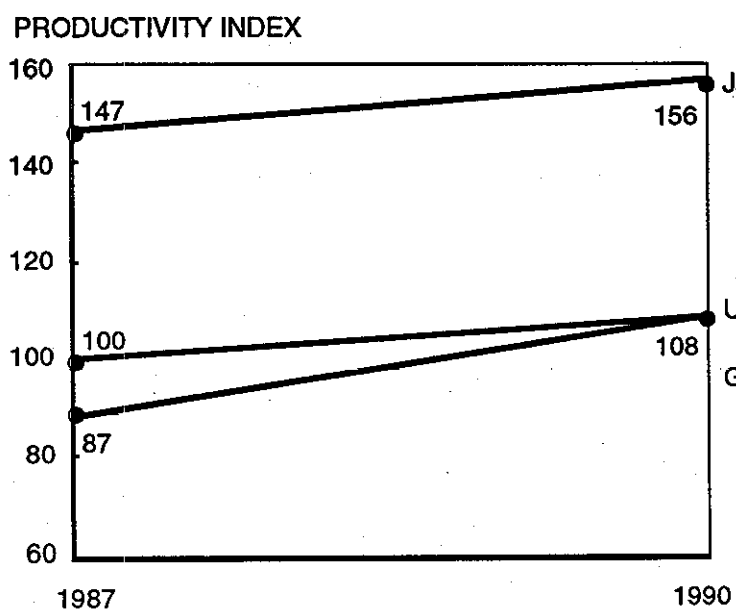
Exhibit D - 7

REAL LABOR PRODUCTIVITY CHANGE IN THE STEEL INDUSTRY 1987-90

VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED

Index: U.S. 1987 = 100



	Real annual productivity change 1987-90
Japan	2.0%
U.S.	2.6
Germany	7.5

Source: Census of Manufactures; McKinsey analysis

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Exhibit D - 8

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES 1990

STEEL INDUSTRY

External factors	Nature of competition	Production process	Labor productivity
Germany: Significant regulatory barriers to new entrants (minimills); state support for old players	Moderate price and product competiton in regional market; strong exports	Low share of minimills; good integrated technology; poor organization of functions and tasks	100%
Japan: Significant pressure from other industries (autos) to improve productivity and develop new products	Low price competition; significant product innovation in regional market; strong exports	High share of minimills; very strong integrated technology; strong organization of functions and tasks	145%
U.S.: Trade protection; barriers to removing non-productive capacity	Significant price and product competion; low exports, very high imports	High share of minimills; lagging integrated technology; moderate organization of functions and tasks	100%

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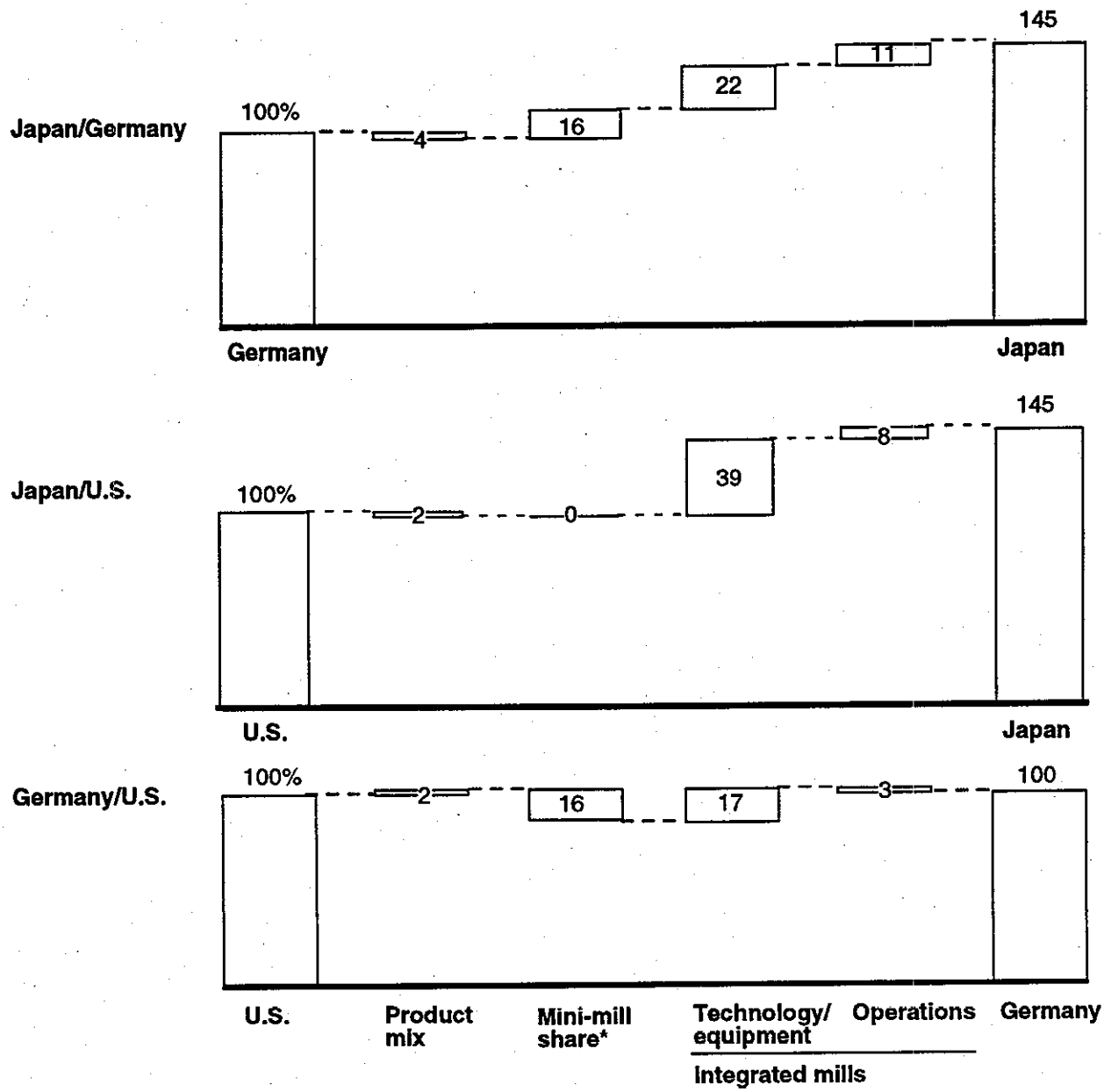
Exhibit D - 9

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES 1990

PRODUCTION PROCESS LEVEL

VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED



* Includes technology and operations

Source: Steel industry model; Technical data base; McKinsey analysis

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behavior of industries. The third level examines external factors such as the policy environment and the product market environment.

Causality at the Production Process Level

At the production process level, the different productivity of Germany, Japan and the U.S. can be largely explained by: (1) differences in the share of minimills, (2) differences in the mix of technology in integrated mills and (3) differences in the organization of operations of integrated mills (Exhibit D-9). A minor factor that helps explain the productivity differences at this level is (4) the different mix of products manufactured in each of the three countries. Differences in technology and operations within minimills are generally minimal.

¶ Share of minimills as a causal factor. The lower share of minimills in Germany explains a large part of the gap in productivity between operations in Germany and those in Japan, and would reduce the relative productivity of steel operations in Germany relative to those in the U.S., were it not for offsetting technology advantages in integrated facilities (Exhibit D-9). For example, if Germany had the same ratio of minimills to integrated mills as Japan and the U.S., then the productivity of its operations would be 16 percent higher.

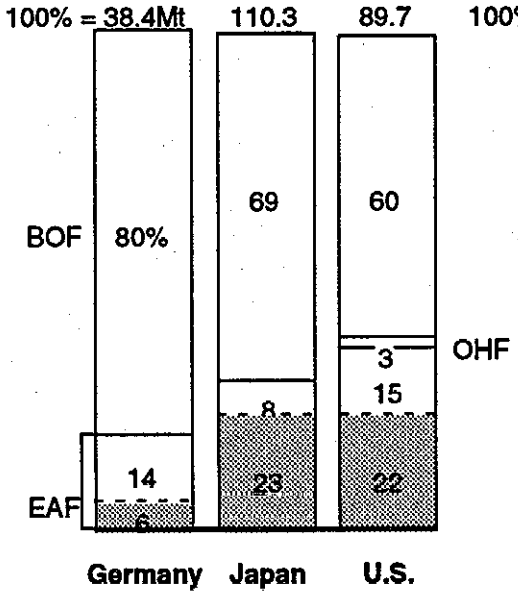
While producers located in the U.S. lead those in Japan and Germany in the use of electric arc furnaces, a number of them are located in integrated facilities or in specialty steelmakers (e.g., stainless steel) that do not fit the industry definition of minimills. Those that do fit the description of minimills have a similar share of production in Japan and the U.S., at about 22 percent of production. Germany, on the other hand, derives only 6 percent of its output from two minimills (Exhibit D-10).

Based on a number of benchmark studies and economic models in each of the three countries studied, we estimate that minimills are more than twice as productive as integrated mills when measured in terms of value added per hour worked (Exhibit D-11). Technology differences are a part of the reason. As mentioned above, integrated mills process raw materials into iron, which is then converted into steel. The material handling, blast furnaces, and basic oxygen furnaces required in this process dictate a minimum efficient capacity of 3 to 4 million tons per year. Minimills eliminate the entire ironmaking process, but use scrap steel which is then melted and converted using EAF technology. The minimum capacity for such a process can be as low as 100,000 tons per year and, while more intensive in terms of capital and electricity, requires much less labor per unit of physical output. In addition, because minimills are somewhat newer than the majority of integrated mills, they tend to have more

Exhibit D - 10

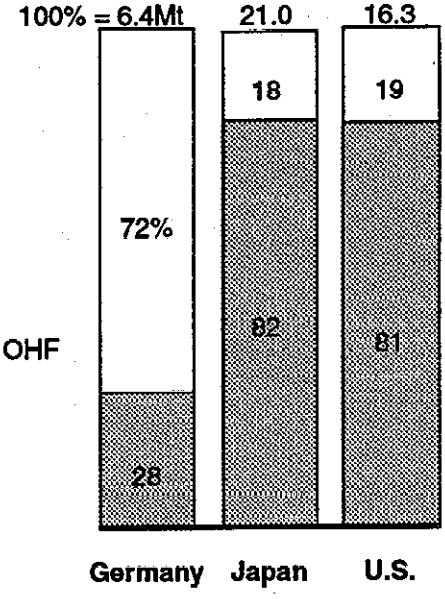
MINIMILL MARKET SHARE 1990

CRUDE STEEL PRODUCTION
Percent

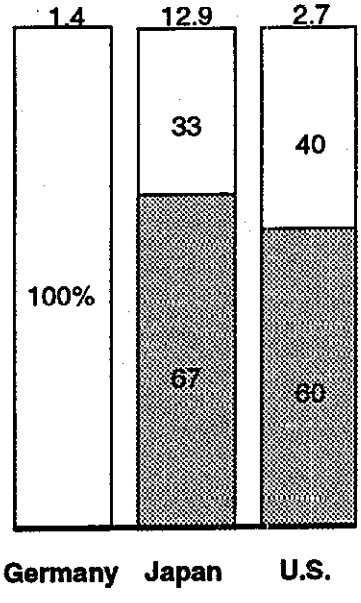


LONG PRODUCT SEGMENTS
Percent

Bars, wire rods, light sections



Medium and heavy sections



Source: IISI; annual reports; industry associations; McKinsey analysis

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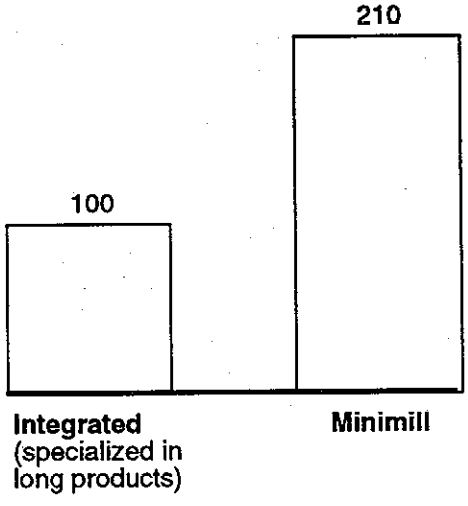
Exhibit D - 11

PRODUCTIVITY COMPARISON MINIMILLS VS. INTEGRATED MILLS* 1990

VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED

Index : Integrated mills = 100



* Based on comparable products

Source: Annual reports; Steel industry model; McKinsey analysis

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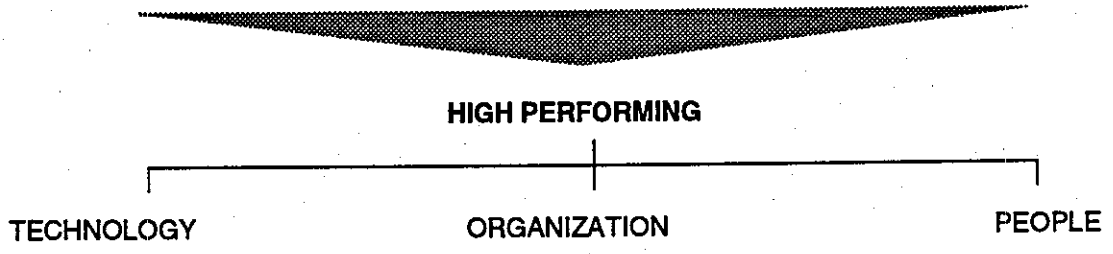
Exhibit D - 12

REASONS FOR MINIMILL ADVANTAGE ON THE PRODUCTION PROCESS LEVEL

Minimal complexity	Streamlined management	Flexibility	Strong supporting system
Less labor intensive technology (EAF; 100% continuous casting)	Highly decentralized	Flexible work rules	Incentive payment >50% of total
Target commodity products in integrated markets	Less corporate bureaucracy: headquarters <20 people	Multicrafting	Workforce evaluated on overall team output
Simple product mix	Inside sales	Largely non unionized in U.S.	Constant improvement atmosphere bottom-up initiatives
	Very fast decision process	Teamwork	
	Small plants (<500 people)	Cross-functional interactions	



Source: Interviews; McKinsey analysis

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modern equipment in downstream facilities than do integrated players. This also reduces the need for labor.

The productivity advantage of minimills does not come just from technology, however. What distinguishes minimills from integrated facilities is not only the use of less labor-intensive melting technologies and finishing technologies, but also a simpler process in terms of inputs (scrap), products (mostly commodity long products), and operating structure. Until recently, minimill production has been limited to a narrow range of commodity long products because minimills could not attain the quality levels required of flat products. As a result, minimills have focused their operations on a limited number of products. This focus, combined with new technologies, has allowed minimills to reduce production complexity, encourage labor flexibility, and limit the need for expensive overhead (e.g., R&D, production planning). These factors have translated into organizational differences that are visible throughout the mill (Exhibit D-12).

In fact, we estimate that 50 to 70 percent of the productivity advantage of minimills (over integrated mills) is due to operating differences rather than purely technical differences. (This depends greatly on the products involved, the technologies being used, and the companies being compared.) Relative to integrated mills, management in minimills is highly decentralized and responsive. Corporate overhead is almost negligible (in large minimills as few as 20 people or less). The work force has a much higher degree of flexibility (in the U.S., minimills are largely nonunion, but even in unionized facilities work rules are more flexible, allowing for multicrafting, team-based problem solving, and cross-functional interaction). Finally, management has built supporting systems, including compensation (profit sharing, productivity pay) and team-based evaluation, that contribute to an environment of continuous improvement and bottom-up initiatives.

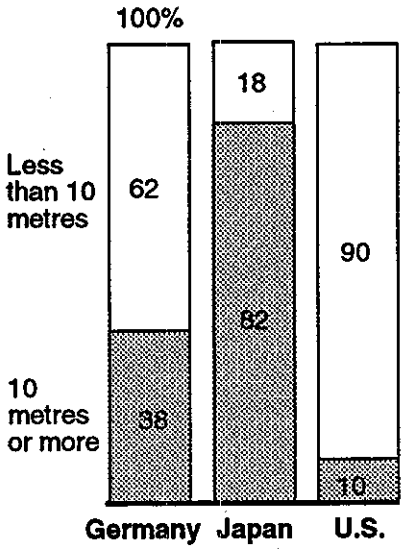
Integrated producers, on the other hand, have had a hard time reducing product complexity because of the scale and technology of their primary operations. Blast furnaces only run efficiently at a given size and rate of output, on a continuous basis, and are very expensive to shut down. In order to absorb the steady flow of iron, integrated producers built a variety of rolling and finishing mills to produce a wide range of products so that the operation could run full. Traditional, large integrated steel mills typically produced 10 to 15 different products at a single site. This approach added to the organizational complexity of the operation and resulted in higher production and overhead employment per unit of output than in minimills, which typically produce one or two products. In addition, the past wealth and power of integrated producers and of their unions has left a legacy of organizational rigidity.

Exhibit D - 13

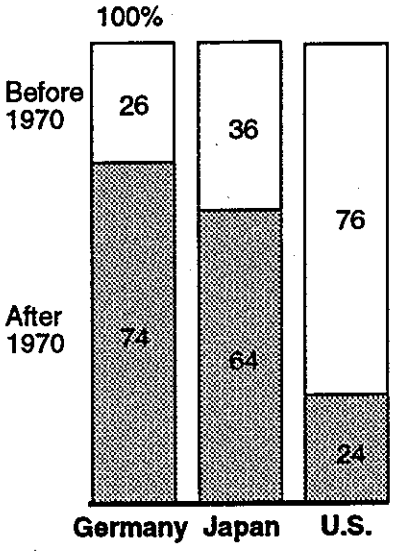
MIX OF EQUIPMENT IN INTEGRATED PLANTS

Preferred equipment

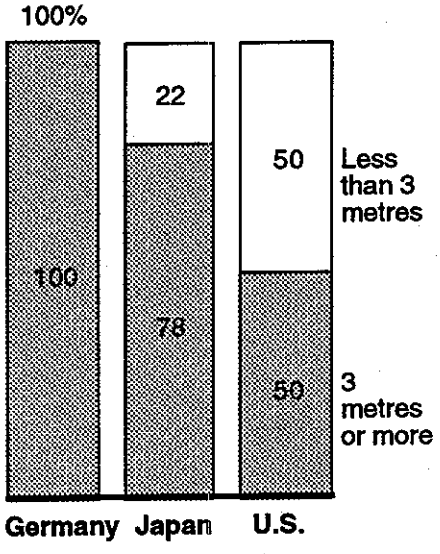
BLAST FURNACE DIAMETER



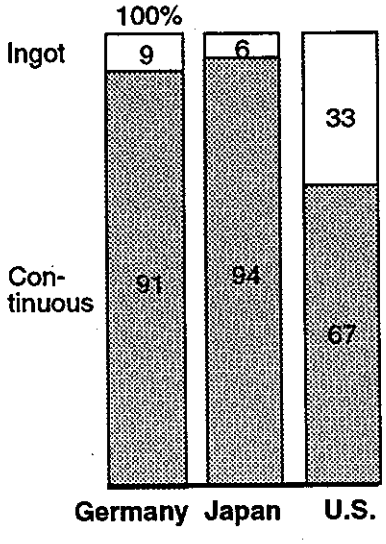
AGE OF BLAST FURNACES



HOT WIDE STRIP MILL CAPACITY



CASTING TECHNOLOGY - 1990



Source: McKinsey steel database

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¶ Capital and scale in integrated mills as a causal factor. Steel operations in Japan also gain a productivity advantage over those in Germany and, especially, the U.S. from the scale and age of technology and equipment in integrated facilities. Operations in Germany also have an advantage relative to those in the U.S. (Exhibit D-9). While operations in the U.S. have maintained a number of facilities and equipment that predates World War II, much of the equipment in Germany was rebuilt after the war. In both cases, this equipment has since been frequently upgraded and refurbished, but Germany has the advantage of a newer base. Operations in Japan are even more modern, having been built up significantly in the 1960s and early 1970s. A large part of these operations has been redesigned to incorporate more automated systems (e.g., material handling, coil binding, wrapping), continuous systems (e.g., casting, rolling, pickling, and annealing) and electronically controlled processes. Moreover, the Japanese industry in many ways effectively redefined the state of the art in scale and process technology (e.g., blast furnace scale). The resulting differences in technology, especially important in such areas as blast furnaces and casting equipment (Exhibit D-13), explain much of the productivity advantage in Japan. As a result of their newer, larger and more automated equipment, integrated mills in Japan required approximately 25 percent fewer labor hours in downstream facilities (material handling, pickling, rolling, annealing and coating) than those in the U.S. Relative to integrated mills in Germany, those in Japan employed 15 percent fewer labor hours in downstream facilities.

Capital intensity figures confirm that investment levels were much higher in steel operations in Japan (Exhibit D-14). On a capital stock per hour worked basis, producers in Japan invested over 20 percent more than those in the U.S. during the period from 1970 to 1987. Capital stock numbers for operations in Germany over the same period seem surprisingly low (only 66 percent of the U.S.), but make sense when one considers the low share of minimills and the fact that integrated mills are less capital intensive (on an hours worked basis). While it is clear that all three industries have invested in upgrading their steelmaking equipment and facilities, the labor saving of this investment has probably been lower in the U.S., where it has overwhelmingly been directed at brownfield investment in existing sites. (Brownfield returns are typically lower than greenfield returns since retrofit costs are often higher than the costs of new designs, and the logistics of older plants often undermine the efficiency of newer processes.)

¶ Organization of functions and tasks in integrated mills as a causal factor. If we assume a similar mix of technologies and a similar mix of products in all three industries, the key lever for raising productivity would be in operations, or the integration of functions and tasks. Although the intra-industry differences in steel operations are often greater than the inter-

Exhibit D - 14

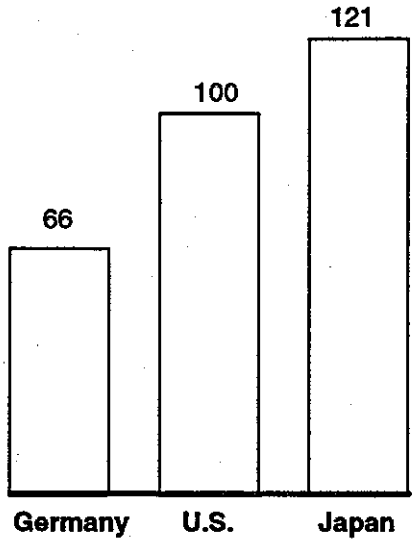
CAPITAL INTENSITY

STEEL INDUSTRY

Index: U.S. = 100

CAPITAL STOCK* PER HOUR WORKED

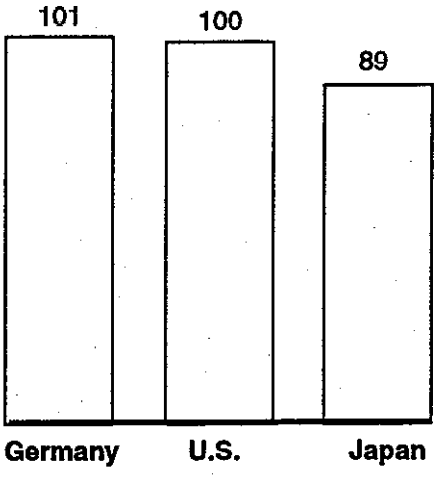
100% = $172



CAPITAL STOCK* PER TON SHIPPED

Percent

100% = $1,115,000



* Stock is accumulated from 1970 to 1987 applying depreciation from years 14-18

Source: Census of Manufactures; National investment statistics; McKinsey analysis

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Exhibit D - 15

ORGANIZATION OF FUNCTIONS AND TASKS

Key organizational characteristics of steel companies operating in Japan

STRONG HORIZONTAL ORGANIZATION

Cross-functional committees	Strong planning department	Strong technical control function
Teams are basis of actions	"Transmission belt" between headquarters and plants	Maintains basic operational principals and develops programs for problems area
Strong problem-solving skills (focusing on efficiency, quality, delivery, and safety)	Excellent integrated planning systems	Integrating plant managing, maintenance, process and technical control, environmental functions, etc.
Learning organization		
Ever more challenging goals		

CONTINUOUS IMPROVEMENT ETHIC

EXCELLENT ORGANIZATION OF FUNCTIONS AND TASKS

Outstanding technical support	Flexibility	Self management values
Continuous training	Multicrafting plant operating/maintenance	TQM
Large number of engineers (at headquarters)	Company-owned subcontractors	TPM
Large number of researchers (at headquarters)		Kaizen

Source: Interviews; McKinsey analysis

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industry ones, operations in Japan are noted for having performed better along this operational dimension in the 1980s than operations in the U.S. and, especially, Germany.

The organizational elements which characterize the integration of functions and tasks in steel operations in Japan are the following (Exhibit D-15):

- Strong corporate cultures characterized by: (1) corporate planning or steel planning departments that provide higher levels of management capacity and leadership to the mills; (2) strong technical development and control functions that maintain basic operating principles, solve problems, and integrate mill functions; and (3) cross-functional teamwork for problem solving, learning, and high internal aspirations.

- Excellent labor relations characterized by: (1) successful efforts to recruit and permanently retain some of the best students from Japanese universities and technical schools; (2) high levels of work force flexibility manifest in multicrafting (e.g., in maintenance), the use of operators for routine maintenance, and the use of a subcontracted work force as a buffer for adjusting capacity to match demand; and (3) worker-led self-improvement programs or *jishu kanri* (JK) activities such as total quality management (TQM), total productivity management (TPM), and continuous improvement (*kaizen*).

- A resulting ethic of continuous improvement.

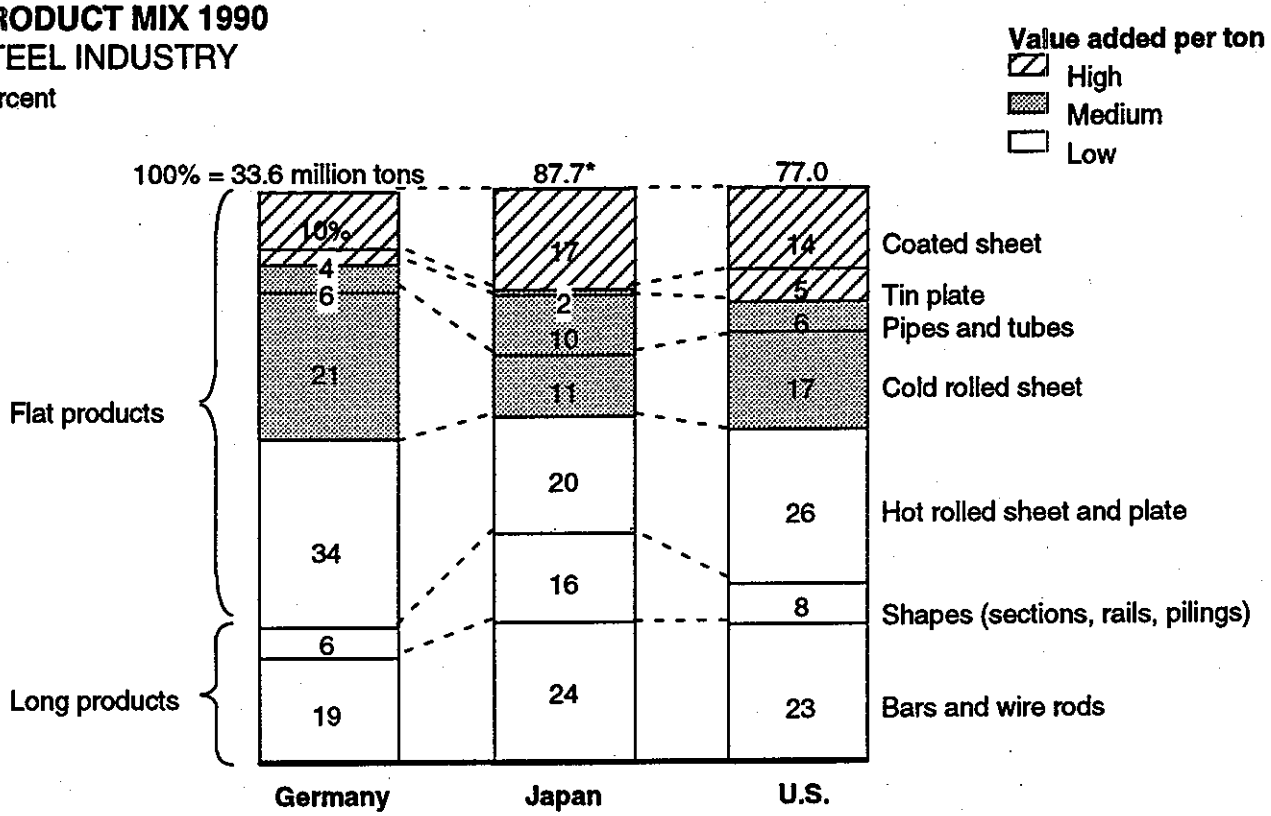
Steel operations in the U.S. have only attempted to introduce these innovations within the past 10 years, while most in Germany have yet to do so. Workers in the U.S. and Germany cooperate in TQM programs and quality circles but, in many cases, management has been unable or reluctant to introduce more significant cultural change. In some cases, especially in Germany, external pressures and adherence to social market ideals have caused management to commit itself to limits on work force reduction. As a result, operations in Germany remain somewhat hierarchical and overburdened with organizational complexity (e.g., more levels of management and less flexibility in the work force). Manning levels across many functions are higher than in operations in Japan and even somewhat higher than those in the U.S.

¶ Product mix as a causal factor. Product mix is a minor factor. Although it is difficult to generalize, flat products, such as steel sheet, strip and plate, command higher prices and are more often higher in value added per hour worked than long products. In addition, coated sheet is even higher in terms of value added per hour worked. This difference is partly due to end-use applications and the production processes required. Flat products are generally used in other industries, such as automotive and packaging,

Exhibit D - 16

PRODUCT MIX 1990
STEEL INDUSTRY

Percent



* Excluding special steels

Source: Annual reports; IISI; National statistics; McKinsey analysis

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Exhibit D - 17

NONDIFFERENTIATING INFLUENCES ON 1987-90 PRODUCTIVITY

Scale economies	Critical scale for integrated mills is ~3 million tons/year, for minimill 0.4-0.5 million tons/year. The majority of players are above this limit in the U.S., Japan and Germany
Labor skills	Skill level differences, independent of management influences on training, recruiting, multicrafting and continuous improvement, are negligible
Raw materials, inputs	Important raw materials (e.g., iron ore, scrap, coal) are sourced globally; in Germany partially locally (Hüttenvertrag); no problem of availability Electricity is more expensive in Japan and Germany, but large efforts in energy saving have reduced vulnerability Scrap is cheapest in the U.S.; more expensive in Japan than Germany
Capacity utilization	Adjusting for non productive capacity in Japan, there are negligable utilization differences; trend in all three countries was similar from 1987-90 (however, extrapolation to 1992 may require cyclical adjustment)

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that require very high quality products. In 1990, integrated facilities made the greatest part of these products; minimills had not yet learned to overcome impurities in their scrap supplies or to achieve the minimum efficient scale of hot strip mills. Long products, such as shapes (e.g., H-beams), tubes and pipes, and wire rods, are generally used in light and heavy construction. Rather than requiring an attractive appearance, the key buying factor in long products is strength, which is easily satisfied using EAF technologies. As a result, there has been much more competition and lower prices in long products.

In general, operations in Japan have a higher share of long products than those of either Germany or the U.S. (Exhibit D-16), but this difference is offset by a higher share of coated products than operations in Germany. Operations in Japan also have a higher share of specialty products, but one that is difficult to quantify. The resulting effects of this mix on productivity is minimal, however, resulting in 5 to 10 percent of the productivity gap between any two industries.

While no one would suggest that labor skills, raw materials, and capacity utilization have no effect on steel productivity, we found few differences in the countries under study along these dimensions in the 1987-1990 period. As a result, we found that these variables were non-differentiating in terms of 1990 productivity. The similarity of capacity utilization figures, however, may mask a more significant difference related to the trend in output. By 1990, the U.S. steel market was declining, while it was booming in Japan and still strong in Germany. Declining markets tend to weaken productivity performance even with similar operating rates. Therefore, the U.S. performance gap with Japan may be overstated if one focuses only on 1990 data. This hypothesis is, in fact, born out by the significant deterioration in the performance of operations in Japan after the bursting of the bubble economy in 1991. Finally, only marginal differences could be found relating to intrinsic motivation (such as the unpaid hours worked by employees in Japan mentioned above) (Exhibit D-17).

External Factors and Industry Behavior

The observed differences at the production process level result from management decisions. What we now want to understand are the reasons for: (1) a relatively lower share of minimills in Germany than in Japan and the U.S.; (2) the relatively higher levels of investment in integrated operations in Japan and, to some extent in Germany than in the U.S.; and (3) the differences in organization across each of these industries. The explanations of these differences at the production process level are found in the external environment and in the industry structure and behavior.

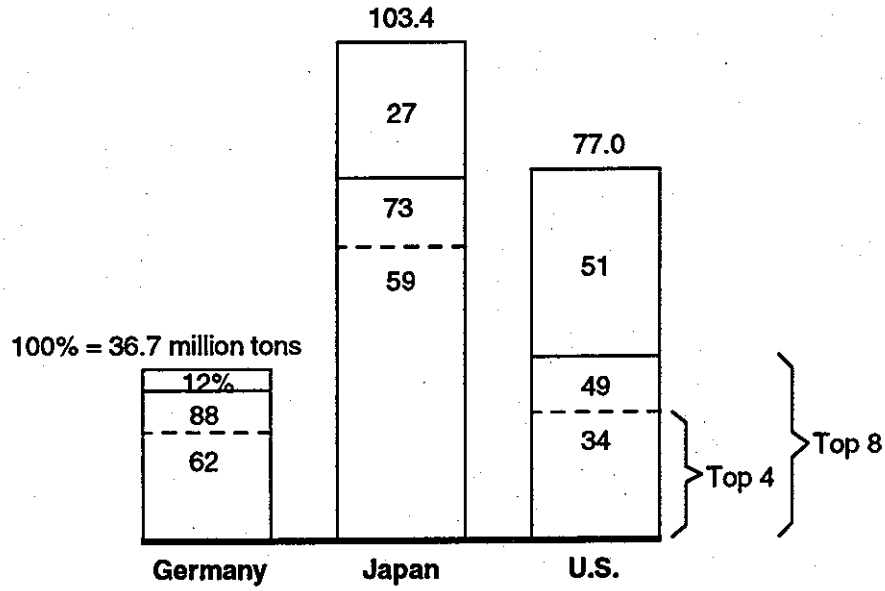
¶ Causes of differences in minimill share. The lower share of minimill operations in Germany, relative to the U.S. and Japan, is the result of a

Exhibit D - 18

STEEL MARKET CONCENTRATION 1990

SHARE OF 4 LARGEST AND 8 LARGEST PLAYERS

Percent



Source: Annual reports; IISI

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Exhibit D - 19

MINIMILL ENTRY ACROSS COUNTRIES

	Germany	Japan	U.S.
Incentives	Low • Technical bias for integrated steel • Good cost and quality of integrated steel (relative to other European producers)	Moderate • Good cost and quality of integrated steel • Technical bias for integrated steel • Rapid market growth (room for new players)	High • High cost and many low quality integrated mills • Cheap scrap available • Cheap electricity available through co-generation • Minimill prices lower than imports
Barriers to entry	High • Few entrepreneurs in the industry • High level of political, financial and labor interference • Capacity quotas (EC) • High electricity costs	Moderate • Integrated producers limit scrap supply by introducing EAF technologies themselves • High scrap prices • High electricity costs	Low • Integrated producers unable to control capacity, distribution, etc. • Concern about steel industry by antitrust authorities • Higher level of entrepreneurship • Venture capital available • Strong and growing local markets far from strong integrated players (e.g., Florida, Texas)

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number of factors including higher barriers to entry and exit, different competition rules and enforcement, protection from new entrants and imports, government intervention in the labor markets, different markets for corporate control, and the influence of factor markets.

While a snapshot of domestic steel production shows that steel operations in Germany were somewhat more concentrated than those in Japan and the U.S. in 1990 (Exhibit D-18), we found that this concentration was not particularly relevant to our observed differences in productivity. The relevant markets for steel production are often regional or – in the case of Japan – global, and concentration has little effect on industry behavior. What has played a much more important role in the past is the entry and exit of capacity and players.

In each of these markets, chronic overcapacity and flat-to-declining demand growth have limited entry since the first oil crisis. Even Japan has seen no new greenfield investment in integrated facilities since the early 1980s. In all three countries, capacity growth in integrated facilities was largely the result of speed-ups, reduced downtime, and investments in new equipment for existing plants. The most important source of new entrants into the steel industry, therefore, came in the form of new minimills and minimill companies.

The incentives and barriers to the introduction of minimills were very different in each of these countries (Exhibit D-19). In the U.S., the incentives included cheap scrap and electricity, and easy market share growth because of the higher costs and lower quality of integrated mills. As a result, minimills could produce steel as cheap as, or cheaper than, imported steel. Barriers in the U.S. were also low as a result of industry fragmentation (e.g., the breakdown of industry concentration), strong and growing local markets far from most integrated producers (e.g., Florida, Texas, California) and the availability of capital and entrepreneurship outside of the steel industry (e.g., steel users).

In Japan, the incentives and barriers were both moderate, but the outcome was similar. The cost and quality of the integrated players in Japan were much better than those in the U.S., and there was a technical bias for integrated steel. Nonetheless, the rapidly growing market until the 1980s provided ample opportunity for entrepreneurs to start up minimills. In fact, integrated players, seeing the threat to industry conduct from independent minimill players (e.g., Tokyo Steel), took a controlling interest in many minimills. The growth in capacity and demand for scrap eventually raised barriers to further independent players entering the market.

The low number of minimills in Germany was the result of low incentives and very high barriers. The market in Germany had a technical

Exhibit D - 20

MARKET FOR CORPORATE GOVERNANCE

	Germany	Japan	U.S.
Ownership	• State and private ownership in Europe; largely private ownership in Germany • Bank financing	• Private ownership • Bank financing	• Private ownership • Market financing
Control function	• Unions sit on board of directors (50% of seats) • Banks sit on board of directors/control majority of voting stock at annual meetings • Coal suppliers and political interests represented by unions and banks • Business run by consensus (social market economy)	• Cross holdings • Banks and affiliated companies exercise control • Business run by consensus	• Independent Board of Directors represent interests of shareholders • Market plays control function
	• Less incentive to improve productivity		

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Exhibit D - 21

FACTOR MARKETS

	Germany	Japan	U.S.
Inputs (materials and energy)	• High cost of energy (electricity) • Moderate cost of scrap	• High cost of energy (electricity) • High cost of scrap/low availability	• Low energy cost (electricity) • Low scrap costs/high availability
Capital	• Low cost of capital from banks • Less pressure to perform • No venture capital	• Low cost of capital from banks and unrealized gains	• High cost of capital • High hurdle rates/short payback requirements
Labor	• Inflexible labor force • Strict legal restraints • Highly unionized • Strained/regulated relationship management/workforce	• Flexible work force through subcontracting • Lifetime employment	• Integrated producers face more labor constraints • Minimills nonunionized • Adversarial relationship management/workforce (integrated)
	• Resistance to change	• Some flexibility; able to change	• Opportunities for minimills; integrated mills resistant to change

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bias for integrated steel and was satisfied with the cost position and quality of the industry's output, especially relative to other European players. The German market lacked the strong growth available in Japan, however, and the barriers to minimill production were substantial. Only two minimills were built in Germany in the early 1970s, and these were nearly driven out of business in the 1980s. The barriers came from a number of factors:

- The market for corporate control in Germany provided little incentive to management due to political intervention and pressure from labor markets (an integral part of the "social market economy" of postwar Germany). These forces kept integrated producers from switching to technologies that would radically reduce jobs in either the steel industry or in its suppliers (e.g., coal and iron ore) (Exhibit D-20).

- Factor markets also provided little incentive (Exhibit D-21). While Germany may have had cheaper credit than the U.S. as a result of bank lending (e.g., lower hurdle rates, longer payback), there was also less pressure to perform or find high-paying investments. In addition, high energy and scrap costs, inflexible labor, and adversarial relationships between management and unions resulted in disincentives to moving to less labor-intensive production.

- To complicate matters, the European steel crisis, which started in the mid 1970s and grew worse in the early 1980s, resulted in a series of national and EC government attempts to restructure the European steel industry. As voluntary agreements failed, mandatory capacity reduction plans were introduced that were linked to a quota system and financial aid. The quota system, and the high level of subsidies to state-owned and inefficient players, essentially eliminated entry opportunities for new players (including minimills) and reduced the threat to existing players.

The barriers to exit or capacity reduction are uniformly high across all three industries. In both Germany and the U.S., where real reductions in capacity were required, capacity reduction was an issue that quickly became politicized (Exhibit D-22). In both countries, local and state governments intervened to protect jobs, while financial restructuring (including bankruptcy) and labor and other supplier concessions to vulnerable plants allowed insolvent players to continue operating and financial groups to provide employees and entrepreneurs with funding to buy out existing owners. As a result, the staying power of weak players was substantial. This staying power was especially true in the context of the European market, where national governments pumped over $50 billion into the industry from 1975 to 1990 to support weak players and encourage rationalization. Relative to most other European steelmakers, operations in Germany were strong (only receiving about $3 billion in aid). As a

Exhibit D - 22

BARRIERS TO EXIT OF INTEGRATED PLAYERS

Germany/Europe	Japan	U.S.
High • Nationalized steel companies in France, U.K., Spain, Italy • Subsidies ($50 billion from 1975-90) to entire industry (only $3 billion in Germany) • Banks, unions, and government influence on boards of directors • Lack of efficient market mechanism • High closures costs - Severance - Environment	High • Lifetime employment • Real crisis-environment did not hit Japan until today - No small players - No weak players - No old facilities - Managed capacity reduction	High • Chapter 11 protection • Employee buy-outs • LBOs (Wall Street effect) • High closures costs - Severance - Environment

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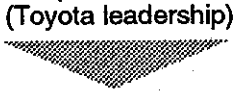
Exhibit D - 23

PRODUCT MARKET CONDITIONS 1980-90

	Germany/Europe	Japan	U.S.
Growth	Flat	Strong	Flat
Demand	German industries demand high quality and extensive technical assistance	Japanese industries demand extremely high quality levels (e.g., Japanese car industry's "zero-defects")	Growing imports prior to 1980s to meet shortfalls in U.S. capacity (regional, semi finished and quality products, and customer service)
Other industries (auto)	Recent pressures for lower costs and new products	Consistent pressure for advanced products and lower costs (Toyota leadership)  Greater incentives to invest in productivity	Recent pressures for lower costs and lighter products

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result, there was a political reluctance to reduce capacity in Germany while weaker European rivals still operated.

¶ Causes of differences in investment in integrated facilities. Investment and profitability are often correlated. For example, profitable industries are often worth investing in. The level of profits within an industry is usually the result both of (1) market conditions and (2) the nature of competition. On both of these fronts, integrated operations in the U.S. faced a more challenging environment in the 1980s, resulting in lower profits and, ultimately, lower levels of investment in integrated facilities.

In each of these industries, the was a key driver of the observed productivity differences, especially the role played by the auto industry (Exhibit D-23). Whereas markets in other regions were in decline, the steel market in Japan and Asia experienced sustained growth through much of the 1970s and 1980s. While production from Japanese operations peaked in 1975 (see Exhibit D-4), the rapid decline experienced elsewhere was avoided until recently because of the rapid growth of the auto and other industries in the 1970s and 1980s, and their willingness to support a profitable steel industry. In 1990, Japan was also experiencing an unprecedented burst of economic activity that resulted in record levels of investment in construction. Throughout this period, the aggressive quality standards and delivery requirements of the auto, machinery, and construction industries ensured a preference for high-quality local products and suppliers.

Other industries, the auto industry in particular, played an important role in helping the Japanese industry obtain higher productivity. For example, the auto industry put a great deal of pressure on steelmakers to develop new products and improve efficiency (i.e., reduce costs), while at the same time allowing the steel industry to keep a share of the productivity gains it generated. Every year, steel prices were essentially decided in price negotiations with major, first-tier Japanese companies in such industries as automotive, electronics, and transportation. Other industries thus played a controlling function by disciplining poor quality or price performance, and rewarding improvement.

In Germany, the market for steel was not as attractive as that of Japan. Steel demand was flat through much of the 1980s, although the market expanded in 1990 as a result of the construction boom resulting from German unification and the movement to a single market in Europe by 1992. Like Japan, however, buyers in Germany also expressed a strong preference for high quality local products and suppliers. This resulted in price premiums that were usually higher than world prices and often higher than steel prices in other EC countries. Unlike Japan, however, the auto industry in Germany never developed a strong influence by

Exhibit D - 24

COMPETITIVE BEHAVIOR IN STEEL INDUSTRIES

	Germany	Japan	U.S.
Domestic market			
• Range of products	• Full	• Full	• Full
• Price competition	• Moderate	• Managed	• Moderate before 1980; intense during 1980s
• New product introduction	• Moderate	• Intense	• Moderate
International market			
• Import share	• Moderate	• Low	• High
• Export share	• High	• High	• Low
• FDI	• Nil	• Nil	• Low to mid-80s; high since mid-80s
Impact on productivity	Emphasis on European and international competitiveness – moderate intensity	Emphasis on innovation and international competitiveness – high intensity	Emphasis on domestic market – low competitive intensity until 1980s; high intensity since 1980s
Nature of competition	Regional/global	Global	Regional/global

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encouraging or rewarding productivity improvements in the steel industry.

The market in the U.S. showed a similar pattern to that of Germany. Demand was largely flat, and other industries did not play as strong a supporting role, although the capital and import markets arguably provided some discipline. Integrated producers had a hard time raising capital to make new investments, and were forced to use off-balance sheet financing mechanisms to attract new investors. Ultimately, most of the leading U.S. integrated firms raised financing through equity investments by their Japanese competitors. The larger, more successful minimills had little trouble investing in new plants and equipment.

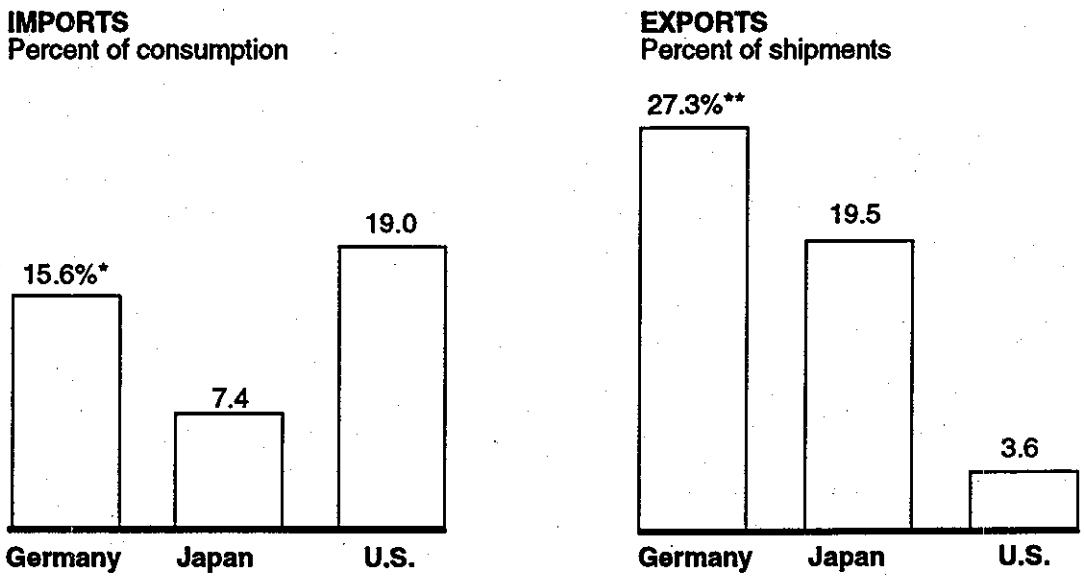
The **nature of competition** is somewhat different in each of these industries (Exhibit D-24). For example, steel operations in both Japan and, to a smaller degree, in Germany exhibit behaviors typical of a low competitive intensity industry (e.g., little price competition). Operations in the U.S. exhibited similar behaviors up until the early 1980s, but have since become more fragmented and now compete intensely. The result of these different competitive environments has been different levels of profitability and investment.

The steel industry in Japan has common understandings and industry practices that optimize industry profitability. Capacity and production are managed according to demand forecasts and production guidelines published by the Japanese government. As a result, shifts in demand are met with similar shifts in supply that keep steel prices in equilibrium. This intercompany cooperation and industry-wide discipline, along with the price leadership of Nippon Steel, resulted in steel prices in Japan that were often 15 to 20 percent higher than on the world market during the late 1980s. The only recent threat to this system has been the independent minimills (roughly 40 percent not affiliated with one of the main steel companies) and imports that have managed to take a growing share of the commodity steel market through price competition. This threat has been sufficient to spur integrated producers to improve productivity, but not yet enough to significantly undermine profits.

Operations in Germany work in much the same way as those in Japan, although the process of setting capacity and production quotas has at times been legislated by the EC Commission. From the mid 1970s to the mid 1980s, the Commission decided production quotas for the whole European market and for individual companies. Only in this way, it was assumed, would European steelmakers keep supply and demand in balance. The end result was higher-than-market prices and limited opportunities for new entrants. Especially in Germany, preference for local production and local suppliers allowed German producers to charge higher prices,

Exhibit D - 25

INTERNATIONAL COMPETITION 1987-90
STEEL INDUSTRY TRADE STATISTICS



* Excluding EC imports (if included: 47%)
** Excluding EC exports (if included: 56%)

Source: International Steel Statistics Bureau; McKinsey analysis

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Exhibit D - 26

SPECIFIC REGULATION OF STEEL INDUSTRY

	Germany/Europe	Japan	U.S.
Trade protection	• VRAs (VERs)* • Anti-dumping** • Import duties	• Import duties • Indirect protection resulting from construction regulation	• VRAs, "Reagan quotas" • Antidumping, TPMs (trigger price mechanisms) • Import duties
Subsidies	• Direct subsidies ($55 billion, 1975-90 in Europe; only $2-3 billion in Germany for restructuring) • Indirect subsidies - Tax breaks - Export promotion - R&D	• Indirect subsidies – Tax breaks – R&D – Export promotion	• Indirect subsidies - Tax breaks • Modest local/ regional subsidies
Capacity management	• 1980-87 "Manifest Crisis" resulted in Quota System/ Davignon Plan linked with restructuring	• Defacto capacity management by "recommending" production levels	• No nationwide capacity/restructuring management

* Liberal agreements with EFTA and OECD; strict agreements with Comecon and developing countries
** To a lesser extent than in the U.S.

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especially to industries that were enjoying high profits, such as the auto industry.

International competition in terms of exports and imports is also different in each of these countries (Exhibit D-25). In all three, imports are controlled to limit the threat to local prices and operating rates of imported steel. These controls are especially important in Japan and Germany, where the capacity and price maintenance behaviors depend on controlled markets. Germany is exposed to high levels of import and export competition, especially within the European Community, but imports from Asian and East European countries are often limited. European governments often resort to trade policy, subsidies and capacity management on behalf of local producers (Exhibit D-26). The government in Japan does not formally regulate trade. However, trading houses limit imports of non-Japanese steel, and many buyers (e.g., auto industry) and some bureaucracies (e.g., transportation, construction) impose product standards (for quality and performance) that are often difficult and expensive for importers to meet. Many give up rather than jump the hurdles.

The U.S. industry, by contrast, no longer has the low competitive intensity and high prices of the 1970s and early 1980s. The growth of minimills and of imports, in spite of trade protection (e.g., VRAs and trade suits), has since eliminated the possibility of such behavior. As a result, the U.S. market has been much less profitable than the market in Germany or Japan (Exhibit D-27). Although many estimates suggest that steel companies around the world have not earned their cost of capital in the past two decades, the capital market system in the U.S. was especially hard on integrated players, dropping the six largest players from A and Aa ratings in 1980, down to B and Ca ratings by 1987.

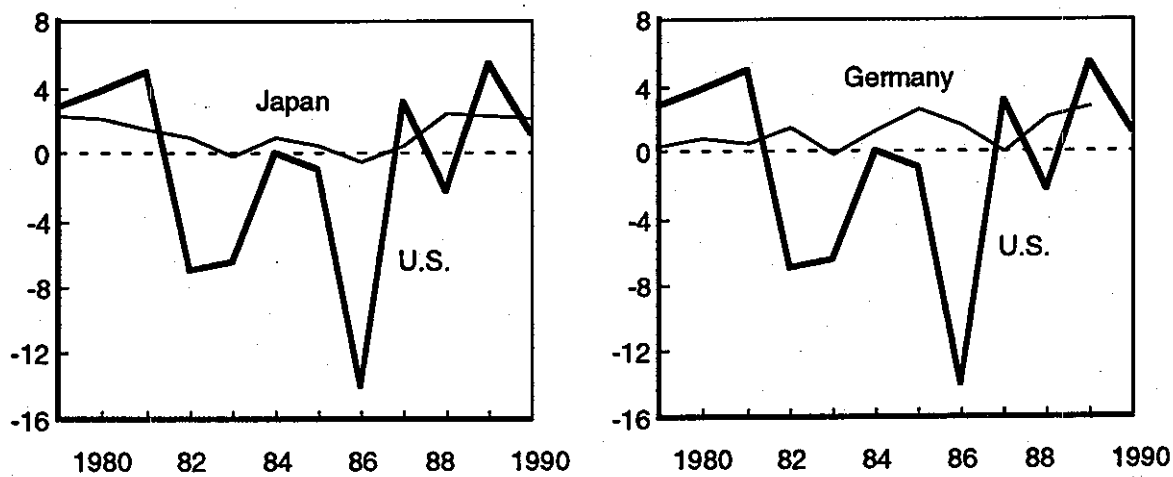
The poor profitability of the U.S. industry, caused by changes in the steel market and in the nature of competition, resulted in low levels of direct capital investment in integrated facilities (relative to Germany and Japan). Nevertheless, financial markets did invest in minimills, and companies operating primarily in Japan did make some investments in U.S. integrated facilities. In Germany, market conditions and the nature of competition supported investment in integrated facilities, but investment was constrained by quota limitations on capacity, especially on minimills. In Japan, by contrast, both demand and industry conduct rewarded – or at least encouraged – capacity growth and efficiency improvement. In the late 1980s, Japan's Big Five steel companies – Nippon, NKK, Kawasaki, Sumitomo, and Kobe – issued convertible securities worth almost 2 trillion yen. As a result, steel operations in Japan invested heavily in facility modernization and capacity expansion. The legacy of this

Exhibit D - 27

STEEL INDUSTRY PROFITABILITY* 1980-90

RETURN ON TOTAL ASSETS

Percent



* A selection of the leading integrated and minimill producers in the U.S. and Japan

Source: Paine Webber

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Exhibit D - 28

SUPPLIER RELATIONSHIP IN STEEL INDUSTRY

	Germany	Japan	U.S.
Issue	Influence of coal industry had an impact on preventing the replacement of integrated facilities with minimills	Close relationship with suppliers/affiliates: - Cooperate on continuous improvement - Perform low value activities	Upstream integration into ore production may have discouraged some integrated producers from adopting more efficient processes
Impact	Possibly delayed restructuring	Productive organization of functions and tasks	Possibly delayed restructuring

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investment is both high productivity as well as significant overcapacity and financial liabilities.

¶ Causes of different organizations of functions and tasks. While it is difficult to determine whether the organization of functions and tasks evolves as a result of changes in technology or environment, or whether it is responsible for their development, it is still possible to describe the differences observed and to make hypotheses.

In the case of steel operations in Germany and the U.S., the legacies of low competitive intensity can help explain the difficulty of achieving significant changes in the operating practices of integrated producers. For example, the low threat of new entrants may partly explain why German steel producers have been less successful in changing their organization and operations. This lack of change has left these integrated producers vulnerable to imports and new technologies – particularly steel from Eastern Europe and from minimills. Many integrated producers in 1990 were still finding it difficult to change their operations and their culture. Now that the free entry of independent minimills in the U.S. has resulted in increased industry dynamism and innovation, we suspect that U.S. operations will see significant productivity gains in coming years, provided minimills can continue to increase their share of markets and the weaker integrated players exit.

The dynamism of Japan, however, is harder to explain. Part of this behavior has to be attributed to the auto producers that worked extensively with steel producers to reduce costs and improve product quality. Another part is due to labor practices, such as *jishu kanri*, that developed after World War II. Relationships with suppliers are also likely to be important (Exhibit D-28). The use of vendors and affiliates to provide materials and services is much more prevalent in the Japanese industry than in either the U.S. or Germany. This allows the industry to push some of its lower productivity activities into other industries or into smaller, affiliated companies.

In summary, the external factors that have had the most influence on productivity in each of the countries under study are regulations (e.g., quota system in the EC) and other industries (e.g., auto demand in Japan). Less important factors – such as macroeconomic conditions, product demand, competition/ concentration rules, corporate governance rules and labor rules – have also had an impact.

OUTLOOK

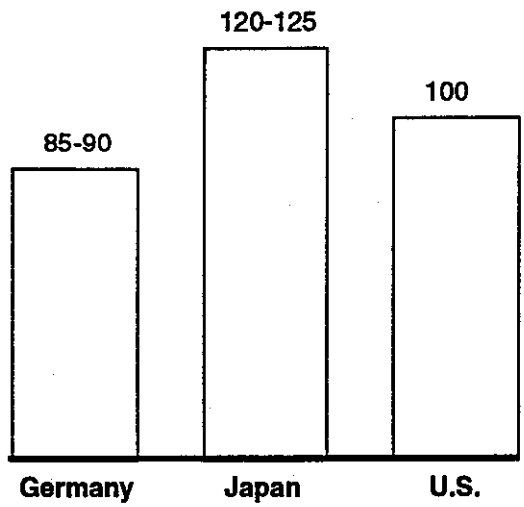
Several trends are clear. Our findings suggest that production will continue to shift from integrated mills to minimills for reasons of higher productivity, higher

Exhibit D - 29

ESTIMATED STEEL LABOR PRODUCTIVITY 1992

VALUE ADDED* AT INDUSTRY PPP PER HOUR WORKED

Index: U.S. = 100



* Estimated value added based on changes in physical productivity

Source: Census of Manufactures; McKinsey steel data base; McKinsey analysis

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returns on capital investment, and lower damage to the environment. In addition, minimills will also begin competing in flat product markets; they have learned to overcome the minimum efficient scale of hot strip mills and are working to overcome the impurities in their scrap supply. Minimills have now begun to enter flat product markets using scrap substitutes (e.g., hot-briquetted iron) and blast furnace iron, often imported from neighboring (low wage) countries – while at the same time exploring new scrap-substitute technologies (e.g., iron carbide). In addition, new technologies have been developed (or are being developed) to reduce the minimum scale of hot strip mills to around 800,000 tons or even less (e.g., thin slab casting using a continuous casting process). Nucor, the leading North American minimill company, is now using these new inputs and technologies to challenge integrated producers in sheet products; others are likely to follow. At least one integrated firm, Dofasco, has announced it will build such a facility with a minimill partner, Co-Steel.

As a result of these technological changes and shrinking efficient scales, investment in the steel industry is likely to change dramatically in future years. The globalization of capital markets has removed the option of integrated players investing their way out of these difficulties. Cheap capital is no longer available in Germany and Japan, and integrated players are at an obvious disadvantage in these over-supplied markets. They are also not likely to be as profitable, unless governments increase the level of protection and impose unacceptable costs on domestic users of steel and steel products.

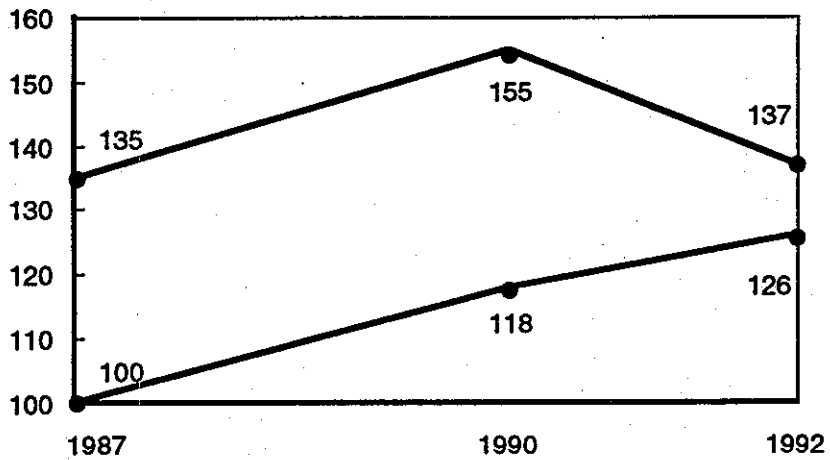
Over the long term, integrated operations will be able to respond to these pressures in only a limited number of ways: reorganize or be eliminated. Our findings suggest that they will have to focus on reducing operating complexity and organizational excess – in short, they must become more like minimills. Layoffs are likely in all three countries, and can be expected to be especially large in Germany and, potentially, in Japan. Integrated companies are exploring new ways to run their businesses, such as abandoning the traditional primary end of the business altogether, for example, by investing in EAF equipment or by using imported semifinished steel to make finished products. This latter approach might make particularly good sense in Europe for two reasons: (1) cheap blast furnace iron is readily available from the former communist countries that have available capacity, lower labor costs, and high unemployment; and (2) employing people in their own countries will reduce their desire to emigrate to the EC. The net effect of such radical restructuring, however, could be a reduction of from 50 to 80 percent of German steel industry employment.

While the productivity of steel operations in Japan was 45 percent higher than operations in Germany and the U.S. in 1990, steelmakers in Japan have since lost ground. Using changes in physical productivity to estimate changes in value-added-based productivity, we have estimated the labor productivity of steel operations in Germany, Japan and the U.S. for 1992 (Exhibit D-29). Operations in Japan have seen their lead narrow to 20 to 25 percent, both because of lower

STEEL TOTAL FACTOR PRODUCTIVITY 1987-92

WEIGHTED AVERAGE OF LABOR AND CAPITAL PRODUCTIVITY*

Index: U.S. 1987 = 100



	Real annual productivity change 1990-92
Japan	-6.1%
U.S.	3.0

* Total factor productivity = $\left(\frac{\text{value added}}{\text{hours worked}}\right)^{\alpha} \times \left(\frac{\text{value added}}{\text{capital stock}}\right)^{1-\alpha}$

Source: Census of Manufactures; McKinsey analysis

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operating rates in the Japanese industry and because of improved productivity in Germany and, especially, the U.S. (The real productivity improvement in the U.S. of 10 to 15 percent resulted from net labor reduction, technical upgrades in areas such as casting, hot strip milling, cold rolling, and coating, and further improvements in organization.)

The Japanese industry is now facing a formidable challenge. The productivity loss reflects a drop in production but not in employment. While a return to the demand levels of 1990 would bring Japanese labor productivity levels back up to the 130 to 135 percent level, it is not obvious that the current downturn is just another dip in the business cycle; real structural changes seem to be required of steel operations in Japan. The growing sophistication of steel producers in other Asian countries has had a demonstrable effect on Japan's net steel trade balance, which declined from 30 million tons in 1985 to 9 million tons in 1991. This, combined with slowing domestic demand, suggests that overcapacity is a long-term problem.

Should this downturn prove to be structural and not cyclical in nature, the steel industry in Japan is bound to lose its huge productivity lead. Overcapacity and under utilization of capacity will put pressure, not only on labor productivity (unless steel companies find ways to lay off workers), but also on capital productivity, which has been reduced even more. As a measure of both capital and labor productivity, total factor productivity for steel operations in Japan and the U.S. illustrates a rapid deterioration of the advantage enjoyed by operations in Japan (Exhibit D-30).

If steel producers in Japan maintain industry conduct through this crisis, they may be able to share the burden of industry rationalization. External pressures, from first-tier companies in other industries (e.g., auto, electronics, transportation) and from government agencies, might also provide the necessary incentives to streamline production and improve productivity. Another possible outcome, however, is that the Japanese market may see much more competitive intensity and lower prices. Pricing and capacity coordination may break down if capital markets place more pressure on steel companies to perform. In addition, Japanese steel companies may prove incapable of developing ties to other excellent customers in Asia (e.g., shipbuilding and autos in Korea, electronics in Malaysia). Without continued growth in the export market, steel production in Japan is likely to drop further.

The result of these changes will be that many traditional integrated companies will disappear in the coming years, although some will make the required transition to new technologies and to new organizational structures. In Germany and the U.S., although the adjustment process has been underway for some time, it has much farther to go. In Japan, operations are already very productive, but will only remain so if producers can reduce capacity, maintain competitiveness in the still growing Asian steel market, and rethink their traditional reliance on scale and massive investment.

Exhibit D - 31

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES
STEEL INDUSTRY

● Important
O Secondary
X Undifferentiating

External factors

- Market conditions
  - Demand factors — O
  - Relative input prices/factor availability — X
  - Other industries (autos) — ●
- Policy and regulation
  - Macroeconomic conditions — O
  - Competition rules and concentration rules — O
  - Corporate governance rules — O
  - Labor rules and unionism — O
  - Other regulations (tariffs, nontariffs) — ●

Nature of competition — ●

Production process

- Output
  - Mix, variety, quality — O
- Production factors
  - Capital (intensity, vintage, technology) — ●
  - Scale — ●
  - Design for manufacturing — X
  - Basic skill of labor, intrinsic motivation — X
  - Raw materials, parts — X
- Operations
  - Capacity utilization — X
  - Organization of functions and tasks — ●

LABOR PRODUCTIVITY

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SUMMARY AND POLICY ISSUES

Our findings on the causes of productivity differences in the steel industry are summarized in Exhibit D-31. In general, the main drivers of the productivity differences related to differences at the production process level, especially in regard to the share of minimill technology, the age and scale of capital in integrated facilities, and the organization of functions and tasks in integrated facilities. The production processes differed because of profound differences in the external environment and the nature of competition.

In Europe, the importance of employment in steel resulted in political and

facilities, and by improving their organization of functions and tasks in integrated

PRODUCTIVITY IN THE COMPUTER INDUSTRY

The computer industry has been one of the fastest growing and changing industries. It is often used to represent modern industry, and it is characterized by its constant innovation and extremely high knowledge intensity. It is clearly one of the most globalized industries we have studied. The computer industry is important not only for its own sake, but for the productivity of other industries such as services and white-collar office activities.

In hardware manufacturing, we have observed a convergence in productivity throughout the late 1980s. As company activities in this industry go beyond borders, products, as well as production processes of hardware, are becoming more similar throughout the Triad. The distinctiveness of products made in each region is now disappearing. This productivity convergence is driven by the standardization of parts and components, global activities of multinational companies, cross border alliances and active international benchmarkings by manufacturers.

Although we understand that software and hardware are complementary and that the software side of the computer industry is increasing in its value and importance, we made productivity comparisons only in hardware manufacturing production. The primary reason is that we are studying "manufacturing" productivity. The nature of software production is totally different from that of manufacturing. In addition, the Census for Manufactures does not provide data for software and services and a purchasing power parity (PPP) for software is not available at all. Our study of the hardware side of the industry does however yield many interesting conclusions. In particular, the study of the hardware manufacturing shows how innovation has spread across borders and led to productivity convergence. This finding could provide an important lesson for other industries in showing how the lack of barriers to globalization leads to rapid productivity improvements on a global best practice level.

This industry has exhibited two major trends. The first major trend is a shift from large mainframes to desktop computers as the predominant type of hardware. As Exhibit E-1 shows, the number of personal computers and work stations is increasing as companies use them to replace large to medium-scale computers. This change is due in large part to the improved performance and functionality of smaller computers. In turn, this has led to a shift in user demand away from centralized processing systems to more decentralized "client" systems that are networked to "servers."

The second major trend is the increasing use of open systems. Computer manufacturers at one time competed by offering hardware which required their own proprietary software. Today, however, users compel manufacturers to comply with de facto standards. This movement away from a closed, proprietary system

Exhibit E - 1

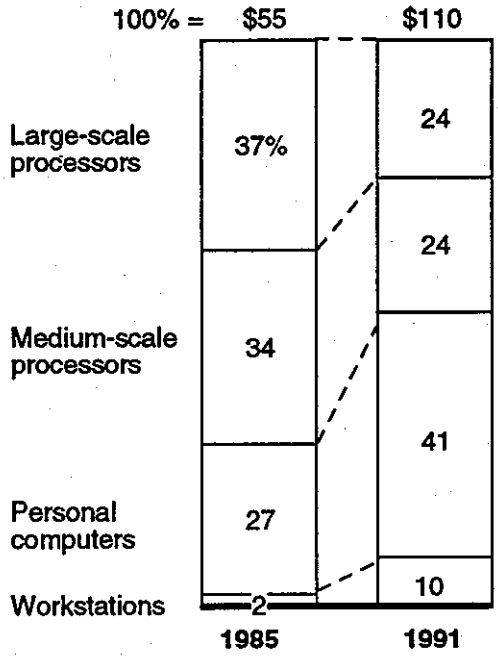
MAJOR TRENDS IN THE COMPUTER INDUSTRY

WORLDWIDE PRODUCTION

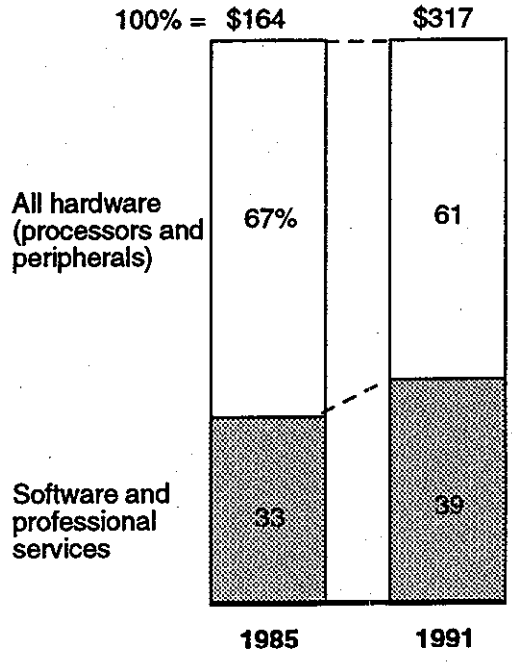
$ Billions

Excluded in this study

HARDWARE CHANGES – PROCESSORS



PRODUCT CHANGES – HARDWARE VS. SOFTWARE AND SERVICES



Source: McKinsey data base; McKinsey analysis

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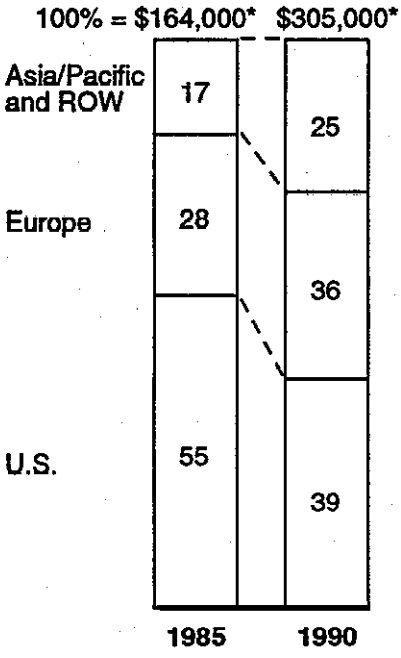
Exhibit E - 2

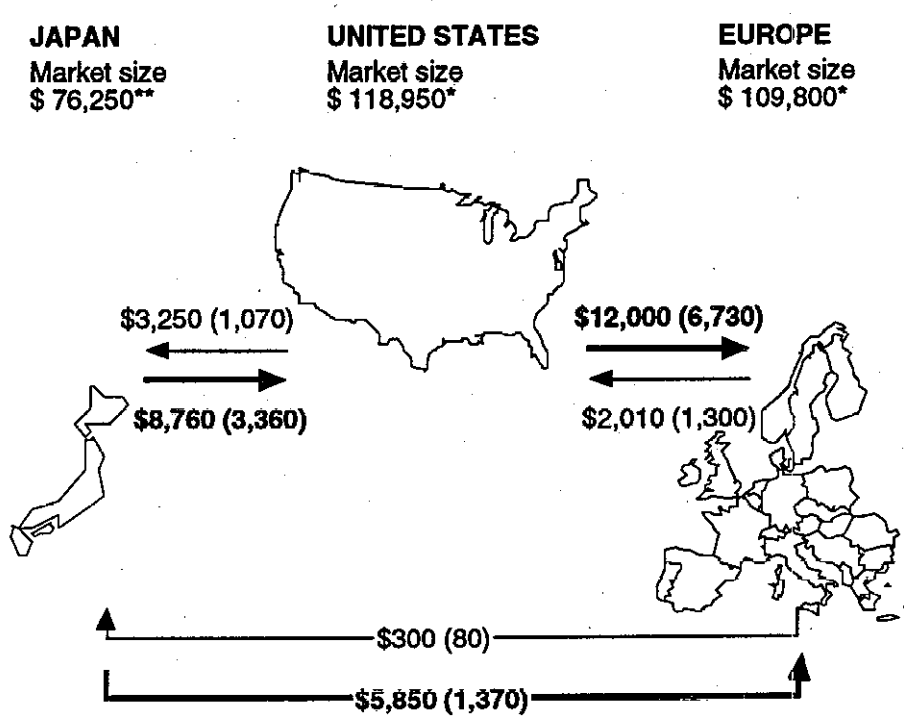
COMPUTER MARKET AND TRADE

1990 (1984)

$ Millions

GEOGRAPHIC MARKET CHANGES





* Including software and services

** Including other Asia and rest of the world

Source: McKinsey Computer Industry Annual Report, 1992; Electronics International Corporation

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architecture has accelerated into the world-wide standardization of the industry. This standardization has contributed to significant improvements in the cost performance of computers resulting from scale economies. The advancement of semiconductors, especially microprocessors, has contributed to the performance of computers. It also increased the availability and compatibility of computer software.

These trends are changing the computer industry all over the world. Companies which perform well today could easily become losers in the next 5 years because of the industry's dynamic nature. This intensive, "free" competition drives technology developments and vice versa. Players who fail to adapt to new environments will soon disappear.

Industry Overview

The production process of computer manufacturing takes place in two basic steps. One is assembly and the other is loading software and testing. In PC manufacturing, the standardization of computer parts and components has made the assembly process simpler and shorter. The increasing use of outsourcing for component production has made the computer production process less oriented toward manufacturing, but more toward testing and packaging. The software loading and testing process is also largely automated. In larger computers, the production process is rather complex, relying more on manual processes which are mostly done in-house. In addition, the trends toward simpler processes and the increasing use of outsourcing are true, but to a lesser extent.

The computer industry is probably the most globalized of our case studies by any measure. As Exhibit E-2 shows, its output is heavily traded and the volume of trade is rapidly increasing. Operations in the U.S. and Japan have huge and increasing trade surpluses with Europe; Japan has a large trade surplus with the U.S.; and the market outside of Europe and the U.S. is growing faster than these regions. In addition, foreign direct investments (transplants) are a major part of each domestic industry's production, especially in Europe. Multinational companies originating in the U.S. fully manage 56 percent of computer production. These multinationals have been the industry leaders in Europe since the 1960s.

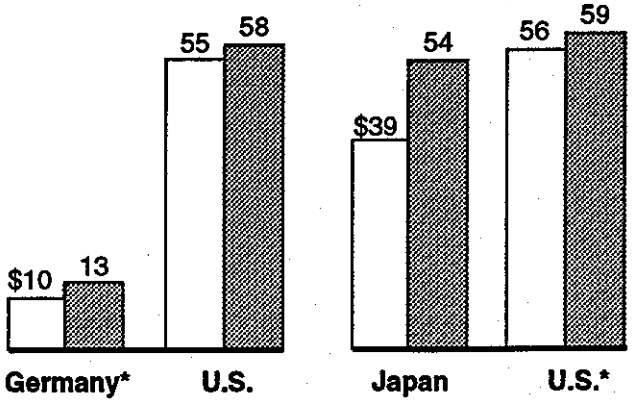
The size of the Japanese industry is now approaching that of the U.S. in terms of output (converted to U.S. dollars using industry PPP). The German computer industry alone is about one fifth that of the U.S. in terms of output, but the industry size in the whole of Europe is roughly equivalent. While industry output is increasing in all regions, value added and employment are declining as a result of industry restructuring (Exhibit E-3).

The annual market growth of this industry (in nominal dollars) was over 15 percent until 1988, and then slowed to 3 to 7 percent after 1989. The physical output growth (real growth) of the industry would be over 30 percent per year over

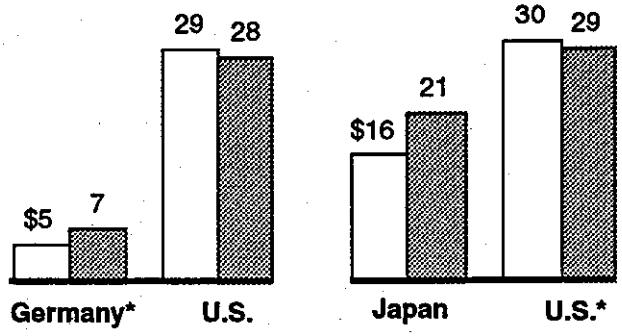
Exhibit E - 3

COMPUTER INDUSTRY
1987 AND 1990

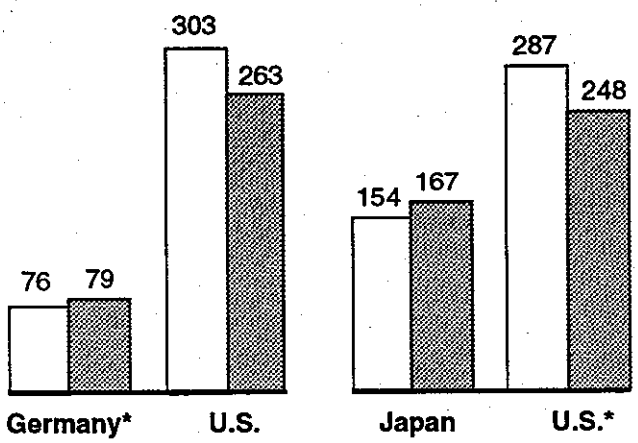
OUTPUT
$ Billions



VALUE ADDED
$ Billions



EMPLOYMENT
Thousands



* Including auxiliary unit, excluding legal units below 20 employees
Source: Census of Manufactures; McKinsey analysis

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INDUSTRY COVERAGE AND ADJUSTMENTS

Industry definition

¶ Hardware and software. We defined the computer industry as hardware manufacturing. In other words, we excluded service activities such as software programming services and maintenance, because they are categorized in the non-manufacturing industry and are not included in the Census for Manufactures. Software and other services represented 39 percent of the total data processing industry revenue of $317 billion in 1991, compared to 33 percent in 1986.

¶ Finished goods and core parts. Computer parts and components manufacturing (including semiconductors, ASICs, LCD displays, keyboards, and PCBs) are categorized under electronics parts manufacturing and not in the computer industry. Therefore, we only captured the finished goods assembly of computers in our project. The industry category is slightly different. The Japanese census tends to include manufacturers of semifinished and peripheral components in the industry code for data processing machinery (Japanese SIC 3051). However, the U.S. census strictly separates all parts and components manufacturers into different industry codes and doesn't include them in computers and peripheral devices (U.S. SIC 3571, 3572, 3575, and 3577).

¶ Product mix. The census does not provide the breakdown of computers by type (e.g., PCs, minicomputers, mainframes and workstations). Thus, we did not compare productivity by type of product from the census data and had to construct an aggregate industry PPP from other data to take the product mix more effectively into account. Production in Europe is still focused on large computers while the U.S. has the largest share of PCs. Japan is in between the two regions but is relatively more focused on peripheral production.

PPP

The only exact product matching we were able to find was personal computers. We have researched wholesale pricing of personal computers and calculated unit price ratios from publicly available sources. We double checked this PPP with internal data of personal computer manufacturers in producer prices level. Then, we have estimated the PPP for other products like mainframe, minicomputer and peripherals by confirming the data with McKinsey colleagues. We did not use census unit prices in this case study.

Double Deflation Adjustment

In the computer industry, many parts and components are standardized and heavily traded in the global market. We assumed that these standardized parts (e.g., semiconductors, MPUs, HDDs, flat panel displays) are traded at market exchange rates. The market exchange rate in 1987 was 1.80 DM/$ and 145 yen/$. The PPP we used for output is 2.29 DM/$ and 153 yen/$ in 1987. Therefore, we had to use a different PPP for inputs. Based on the assumption that most of the core parts for computers are traded or priced in the international market, we estimated that 55 percent of the material inputs are globally priced and, as such, should be converted using market exchange rates. As Exhibit 8 shows, the impact is a 10 percent and a 4 percent decrease in German and Japanese productivity respectively. Because of the lack of sufficient raw material data in the German census, we have based this calculation on the U.S. census materials breakdown. Since the U.S. computer products mix have highest PCs portions and since PCs are the most standardized and have the most widely traded parts, the impact of double deflation can be overstated. However, the trend in productivity is still towards convergence.

the last two decades if we measured it using constant producer prices. At this growth rate, the industry is now 250 times bigger than it was two decades ago.

The producer price index shows how rapidly the price of computers has decreased with improving technologies. Personal computers have shown the sharpest drop in prices since 1989, implying a high level of competitive intensity and rapid technological change in the industry (Exhibit E-4).

PRODUCTIVITY RESULTS

Adjustments

Before comparing the productivity of computer manufacturing, we had to make adjustments reflecting subtle differences in PPP for input and output (double deflation). We should also be aware of the differences in industry definition and in mix of the products in each of the three countries (See box entitled "Industry Coverage and Adjustments").

Labor Productivity

Using value added per hour worked, converted at the computer industry PPP, the productivity of Germany and Japan was 81 percent and 82 percent of the U.S. level in 1987. Towards 1990, the productivity of the three regions was converging to 89 and 95 in Germany and Japan (Exhibit E-5).

As Exhibit E-6 shows, the real annual productivity growth between 1987 and 1990 was 17 percent for Germany, 19 percent for Japan, and 14 percent for those in the U.S. (deflated by producer price indexes). The source of the productivity growth is different for each of the countries. In the U.S., as Exhibit E-7 shows, hours worked were reduced through a massive industry restructuring. Mainframe manufacturers significantly reduced their employment in the late 1980s; IBM's layoffs were symbolic of the downsizing occurring in the mainframe segment of the industry. Production shifted to PCs and PC manufacturers, while also reducing employment, increased production throughout this period.

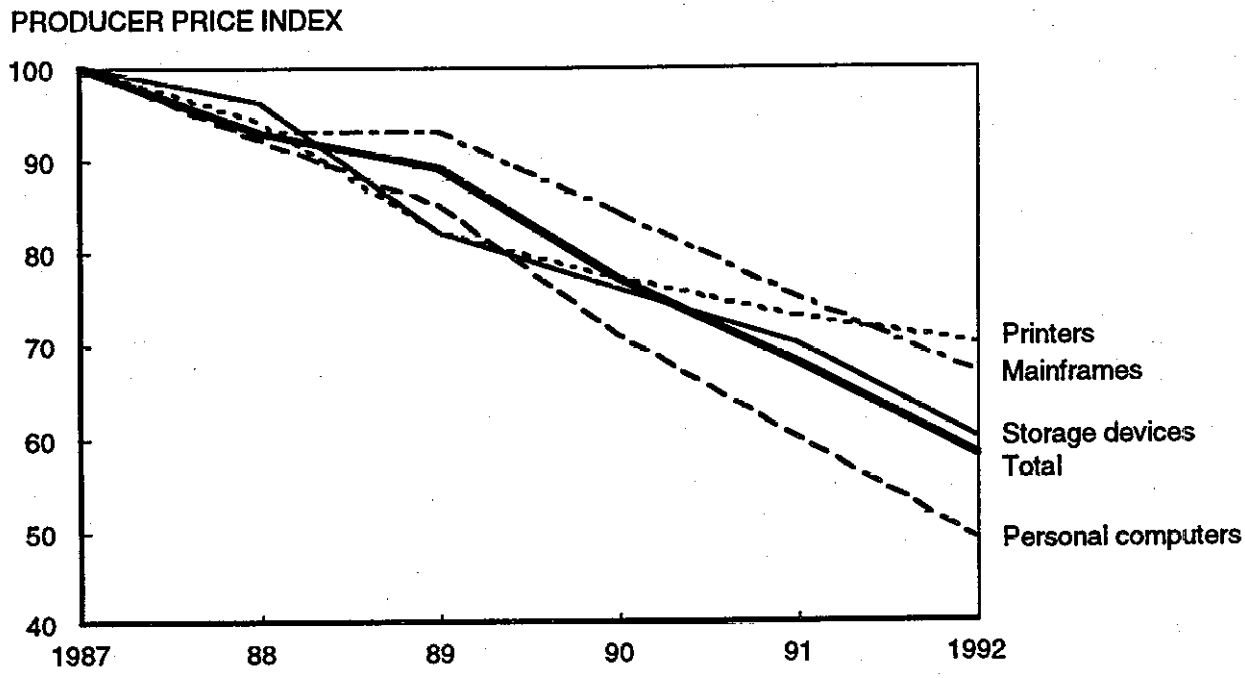
Background to Productivity Growth

New phenomena were at work in PC manufacturing. Due to the increasing standardization of core parts and the outsourcing of subsystem manufacturing by PC manufacturers, the value added as a percentage of sales in PC assembly was decreasing. In addition, the increasingly automated production process required less labor input. Consequently, the production process became simpler and more uniform across the region. This trend can also be observed in workstations and medium-scale processors.

Exhibit E - 4

PRICING TRENDS FOR MAJOR PRODUCTS IN THE U.S. MARKET

Index: 1987 = 100



Source: Bureau of Economic Analysis

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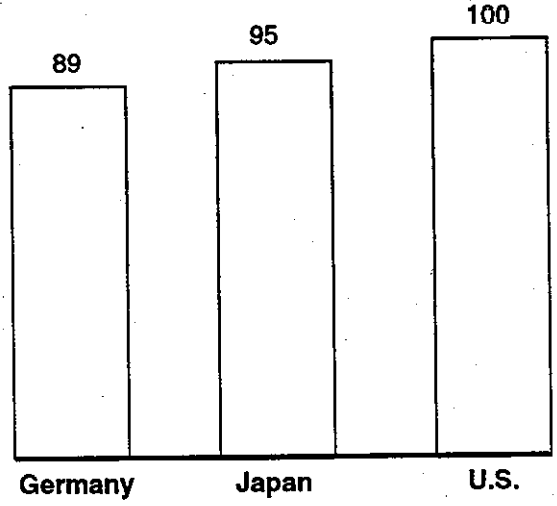
Exhibit E - 5

COMPUTER LABOR PRODUCTIVITY 1990

VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED

Index: U.S. = 100



Source: Census of Manufactures; McKinsey analysis

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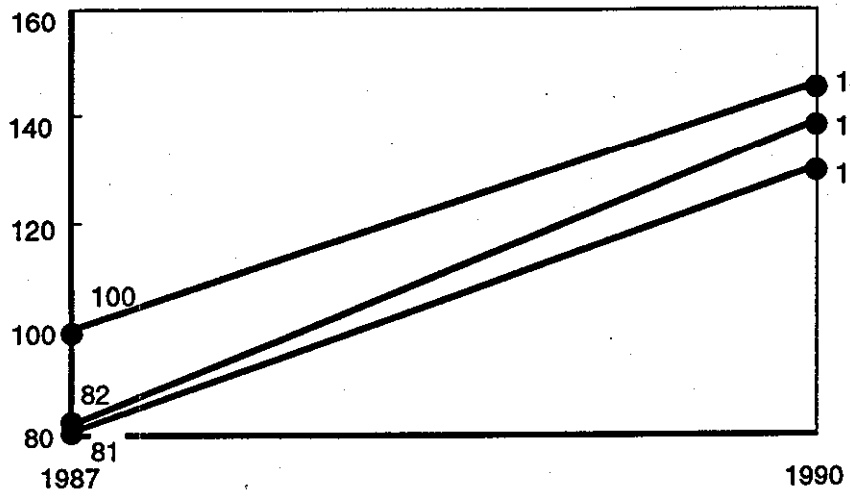
Exhibit E - 6

REAL LABOR PRODUCTIVITY CHANGE 1987-90

VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED

Index: U.S. 1987 = 100



	Real annual productivity change 1987-90*
U.S.	14%
Japan	19
Germany	17

* Deflated by producer price indexes

Source: Census of Manufactures; McKinsey analysis

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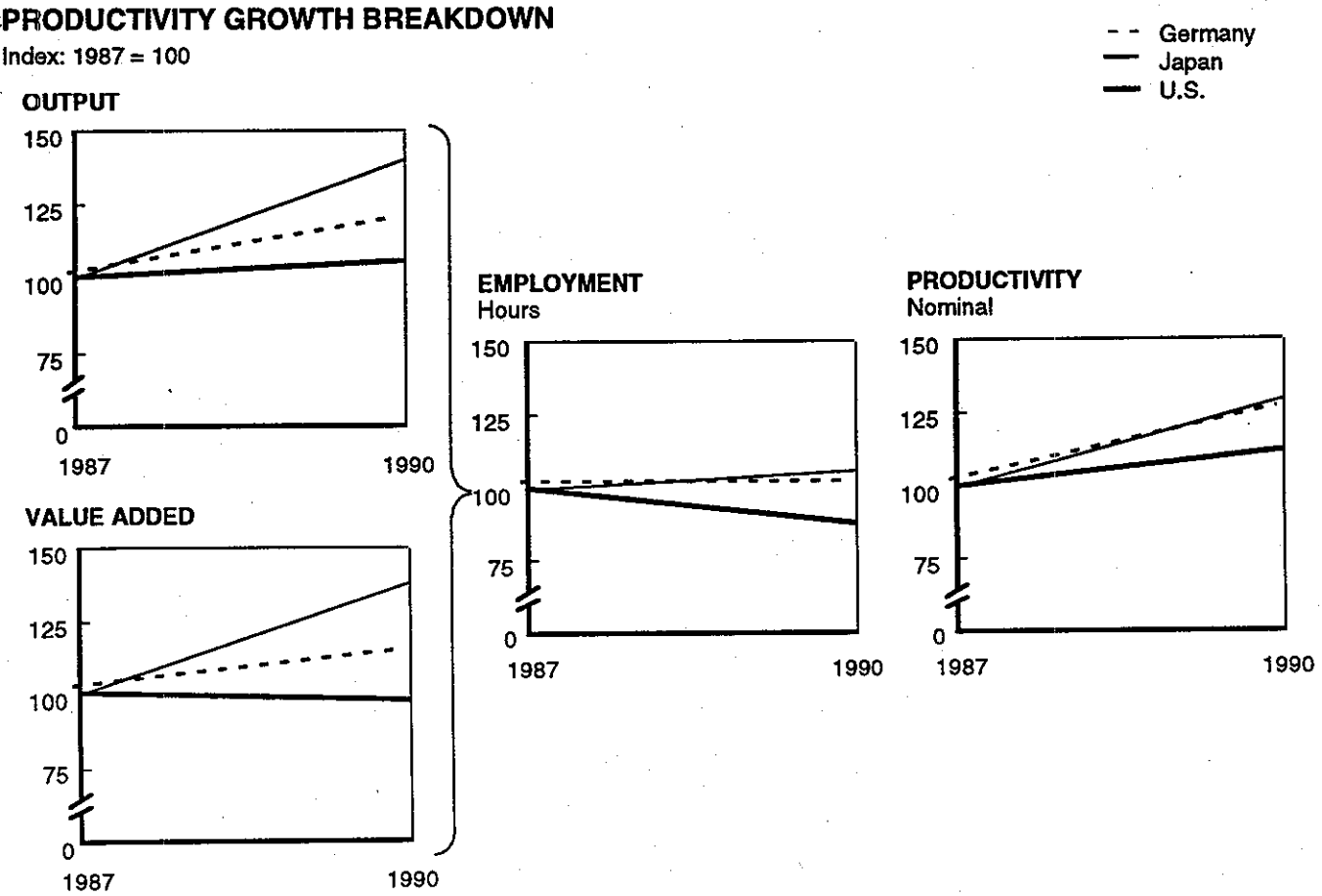
Exhibit E - 7

PRODUCTIVITY GROWTH BREAKDOWN

Index: 1987 = 100



Source: Census of Manufactures; McKinsey analysis

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Exhibit E - 8

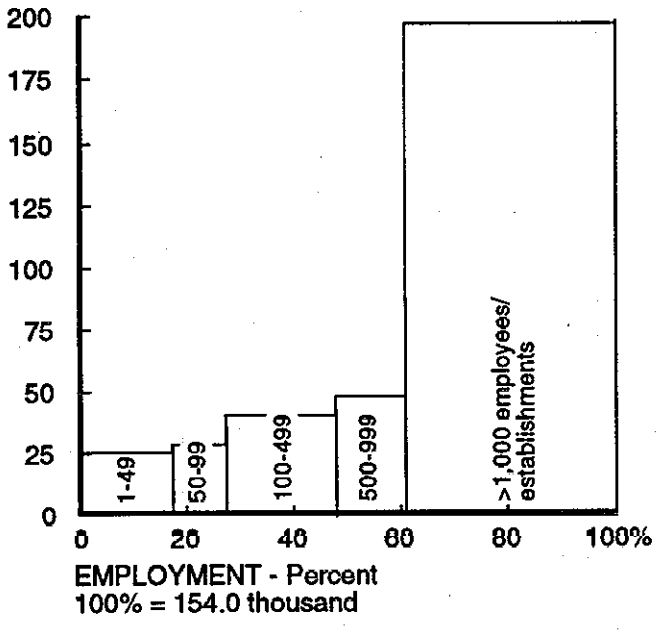
LABOR PRODUCTIVITY DIFFERENCES BY ESTABLISHMENT SIZE 1987

COMPUTER INDUSTRY

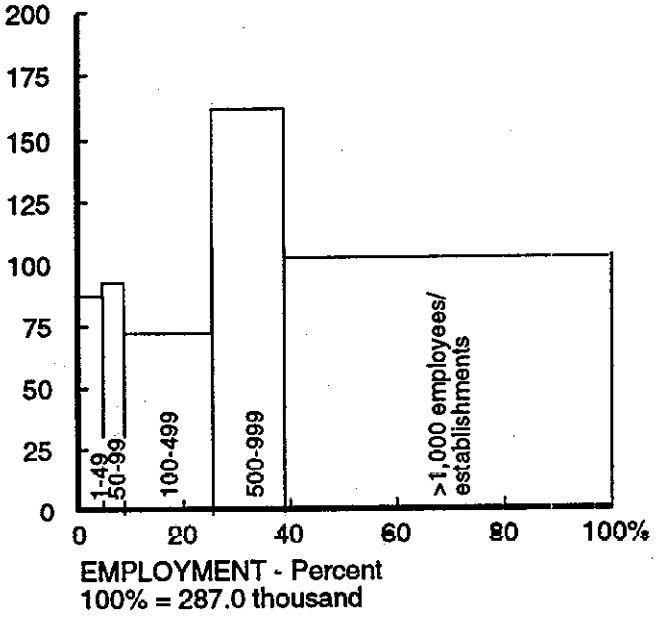
VALUE ADDED PER HOUR WORKED

U.S. dollars

JAPAN



U.S.



Source: Census of Manufactures

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Another phenomenon during this period was a shift of production to Asia and Europe. Major PC manufacturers, such as Apple and Compaq, now have factories in places such as Singapore and Ireland. The percentage of their production in the U.S. is getting smaller as the cost advantage of Asian manufacturing for subsystems increases. A similar trend is observed for manufacturers originating in Japan and Europe. However, this trend has been mitigated somewhat by the fact that good customer service increasingly requires production facilities to be located near the final market. This shift towards Asian production is one of the reasons why the labor input of the U.S. computer industry fell during the late 1980s.

For operations in Japan, massive investments in information technology during the "bubble" economy of the late 1980s resulted in high output growth in the Japanese computer industry(Exhibit E-7). Japanese productivity has increased because the industry was able to manage the increase in output with a relatively small increase in labor input, . Today, however, computer manufacturers in Japan are having a hard time adjusting to the demand slow-down.

For operations in Germany, the situation is somewhere between that of operations in the U.S. and Japan. The impact of client-server computing was not yet significant in the late 1980s and computer makers in Germany still had huge sales in large-sized computers. The German industry also began restructuring during this period and reduced labor input. As a result, the productivity increase was higher than in the U.S.

Productivity by Size of Establishment.

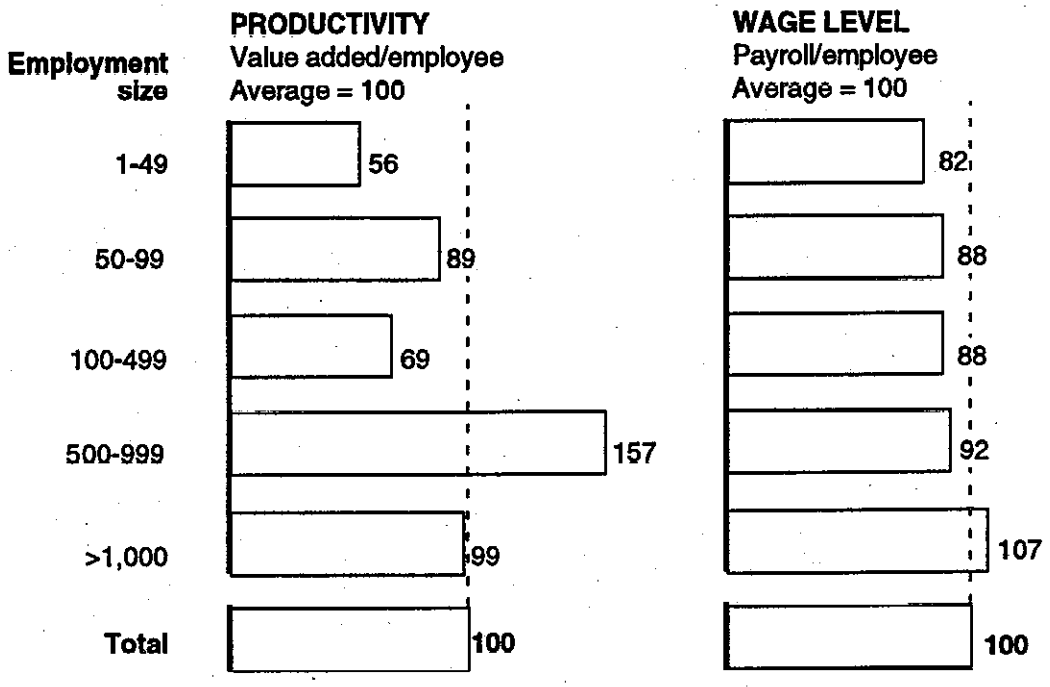
We found very different relationships in Japan and the U.S. between productivity and establishment size. As Exhibit E-8 shows, the establishments in the U.S. with 500-1000 employees are much more productive than the larger establishments. In Japan, on the other hand, large establishments are much more productive than smaller ones.

One possible reason for the higher productivity of smaller establishments in the U.S. is the emergence of small, but innovative storage, PC, and workstation manufacturers. These establishments are independent and more productive than other manufacturers because they have fewer workers in overhead and support functions, focus on fewer products and simpler production processes, are in an earlier stage of the product life cycle (and thus gain higher margins), and outsource intensively, keeping only high productivity activities in-house. At the same time, the dynamically changing industry environment forces large establishments, which are often mainframe producers, to adjust to the cost of declining margins in their traditional products and businesses.

The Japanese size difference in productivity has an entirely different explanation. In Japan, large establishments tend to focus on finished goods with fully automated and rationalized production processes, while small establishments

Exhibit E - 9

U.S. COMPUTER INDUSTRY 1987



Source: Census of Manufactures

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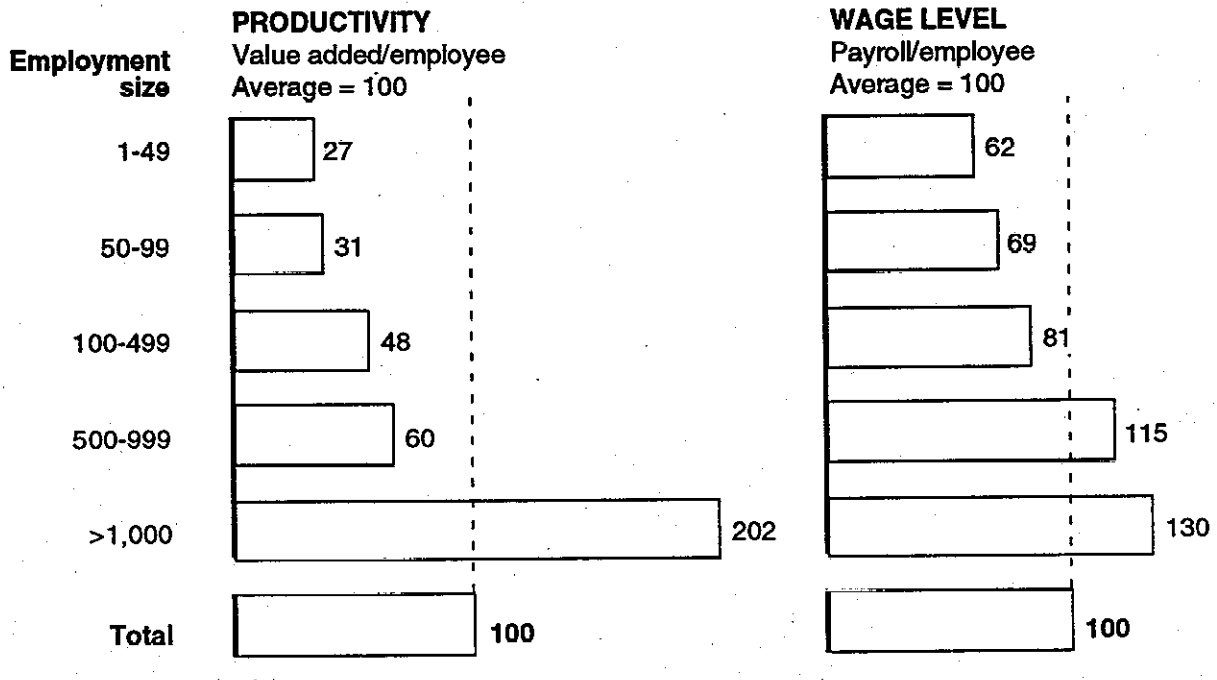
Exhibit E - 10

JAPANESE DUAL ECONOMY 1990



Source: Census of Manufactures

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manufacture semifinished goods or attachments with more labor intensive processes. Small establishments in Japan very often supply their semifinished parts to larger establishments and are often partly owned by, or engage in binding long-term relationships with, the firms they supply. Large corporations do most of the industry R&D and then transfer product and production technologies to their smaller suppliers. Small firms in Japan are therefore much more dependent on large firms than their American counterparts.

This relationship between large and small firms in Japan helps explain the difference in productivity. Small establishments are often used as production capacity buffers and are subcontracted for final assembly production when larger establishments have excess demand. This allows larger companies to enjoy stable production levels, practice life-time employment, and attract a higher-skilled labor force. Small companies are faced with very unstable demand, and since they are allowed relatively thin margins by their larger customers (who control new technologies and thus wield significant bargaining power), they pay low wages and attract less-skilled, less-experienced labor (Exhibits E-9 and E-10). Although the industries in Japan and the U.S. divide low and high-productivity activities differently with respect to firm size, the industry-wide productivity is quite similar.

CAUSES OF PRODUCTIVITY CONVERGENCE

Two recent industry phenomena have supported the convergence of computer manufacturing productivity in the three regions under study. First, the standardization of operating systems, parts, and components has made benchmarking and product comparisons much easier. Second, an increased rate of technological spillover has caused a convergence in production technologies and management practices. Global alliances and joint ventures provide opportunities for information exchange; foreign direct investments transfer innovations from one market to another; and the standardization of products has increased the possibilities for precise reverse engineering (Exhibit E-11).

Causality at the Production Process Level

Companies in each region of the Triad have traditionally taken different approaches to improving productivity. Practices are now converging however, as a result of increasing globalization and other fundamental industry trends. The U.S. has led many new innovations, which have now spread over the rest of the world. For example, operations in Japan traditionally excelled in streamlining production and product development (as we have seen in other assembly industries such as consumer electronics and the auto industries). Their production efficiency is well known in this industry. However, these advantages are now being eliminated by operations elsewhere that are rapidly catching up.

Exhibit E - 11

CAUSES OF LABOR PRODUCTIVITY 1990
COMPUTER INDUSTRY

External factors	Nature of competition	Production process	Labor productivity
Active foreign direct investment by multinational corporations	Standardization of products, operating system, parts and components	Convergence in management practice - Organization of function and tasks - Product design - Technology - Other production practices	Productivity is converging to same level
Geographic consolidation/ concentration of parts and components supplier	Increasing compatibility of software and hardware network by open system		U.S. (100%)
Global alliances and partnership	Intensive cross-border OEM relationship within industry		Japan (95%)
Active international benchmarking			Germany (89%)

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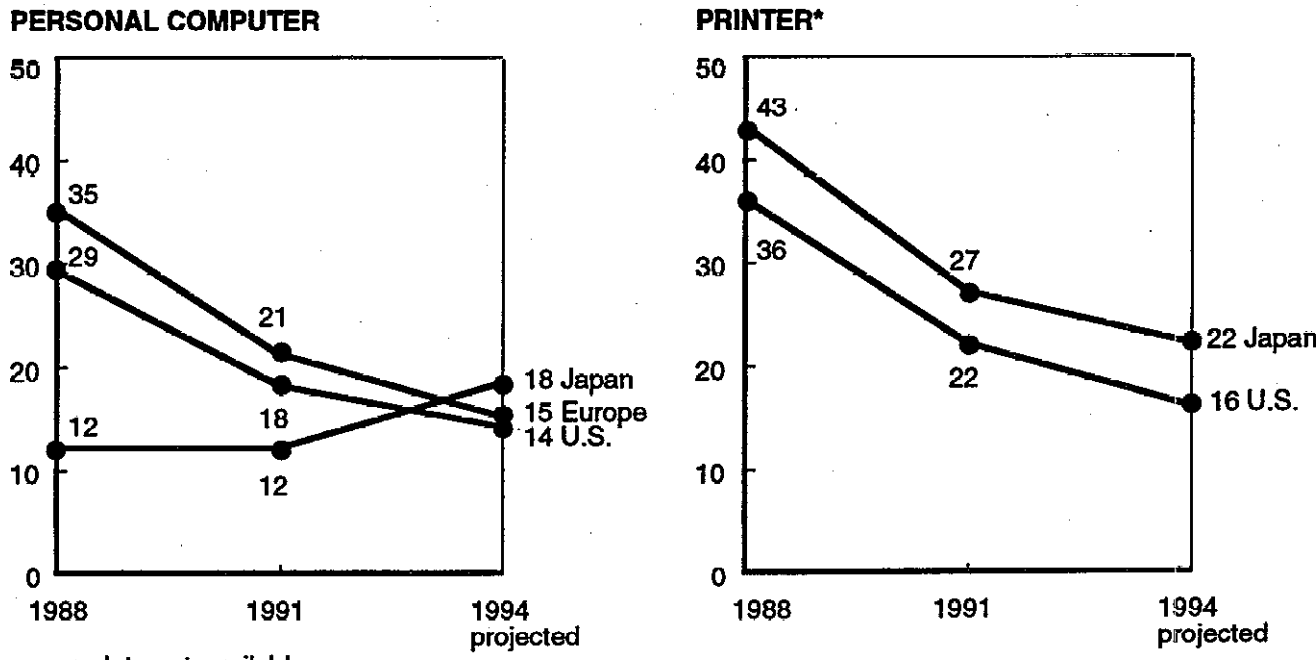
Exhibit E - 12

CONVERGENCE OF PRODUCT LIFE CYCLES

Months



* European data not available

Source: *Excellence in Electronics* Survey

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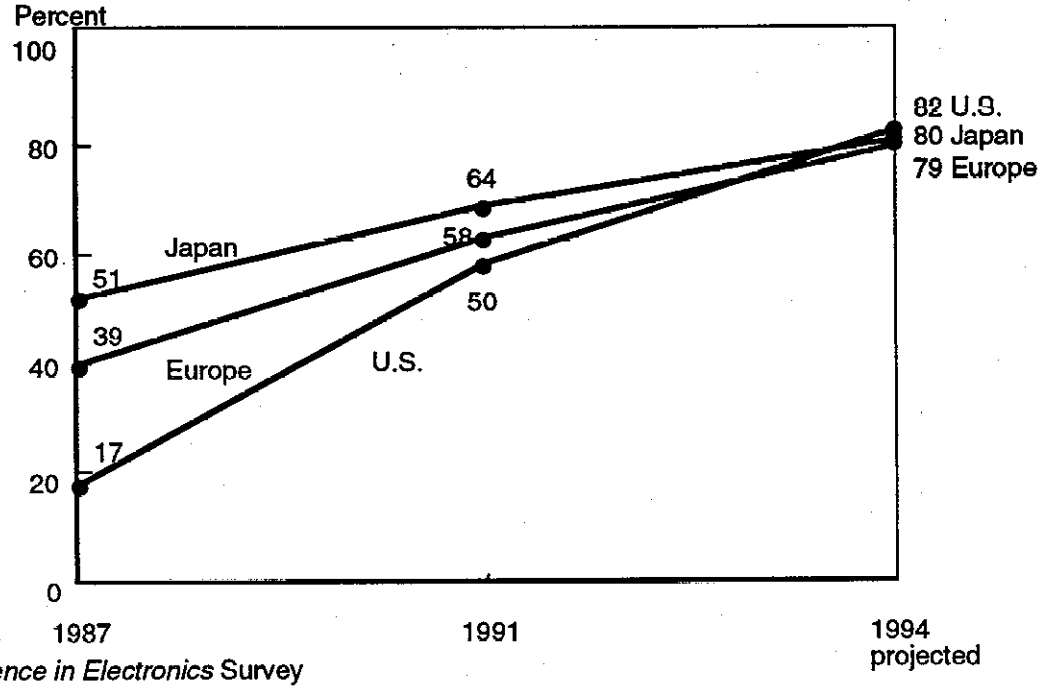
Exhibit E - 13

EVOLUTION OF COMPONENT TECHNOLOGY

COMPUTER TOTAL

Use of SMT technology for PCB



Source: *Excellence in Electronics* Survey

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¶ Innovation. Needless to say, innovation drives the productivity development of the computer industry. Having many innovative companies in a region gives advantages to that region. As we can see from productivity by size of establishments, small but focused companies in the U.S. lead the industry in terms of innovation and productivity. However, these innovations are quickly transferred to other regions. In the case of workstations, new products or product standards created in the U.S. are simultaneously produced by manufacturers in Japan and Europe, often through joint ventures.

¶ Product life cycle (product redesign). Another interesting result from the survey is the converging product life cycles of computer products. As Exhibit E-12 shows, the product life cycle of new PCs is now converging within a range between 14 and 18 months across the Triad, and we found a similar tendency in printer life cycles.

As products become more global and international competition among producers intensifies, product life cycles will continue to converge. This trend means that players are now required to have similar production process renewals and similar product development lead times. As a result, the shorter development times for higher-productivity products in Japan will no longer be a differentiating factor across the Triad.

The case of automation provides an example of convergence in the production process. Automation machinery is globally traded and the technology is widely available; the decision to automate is driven by the length of a product's life cycle. A shorter life cycle makes it more difficult to recover the automation investment costs. Therefore, in final assembly of PCs, for example, the automation level is not always increasing. As product life cycles converge within the Triad, degrees of automation would also be similarly influenced.

¶ Process technology (machinery and equipment, intangible capital). We have also observed the convergence phenomenon in the production process of one of the key components. Surface Mounting Technology (SMT) is one of the most advanced technologies in computer manufacturing. This technology is used to mount electric devices on printed circuit boards (PCBs). As the surface density of PCBs increases, the insertion technique is shifting from manual to surface mounting (SMT). An interesting finding from the survey is that companies based in Europe, Japan, and the U.S. are pursuing the development of SMT to a similar degree (Exhibit E-13). SMT is a good example of how production processes are now converging.

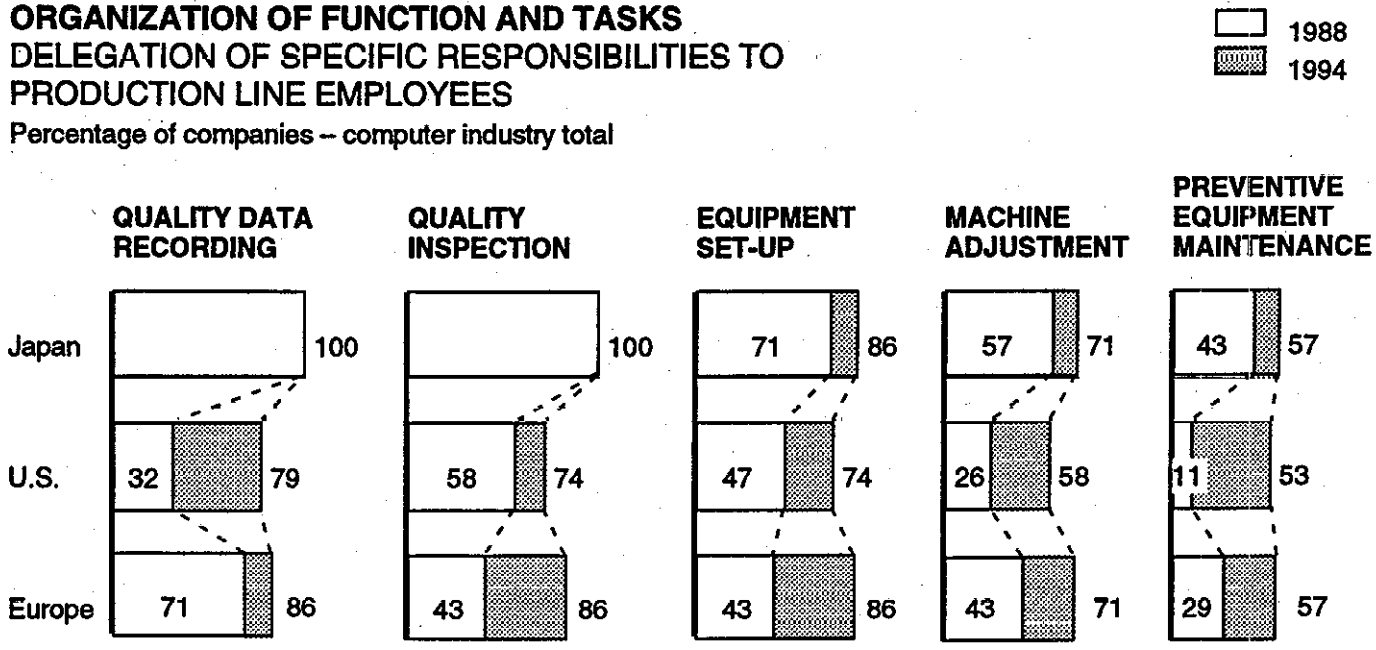
¶ Front-line empowerment (organization of functions and tasks). One of the typical examples of the Japanese production system is the delegation of responsibilities to production line workers. McKinsey has surveyed

Exhibit E - 14

ORGANIZATION OF FUNCTION AND TASKS

DELEGATION OF SPECIFIC RESPONSIBILITIES TO PRODUCTION LINE EMPLOYEES

Percentage of companies -- computer industry total



* Projected by the companies themselves

Source: *Excellence in Electronics* Survey

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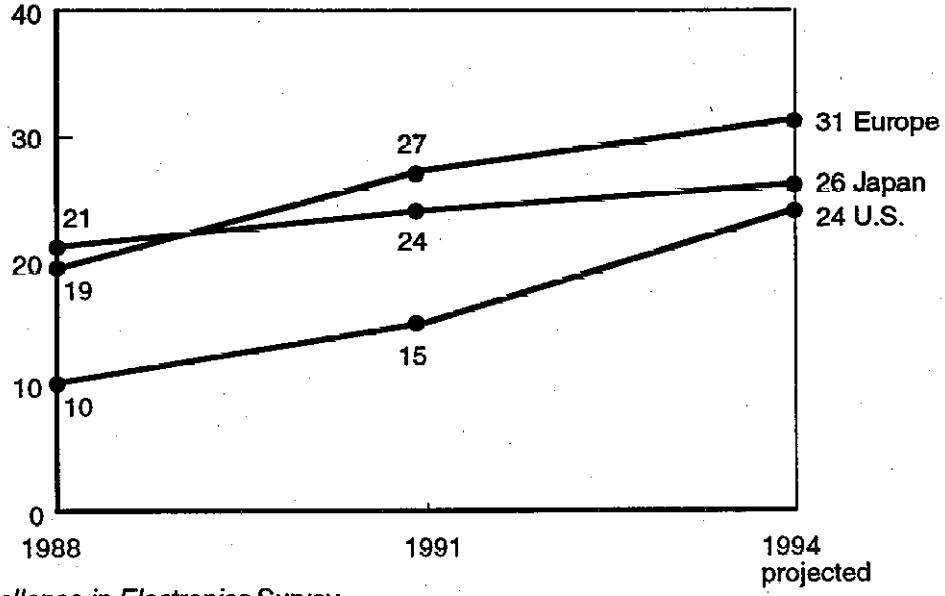
Exhibit E - 15

INVENTORY TURNOVER CONVERGENCE

COMPUTER TOTAL

Turnover/year



Source: *Excellence in Electronics* Survey

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103 worldwide electronics companies with a detailed questionnaire, and has developed a database of companies, including many in the computer industry. As Exhibit E-14 shows, one interesting result is that the delegation of responsibility is converging among computer companies in the Triad. Front-line empowerment, which was perceived as a Japanese production feature, is now being applied to production processes in other regions. The survey also shows that more productive companies delegate more responsibility to workers. As a result, this particular Japanese advantage is being lost as workers' responsibilities are becoming similar among Triad manufacturers.

¶ Other practices in production processes. We have also observed convergence of many other aspects of production. Product complexity (measured by number of parts per subassembly), inventory turnover of raw materials and work-in-process, and delivery accuracy (measured by percentage of on-time shipments) are rapidly becoming more similar. All these examples reflect one common theme: differences in hardware production are disappearing (Exhibits E-15, E-16).

The process of assembling hardware is becoming less and less differentiated as the globalization of production progresses. We will look at the convergence mechanism of the production process in the next section.

Industry Behavior

In this case study, we discuss the external factors that have led to productivity convergence rather than productivity differences. The major vehicles for this convergence are the following: (1) the dominance of multinational corporations and their high levels of foreign direct investment, (2) the standardization of parts and components and their global consolidation, (3) the development of global alliances and partnerships, and (4) the active use of benchmarking within the industry. As a result, the nature of competition is similar across the Triad.

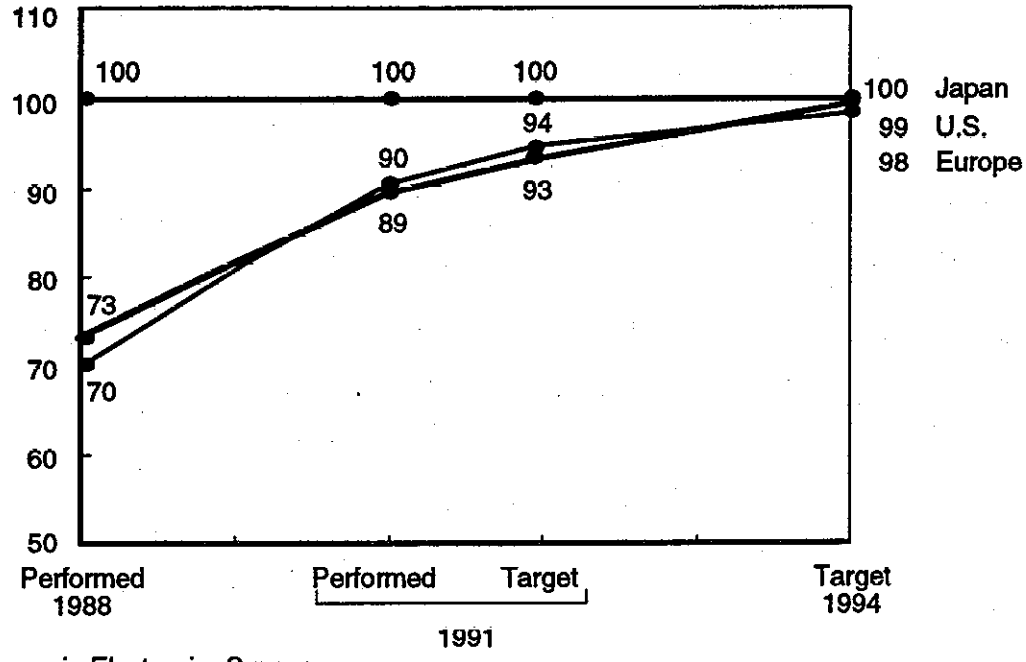
¶ Multinational corporations and foreign direct investment. In this study, we compare the productivity of computer manufacturing in each region, regardless of the ownership of the facilities located there. As Exhibit E-17 shows, a large portion of computer production in Europe is done by multinationals originating in the U.S., and the ratio is probably even higher in Germany. These multinationals have been playing an important role from the beginning of the industry. IBM has been the number 1 producer in each region since the 1960s, and still holds 42 percent of the market for large-sized computers today. Siemens, the biggest German producer, has increased its market share in terms of brand sales, in part due to acquisitions. However, a major part of Siemens mainframes are now OEM manufactured by Fujitsu, a multinational originating in Japan. In Japan, 17 percent of computer production is done

Exhibit E - 16

DELIVERY ACCURACY

COMPUTER TOTAL

Percentage of on-time shipments



Source: *Excellence in Electronics* Survey

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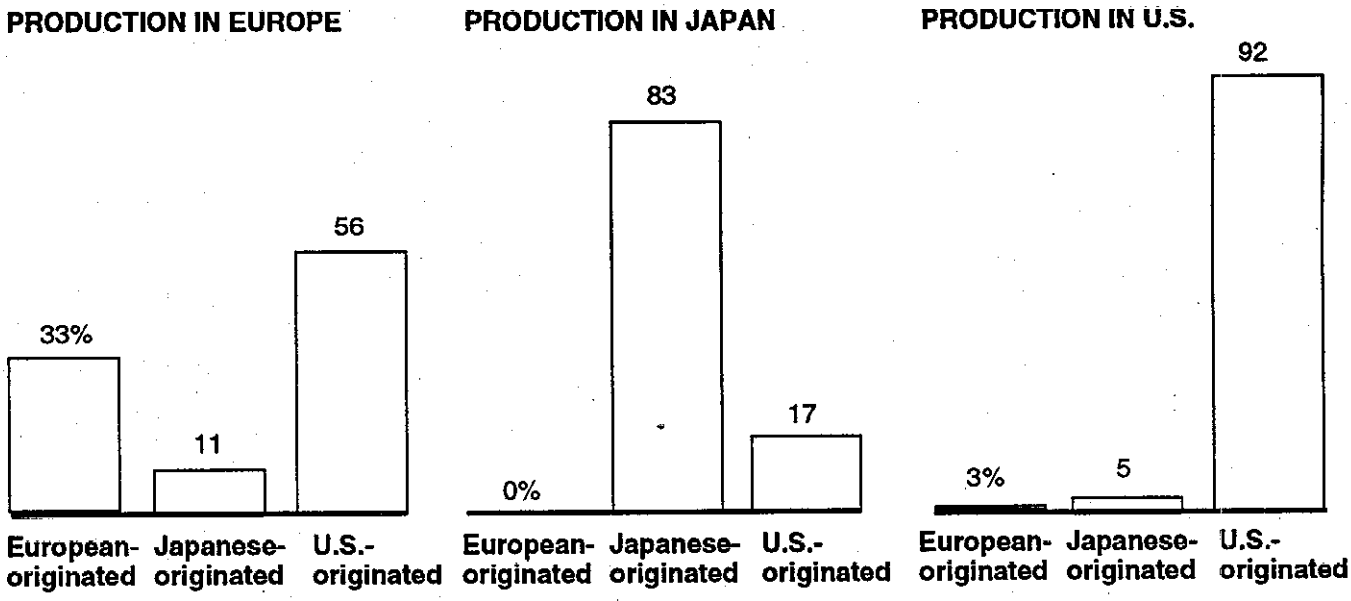
Exhibit E - 17

COMPUTER PRODUCTION AND THE ORIGIN OF COMPANIES

Percent production 1990



Source: Electronics International Corporation

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by multinationals originating in the U.S., namely IBM, Unisys, DEC, and Hewlett Packard. The 17 percent figure does not seem very high, but it is the highest share of non-Japanese originated production in Japan in any of our nine case studies. The computer industry also exhibits the highest non-German originated share in Germany among the industries we study. The relative openness of Japan and Germany to foreign direct investment in this industry has made it one of the most globalized. Multinationals originating in the U.S. have transferred production processes to their transplant facilities, and interviews confirm that the productivity of transplants rivals the productivity of the home country.

¶ Standardization of parts and components and their global consolidation. In computer production today, a given part or component is often sourced from one or two suppliers worldwide. The globalization and standardization of PC parts and components is almost complete, while in other computer products it is proceeding rapidly. For example, the semiconductor memory industry is mainly controlled by manufacturers primarily operating in Japan and Korea who sell to most assemblers of PCs, workstations, and medium-scale processors. In micro-processors, Intel has a 70 percent share of the world market and its processors are used regardless of the geographic location of OEMs. Flat panel displays, such as liquid crystal displays, active matrix displays, and plasma displays, are mostly purchased from producers located in Japan, like Sharp or Toshiba. CRT (brown tube-type) displays are produced in Taiwan and Korea. Motherboards and keyboards are mainly produced in Taiwan, either by local companies in Taiwan, or by Triad transplants seeking lower costs of production. Other components, like FDD (floppy disk drive) or HDD (hard disk drive), are also made by several manufacturers headquartered in the U.S. and Japan. Printed circuit boards produced in Taiwan have the same board size and screw hole positioning regardless of manufacturer. The question of the "nationality" of computer products is thus becoming meaningless.

The consolidation and concentration level of the computer parts and components industry is much higher than in the computer assembly industry. More importantly, consolidation has taken place on a global basis so that every assembler sources a given part from the same dominant region.

With regard to parts for larger computers, trade is growing among Triad mainframe producers. Siemens is sourcing 9-inch HDDs for mainframes from NEC, a Japanese producer. Hitachi, NEC, and Fujitsu are supplying mainframe parts and subassemblies to the European producers Olivetti, Bull, and Siemens, respectively. However the consolidation of parts and components in mainframes and mini-computers is behind that of PCs.

¶ Global alliances and partnerships. Global alliances and partnerships are very active in this industry, although their effectiveness varies considerably. In the mainframe industry, for example, most of the products sold by Siemens are at least partly manufactured by Fujitsu. Most of the Olivetti brand mainframes are manufactured by Hitachi, and part of the Bull brand mainframe is manufactured by NEC. In the PC industry, the first version of the Apple notebook computer (the "Power Book") was manufactured by Sony. Citizen, a Japanese watch manufacturer, used to manufacture PCs for the Compaq brand. Panasonic (Matsushita) manufactures PCs for the IBM brand. Hitachi sources workstations from IBM Japan. Amdahl and ICL are now owned by Fujitsu. The list of cross-border relationships is endless. The result is that manufacturers have set up information exchange channels through specific business alliances which are another convergence vehicle for productivity.

¶ Active international benchmarking. In this industry, benchmarking is constantly being done by manufacturers, research companies, and customers. Many computer manufacturers such as IBM, Hewlett Packard, and DEC invest significant resources in monitoring their competitors' products, processes, and productivity. Computer industry market research firms publish periodical reports with price performance comparisons and detailed product specifications. In addition, many computer industry magazines publish product comparisons. The result of all this independent benchmarking is an excellent source of feedback to manufacturers, increasing their awareness of comparative performance and improvement opportunities.

External Factors

¶ Historical context. When we talk about external factors affecting the computer industry, we must look back into the history of its development in each region. The industry was born in the U.S. and spread out to the rest of the world. As a result of intellectual property protection and high product-conversion costs for proprietary software, the industry tended to be controlled by a limited number of producers. Initial government reaction to the industry is still affecting productivity levels today. The Japanese government protected and promoted the industry intensively in its early stages, but later they deregulated and exposed it to fierce global competition. The German government has tried to protect and promote computer companies originating in Germany, but the largest part of computer production in Germany has been done by multinationals originating in the U.S. Government protection reduces incentives for companies originating in Germany to improve their productivity to the world's best practice level. These companies are still struggling with lower performance.

Exhibit E - 18

HISTORICAL BACKGROUND OF COMPUTER INDUSTRY

GERMANY AND JAPAN

	1950 or before	1960	1970	1980	1990
Germany	**1941** – K. Zuse developed computer "Z3" **1949** – Zuse Co. established **1954** – Zuse started computer business	**1964** – Siemens allied with RCA and customized RCA "Spectra 70" **1966** – Siemens released "Siemens 4000" German government started industrial policy to promote computer industry (more software focused) **1964** – System 360 released	Siemens acquired Zuse Nixdorf started small computer manufacturing **1972** – Nixdorf and Telefunken make JV "Telefunken Computer" **1972** – UNIDATA started (European JV) failed in 1974 Siemens acquired Telefunken Computer	**1983** – Siemens released 7860 model E, L, R (OEMed from Fujitsu) **1987** – Siemens and BASF made joint venture "Comparex Information System" (OEMed from Hitachi) **1987** – Siemens entered into HDD supply contract with NEC	**1990** – Siemens acquired 51% of Nixdorf and established SNI (Siemens-Nixdorf Information system)
Japan	MITI, Industrial Technology Institute, Electronics Laboratory developed - ELT Mark III (1956) - ELT Mark IV (1957) **1957** – Electronics Industry Promotion Provisional Law - NEC: NEAC-2201, 2202, 2203 (1958-59) - Hitachi: HITAC-102, 301, 501 (1959-60) - Hokushin: HOC-100, 200 (1958-60) - Matsushita: MADIC-1 (1959)	**1961** – MITI established JECC (Japan Electronic Computer Company) **1962-64** – MITI initiated FONTAC project **1967-72** – MITI initiated "ultra high performance computer development project" **1964** – Matsushita dropped out	**1971** – Fujitsu and Hitachi allied in joint development, manufacturing **1971** – Mitsubishi allied with Oki Electronics **1971** – MITI initiated "Computer development promotional subsidy program" (¥5–¥20 billion/year) **1971** – Fujitsu-Amdahl corporation **1978** – Toshiba dropped out of manufacturing mainframe	**1985** – Fujitsu surpassed IBM Japan in market share in Japanese market	
IBM-Japan	**1937** – Japan Watson Accounting machine **1950** – Japan IBM established (only sales company) **1958** – IBM introduced 650 **1959** – IBM-704	**1960** – IBM World Trade entered into technical support contract with IBM Japan **1963** – IBM Japan started production IBM-1440 **1967** – IBM Japan opened Fujisawa factory	**1971** – IBM Japan opened Yasu factory		

Source: McKinsey analysis

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If we look at the history of the computer industry in each region, we find interesting differences. Computers became available on a commercial basis in the U.S. in the early 1950s. The first computer was Univac (Universal Automatic Computer), produced and sold in 1951 by Remington Rand. IBM then started producing the IBM 701 in 1953, the 704 in 1955, and the 705 in 1956. It also launched its first mid-sized computer, the IBM 650 in 1955. The 650 became a best seller and IBM established a strong position in the industry, taking a 73 percent share of all computers installed by 1956. Since then, IBM has been by far the largest player in the U.S. market.

As Exhibit E-18 shows, IBM entered the Japanese market in the early 1950s and introduced its IBM 650 in 1958. At that time, no Japanese manufacturers were capable of making computers on a commercial basis. IBM also played an important role in the European market in the 1950s. This position was partly a legacy of IBM's global control of the punch card system business. Since then, IBM has remained the largest player in each region of the computer industry, except Japan. In 1960, IBM had roughly 5,000 patents related to computers in and out of the U.S., and any manufacturer trying to make computers on a commercial basis had difficulty breaking through this patent barrier. In addition to the technological and production process patents, IBM's closed system of proprietary hardware and software created very high conversion costs for users to switch computers and a high entry barrier for competitors.

The second difficulty in competing against IBM was the financial burden of supporting both R&D and computer leasing. In order to keep developing new technology and new products in the computer business, huge R&D resource commitments were required. Also, computer companies traditionally leased their products out to end-users and thus had to cover the huge financial cost of computer production themselves. Hence, small companies without significant financial resources could not have entered the market. IBM had a governing market position on punch card system and could count on its rental fee revenue to finance its development and operating costs. IBM also obtained low-cost, long-term financing from Prudential Life Insurance. As a result, IBM was able to maintain its advantageous position for a long time.

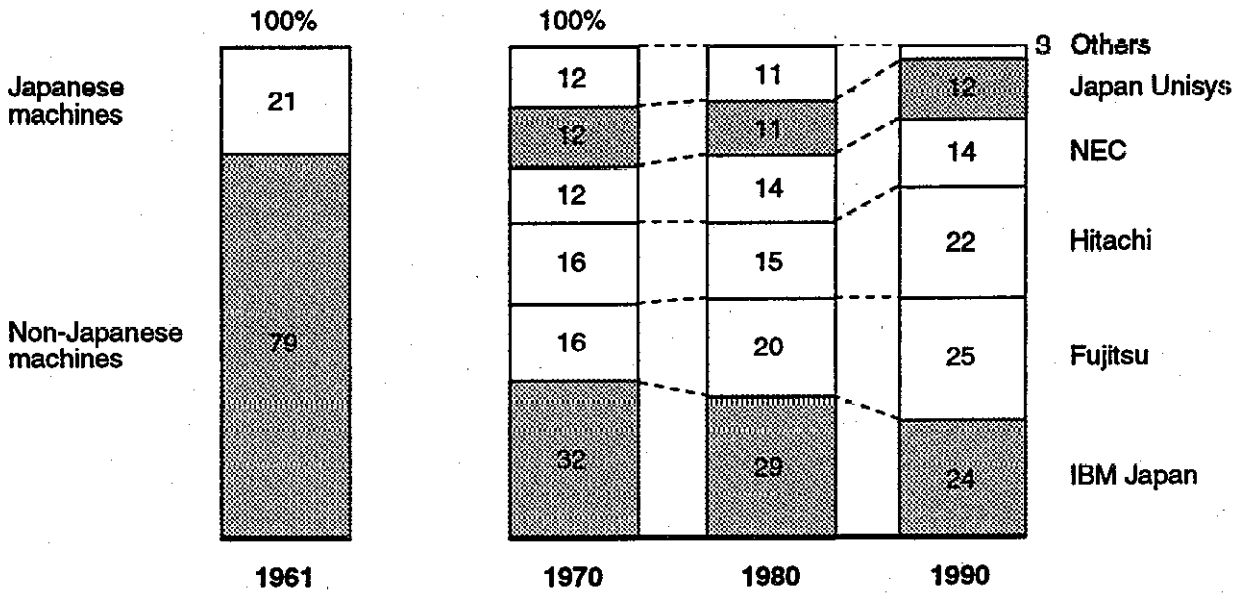
The leading and differentiated position of IBM, while limiting the degree of competition during the early stages of the industry, did have numerous positive benefits. The concentrated R&D efforts of IBM led to the development of new technologies and products. In the 1970s, when U.S. antitrust legislation forced IBM to switch to open system architectures, the benefits of IBM's research efforts spilled over to the industry at large. IBM clone manufacturers developed products using the industry standard which IBM had created, and competition among these new entrants

Exhibit E - 19

JAPANESE COMPUTER MARKET SHARE

MAINFRAME COMPUTERS

Percent: installed base value



Source: Nikkei Computer; JECC

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brought down prices and drove product and process improvements. While the increased competition in the 1970s led to lower prices, better products, and higher consumer surplus, it is not clear that the fundamental research done by IBM in the 1950s and 1960s would have been economically possible in the more competitive environment of the 1970s.

- Market conditions and regulatory environment in the Japanese industry. The Japanese government arranged to create a domestic industry that was able to compete with IBM. The Ministry of International Trade and Industry (MITI) requested that IBM open its patents to Japanese manufacturers in return for its exceptional approval of IBM's 100 percent ownership of its transplant operation under Japanese law in 1960. In this way, the Japanese government sought to support the domestic computer industry. It had already funded R&D projects in the 1950s, and later, it had institutionally promoted the industry by helping to establish a leasing/financing company for computers (Japan Electric Computer Company: JECC). The Japanese government also provided tax exemption for profits from the computer business from 1961 to 1966.

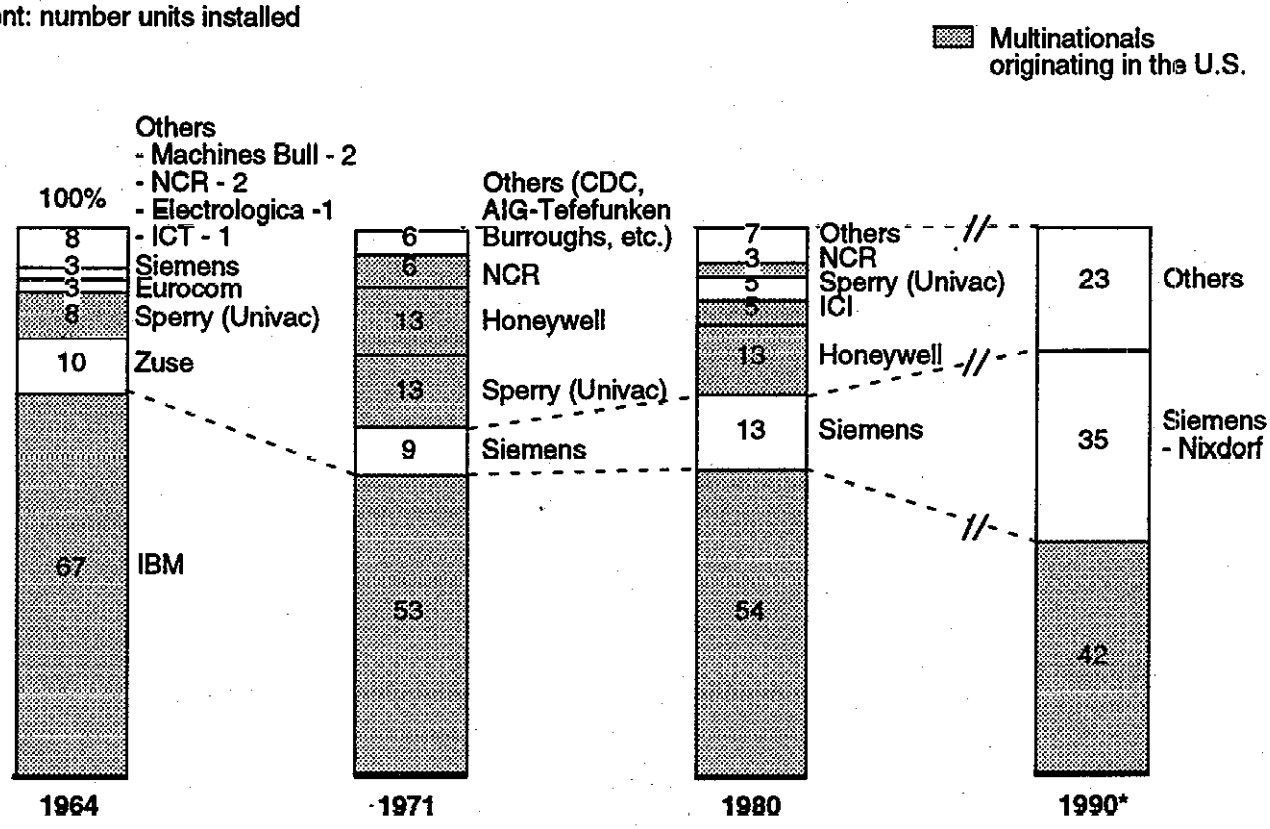
  As we see in Exhibit E-19, computer manufacturers originating in Japan have been gradually increasing their domestic market share. In the world computer market, Japan was the only country to have broken IBM's original regional position. These government programs provided support at an early stage of the domestic industry development and eventually functioned as a "global antitrust policy." In 1964, the Japanese government decided to open the computer market to imports and partly deregulated foreign direct investment, an action which the U.S. had strongly requested. In 1975, all imports and foreign direct investments were deregulated. Along with the deregulation, the Japanese government subsidized the domestic computer industry with a 35 billion yen budget and urged the six major computer manufacturers to group themselves into three by alliances. Fujitsu and Hitachi made an alliance and codeveloped a domestic computer which surpassed the IBM 370 in some performance aspects. This development was successful due to government subsidies and technology acquired through the alliance of Fujitsu and Amdahl. MITI also initiated semiconductor development projects, which became critical for high performance computers. Since this time, computer manufacturers originating in Japan have competed intensely with IBM.

  In the PC market, the situation was totally different. The domestic Japanese PC market has been naturally protected by Japanese linguistic applications. In order to run software written in Japanese characters,

Exhibit E - 20

GERMAN MAINFRAME COMPUTER MARKET SHARE

Percent: number units installed



* Market share of large scale computer systems (>$1 million); data not consistent with previous years

Source: IDC; Dempa- Shinbun; World Computer Almanac

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PCs have had to carry extra Random Access Memory (RAM) in order support Japanese language applications. The number of non-Japanese PC manufacturers which sold Japanese language PCs in the Japanese market was very limited. In fact, until recently, only IBM did. As a result, the Japanese PC market has been dominated by NEC which controlled over 50 percent of the market by leveraging its Japanese software availability. This doesn't affect larger computers since it only influences man-machine interfaces. In our productivity comparison, the reason why the Japanese industry PPP is higher than the market exchange rate is partly because of this natural protection from global competition. In 1991, Compaq and Dell started exporting PCs to the Japanese market by releasing a new type of operating system called DOS/V which supports the Japanese language. Today, the Japanese PC market is becoming intensely competitive because of lower priced, imported PCs by manufacturers primarily based in the U.S.

- Market conditions and the regulatory environment in the German industry. In Germany, IBM's position has been eroded but not overcome (Exhibit E-20). The German government tried to promote the domestic computer industry by fostering research projects or by suggesting mergers and joint ventures to create economies of scale. Siemens, in particular, repeatedly acquired companies in trouble. It reorganized its information system business in 1976 and made it profitable for the first time in 1978. Nixdorf could not compete in the market and was acquired by Siemens in 1990. The goal of this consolidation was presumably the creation of a German-based company that could rival IBM, but the creation of a single German computer company was not combined with the exposure of that company to world-class competition. While each country favors its domestic industry for public procurement (e.g., "Buy American" in the U.S. or high Japanese share in Japanese public sector bidding), it only becomes protection when companies are not competitive in the global market. By insulating Siemens from both domestic competition (by encouraging acquisitions) and foreign competition (by providing procurement contracts), German policy lessened the incentives for improvement to world-class productivity standards.

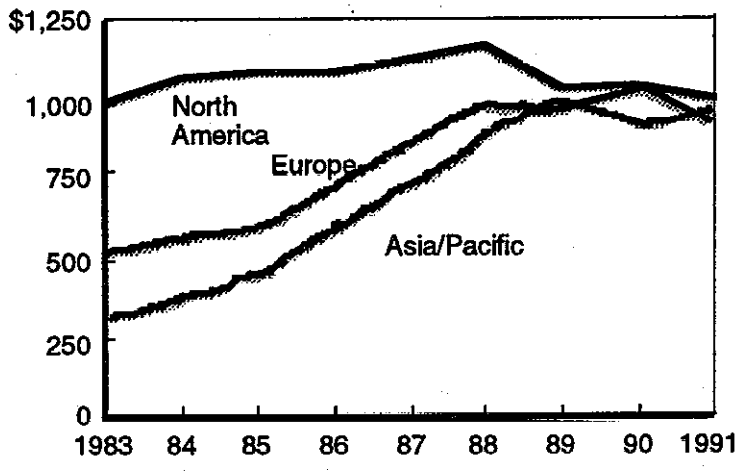
Development Towards the 1990s

The implication of differences in the external factors in Germany and Japan is that active government intervention which introduced competition and promoted domestic industry worked better in Japan than in Germany. In Japan, the government obtained the transfer of basic patents to Japanese manufacturers and offered government support in the early stages. However, the government also encouraged the development of an industry structure which featured three or more domestic competitors and allowed IBM (and later other U.S.-based companies) to compete as well. Furthermore, Japanese companies were also encouraged to

Exhibit E - 21

COMPUTER DEMAND LEVELS ARE CONVERGING

REGIONAL DATA PROCESSING SPENDING PER WHITE-COLLAR WORKER*
1985 U.S. dollars**



* Including software and services
** Using exchange rate

Source: McKinsey data base; McKinsey analysis

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compete abroad. By the 1980s, the Japanese computer market was relatively open and no significant government subsidies were given to the industry. Convergence in productivity suggests that having manufacturers headquartered in Japan competing in the global market is now good policy. Generally, it is doubtful that government protection has positive results in developing an industry beyond giving it a chance to get started. It often spoils the industry and reduces the incentive to be globally competitive, as was the case in the German-based computer industry. Manufacturers originating in Germany still receive significant government protection and procurement contracts and the relative price of computers in Germany is higher than in the U.S. or Japanese market. Looking at the productivity level of German-based companies, it is clear that the protection is hindering productivity convergence.

OUTLOOK

The productivity convergence of the computer industry will continue as the globalization of manufacturing activities proceeds. We may observe new hardware product developments, but the innovations will be quickly transferred to each region with the convergence vehicles we have seen before. Intense competition will likely result in ongoing consolidation.

As we see in Exhibit E-21, computer demand today is also converging. The diffusion of products and production processes throughout the advanced economies is resulting in a convergence in customer demand for computers. This convergence of demand will continue to drive the convergence of products and of production processes. The net result will be that intense competition will be a driving force for productivity improvement. While this industry may see a slow-down in market growth in nominal dollars in terms of real growth, after adjusting for price decreases, market growth will be high. In other words, consumers will continue to benefit from the rapid improvements in productivity through an ever increasing consumer surplus.

SUMMARY AND POLICY ISSUES

The national productivity of computer hardware manufacturing has converged and will remain converged in the future given intense global competition and convergence vehicles. This is summarized in Exhibit E-22. New innovations of products or production processes are transferred across borders immediately by multinational companies or global alliances. Parts and component manufacturers have been consolidating further and are leading the standardization of products and production process across advanced economies. The lack of barriers to global competition has been a key driver for productivity convergence.

The single most important policy implication of this study is, in short, encouraging competition. Trade protection and subsidized procurement inhibit competitive

Exhibit E - 22

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES
COMPUTER INDUSTRY

● Important
O Secondary
X Undifferentiating

External factors

- Market conditions
  - Demand factors — X
  - Relative input prices/factor availability — X
  - Other industries — X
- Policy and regulation
  - Macroeconomic conditions — X
  - Competition rules and concentration rules — ●
  - Corporate governance rules — X
  - Labor rules and unionism — X
  - Other regulations (tariffs, nontariffs) — X

Nature of competition — ●

Production process

- Output
  - Mix, variety, quality — O
- Production factors
  - Capital (intensity, vintage, technology) — X
  - Scale — X
  - Design for manufacturing — O
  - Basic skill of labor, intrinsic motivation — X
  - Raw materials, parts — X
- Operations
  - Capacity utilization — X
  - Organization of functions and tasks — O

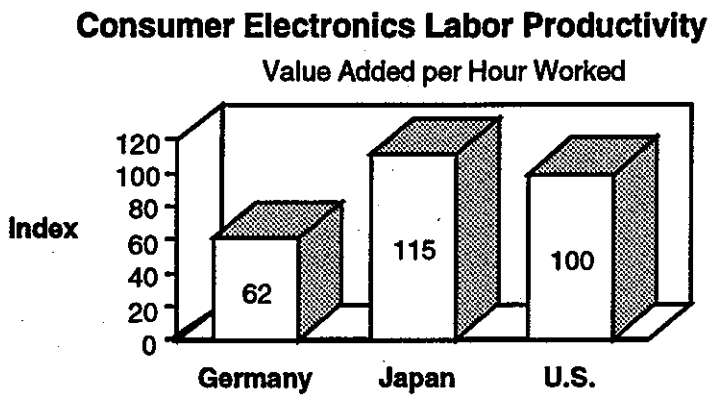
LABOR PRODUCTIVITY

pressures that force the adoption of the global best practice. However, as shown in the development of the industry in Japan, it is clear that government can play a role in encouraging technology transfer, so long as it also encourages domestic and international competition. At the same time, the German experience illustrates the risks of extending protection and subsidies to domestic producers.

In this industry, given the level of globalization and speed of changes, global market mechanisms seem to work quickly. Any trade policy or regulation aimed at constraining activity may cause a slowdown of productivity growth and a shift of production to less regulated regions. The only necessary regulations might be those intended to foster competition. As an extremely knowledge-intensive industry, computer products are often considered to be intellectual property and are protected by laws or patents that create a natural tendency toward constrained competition. The Japanese strategy of protecting its infant industry while getting IBM to relinquish some of its patent protection, functioned to promote industry competition in the 1960s. The industry in Japan was eventually able to compete with IBM, and this competition contributed to the rapid world-wide productivity growth of computer manufacturing over the past three decades.

There is a trade off, however, between the protection of intellectual property (to assure the return of R&D investments for innovation) and the diffusion of developed technologies. Often the diffusion of technological know-how is required to break down the inefficiencies associated with high market concentration. In the development stage of an industry, innovation should be encouraged with strong intellectual property rights. Later, however, the benefits of the technology should be enjoyed as efficiently and widely as possible.

CONSUMER ELECTRONICS CASE STUDY SUMMARY



High competitive intensity of consumer electronics companies in Japan drove up physical productivity and spilled over to the U.S. through foreign direct investments. Operations in Germany have been under major restructuring to improve product design and organization of functions and tasks.

German consumer electronics companies demonstrates a theme common to many of the cases: **a "domestic industry" with trade barriers is a major cause of low productivity,** high prices relative to value, and less innovation in design for manufacturing and organization of functions and tasks. The consumer electronics industry in Germany is at a crossroads today. It must either open up to global competition and reap the benefits of better products and improved productivity, or continue to be protected and see productivity fall further behind.

The case of Japan echoes many other cases by showing that **high competitive intensity – in this case mainly within Japan – is good for improving physical productivity, innovation, and value.** Consumer electronics also exemplifies Japan's dual economy, one comprised of several highly productive, export-oriented companies supported by low productive subcontractors, parts and component manufacturers. The productivity increase in recent years is mainly attributable to a displacement of the production of smaller companies to Southeast Asia as a result of the high yen appreciation.

While at first glance these productivity figures imply that **consumer electronics makers in the U.S. are competitive**, they mask a simple truth about this industry. Unlike the other case studies, the industry in the U.S. is very small. The only major product made in the U.S. is the TV, and **only 8 percent of the TVs made in the U.S. are produced in factories operated by the companies originating in the U.S.** Lack of involvement in consumer electronics is not necessarily bad for the U.S. economy as a whole, because value added per person in this industry is lower. This is partly due to fierce price competition among the companies originating in Japan.

PRODUCTIVITY IN THE CONSUMER ELECTRONICS INDUSTRY

The output of the consumer electronics industry in Japan is roughly 10 times the size of the U.S. and Germany. Not surprisingly, the consumer electronics industry in Japan is not dramatically more productive than what remains of the industry in the U.S. However, productivity in Germany lags behind the other two substantially. The main causes of the observed productivity gap with Germany are differences in design for manufacturing and differences in the organization of functions and tasks. In addition, operations in Germany are affected by the substantial protection of the EC market. The consumer electronics industry in Japan demonstrates only a slight productivity advantage over the U.S. because the U.S. concentrates on the most productive of the product categories and not on a full range of products.

For the last three decades, consumer electronics has been one of the most important industries in bringing new amenities to our daily lives. Products such as TVs, VCRs, CD players, and hi-fi audio equipment have become an integral part of our households. Moreover, the quality, variety, and availability of these products has improved significantly over the last few decades, while at the same time their prices have continued to decline. The high competitive intensity of companies brought us new and innovative products and led to the rapid replacement of less productive operations ("creative destruction"). The net result of these trends has been a large transfer of economic surplus to consumers.

However, the industry has not created high productivity jobs in the global economy, and the shift in jobs across borders has been small. Higher competitive intensity of the industry has made the jobs in this industry low paying and limited just as it has made the products higher quality and numerous.

The consumer electronics industry has been the subject of many discussions and debates in the popular press, especially in terms of the industrial and trade policies of Europe and the U.S. Many have argued that the unfair trade policies resulted in the loss of U.S. domestic consumer electronics production. On the contrary, our finding is that productivity differences are sufficient to explain the outcome. In order to resolve this issue, we will develop a point of view on the relative performance of the different countries, as well as an understanding of the causes of differences in productivity. Furthermore, we will discuss the implications for corporate strategy and industrial policy.

Industry Definition

The consumer electronics industry is defined here as "household audio and video equipment manufacturing." In the U.S., it includes TVs, VCRs, stereos, car

Exhibit F - 1

INDUSTRY DEFINITION

	SIC code	Industry	Major product
Germany	3670	Manufacturing of audio television and phonotechnical equipment	TV receivers, VCRs, automobile radios, power amplifiers, microphones, other audio equipment, audio disks, records (pre-recorded), audio tapes (pre-recorded), parts and components for audio, TVs
Japan	3043	Radio and TV receivers	Radios, TVs (including VCR)
	3044	Electric audio equipment	Stereos, tape recorders, car-stereos, record players, blank tapes other audio equipment, parts and components for audio
	3062	Video recording and duplicating equipment	VCRs, video cameras, parts and components for video equipment
U.S.	3651	Household audio and video equipment	Household TVs, radios, VCRs, other equipment

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stereos, radios, record players, video cameras, tape recorders, and other audio products. The three regions differ slightly in industry coverage in products and parts (Exhibit F-1).

In 1990, about 400,000 people worked in the consumer electronics industry in the three countries: 70 percent of them in Japan, 20 percent in Germany, and 10 percent in the U.S. (Exhibit F-2). The employment represents 2.5 percent of total manufacturing employment in Japan, 1.2 percent in Germany, and 0.2 percent in the U.S. Not surprisingly, output is also very different across the regions. The consumer electronics industries in Germany and the U.S. are only one-tenth the size of that in Japan and the industry size has been stable over the 20 years (Exhibit F-3). We must be aware that the employment in the three countries studied represents about one-third of total world consumer electronics industry and today Southeast Asia is growing to be the biggest production region.

Contrary to the image formed from the many recent new product developments, worldwide nominal dollar sales have grown only 6 percent annually (1986 to 1991) using market exchange rates (Exhibit F-4). Real growth rates worldwide are similar, since the producer price index in U.S. dollars was constant during this period. Production volume of new products increased rapidly after release, but quickly decreased as products rapidly matured and returns declined to marginal levels.

Starting with radio receivers in the 1950s, the consumer electronics industry has released many generations of new products (e.g., black and white TVs, color TVs, stereos, tape recorders, hi-fi audio equipment, CD players, VCRs, and video cameras or camcorders). In general, at least one new product generation appeared every 10 years. As one generation became obsolete or saturated the market, a new one came into the market and sustained the growth of the industry.

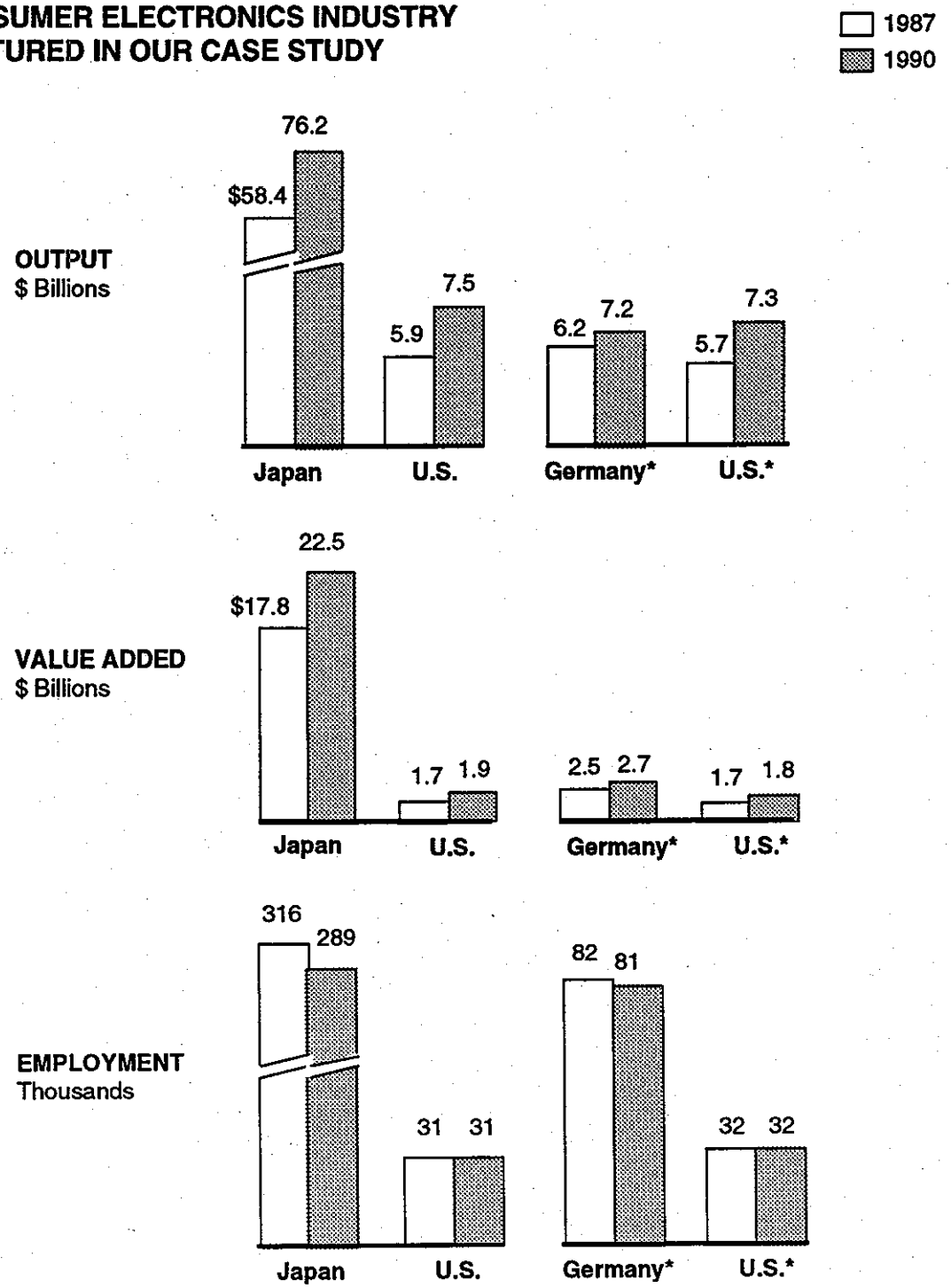
Many of these markets are now saturated, with sales focused mainly on replacement. Furthermore, the industry currently lacks a new generation of large-scale products. Household penetration of radios and TVs has reached almost 100 percent, while the penetration of audio equipment and VCRs has been stable. Only those companies which are ultra-efficient, or can overcome the maturation of demand by releasing new, differentiated products faster than others can remain and grow in this industry. As such, the two key factors for success in this industry are the capability to develop new and innovative products and the production process efficiency needed to survive in the commoditized market.

The Production Process

Consumer electronics has two types of manufacturing. One type is part and component manufacturing and the other is final assembly. These two manufacturing processes are often carried out in different locations or countries by different companies. Major parts include printed circuit boards (PCBs, i.e., the

Exhibit F - 2

CONSUMER ELECTRONICS INDUSTRY CAPTURED IN OUR CASE STUDY



* Including auxiliary unit, excluding legal units below 20 employees

Source: Census of Manufactures

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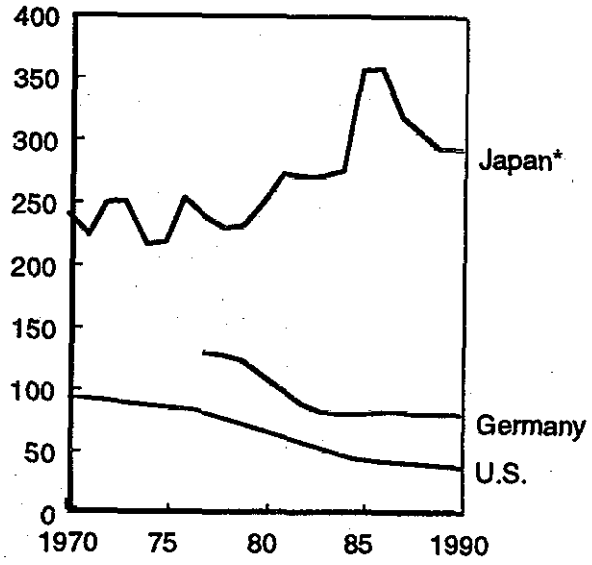
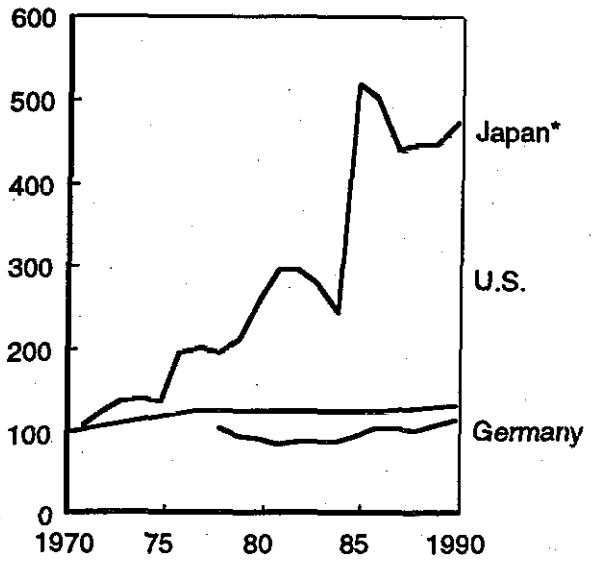
Exhibit F - 3

INDUSTRY SIZE TREND

EMPLOYMENT
Thousands



OUTPUT
Index: 1978 = 100



* VCR was included after 1985

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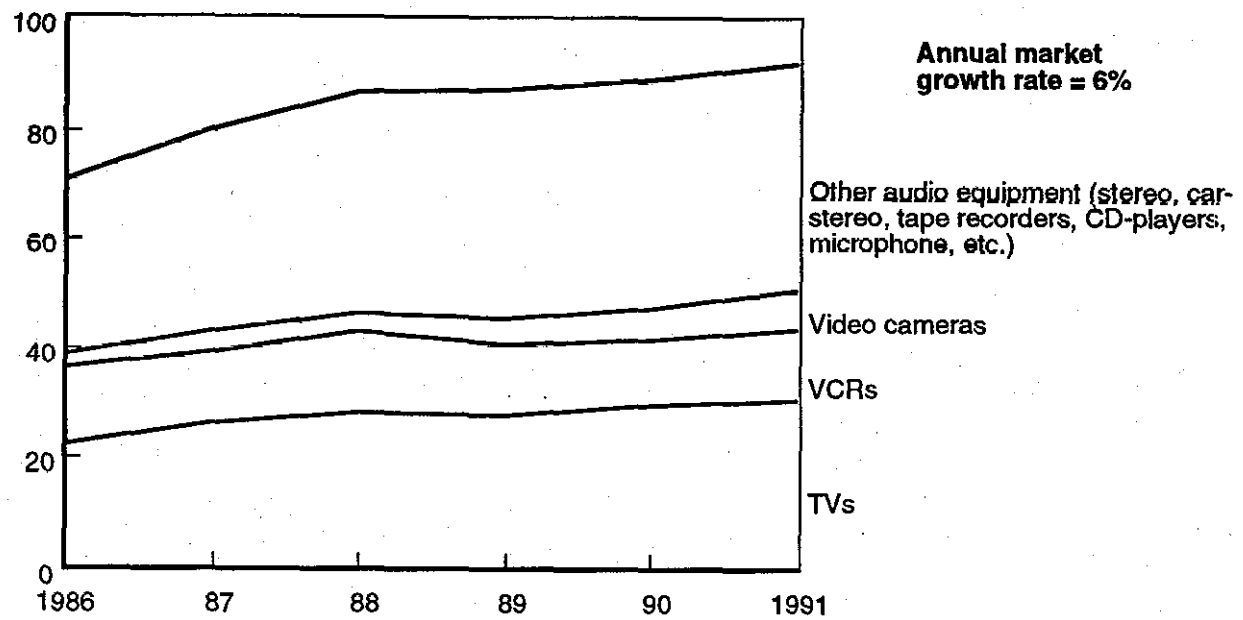
Exhibit F - 4

WORLDWIDE MARKET DEVELOPMENT OF CONSUMER ELECTRONICS INDUSTRY

PRODUCTION BY PRODUCT

Nominal $ Billions



Source: Electronic International Corporation

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INDUSTRY COVERAGE AND ADJUSTMENTS

Industry Definition

Industry coverage in products. In addition to final products, German and Japanese industry codes include some parts and components manufacturers for audio and video equipment which are separately categorized in the U.S. census. There are some other differences. The German industry includes pre-recorded records and tapes which are not in the Japanese or U.S. census data. However, the impact of these products is relatively small as they account for only 6.2 percent of output. In Japan, "electronic audio equipment" also includes blank tapes, which account for 7.7 percent of the entire consumer electronics industry in Japan (Exhibit F-1).

Semifinished products manufacturing. There is a slight difference in the treatment of the manufacturing of semifinished products in the Standard Industry Classification of each country. The Japanese census includes manufacturers of parts and semifinished components in its industry codes: (e.g., in "electric audio equipment" and "video recording and duplication equipment"). The German census also includes core parts production in its census. However, the U.S. census strictly separates all parts and components manufacturers in a different industry code (e.g., not in the "household audio and video equipment" finished products code). As a result, the number of establishments in Japan classified as being in this industry is over 5,000, but half of these are parts and semifinished components manufacturers. In the U.S. there are only 378 establishments. Due to the relatively lower productivity of parts production in Japan, this difference could potentially understate the productivity of Japanese industry.

PPP

We have improved product category matches from the Census of Manufactures and calculated a PPP for each consumer electronics product (e.g., TVs, tape recorders, car stereos, etc.). We divided each product category into different sizes and compared, for example, TVs of the same size. Then we calculated a weighted average PPP for the entire industry.

We confirmed our PPP with other price comparison data like the Japanese MITI survey and an electronics sector survey. Our PPP looks reasonable compared with the other surveys.

Double Deflation

In the consumer electronics industry, most of the parts and components inputs are standardized and heavily traded in the global market. We can assume that these standardized parts, (e.g., semiconductors, CRTs, magnetic heads, and LCD displays) are traded with market exchange rates. The PPPs we used for output in the productivity calculation were 2.93 DM/$ and 139 Yen/$ in 1987. The market exchange rates in 1987 were 1.80 DM/$ and 145 Yen/$. Therefore, we have adjusted the productivity calculation by using different exchange rates for outputs and inputs (the double deflation technique). The result is a 10 percentage point decrease in productivity in Germany, while the impact on productivity in Japan is negligible (less than 1 percentage point).

chassis of TVs), Cathode Ray Tubes (CRTs), other displays, magnetic heads, laser pickups, speakers and packaging. Today, as PCB density increases, its size is decreasing. While most basic devices are now standardized, components like PCBs, integrated circuits (ICs), and plastic packaging are custom designed by assemblers and manufactured by subcontractors.

TV manufacturing is a good example of consumer electronics assembly. The TV assembly line flows from unpacking parts onto conveyer lines to monitoring the image of assembled TVs. The core parts of a television include CRTs, a chassis, plastic cabinets, and speakers. The CRTs and the chassis, the most labor-intensive and high-value components, are often manufactured in different lines or locations. The design and organization of their production is crucial for production yields, since higher rates of manual processing (e.g., soldering) adversely affect the products' default rates. The final assembly line of TVs is more automated; each worker produces 10 to 30 TVs per day. Therefore, the labor cost component in final television assembly is small.

The three regions differ in the degree of vertical integration. The consumer electronics industry in Germany had a higher value added as a percentage of output in 1987 (around 40 percent), while the U.S. and Japan were close to 30 percent. This difference is partly because of different industry definitions. The census statistics include parts and components production in Germany and Japan but not in the U.S. In addition, companies based in Germany manufacture their chassis and PCBs relatively more in-house, while companies in Japan often outsource them. Final assemblers, or original equipment manufacturers (OEMs), source parts and components from suppliers and then assemble and test them. OEMs often exchange standardized parts, such as CRTs or magnetic heads, with each other. Major OEMs based in Japan often have white goods production (e.g., refrigerators, washers and dryers, and microwave ovens) within their operations, but outsource PCB production to subcontractors. This practice is less common in Germany, and it potentially affects German productivity negatively.

PRODUCTIVITY RESULTS

The relative productivities of the consumer electronics industries in Germany, Japan, and the U.S. in 1990 were: 62 percent, 115 percent, and 100 percent, respectively after the double deflation adjustment (see box entitled "Industry Coverage and Adjustment") (Exhibit F-5). If we compare the productivity of the largest U.S. category, TVs, the gap between the U.S. and Japan increases to 31 percentage points (Exhibit F-6).

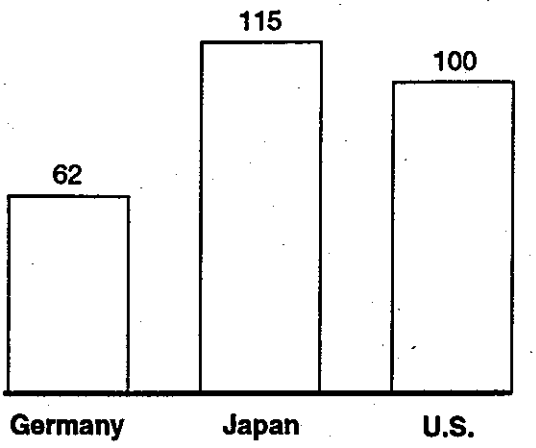
In the aggregate, productivity in Japan surpassed productivity in the U.S. and increased the gap with Germany between 1987 to 1990. The annual growth rate of productivity in Japan between 1987 and 1990 was 15.0 percent compared to 6.1 percent in the U.S. and 6.9 percent in Germany (Exhibit F-7).

Exhibit F - 5

CONSUMER ELECTRONICS LABOR PRODUCTIVITY 1990

VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED

Index: U.S. = 100



* Japanese comparison with the U.S. includes all establishments; German comparison based on firms with >20 employees

Source: Census of Manufactures; McKinsey analysis

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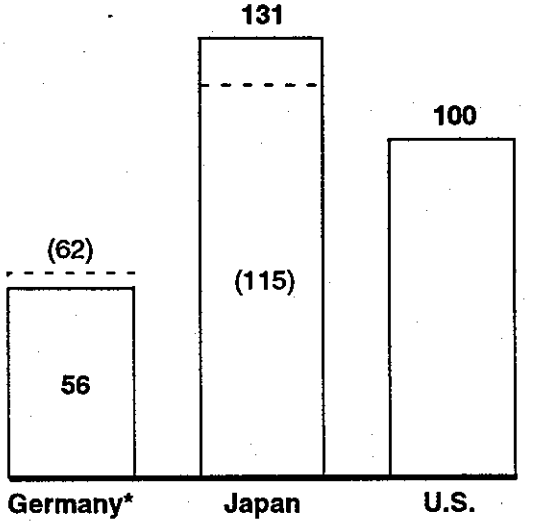
Exhibit F - 6

LABOR PRODUCTIVITY OF SIMILAR PRODUCTS – TV

( ) Overall consumer electronics industry

VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED

Index: U.S. = 100



* German data is from *Excellence in Electronics* survey without double deflation adjustment

Source: Census of Manufactures; *Excellence in Electronics* Survey

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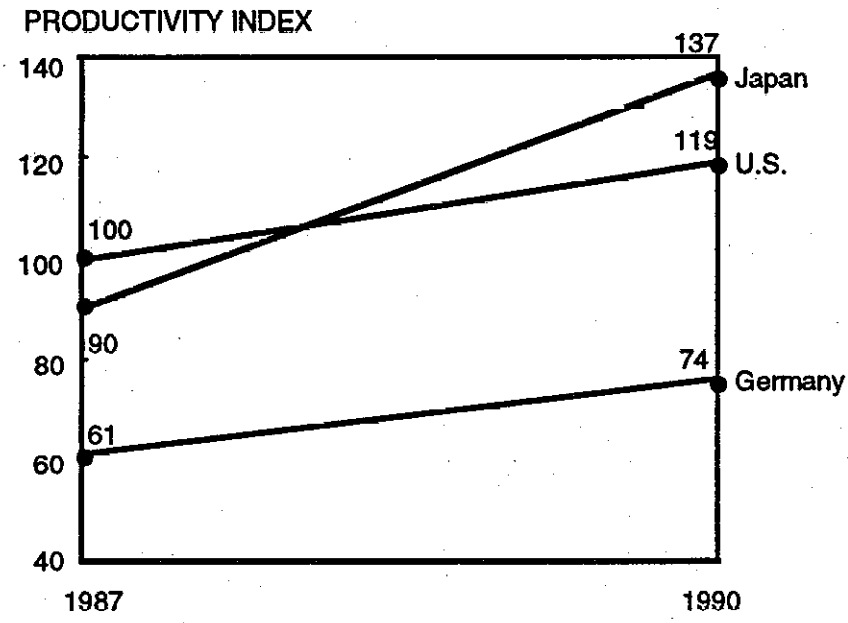
Exhibit F - 7

REAL LABOR PRODUCTIVITY CHANGE IN THE CONSUMER ELECTRONICS INDUSTRY 1987-90

Index: U.S. 1987 = 100



	Real annual productivity change 1987-90
Japan	15.0%
U.S.	6.1
Germany	6.7

Source: Census of Manufactures; McKinsey analysis

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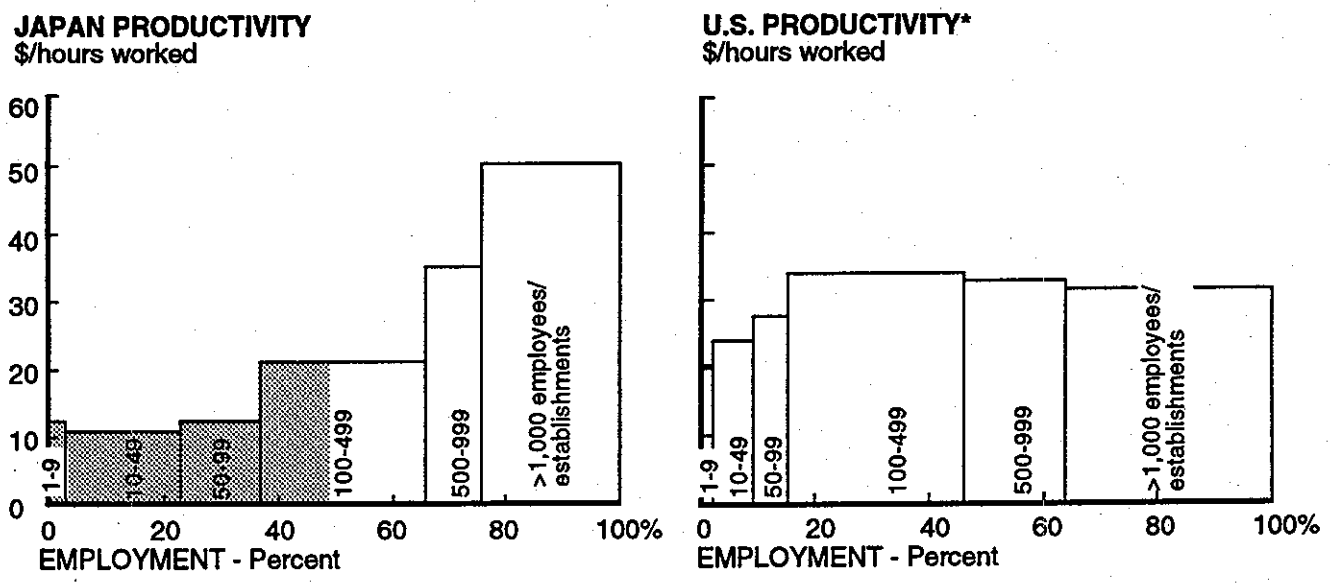
Exhibit F - 8

JAPANESE DUAL ECONOMY 1987

CONSUMER ELECTRONICS INDUSTRY

VALUE ADDED PER HOURS WORKED

Parts and component manufacturers included



* No parts manufacturers in the U.S.

Source: Census of Manufactures

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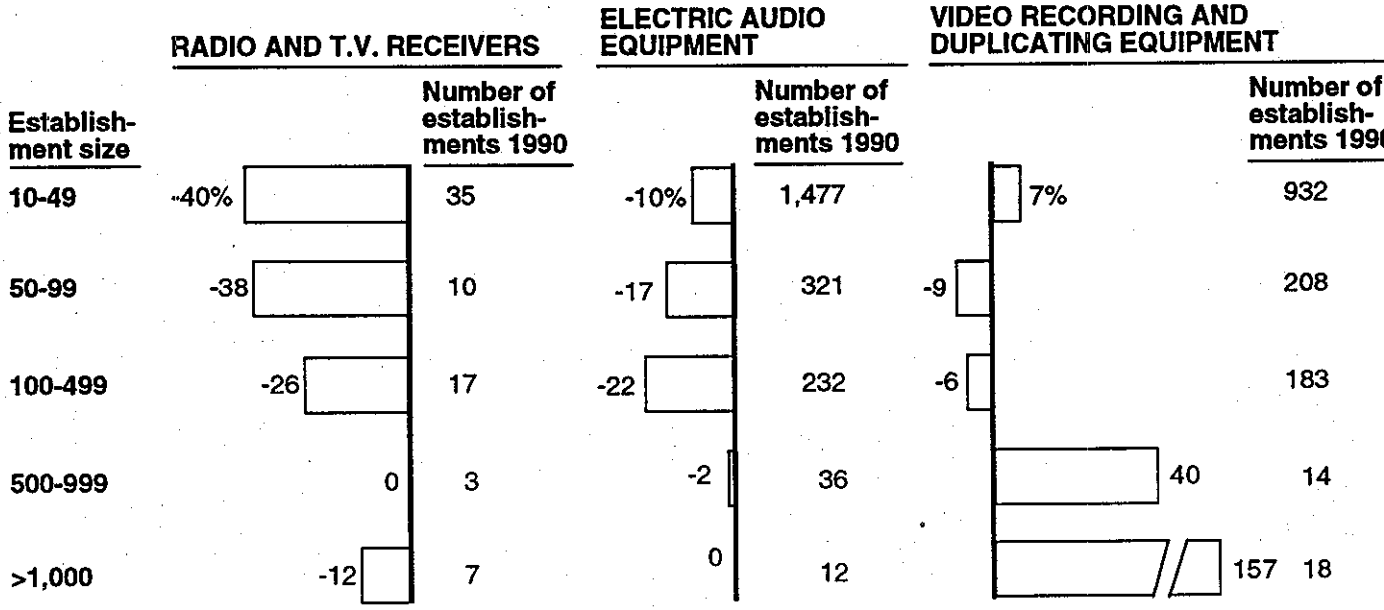
Exhibit F - 9

GROWTH BY ESTABLISHMENT SIZE

JAPAN

Percent 1987-90 growth number of establishments



Source: Census of Manufactures; McKinsey analysis

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The high productivity growth in Japan stems mainly from two factors. First, physical output has increased in Japan; productivity increases are often associated with increases in demand. Second, employment in the industry in Japan has decreased, primarily in the smaller, less-productive establishments which saw their production shift to Asia and elsewhere. This case is only one of our nine case studies in which the decline in employment in Japan between 1987 to 1990 was more than that in Europe and the U.S.

Productivity by Size of Establishment

We found very interesting results when comparing productivity figures by size of establishment. As Exhibit F-8 shows, in the U.S., establishments do not become more productive on average as the number of employees increases above 100. In Japan, by contrast, plants with more than 1,000 employees are much more productive than smaller establishments. The distribution of productivity is completely different in the two countries.

There are explanations for this big difference in productivity in Japan. In Japan, large establishments tend to focus on finished goods and key components production, while small establishments manufacture semifinished components or parts, and supply them to larger establishments. In addition, large establishments are often fully automated and rationalized in their production process, while smaller establishments have more labor intensive processes. It is, therefore, not surprising that smaller establishments pay lower wages.

Since smaller companies have lower costs and more flexible organizations, large establishments sometimes use them as production capacity buffers and subcontract out a part of their final assembly production when they have excess demand. At the same time, large corporations spend a large percentage of their budgets on R&D and transfer new production technologies to smaller suppliers, who usually do not invest much in R&D. This high R&D value added is captured in large corporations through lower input costs and better capacity utilization.

After the Plaza Accord of 1985 and the rapid yen appreciation which followed, the number of small- and medium-sized consumer electronics companies in Japan decreased significantly, increasing the average productivity of the consumer electronics industry in Japan (Exhibit F-9). Some of these companies shifted their production to other industries or changed production location. Furthermore, large companies began sourcing components from suppliers in Southeast Asia, and the remaining smaller companies provided only buffer production of parts. Some of the small companies changed their business from parts manufacturing for consumer electronics to supplying other growing industries such as the automotive or computer industry.

Exhibit F - 10

CAUSES OF PRODUCTIVITY DIFFERENCES 1990

CONSUMER ELECTRONICS INDUSTRY

External factors	Industry structure and behavior	Production process	Labor productivity
EC trade protection and subsidies allow unproductive companies to survive, but the industry in Germany is restructured by other European based companies The exchange rate change is forcing unproductive Japanese companies to shift to Asia VRAs and local content regulations in the U.S. led to the establishments of transplants	**Germany:** EC level protection allow higher consumer electronics prices **Japan:** Very high competitive intensity in quality, variety, and prices **U.S.:** Industry has been restructured by transplants and by a shift of chassis production to Mexico	Superior product design in Japan Better organization of functions and tasks Shorter product life cycle in Japan Specialization of production in Japan in some technology intensive products (e.g., LCD TV, video camera)	Large productivity gap between Japan and Germany - Germany = 62% - Japan = 115% - U.S. = 100%

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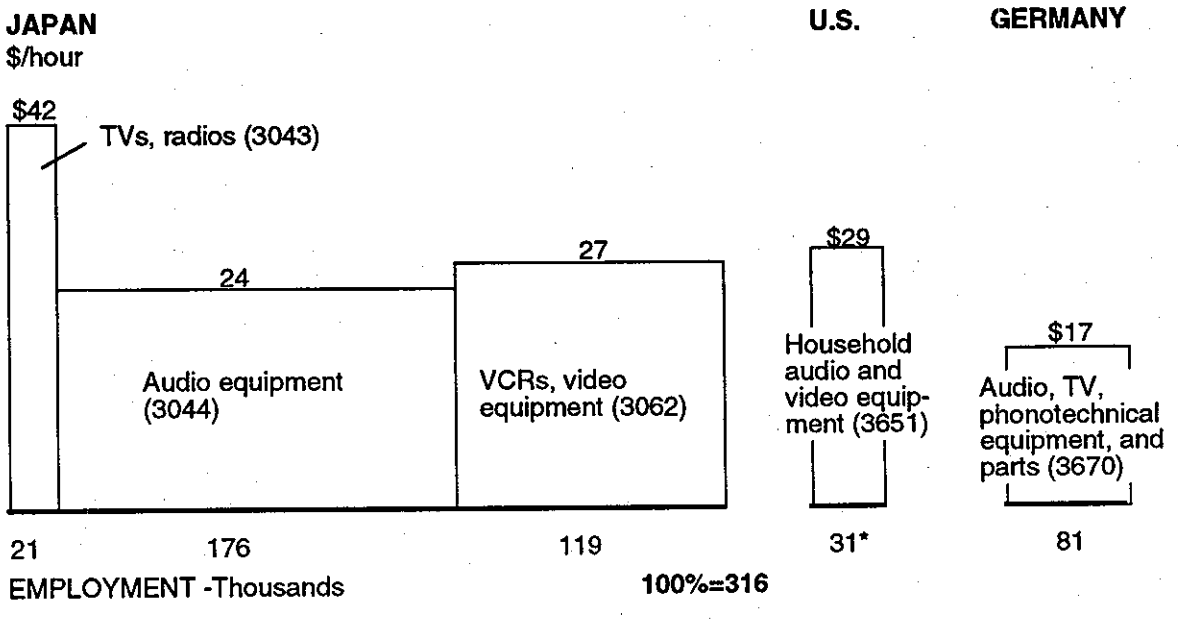
Exhibit F - 11

INDUSTRY MIX SIGNIFICANTLY INFLUENCES PRODUCTIVITY 1987

VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED



* TV: 48%; Others: 52%

Source: Census of Manufactures; McKinsey analysis

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CAUSES OF PRODUCTIVITY DIFFERENCES

Summary

Since the U.S. consumer electronics industry today mainly consists of transplants from Japan and Europe, we will first focus on the causes of the differences between Germany and Japan. Then, we will discuss the different industry dynamics in the U.S. and Japan.

COMPARISON OF OPERATIONS IN GERMANY AND JAPAN

Exhibit F-10 summarizes our view on the causes of productivity differences among the consumer electronics industries. In the production process level, the most important causalities come from differences in design for manufacturing and organization of functions and tasks. In Japan, the appreciation of the yen forced unproductive Japanese parts suppliers out of the country, often into other parts of Asia. In Europe, the trade protection and subsidies of the European Community allowed less productive companies to survive. At the same time, companies in Germany are being restructured by other European companies, as the European consumer electronics industry continues to consolidate.

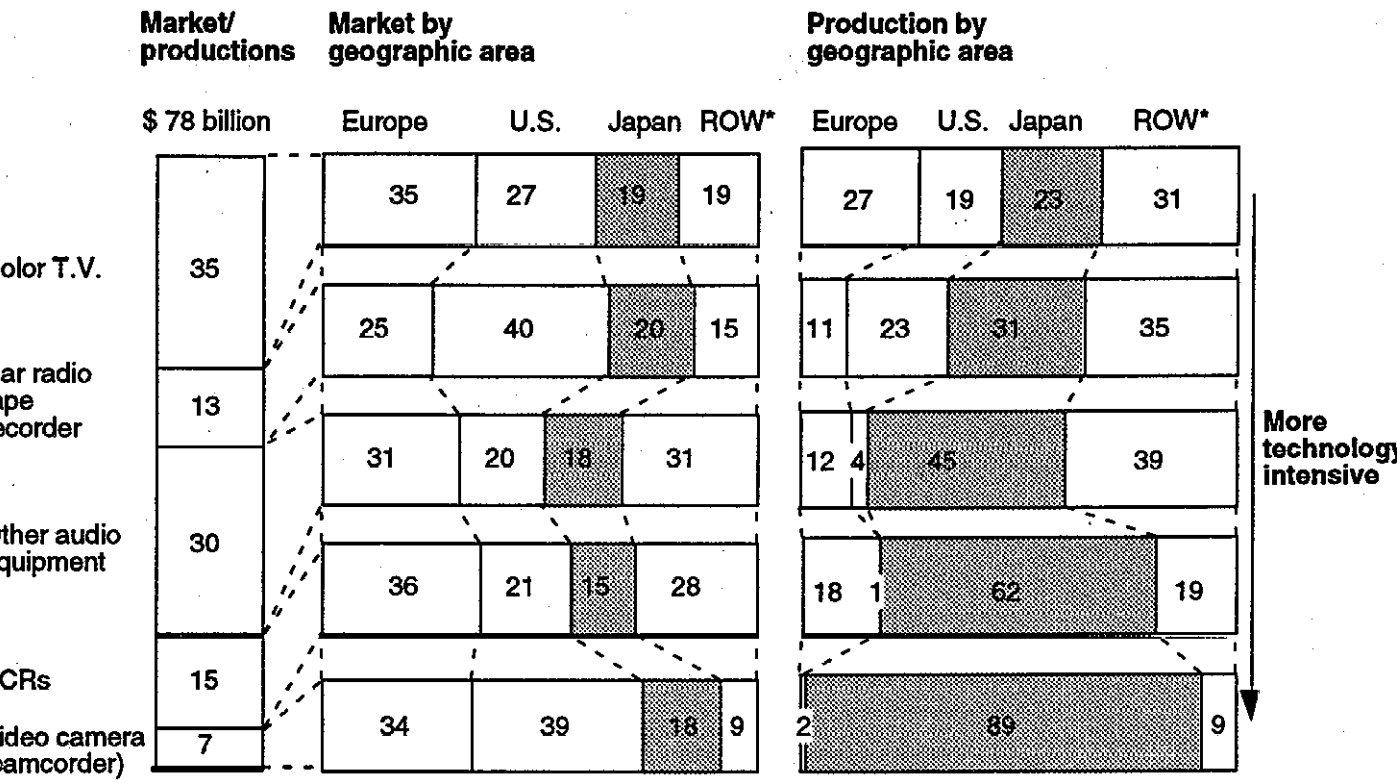
¶ The influence of national product mix on productivity. Product mix has significant influences in each region. In Germany, TVs and radios account for 30 percent of the industry in terms of employment, but in Japan they account for less than 10 percent of total consumer electronics employment. Sixty percent of all VCRs are made in Japan, while European production is small and is performed mostly in joint ventures with Japanese companies. In general, the value added per hours worked of VCRs is less than two-thirds that of TVs, and as such, a higher portion of VCRs in Japan reduces the overall productivity of the consumer electronics industry in Japan. Audio equipment, which is also low in productivity, has a relatively large share in Japan (Exhibit F-11). If we were to limit the comparison to products produced in all three markets (primarily TVs), productivity in Japan would be much higher, and the gap between the U.S. and Japan would increase by a factor of two.

Another difference in product mix is reflected in Japanese specialization of new products. Companies operating in Japan have a higher share in technology-intensive new products. Worldwide, Japan's share of production is 23 percent for TVs, 31 percent for car radios and tape recorders, 45 percent for other audio equipment, 62 percent for VCRs, and 89 percent for video cameras (Exhibit F-12). Furthermore, liquid crystal display (LCD) monitors and TVs were still only made in Japan in 1990. Although counter-intuitive, this result often works against Japan in terms of productivity. VCRs and video cameras, which are usually considered to

xhibit F - 12

IARKET SIZE AND PRODUCTION BY LOCATION 1990

ercent



Rest of the world

ource: Electronics International Corporation

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Exhibit F - 13

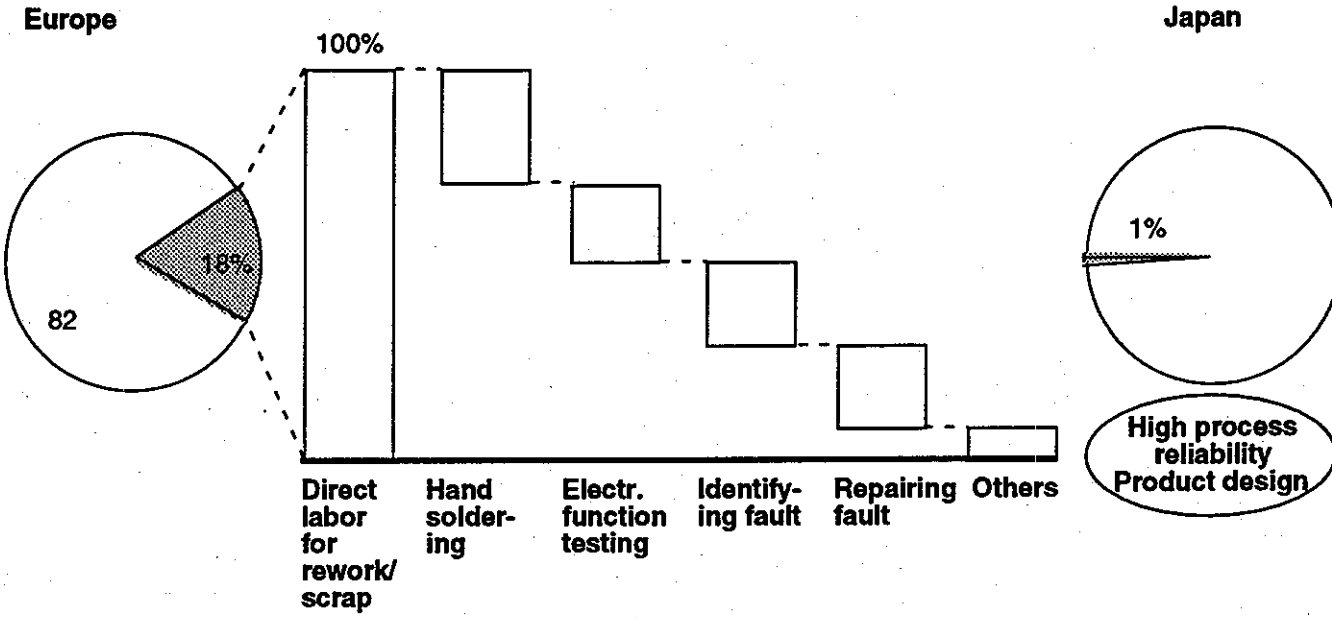
ORGANIZATION OF FUNCTION AND TASKS: DIFFERENCES IN REWORK AND SCRAP

SHARE OF DIRECT LABOR HOURS AND PROCESSES

Total production hours = 100%*

EXAMPLE

Rework and scra



* Percent of hours in different functions for rework/scrap

Source: McKinsey analysis

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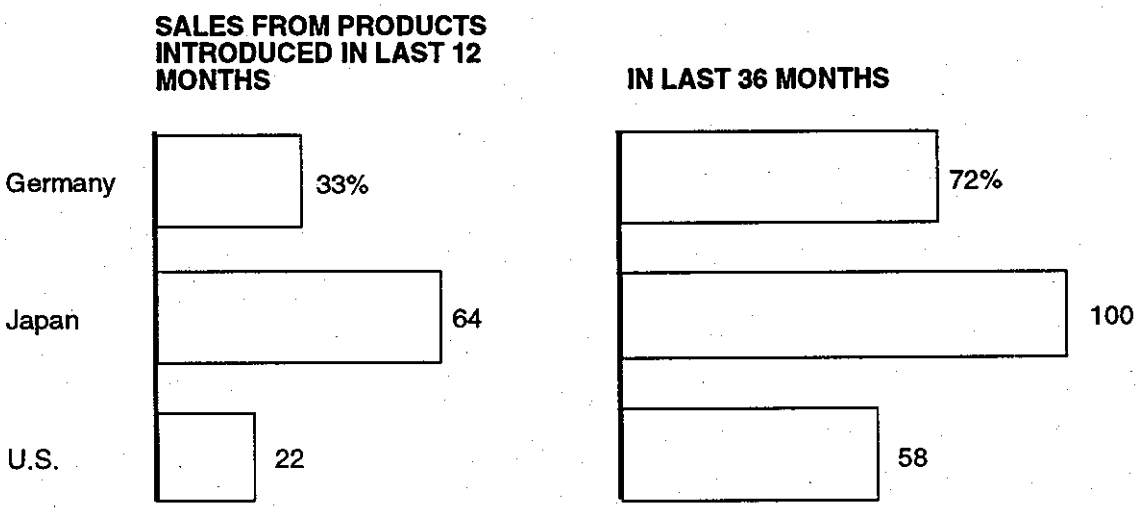
Exhibit F - 14

PRODUCT LIFE CYCLE

Percent



Source: *Excellence in Electronics* Survey

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be technology-intensive, high value-added products, turn out not to be on a per hour worked basis. This concentration on low-productivity products lowers the industry productivity of Japan on average and decreases the productivity gap with the other two regions.

Causality at the Production Process Level

¶ Design for manufacturing as a causal factor. One of the main causes for the productivity differences is design for manufacturing. The designs of products manufactured in Japan are superior in two ways. One is a superior design-to-cost process, which reduces the inputs and assembly processes required by using simpler structures and components. This result is mainly achieved through parts standardization across products. Standardization increases the simplicity of products, commonality of parts, and minimizes the creation of unused features. It also reduces the manpower required in the testing process. In addition, recent models are designed to fit customers' needs. This design eliminated functions which customers did not value and made the product less complex than competing products from other countries.

The other superior aspect of designs in Japan is their manufacturability, which results in significantly less rework and scrapping. These manufacturing-oriented designs reduce labor inputs by as much as 17 percent (Exhibit F-13). Although hard to describe, these innovations are usually an accumulation of improvements on the product development side, with close feedback from those involved in production. This advantage in design for manufacturing is dependent on better organization of functions and tasks by the product development and process engineers.

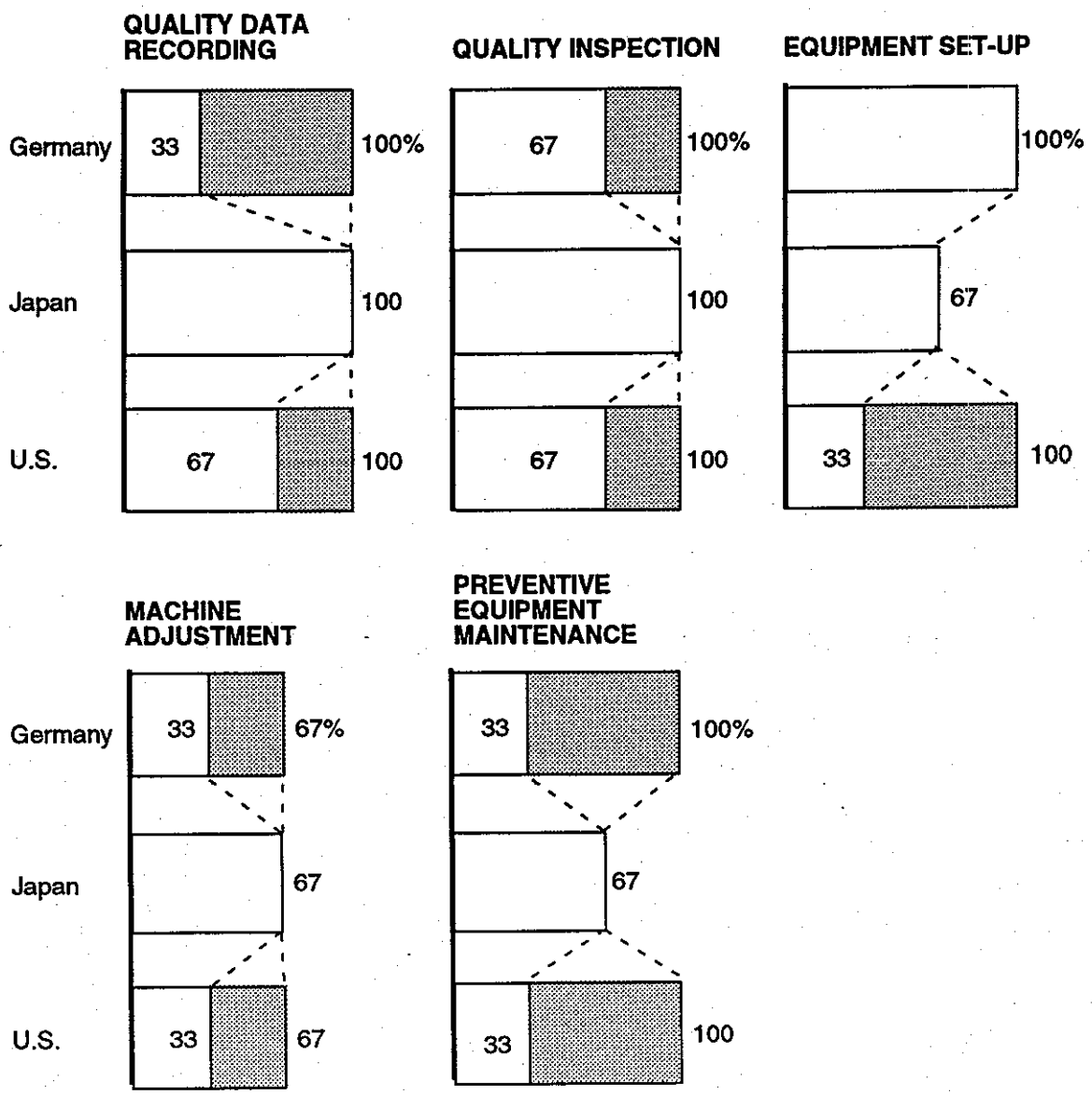
¶ Product redesign as a causal factor (product life cycle). McKinsey's detailed "Excellence in Electronics"survey of 103 world electronics companies revealed that the life cycle of products made by companies in Japan was two-thirds that of companies in Germany. Moreover, the share of corporate sales from products introduced in the last 12 months was 64 percent in Japan and only 33 percent in Germany (Exhibit F-14). Companies in Japan release new products more frequently, and sales from these products are much higher than those of their German counterparts. Companies that release new products earlier than competitors gain higher value added since the product prices start out high but drop quickly. Time is an essential factor for success in this industry and companies in Japan have done a better job at managing it. We suspect this might provide higher value added for productivity in Japan.

Exhibit F - 15

ORGANIZATION OF FUNCTION AND TASKS: PRODUCTION LINE EMPLOYEE RESPONSIBILITY

CONSUMER ELECTRONICS INDUSTRY

Percentage of companies



Source: *Excellence in Electronics* Survey

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¶ Organization of functions and tasks as a causal factor. One of the typical examples of the Japanese production system is the delegation of responsibilities to production line workers (front-line empowerment). As Exhibit F-15 shows, one interesting result is that the delegation of responsibility was different in 1988, but is now converging among consumer electronics companies in the Triad. Front-line empowerment, which used to be perceived as a Japanese production feature, is now being applied to production processes in other regions. As a result, this particular advantage of Japan is being lost as workers' responsibilities become similar among Triad manufacturers. The survey also shows that more productive companies delegate more responsibility to workers. They also use a team approach and frequent job rotations to increase cooperation and communication among divisions, and to break down organizational barriers. In Germany, product developers and assembly line engineers are more segregated, and the status of researchers and product designers are clearly higher than that of line engineers. The regular rotation and more frequent interaction between R&D and line engineers found in companies in Japan produce better designs for manufacturing.

¶ Less important causal factors

- Machinery and equipment (technology). Two different types of technology influence the observed productivity levels. One is standard production process technologies, like PCB mounting. According to the McKinsey "Excellence in Electronics" survey, the timing of introduction of surface mounting technology (SMT) is converging, and companies in the Triad are using the same generation of technologies to manufacture their products. These globally available technologies are increasingly becoming non-differentiating factors in explaining the productivity differences.

  The other type of technology which differentiates companies from their competitors is the core product, or core process, technology which is integrated into company operations. For example, the Japanese manufacturer, Sharp, is on the leading edge of LCD design and production. When Sharp released its new video camera with a color LCD monitor screen, no competitor could produce an equivalent product for at least a year. This kind of technology can differentiate a company from its competitors and result in higher value added. Sony, for instance, has a clear advantage in laser pickups and high density mount and precision deck mechanism technology used for PCB mounting. These technologies result in its dominant market share of the portable CD player market. These company-based advantages can raise the productivity of the entire region in which the companies operate. Technology is one of the reasons why the consumer

electronics industry in Japan has a higher productivity. However, these technologically differentiated products such as LCD-TVs, video cameras with LCD monitors, and portable CD players, are still a small part of total consumer electronics production. For example, LCD TVs account for only 12 percent of the all TV units produced in Japan and 3 percent of Japanese TV production value, and they were only produced in Japan in 1990. Portable CD players constituted 11 percent of total CD player production value in 1990 in Japan, and less than 1 percent of total world consumer electronics production in terms of value. Although technology may affect the industry more in the future, the current impact on productivity is relatively low.

External Factors and Industry Behavior

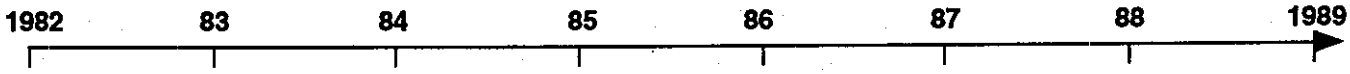
The consumer electronics industry has been through a dynamic restructuring in each region. In Japan, less-productive, small- to medium-sized parts and components manufacturers shifted to Asia or went out of business because of the rapid yen appreciation after 1986. This change raised the productivity of the industry on average. In Germany, protection at the EC level has kept consumer electronics prices high, and allowed relatively unproductive companies to survive. Within the EC, however, the consumer electronics industry in Germany has been forced to restructure by pressures from other companies in Europe (e.g., Thomson and Philips).

- ¶ The nature of competition. Today eight of the world's ten largest consumer electronics companies are headquartered in Japan and control 75 percent of world production: Matsushita, Sony, Hitachi, Toshiba, Sanyo, JVC, Sharp, and Mitsubishi. The competitive intensity in the Japanese market is probably the highest among the three regions, and is now spilling over to the rest of the world as companies in Japan invest overseas. Today, these transplant operations are spreading competitive intensity as well as high productivity around the world. Companies in some countries, rather than facing this threat, are seeking market protection against competition from Japan.

- ¶ Regulations (VRAs, non-tariff barriers). In Germany, consumer electronics companies have gone through a transition. Since the 1970s, the German consumer electronics market, in accordance with European Community regulations, has been protected by tariffs. In the 1980s, European manufacturers delayed the development of VCRs, and imports from Japan rushed into the European market. In 1982, the French government suddenly routed all VCR imports through Poitiers, an obscure custom post, to get the Japanese-owned companies to agree on "export moderation" to the EC as a whole, and to reduce the balance-of-payment deficit in France. Since 1983, there has been a VRA on Japanese VCR exports to the EC. In response, the Japanese-owned manufacturers

Exhibit F - 16

EUROPEAN MARKET PROTECTION – VCR



Dumping suit against Japanese import:

5,160,000 in 1982

Export modulation by Japan

Agreement in 1983
- Abolish French tariff on VCR
- Close dumping file
- Voluntary export restraints: 4,550,000
- Setting minimum export prices

Agreement in 1984
- Limit Japanese export to EC: 3,950,000 including transplant production unless
  - High local content in early 1983
  - Increase local content continuously

Agreement in 1985
- Same as 1984 agreement
- VER: 2,250,000
- Kept minimum export prices

Trade monitoring

Japanese export monitoring
- Monitor quantity and price of specific model of VCRs
- Any problems, MITI and EC committee resolve the issue with conditional treatment

Dumping suit against all Korean and two Japanese manufacturers by EACEM
- 25.2 - 39.2% dumping tax on Korean imports
- 18% dumping tax on Japanese imports

Dumping tax was removed with 10-22% voluntary price increase filed by VCR makers

Joint Ventures:
- J2T holdings (in Germany -1982): JV with Thomson and JVC
- MB Video (in Germany -1982): JV with Bosch and Matsushita

Asia
- International Video Products, Singapore: JV with Thomson and Toshiba
- Philips JVC Video Manufacturing, Malaysia 1991: JV with Philips and JVC

Source: Electronics Industry Almanac

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have built transplants or engaged in joint ventures in Europe (e.g., Sony Wega, J2T Holding, MB Video in Germany) (Exhibit F-16).

The TV industry in Germany has been protected from Japanese imports by EC tariffs and trade regulations. However, with the integration of the European Community, the consumer electronics industry in Germany was restructured by other European companies, namely Thomson and Philips. German companies such as Saba, Nordmende, Dual, and Telefunken were acquired by Thomson, while Grundig is now 31.6 percent owned and controlled by Philips. This restructuring may have helped manufacturers in Germany raise their productivity levels to those of Thomson or Philips, but the continued lack of full exposure to competition from Japan has left Germany behind Japan and the U.S.

¶ Less important factors

- Demand factors. Product demand differs in some respects across regions. For example, the U.S. and German customers tend to watch TVs in relatively darker rooms while Japanese customers watch TVs in bright rooms. These different viewing habits require different resolution levels in the cathode ray tube. In addition, Japanese customers tend to buy multifunctional TVs with broadcasting satellite tuners or "picture in picture," (i.e., a small screen appears within the regular screen). Although this difference in taste might be the result of marketing in Japan, consumer demand in Japan is such that TVs for the Japanese market are required to have higher performance capabilities. The impact of performance differences on productivity is small and manageable for manufacturers operating in Japan. However, for companies based in the U.S. or Europe trying to enter the Japanese market, these requirements may become a problem, especially when combined with other barriers. We find the same Japanese demand for high quality in other products, such as portable cassette players (for compactness and function), and VCRs (for more functional reservation systems) simply because of consumers' preference to purchase new technical gadgets. These higher performance requirements in Japan have partly prevented the entry of non-Japanese foreign direct investment, and the more sophisticated demand requirements have meant that new product and market developments are taking place primarily in Japan.

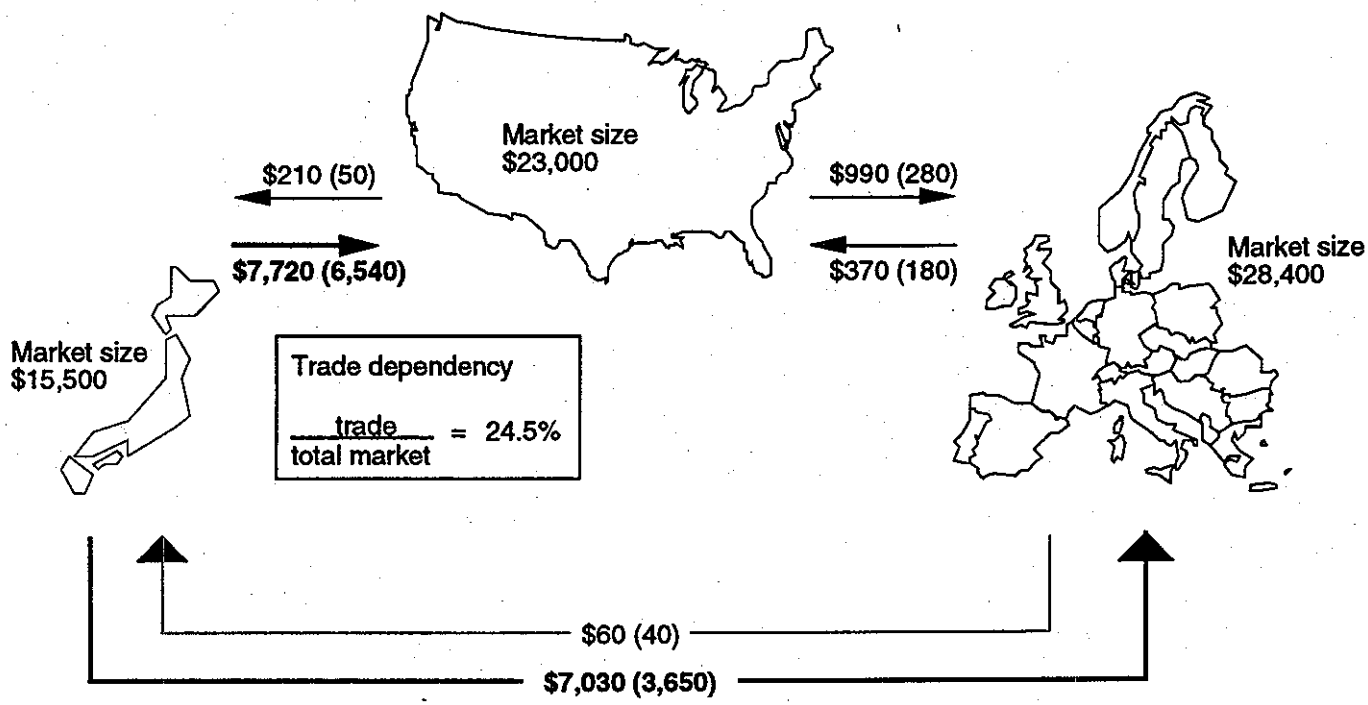
- Labor rules and unionism. The consumer electronics industry has seasonal demand volatility. In Germany and the U.S., the demand for consumer electronics goods reaches its peak in December, especially around Christmas. In Japan, it is April, June and December. People move to new locations in April as the school year begins. In addition, Japanese workers receive a biannual bonus in June and December,

Exhibit F - 17

TRADE IN CONSUMER ELECTRONICS

1990 (1984)

$ Millions



Source: Electronics International Corporation

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which stimulates durable goods consumption. Therefore, consumer electronics companies in Germany and the U.S. maximize their production prior to one peak period while companies in Japan have peak demand periods spread more evenly throughout the year. Companies in the U.S. hire seasonal workers and adjust production capacity to meet this demand volatility, but companies in Germany have less flexibility to adjust the number of workers because of strict union rules. This inflexibility obviously hurts companies in Germany.

COMPARISON OF OPERATIONS IN JAPAN AND THE U.S.

When we compare the consumer electronics industries in the U.S. and Japan, we need to limit the scope of our industry to televisions, because this is the only substantial product category made in the U.S. In addition, we need to understand the transition that companies originating in the U.S. have gone through in their manufacturing of TVs since the 1970s. For example, over 90 percent of U.S. television production is now manufactured by companies originating outside of the U.S, largely from Japan and from Europe. In this discussion of causality, therefore, we will focus on why the U.S. consumer electronics industry is so small, and on why its productivity is so high compared to Japan.

¶ Influence of product mix. The impact of product mix is much more significant in the case of the U.S.-Japan comparison. In the U.S., TVs and radios account for 50 percent of the industry in terms of employment, as opposed to 10 percent in Japan. There is no production of VCRs in the U.S. This situation may imply two things: TV manufacturing may remain in the U.S. because it is highly productive, and trade protection (e.g., VRAs) may also make the relative productivity of this product higher by causing transplant operations to be built in the U.S.

In addition, TV manufacturers in the U.S. shifted some of their labor-intensive production to Mexico (e.g., chassis manufacturing) while final assembly and high-productivity activities have remained in the U.S. This shift has raised the average productivity of television manufacturing performed in the U.S.

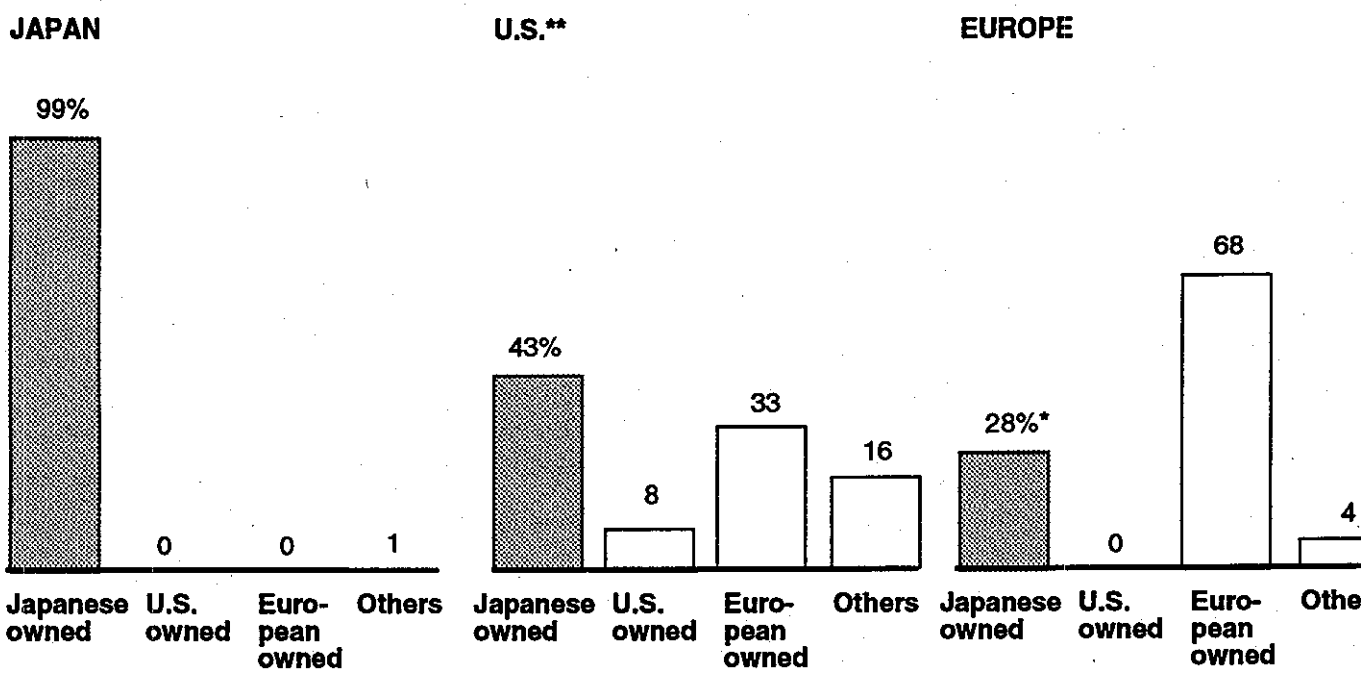
Causality at the Production Process Level

¶ Company mix and productivity. The consumer electronics industry is, in fact, one of the most globalized industries in our study, with about 25 percent of the Triad market being served through inter-Triad trade (Exhibit F-17). It is also mostly made up of transplant operations from Japan and Europe, in part due to the existence of VRAs. Fully 43 percent

Exhibit F - 18

ORIGINS OF CONSUMER ELECTRONICS PRODUCTION 1990

Percent



* In Germany, probably less than 28%

** Only TV manufacturing

Source: Electronics International Corporation; McKinsey analysis

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of television production in the U.S. is manufactured by companies originating in Japan, and another 33 percent is made by companies originating in Europe. Companies based in the U.S. serve only 8 percent of the U.S. market (Exhibit F-18). In TV production, for example, Zenith is the only U.S.-based company remaining. Average U.S. productivity therefore measures the productivity of a mix of Japanese, European, and the U.S.-owned companies, where the high share of more productive Japanese transplant contributes to higher overall productivity.

Historical Industry Behavior and Nature of Competition

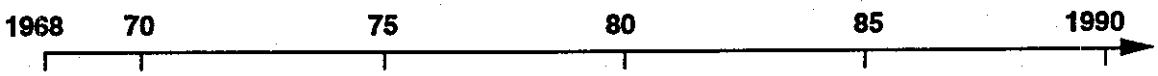
¶ Historical background of the consumer electronics industry in the U.S. Japanese exports to the U.S. market started with the transistor radio in the 1950s, followed by TVs in the 1960s. Manufacturers in the U.S. were especially hurt by lower-priced TVs from Japan. In 1968, the U.S. Electronics Industrial Association charged 11 Japanese-owned companies with dumping, and in 1969 and 1971, Zenith and Magnavox filed a request for a unitary tax against Japan. Those two suits were dismissed in 1978, but a series of additional lawsuits filed against Japanese manufacturers (e.g., antitrust damage claims and escape clause applications) led Japanese-based companies to agree to voluntary restraint agreements (VRAs) and orderly market agreements (OMAs) which included local content requirements for transplants. When implemented, these restricted the number of Japanese TV shipments to the U.S. to 1,750,000 units (Exhibit F-19).

By the mid-1970s, most of the Japanese-owned manufacturers had been exporting over 1 million TV units each per year, which was the minimum TV production needed for critical scale. The increasing trade friction between the U.S. and Japan, and the resulting VRAs encouraged Japanese-based manufacturers to directly invest in TV manufacturing in the U.S. Sony started TV production in the U.S. in 1972, Matsushita acquired Quasar in 1974, and Sanyo acquired Worwick in 1977. Toshiba and Mitsubishi entered the U.S. production in 1978, as did Hitachi and Sharp in 1979. Today, 43 percent of U.S. television production is made in the transplants of companies originating in Japan (Exhibit F-20). The Japanese transplants brought higher productivity to the U.S. The original TV manufacturers in the U.S. decided to divest themselves of their TV production and sold it to non-U.S. based companies. For example, RCA and GE brands are now owned by Thomson, and Magnavox and Philco have been taken over by Philips. The only original TV producer that is still in operation today is Zenith, and it has already shifted its core component production to Mexico.

In the 1980s, most of the TV manufacturers in the U.S. including transplants shifted their component production to Mexico. Average

Exhibit F - 19

U.S./JAPAN COLOR T.V. TRADE RELATIONS



- 1968 EIA – 11 Japanese mfgrs. dumping charge
  - 1969 Zenith claimed: Unitary Tax
    - 1971 Magnavox claimed: Unitary Tax
  - 1969 NUE, New Jersey Fed Court Antitrust damage claim $360 million

1978 discharged

1979 discharged (Philadelphia court)

Merged

- 1974 Zenith Philadelphia Federal Court antitrust damage claim $900 million
  - 1975 GTE Sylvania, Philco ITC Unfair import
  - 1975 COMPACT* ITC Escape clause application
    - 1977 Japanese VRA started 1,750 thousand units export per year: OMA**

U.S. manufacturers strategy

- Establish VRA for Japanese, Korean Taiwanese T.V. manufacturers
- U.S. manufacturer shift production to Mexico
- Japanese trans-plants in the U.S. have local content constraints (50% sourcing from U.S.

* COMPACT (Committee to Preserve American Color Television)

** OMA (Orderly Market Agreement, including 50% local content value-added restrictions)

Source: Long Term Credit Bank Report

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Exhibit F - 20

ORIGINS OF COLOR TV COMPANIES IN THE U.S.

1975 AND 1987

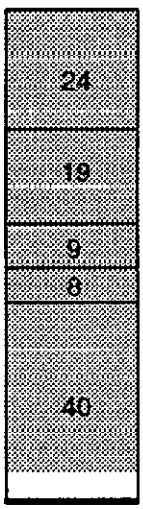
Percent

▨ Inside the U.S.
□ Outside the U.S.

U.S. PRODUCTION SHARE OF COLOR TV

1975

100% = 5 million units

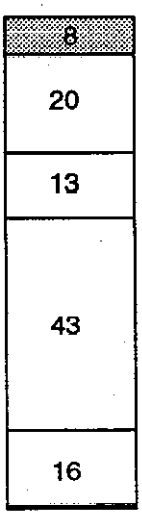


Lack of critical mass production (1 million)

- Zenith
- RCA
- GE
- Quasar
- Others
  - Philco
  - Magnavox
  - Worwick
  - Sony
  - Admiral
  - National Union Electric Corporation

1987

100% = 13 million units*



- Zenith
- RCA-Thomson
- Philips (Magnavox)
- Japanese manufacturers Sharp 7, Matsushita 7, Sanyo 7, Sony 7, Toshiba 6, Mitsubishi 5, JVC 3, Hitachi 2
- Others (e.g.,Samsung, Goldstar, Harvey Industry, Daewoo)

MAJOR EVENTS IN U.S. COLOR TV INDUSTRY

- Shifted module and chassis assembly to Mexico and shipping semi-finished TVs to U.S.
- Acquired by Thomson (France) 1987
- Acquired by Thomson (France) 1988
- Acquired by Matsushita (Japan) 1974
- Acquired by Philips (Netherlands) 1981
- Acquired by Philips (Netherlands) 1974
- Acquired by Sanyo (Japan) 1976
- Expanded San Diego factory to Tijuana, Mexico 1987
- Acquired by Rockwell 1974
- Acquired by Electrolux (Sweden) 1974

* U.S.-produced sets only (excluded Mexico-made TVs)

Source: Long-Term Credit Bank Report; EIA; McKinsey estimates

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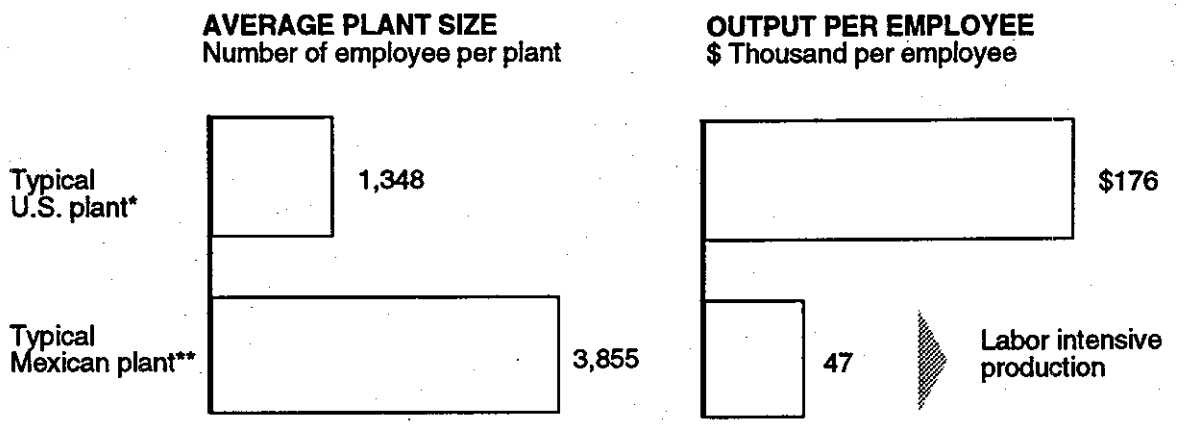
Exhibit F - 21

PLANT SIZE AND OUTPUT IN U.S. AND MEXICO 1991



* Based on a sample of six factories
** Based on a sample of four factories
Source: *Excellence in Electronics* Survey

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employment in plants located in Mexico is three times higher than plants in the U.S. However, labor productivity as measured by production output per employee is almost four times lower (Exhibit F-21). In other words, jobs in the U.S. consumer electronics industry have shifted to Mexico, more so than to Japan or Europe. Japanese and European transplants in the U.S. also have taken advantage of labor and other factor cost differentials through the vertical disintegration of the production processes. This shift of the low productivity parts of TV production to Mexico has been similar to the shift of Japanese part manufacturing to Southeast Asia.

¶ The creative destruction of the consumer electronics industry. The producer price of VCRs in Japan declined sharply after 1985 so as to remain competitive on a dollar basis. The real implication of this decline on VCR productivity is complex, however. While physical productivity increased, the nominal dollar productivity of VCR production in Japan decreased by over 30 percent from 1985 to 1990 as a result of sharp product price decreases (Exhibit F-22). The fierce competition among manufacturers based in Japan commoditized the VCR industry and dragged down the nominal productivity level. The price drop of VCRs has clearly benefited consumers and contributed to huge consumer surpluses. However, it made the entire VCR manufacturing industry less attractive to manufacturers and resulted in a reduction or exit of players in Europe and the U.S. From a financial point of view, the consumer electronics industry in the U.S. is better off by having given up on VCR manufacturing. Also the economy is better off because of the low productivity of this product. The differences in competitive intensity in the TV and VCR segments of this industry underscores the fact that the physical productivity of industries with different product mixes cannot be measured solely by value added per hour worked.

We can observe this commoditization phenomena in other consumer electronics products such as radio cassette recorders and CD players. The fierce competition among companies based in Japan often resulted in sharp price declines (Exhibit F-23), which made the industry unattractive because of the difficulty of earning cost of capital. The real issue was not that companies in Japan were wiping out other competitors, but that they commoditized the industry and increased their physical productivity at the same time. The intense competition brought on by companies in Japan benefited consumers but hurt manufacturers. Europe and the U.S. took different approaches to this "creative destruction." European companies pushed for the market protection now provided by the EC while companies based in the U.S. largely made the decision to exit.

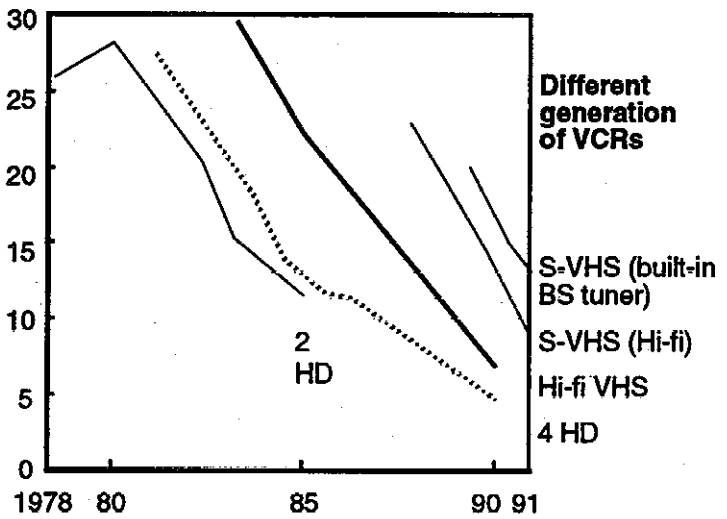
¶ Exit decisions of the U.S.-owned companies. In the U.S., companies are very sensitive to threshold hurdle rates necessary to earn their cost of

Exhibit F - 22

INTENSE COMPETITION AMONG JAPANESE MANUFACTURERS

VCR PRICE TRENDS

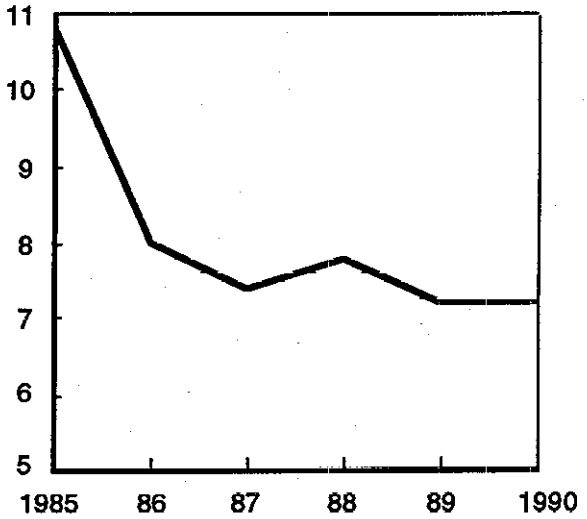
¥ Thousands



NOMINAL PRODUCTIVITY OF JAPANESE VIDEO INDUSTRY (3062)

Value-added per employee

¥ Millions



Producer price index: 1985 = 100	100	83	73	64	58	54

* Operating income after depreciation/sales

Source: Census of Manufactures; annual reports

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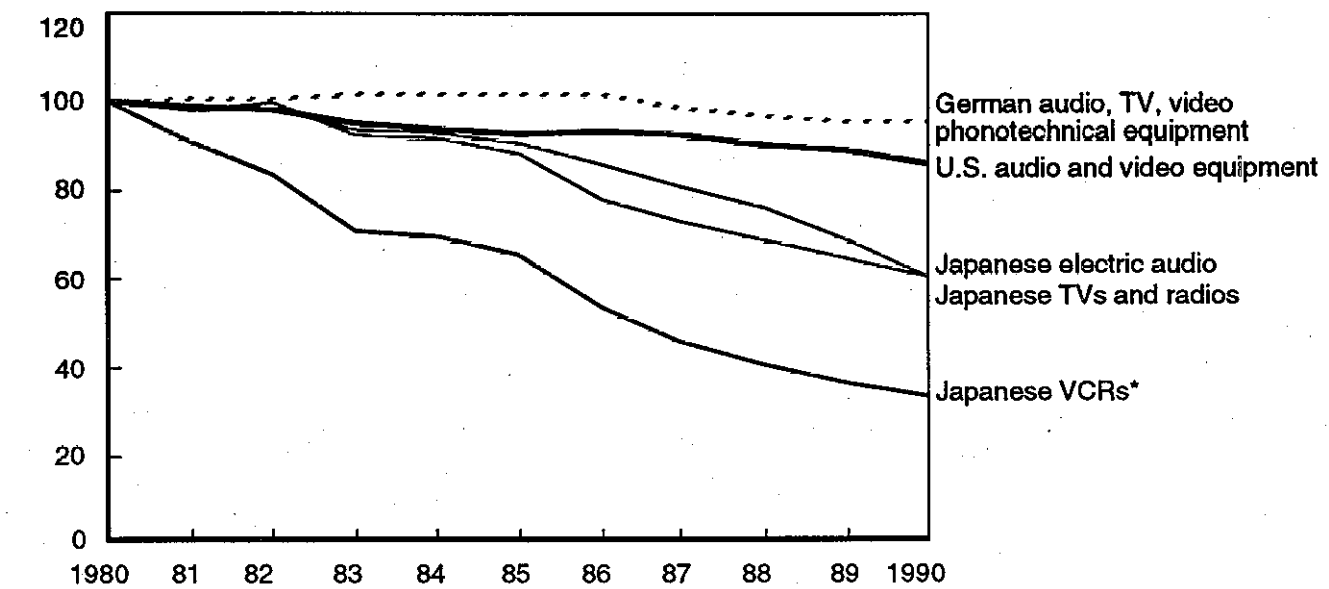
Exhibit F - 23

PRODUCER PRICE INDEX

Index: 1980 = 100



* 1980-85 figures are wholesale price index

Source: Bank of Japan; Department of Commerce; Statistisches Bundesamt

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Exhibit F - 24

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES
CONSUMER ELECTRONICS

● Important
O Secondary
X Undifferentiating

External factors

• Market conditions	
- Demand factors	O
- Relative input prices/factor availability	X
- Other industries	X
• Policy and regulation	
- Macroeconomic conditions	O
- Competition rules and concentration rules	X
- Corporate governance rules	O
- Labor rules and unionism	O
- Other regulations (tariffs, nontariffs)	●

Nature of competition ●

Production process

• Output	
- Mix, variety, quality	X*
• Design of production factors	
- Capital (intensity, vintage, technology)	O
- Scale	X
- Product design	●
- Basic skill of labor, intrinsic motivation	O
- Raw materials, parts	X
• Operations	
- Capacity utilization	O
- Organization of functions and tasks	●

LABOR PRODUCTIVITY

* Influence is high in opposite direction

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capital. Hurdle rates are used as a measure of business performance and as a basis for investment decisions. When competition from Japan made the industry less attractive, companies based in the U.S. stopped investing in new plants and equipment since they could not expect adequate returns from them. In addition, many tried to liquidate existing facilities. Gradually, the traditional players in the U.S. television industry became less productive than well-equipped Japanese plants, and made business decisions to sell their production facilities and exit the industry. They have since shifted their resources to more productive and profitable businesses like communication devices, household appliances, or industrial electronics. Exiting the industry was a rational decision at the firm level. However, the long term impact on the technological position of the U.S. economy is difficult to predict since technologies such as high density packaging, SMT, LCD are used for other industries like mobile communication equipment manufacturing.

¶ Regulations on TVs. The only major product remaining in the consumer electronics industry in the U.S. is the television. This market has been protected through VRAs and Orderly Market Agreement (OMAs) since 1977. At this time, many Japanese and European transplants came into the U.S. and a local content regulation was imposed on these transplant operations to ensure that they source more than 50 percent of their parts and components from U.S.-based suppliers. All of these regulations have slowed down the process of "creative destruction" and have kept some television production in the U.S.

OUTLOOK

We have found substantial productivity differences in 1990 among the three countries, and Exhibit F-24 summarizes the major causal factors. This gap increases if we adjust for product mix differences. The causality at the production process level results from differences in design for manufacturing and the organization of functions and tasks. However, differences in these factors are now being studied by companies in Europe through benchmarking or joint ventures. As such, the differences will be smaller in the future as superior production processes spill over into other regions through transplants and foreign direct investments. In the long run, productivity of similar products will converge in the three countries.

However, product mix differences may increase as companies in Japan increase specialization in newer, technology-intensive products like 8mm video cameras or LCD TVs. Japan is ahead in terms of technology accumulation and faster development of new technologies, especially in miniaturization. For example, video cameras, largely manufactured in Japan, are not based on a single technology but rather require a set of core product and process technologies, including digital signal processing, high density mounting, artificial intelligence, and system interface technologies. These technologies are accumulated through the production of other

products like CD players or "walkmans" (portable cassette recorders). Since companies operating in Japan have been active in manufacturing these related products, they have been able to accumulate the core technologies needed for 8mm video camera manufacturing. It follows then that most video camera production is still done in Japan. This technology density issue can be critical for the future development of new types of products which require a combination of several core technologies, and may prove an advantage to companies based in Japan. One cannot predict the impact of product specialization on the average productivity of the industry, as it is unknown how valuable new products will be to consumers because of technology differentiation and how rapidly intense competition in Japan will drive down prices and nominal productivity.

In Germany, restructuring will continue as foreign direct investment from Japan increases and trade protection is losing its control over competition. The head-to-head competition against the companies from Japan will require companies based in Germany, as well as the rest of Europe, to be even more responsive. To succeed at restructuring, their productivity will have to converge to best-practice levels.

SUMMARY AND POLICY ISSUES

The consumer electronics industry in Japan is continuously being faced with the need to reduce employment, especially among small establishments. Jobs have moved to Southeast Asia, and more will do so given current exchange rates. At the same time, companies based in Japan are shifting commoditized product manufacturing to Southeast Asia, retaining only differentiated products manufacturing in Japan. These all contribute to increase productivity of companies operating in Japan.

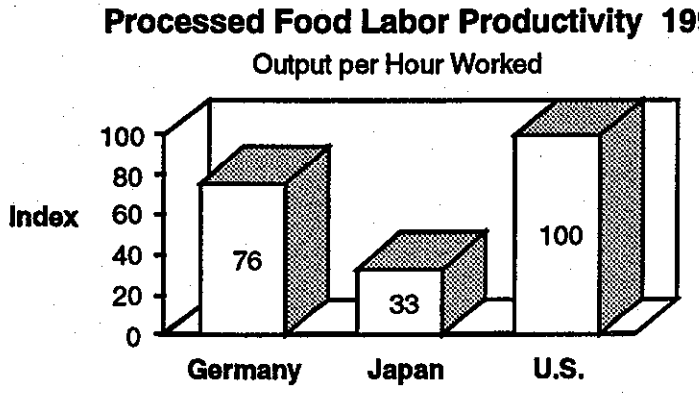
Germany is facing an even more serious problem. Over the last decade, the EC government regulation has provided umbrellas over the German companies, permitting both inefficient domestic companies and labor practices to survive in exchange for higher consumer prices. Japanese transplants in Europe are more productive than German-owned plants, which not only have design deficiencies but also a structural problem in the form of a labor surplus. Companies losing competitiveness are shifting production to Spain or Asia.

The U.S. consumer electronics industry is in a relatively better position, since Japanese transplants are bringing about better production processes. Furthermore, plants in the U.S. have been able to improve productivity by increasing sourcing from Mexico and Asia. Almost all U.S.-originated companies, however, have exited from this low-productivity business and have reallocated resources to other industries. Therefore, we may be able to say the U.S. economy is relatively better off. There might be an argument that the U.S. may shut itself out of an important industry by exiting – consumer electronics will not necessarily always be low productivity, and innovations in consumer electronics may prove vital for other

industry. The European alternative of long-term industry protection, however, would have been very expensive in terms of higher consumer prices, lower domestic productivity, and the diversion of resources from other high tech industries. The return benefits of remaining in the industry are speculative enough, and the present costs of protectionism high enough that the U.S. economy probably benefited in the long term from its exit decision.

The important lesson from this industry is that high competitive intensity is always good for physical productivity. Although Japan protected its infant consumer electronics industry at the cost of higher consumer prices and slower productivity growth in 1950s, the industry has been exposed to global competition since it began competing in export market in the 1960s. In Europe, trade regulation may protect short-term profitability, but in the long run, the productivity gap with the world's leading-edge companies will increase. Protection designed to sustain a so-called "domestic" industry or protect existing jobs is done at the cost of high consumer prices, often much more expensive than the cost associated with the loss of jobs. The consumer electronics industry in Germany is facing a critical choice now. It must either expose itself to global competition, or maintain, to be under the EC protection it has enjoyed in the past. Continued protection will only lead to a vicious circle of weaker performance and further protectionism.

PROCESSED FOOD CASE STUDY SUMMARY



Persistence of craft-based techniques in Japanese food processing has hindered labor productivity. U.S. food industry is highly industrialized. Germany is in transition.

Much of the productivity difference between Germany, Japan, and the U.S. in food processing can be explained by the evolution from **craft-based to industrial-based** production. The adoption of mass production techniques and laborsaving technologies have driven increases in the absolute levels of productivity in the U.S. and Germany. However, this has not been the case in Japan, where the industry employs roughly the same number of workers as the U.S. industry, yet produces just one-third of the output. Furthermore, Japan has over 67,000 food processing establishments, compared to the U.S.'s 21,000. While there are large, modern firms in certain categories in Japan, they do not face competitive pressures from abroad.

The current situation in the Japanese market has been allowed to persist for two basic reasons. On the one hand, **consumer demand for fresh and high-quality products** has helped to keep the industry fragmented, serving primarily local markets. On the other hand, the Japanese industry has been isolated from competition on three fronts. The first is **government regulation.** Tariffs, quotas, content restrictions, and quarantines on imported goods, all help to protect the domestic industry from foreign competition. The **complexities of the distribution system** serve as a second barrier to new entrants. The time and up-front costs associated with establishing a distribution network discourage many from entering the market and thus help to preserve the status quo. In addition to insulation from foreign competitors, Japanese food companies are spared **price pressure from retailers and wholesalers.** In Germany, the top five retailers account for 43 percent of industry sales. In the U.S., the figure stands at 21 percent, but on a market-by-market basis the figure can be as high as 70 percent. By contrast, in Japan the top five retailers account for only 5 percent of sales. The bargaining power of the Japanese retailer is far less than that of its German or U.S. counterpart, and as such, it is less able to squeeze food processors on price. With little price pressure from either retailers or foreign competition, Japanese manufacturers have had little incentive to increase productivity. They remain unproductive and vulnerable to trends of market liberalization and increasing retailer consolidation.

Germany, while closer to the U.S. in terms of consolidation, has a few industries, such as meat and bakery, which more closely resemble their Japanese, rather than their U.S. counterparts. While consumer tastes for fresh and high-quality products are influencing which production methods are chosen, efforts to further consolidate food operations in Germany are expected.

PRODUCTIVITY IN THE PROCESSED FOOD INDUSTRY

Processed food is the largest single consumer goods industry, and as such plays an important role in the health of an economy. In all three countries, it accounts for the largest share of employment in consumer goods manufacturing. Furthermore, processed food covers the largest share of the economy of any of the case studies presented in this report. The importance of the industry is accentuated when one examines the entire food chain, including not only manufacturing but also wholesaling and retailing (Exhibit G-1).

Historically, the food processing industry has been dominated by national and local players. Only in the past 20 years has the face of the industry begun to take on an international look. This switch in the nature of competition has been made possible by a number of factors. Aside from the opening up of international markets and an increase in foreign direct investment, the industry has been helped by changes in production processes which have facilitated consolidation on a larger scale. Specifically, many of the categories in this industry have moved from craft-based to industrial-based production methods. The increase in automation and the adoption of labor saving technologies which accompanied this switch have helped to increase absolute levels of labor productivity, particularly in the U.S. and Europe.

We should not overstate the global nature of the industry, however. While large global players such as Nestlé and Philip Morris have emerged, compared to other industries, processed food is heavily a domestically-based industry. While this situation is changing, a number of forces still compel companies to compete on the level of domestic or even local markets.

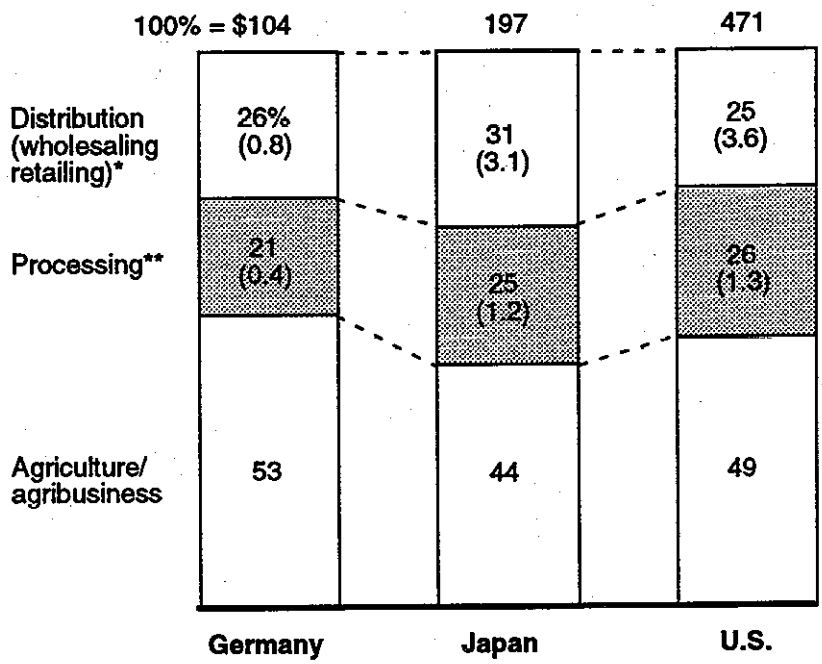
The processed food case study illustrates how differences in consumer demands along with protectionist policies and distribution logistics can impact an industry's productivity by affecting the nature of competition. These factors, along with others, have allowed craft-based techniques to survive in the era of industrial production. The penalty these factors impose on labor productivity is dramatic, primarily in Japan and to a much lesser extent in Germany.

This case study is divided into four sections. The first overviews the processed food industry in the three countries analyzed, Germany, Japan, and the U.S. This section is followed by a discussion of the measurement of output and productivity. The last two sections explore the causes for productivity differences among the countries and what implications these have for the future of the industries.

Exhibit G - 1

VALUE ADDED IN THE FOOD CHAIN 1990

$ Billion, (Employment - million)



* Only includes distribution to retailers, not restaurants

** Employment includes production and auxiliary workers

Note: German figures are only for entities with >20 employees; it is estimated another 0.4 million people are involved in processing/retailing craft based products

Source: Census of Manufactures; OECD; McKinsey analysis

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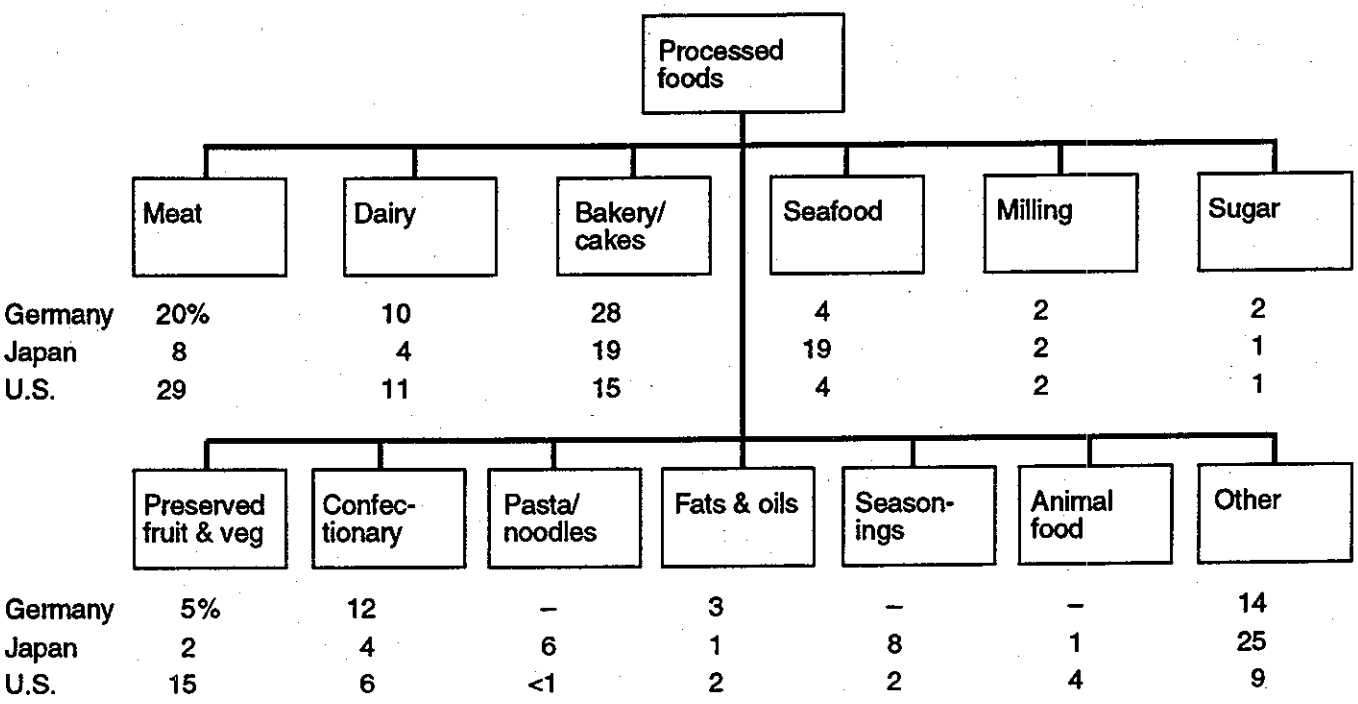
Exhibit G - 2

PROCESSED FOOD INDUSTRY

PERCENT OF TOTAL PROCESSED FOOD EMPLOYMENT



Source: Census of Manufactures; McKinsey analysis

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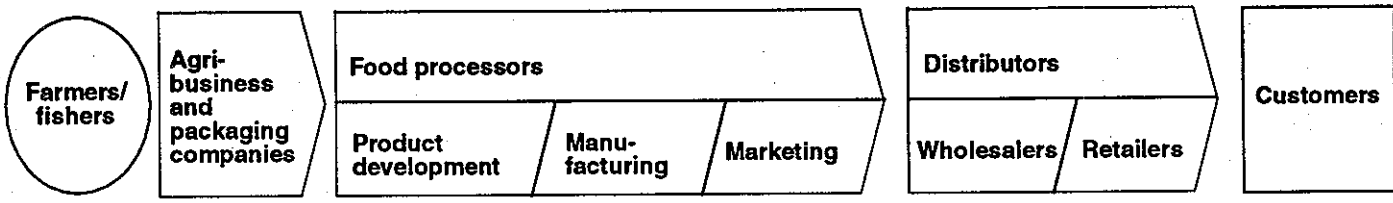
Exhibit G - 3

PROCESSED FOOD PRODUCTION PROCESS



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THE PROCESSED FOOD INDUSTRY

Industry Definition

The definition of "processed food" is not always clear nor easily agreed upon. For the purposes of this project, however, we have included all food products which do not go directly from the farm to the store. In practical terms, this includes all food categories except fresh produce (Exhibit G-2). Beverages, both alcoholic and non-alcoholic, are excluded from the comparisons. In the United States this definition covers most of the products which fall under the heading "Food and Kindred Products" (SIC 20). The comparable industry codes for Germany and Japan are 68 and 12, respectively.

A consequence of using such a broad definition as the one chosen here, however, is that no one or even two production processes cover the bulk of the industry. The techniques and machinery used may often be applicable to just one category. However, while processing varies considerably across categories, the majority of final products tend to take one of four forms: fresh (e.g., meat), chilled (e.g., dairy), frozen, or dried (e.g., canned, boxed foods). Of the four forms mentioned above, the one with the longest industrial history is dried products. Automated canning lines, for instance, can trace their roots back 6 decades. By contrast the mass production of frozen products has been around for only 3 to 4 decades.

The Business System

As for the role of food processors in the larger picture, they typically fulfill but one stage of the food chain (Exhibit G-3), which stretches from farmers to final consumers. The level of vertical integration is for the most part relatively low, rarely exceeding two stages of the chain. A few firms such as ADM which serve as both agribusiness companies and processors, and a few others such as Godiva both process and retail their products. However, for the most part, firms restrict themselves to processing and possibly distributing products.

The majority of processed food, usually over 80 percent, is distributed through the retail channels. The remainder goes to a variety of establishments, including restaurants, hospitals, and schools.

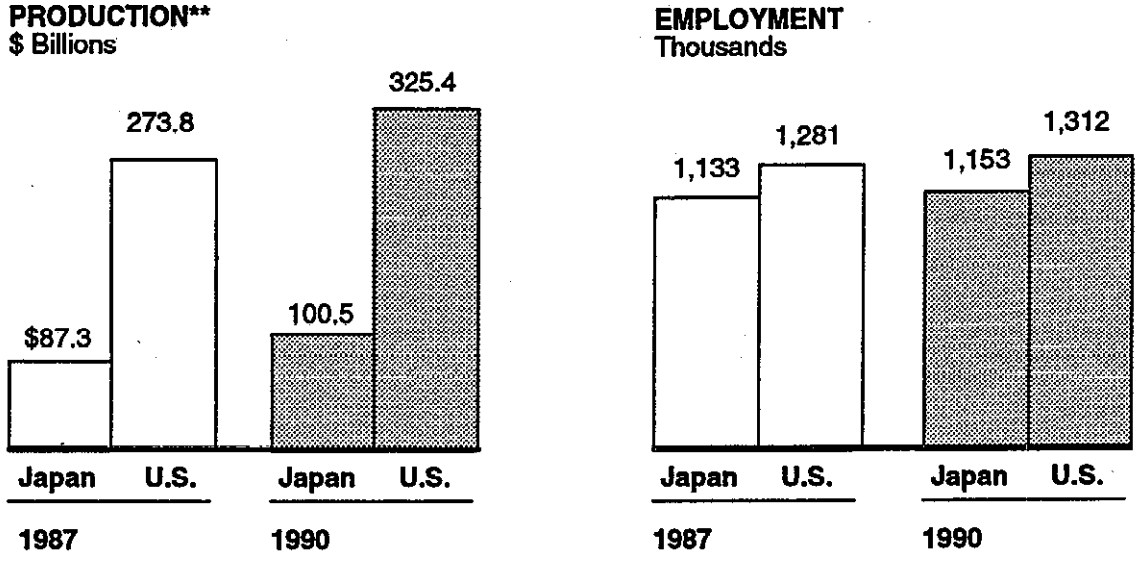
Industry Size

As mentioned earlier, processed food is among the largest industries in an economy. In 1990, the value of U.S. factory shipments was over $325 billion, while the respective figures for Germany and Japan were $65 billion and $101 billion (Exhibits G-4 and G-5).

Exhibit G - 4

PROCESSED FOOD MARKET COMPARISON*

JAPAN/U.S.



* Includes all plant sizes (1 employee and up); employment figures only include plant employment
** At industry PPPs

Note: Population U.S. = 251 million; Japan = 121 million

Source: Census of Manufactures; McKinsey analysis

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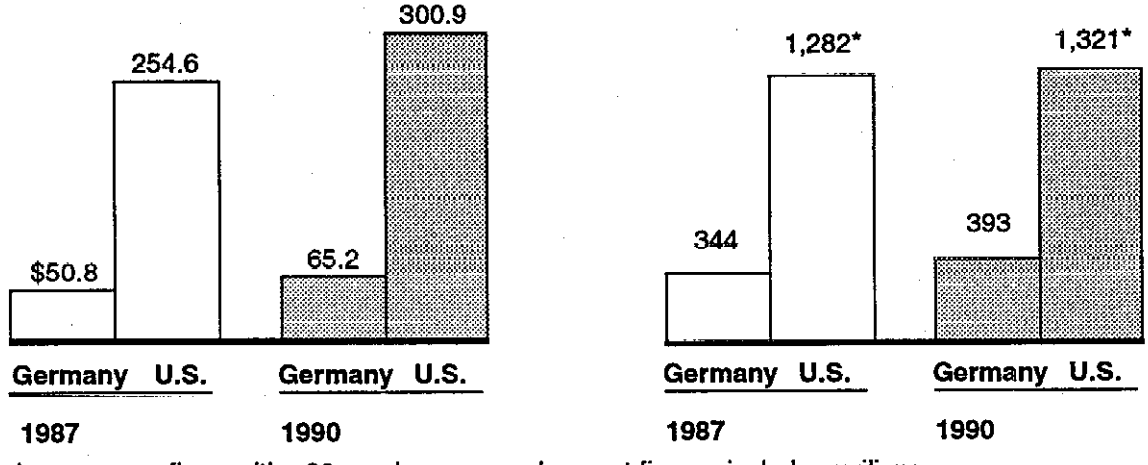
Exhibit G - 5

PROCESSED FOOD MARKET COMPARISON*

GERMANY/U.S.



* Only compares firms with >20 employees; employment figures include auxiliary (overhead) employment
** At industry PPPs

Note: Population U.S. = 251 million; former West Germany = 62 million

Source: Census of Manufactures; McKinsey analysis

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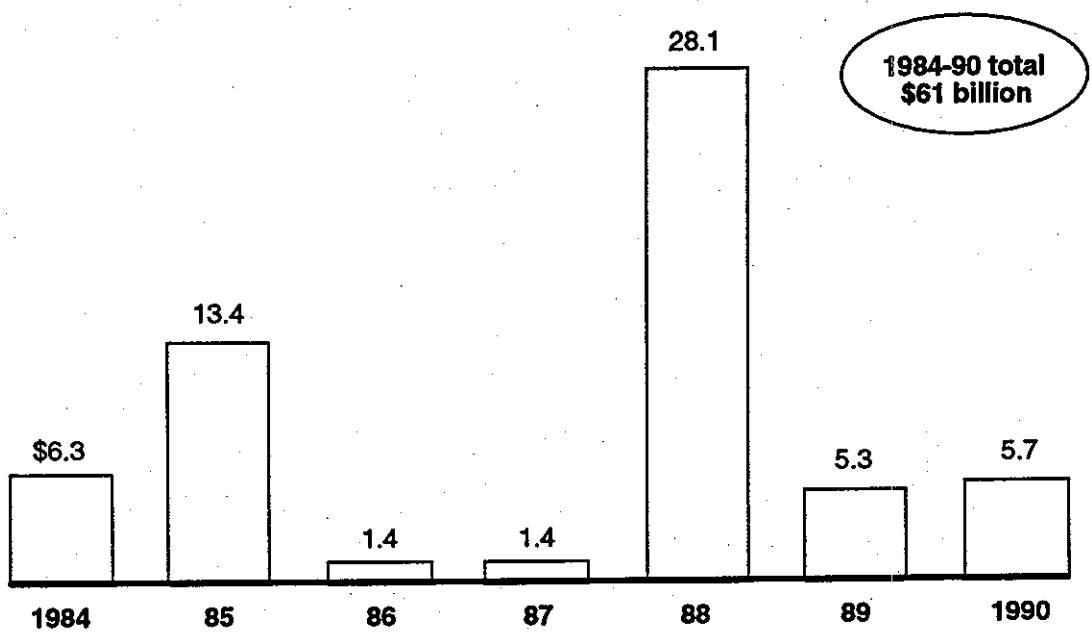
Exhibit G - 6

FOOD PROCESSOR ACQUISITIONS OVER $300 MILLION

ANNUAL PURCHASE PRICE TOTALS

$ Billions



	1984	85	86	87	88	89	1990
Largest acquisitions	• Carnation • Esmark	• General Foods • Nabisco • Imperial Group	• Anderson Clayton	• Beatrice International	• Kraft • Pillsbury • Rowntree	• RJR Europe biscuits • Walker Smith Crisp	• Jacob Suchard • Beatrice

Source: Annual reports; literature searches; McKinsey analysis

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As for industry employment, the U.S., with the largest market, also employs the largest number of workers, 1.3 million in 1990. Japan, by contrast, even though its output is only one-third that of the U.S., employs just slightly fewer workers. German employment is somewhat more in line with the per-employee output of the U.S.

Even though labor ratios vary substantially across the three countries, the value-added content of the manufacturing process is similar, at around 30 to 35 percent of factory sales.

Industry Evolution

Processed food, like many consumer industries, is an industry which relies heavily on advertising and promotion. This aspect of the industry became especially important during the 1980s, particularly in Europe and the U.S. During this period, advertising costs rose substantially due to fragmenting media channels. This situation was aggravated by an explosion in the number of SKUs (stock keeping units). Furthermore, growing consolidation of the retail trade allowed retailers to obtain greater concessions from manufacturers in the form of trade promotions. As a result of these changes, advertising/promotion costs came to account for as much as 50 percent of the wholesale price for highly branded products such as breakfast cereal. The total industry average is also relatively high at roughly 25 percent.

While the 1980s saw an increase in the selling expense of food processors, this increase was counter-balanced by a decrease in the cost of production in Europe and the U.S. This decrease was due in large part to an increase in consolidation, which resulted from the massive wave of mergers and acquisitions of the 1980s. From 1984 to 1990 alone, there were over $61 billion worth of acquisitions over $300 million (Exhibit G-6). Virtually all of these transactions involved only American or European firms.

As mentioned earlier, processed food is still primarily a national and, in some cases, local industry. While trade of processed food has been increasing, the share of imports and exports in final consumption is relatively low compared to the other case studies in this report. In the U.S., for instance, imports and exports combined account for less than 5 percent of consumption. While German figures are considerably higher, the majority of the trade is intra-EC trade. These figures do not mean, however, that there are no global players. While trade may be limited, foreign direct investment is high. In 1990 alone, firms based in the U.S. invested $16 billion abroad while foreign food processors invested $23 billion in the U.S.

PRODUCTIVITY RESULTS

In contrast to the other case studies in this report, the productivity levels for the processed food case are based on factory shipment values as opposed to value

ADJUSTMENTS

Input/Output Data

In order to obtain consistent output figures, we based our results on final shipments. If the industries in the three countries were organized differently in terms of shipping intermediate goods to other processors to finish, we could end up overstating the actual output of the industry through double-counting. In this case it was discovered that Germany had 6 percent more of its factory shipments going to other processors than either Japan or the U.S. As such, the German shipment values were reduced by 6 percent to put them on par with the other two countries and thus eliminate the effect of double counting. Similarly, Japanese shipments had to be verified to avoid double counting arising from subcontracting activities.

Another factor which had to be taken into consideration was differences in hours worked, which vary across the three countries. In Japan the figure is over 2000 hours per year, while in Germany and the U.S. the figures are somewhat lower (Exhibit G-7).

Industry PPPs

A major methodological departure from the other case studies is that in this instance we calculated factory-gate processed food PPPs by starting with final expenditure (ICP) PPPs. This was done because it was impossible to make the usual quality adjustments to PPPs derived from census data matches. To derive factory gate PPPs from final expenditure PPPs required two adjustments.

1. Distribution margins. The final expenditure PPPs reflect the price ratios at the retailer level, and these may be different from those at the factory gate because of differences in the relative margins of the distribution channels. To avoid this problem, distribution margins (both wholesaler and retailer) were calculated for the three countries using census and McKinsey data (Exhibit G-7). Netting these margins out of the product prices made factory gate PPPs feasible.

2. Taxes. Another potential problem in using final expenditure PPPs is that they are calculated to include taxes. As such, differences in sales or value-added taxes could distort the PPPs. As it turns out, tax rates between Japan and the U.S. have the same net effect. However, there was a significant difference with Germany. Adjusting for the higher taxes in Germany brought the German PPP down slightly.

The above adjustments were performed on all individual category PPPs (e.g., meat, dairy, etc.). An aggregate PPP was then obtained by weighting the individual category PPPs by the value of shipments. The resulting industry PPPs from this procedure turned out to be 1.931 DM/$ and 241.1 ¥/$ in 1990, down slightly from 1987 (Exhibit G-7).

added. The reason for choosing this measure was because it was impossible to get accurate input prices for calculating value added as a result of government subsidies. The use of shipments is also justified by the fact that food processing captures a similar portion of the value chain in each of the three countries.

Adjustments

Before making productivity comparisons between the countries, we had to first make adjustments to the factory shipment values as reported by the Census of Manufacturers as well as to the PPPs as reported by the OECD (See box entitled "Adjustments").

Comparability of Results

As with most of the case studies, differences in category definitions and levels of aggregation across the three countries made it necessary to establish two separate comparisons, one between Germany and the U.S. and the other between Japan and the U.S. As a result, the Germany-U.S. comparison applies only to legal units with more than 20 employees, and includes headquarters employment. The specific consequences of this limitation for processed food will be discussed in a later part of the case study. The Japan-U.S. comparison, by contrast, includes all people employed in the industry, but only at the plant level. As such, one should be cautious in making direct comparisons between Germany and Japan.

Labor Productivity

After making the adjustments described above, we were able to arrive at a final dollar value of shipments per hour worked for each of the three countries in 1990. In the Germany-U.S. comparison this turned out to be $90 for Germany and $119 for the U.S., placing Germany at a productivity level 76 percent that of the U.S. By contrast, Japan's productivity was only 33 percent of that of the U.S. (Exhibit G-8).

These figures were up slightly from 1987, due to higher real productivity growth rates in Germany and particularly in Japan (Exhibit G-9). In general, however, the increases in productivity were relatively small in comparison with the other studies in this report.

The productivity figures stated above are the averages for all categories and establishment sizes. As Exhibits G-10 and G-11 show, relative productivities differ significantly across food categories, both in Germany and Japan. Furthermore, the breakdown by size of establishment (or in the case of Germany legal entity) shows that in Japan larger plants are more productive than smaller ones, which is not the case for the U.S. (Exhibit G-12). The larger plants in Japan are at about 40 percent of the productivity levels of similar sized establishments in the U.S., while those

Exhibit G - 7

DATA ADJUSTMENTS

PROCESSED FOOD INDUSTRY

	Calculated PPPs		Average gross distribution margin*	Hours worked per employee	
	1987	1990		1987	1990
Germany	2.071 DM/$	1.931	26	1,889	1,850
Japan	252.5 ¥/$	241.1	31	2,123	2,033
U.S.			25%	1,893	1,917

* Wide range across categories (15-30% depending on type of outlet)

Source: Census of Manufactures; FMI; Japan Ministry of Agriculture; McKinsey analysis

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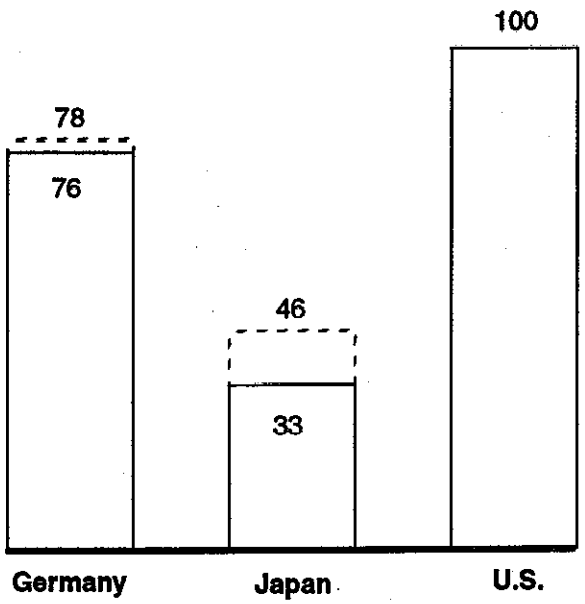
Exhibit G - 8

PROCESSED FOOD LABOR PRODUCTIVITY 1990*

OUTPUT PER HOUR WORKED

Index: U.S. = 100



* Japanese comparison with the U.S. includes all establishments; Germany comparison based on firms with >20 employees; comparable Japanese figure >20 employees is 36% of U.S.

Source: Census of Manufactures; McKinsey analysis

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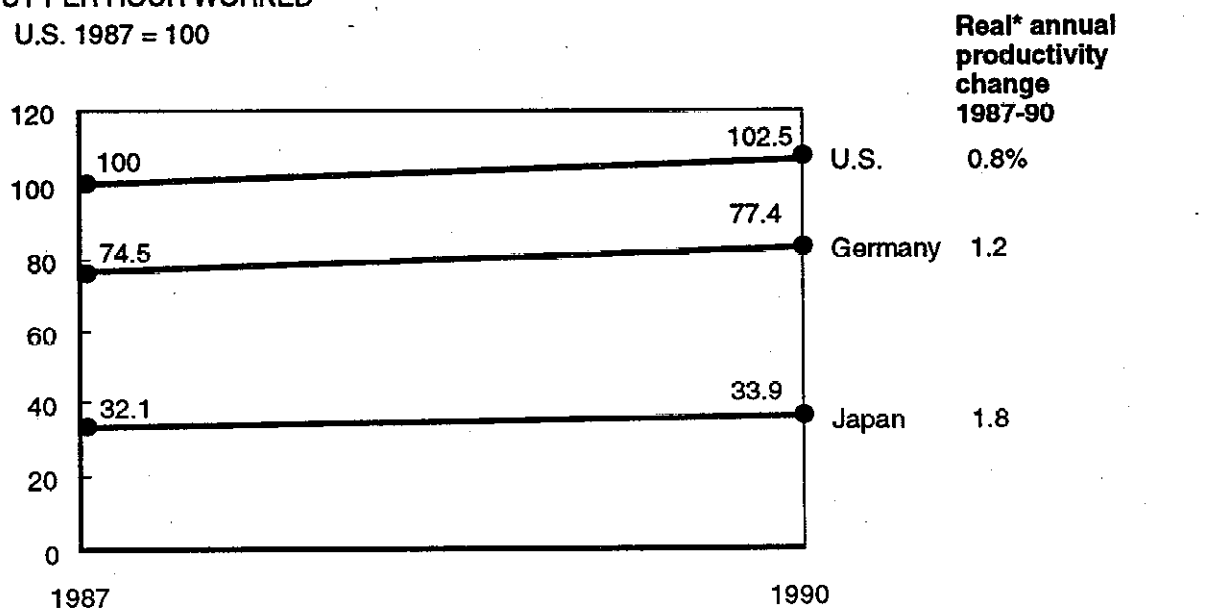
Exhibit G - 9

REAL LABOR PRODUCTIVITY CHANGE IN THE PROCESSED FOOD INDUSTRY 1987-90

OUTPUT PER HOUR WORKED

Index: U.S. 1987 = 100



* Assumes cumulative price increase of 11.6% in U.S. dollars 1987-90

Source: Census of Manufactures; McKinsey analysis

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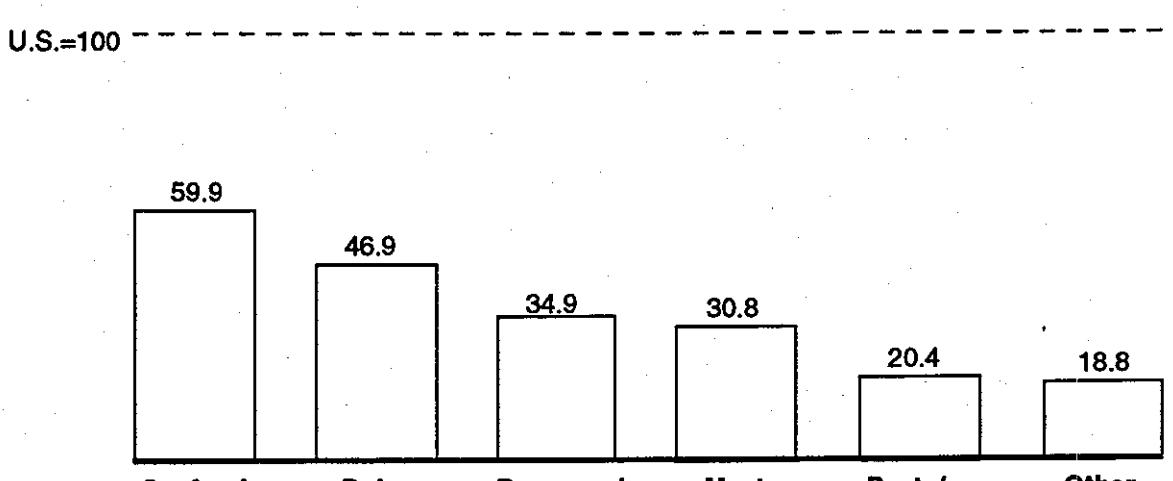
Exhibit G - 10

LABOR PRODUCTIVITY COMPARISONS BY CATEGORY 1990

JAPAN/U.S.

OUTPUT PER HOUR WORKED

Index: U.S. = 100



PPP=	199.0 ¥/$	260.9	221.8	369.5	302.1	235.7

Source: Census of Manufactures; McKinsey analysis

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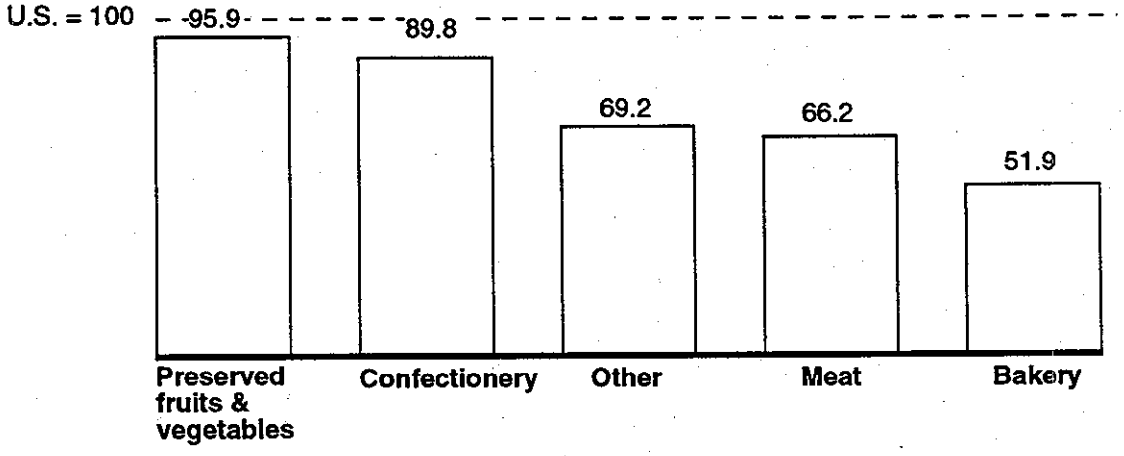
Exhibit G - 11

LABOR PRODUCTIVITY COMPARISONS BY CATEGORY 1990

GERMANY/U.S.

OUTPUT PER HOUR WORKED

Index: U.S. = 100



PPP =	1.96 $/DM	1.70	1.99	2.24	1.75

Note: Comparison only for companies with >20 employees

Source: Census of Manufactures; McKinsey analysis

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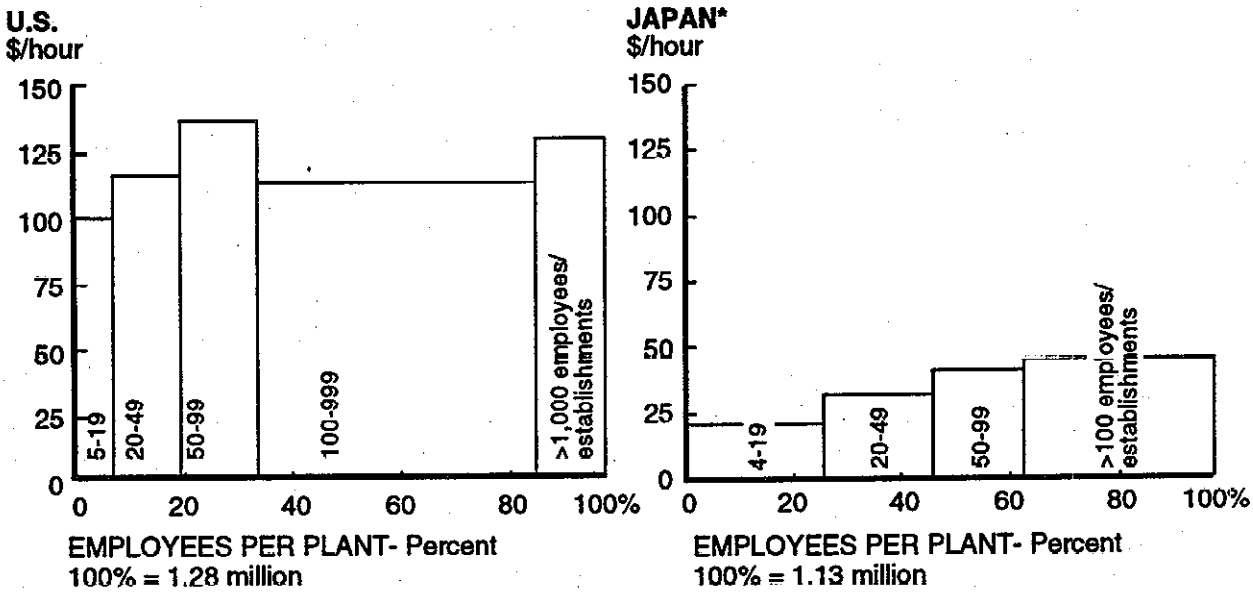
Exhibit G - 12

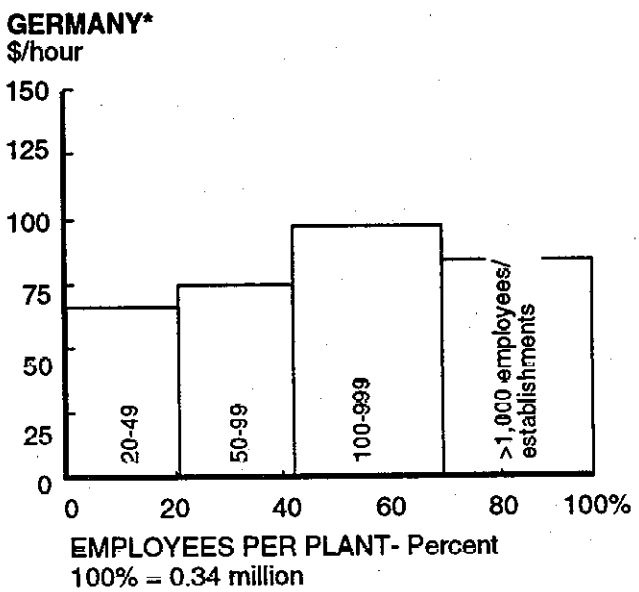
LABOR PRODUCTIVITY DIFFERENCES BY ESTABLISHMENT SIZE 1987

PROCESSED FOOD INDUSTRY

OUTPUT PER HOUR WORKED

U.S. dollars





* PPP = 2.071 DM/$, 252.5¥/$

Note: German data only available for legal entities with >20 employees and include auxiliary workers

Source: Census of Manufactures; McKinsey analysis

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Exhibit G - 13

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES 1990

PROCESSED FOOD INDUSTRY

External factors	Nature of competition	Production process	Labor productivity
Germany: Strong pressure from retailers in Germany/ U.S. but not Japan to improve performance	Price, quality, and environmental concerns drive competition in Germany	Persistence of craft production throughout Japanese industry and in select German categories reduces productivity	Large productivity gap between the U.S. and Japan, smaller between U.S. and Germany - Germany = 76% - Japan = 33% - U.S. = 100%
Japan: Protectionist policies in Japan and, to a much lesser extent in Germany, reduces competition	Competition in Japan focuses on new product introductions and quality; Little price competition	Product mix has moderate effect in Japan; little effect in Germany	
U.S.: Demand factors in Japan (e.g., freshness) help fragmentation persist	Price and advertising serve as basis for competition in the U.S.	Distribution penalty in Japan	

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below 20 employees are only 25 percent as productive as their U.S. counterparts. The German breakdown also seems to indicate a certain degree of economies of scale. However, the effect is relatively small.

CAUSES OF PRODUCTIVITY DIFFERENCES

Using the general framework of this report, we examine here the reasons for the observed differences in productivity at three levels (Exhibit G-13). The first is the production process level, which is the way companies organize themselves to do business. This level includes the degree to which scale and capital matter as well as the level of efficiency in utilizing resources. While this level of analysis explains the most immediate causes of productivity differences between the three countries, the second and third levels attempt to explain why the production process is set up as it is. On the second level we look at differences in the nature of competition of the industry in each country. Finally, on the third level we examine external factors such as government intervention (e.g., regulation) and market characteristics (e.g., product demand) which can influence the production process.

Causality at the Production Process Level

The productivity gaps which exist between Germany and the U.S., and Japan and the U.S., are explained by differences in the production processes across the three countries. In particular, capital and scale turn out to be the leading factor explaining the productivity differences, especially with regards to Japan. Product mix/variety and product design, along with the organization of functions and tasks also turn out to be important contributors to the gap.

- ¶ Capital and scale as a major causal factor. The differences in productivity between craft and industrial production dominate our comparisons. While the majority of operations in the U.S. industry made the transition to industrialized mass production prior to 1980, much of those in Japan and those in certain categories in Germany remain craft-based. In Germany craft industries are restricted primarily to bakery and meat products, where consumer tastes and buying habits have helped preserve traditional production methods. Productivity in these two categories would be even lower if the craft shops below 20 employees were included, where it is estimated that there are at least another 150,000 production workers. Doing so would most likely lower overall German productivity by 5 to 10 percentage points.

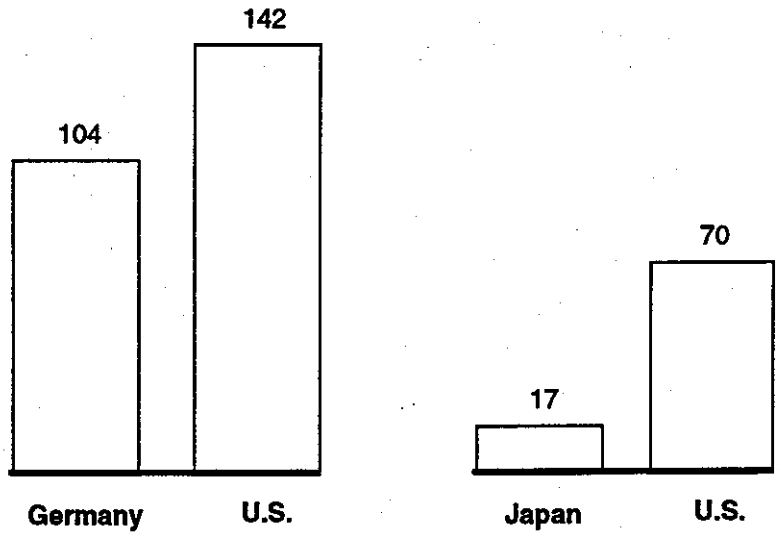
  Associated with the level of craft production is the scale of production. In Germany, entities tend to be roughly three-quarters the size of those in the U.S. as based on employment levels (Exhibit G-14). This is in part due to the fact that plants were designed based on "local-for-local" strategies. In

Exhibit G - 14

DIFFERENCES IN FOOD PLANT SCALE ACROSS COUNTRIES

AVERAGE PLANT SIZE 1987

Number of employees



Note: Japanese comparison includes all plants; German comparison is entities with >20 employees; corresponding Japanese figure is 66

Source: Census of Manufactures; McKinsey analysis

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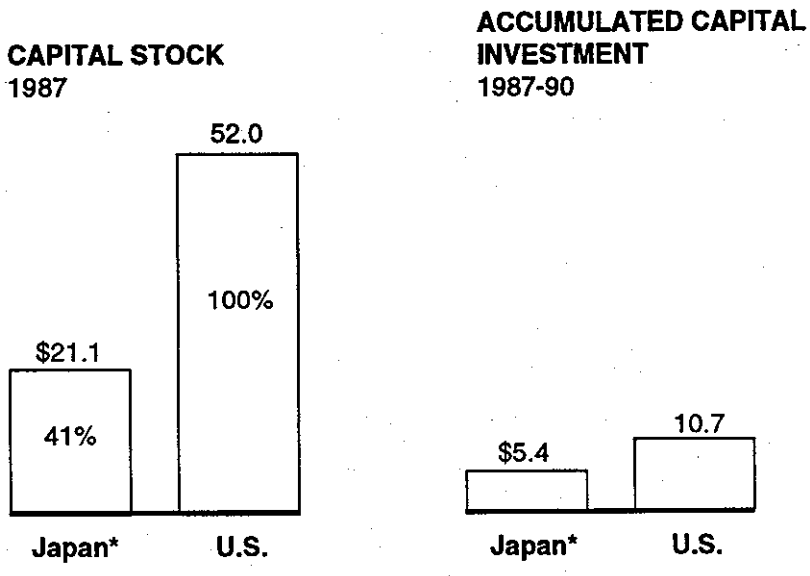
Exhibit G - 15

CAPITAL INTENSITY

PROCESSED FOOD INDUSTRY

$ per hour worked



* Uses fixed capital investment PPP: Japan 218.2 ¥/$

Source: Census of Manufactures; McKinsey analysis

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the case of Germany, this meant serving a population of only 60 million. Furthermore, in Germany many of the plants suffer from an old implantation, meaning poor logistics configuration, wrong building dimensions, etc.. These factors impose a productivity penalty but one which is not large enough to outweigh the capital costs associated with relocating a plant.

In Japan, the signs of craft production are much more pronounced. On average, a plant in Japan employs only 17 workers while the comparable figure in the U.S. is 70 (Exhibit G-14). This is reflective of the fact that Japan has more than 67,000 food processing establishments while the number in the U.S. is only 21,000. A consequence of this proliferation of small craft businesses is that often the minimum scale needed to adopt mass-production technologies is not present.

The issue of craft production is not restricted to small establishments, however. As was shown earlier, even the larger plants in Japan are much less productive than their U.S. counterparts. Part of this difference is attributable to the fact that the largest plants in Japan are involved in bakery products, whose output per hour is substantially below that of other categories. Aside from this effect, however, a substantial productivity gap remains even among the largest plants. They too have not completely switched to industrial production. This result is reinforced when one looks at levels of capital intensity (Exhibit G-15). Japanese capital stock per hour worked is 41 percent that of the U.S. This implies also that while capital per unit of output is similar in the U.S. and Japan, the investments in Japan simply require much more labor to operate.

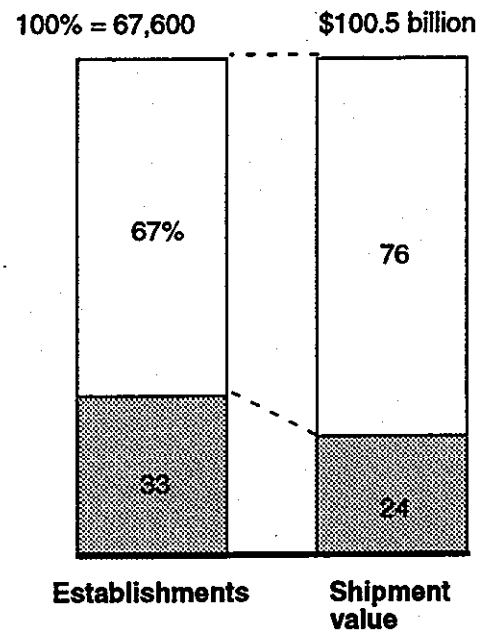
This is not to say that there are no modern plants in Japan. However, those which do operate on an industrial basis are in markets with relatively low levels of competitive intensity. Although these companies may adopt advanced processing methods, they do not reduce employment accordingly because of a lack of competitive pressures, as well as because they used more flexible machinery with smaller lot sizes to accommodate product variety

¶ Product mix/variety/quality as a causal factor. As mentioned in the introduction to this case, the processed food industry has historically been dominated by national or local players. This situation has been due in part to differences in consumer preferences across borders. These differences have hindered the industry's ability to standardize products on a large scale. The effect of these differences in consumer tastes on productivity can be broken down into those resulting from differences in product mix, the existence of unique products, the level of product variety, quality differences, and differences in the design of products.

Exhibit G - 16

PRODUCT MIX 1990

JAPAN



* Soy bean paste, Japanese rice cakes, fish sausage, sushi, petit pouch products, and Japanese noodles

Source: Census of Manufactures; McKinsey analysis

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Exhibit G - 17

SKU PROLIFERATION

PROCESSED FOOD INDUSTRY

	Average number of SKUs per supermarket	Number of new product introductions per year
Germany	6,600*	n/a
Japan	30,000*	30,000-40,000
U.S.	20,000-30,000*	12,000

* Different definition of supermarket across countries

Note: Total number SKUs in a market at any one time will be larger than the average per supermarket as not all stores carry the same products

Source: New Product News; Kokubu; McKinsey analysis

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- Product mix Germany/U.S. An example of differences in product mix across countries in food can be found in the larger bakery industry in Germany relative to that in U.S. The opposite is true with preserved fruits. Depending on the relative productivities of individual industries, there could be a mix effect influencing aggregate results. If a country specializes in an inherently low labor productivity industry because of consumer preferences, its aggregate productivity will reflect this bias. To assess the size of this effect, new productivity figures were calculated for Germany using the employment distribution of the U.S. food industry. This calculation estimates what productivity levels would be if all three industries had the same product composition.

  The effect of product mix was relatively small for Germany, raising productivity from 76 to 78 percent of the U.S. level. The above productivity adjustment might be larger if it were possible to make a mix adjustment based on individual products rather than product categories.

- Unique products and Product mix Japan/U.S. Aside from differences in product mix, a related factor is unique products, ones which are simply not sold in the other markets. Japan is the most striking example of this effect. Roughly one-fourth of all shipments of processed food in Japan have no direct equivalent in the U.S. or Germany (Exhibit G-16). Among the products which fall into this category are Japanese noodles and soy bean paste. In some ways, including these products makes our productivity comparisons inconsistent. The result of the correction for product mix and unique products for Japan was estimated at 13 percentage points, bringing the overall total for Japan to 46 percent of the U.S. level.

- Variety. The issue of variety and product differentiation is also important. While the proliferation of SKUs (stock keeping units) has been an issue in all three countries, Japan appears to be the one for which it has had the greatest impact on production. The number of existing SKUs as well as new product introductions is considerably higher in Japan than either Germany or the U.S. (Exhibit G-17). This proliferation of SKUs affects the production process because critical scale is more difficult to achieve and thus the potential benefits from automation are reduced. Typically in Japan one factory produces 25 to 40 items per day, which makes equipment for mass production not appropriate for marginal products. Even with specially developed flexible equipment, time and capacity losses are unavoidable. A proliferation of SKUs also makes achieving brand scale downstream more difficult because it reduces one's ability to take advantage of economies of scale in terms of advertising and promotion of product

brands. The differences in product proliferation across countries show different levels of product standardization.

- Quality. Theoretically, differences in product quality should be reflected in higher output prices, thus resulting in higher productivity. This is contingent on the PPPs being based on exact product matches. Given the detail used in matching products for the calculation of the PPPs (i.e., 500 food matches using the same brand when available and always the same contents and package sizes)[1], we have no reason to believe that the matches are inaccurate. However, the PPPs do not capture quality differences in the ingredients of the same product in different countries (e.g., if Uncle Ben's rice uses higher quality rice in Japan than in the U.S.). While it is not believed that this issue is of primary importance for explaining the productivity gap, the added costs associated with higher quality could be adding to the lower productivity in Japan and Germany to a small extent.

- Product design. The two aspects of product design which impact food production in Germany and particularly Japan are packaging and additives. The former is particularly important in Japan where the appearance and presentation of food are key buying factors. As a result, the quality and quantity of packaging materials used in Japan is higher than in the U.S. In addition, the average package size tends to be smaller in Japan, thus increasing the packaging material per unit of contents ratio. The result is higher packaging costs. In Germany, "green" packaging required to address environmental concerns adds to manufacturing costs.

  A second aspect of product design which can affect productivity is the use, or rather failure to use, additives. In Japan and Germany public concern about additives and preservatives often restricts their use. This in turn reduces a plant manager's ability to operate long production runs as he/she is more conscious of the potential for spoilage of unsold product.

¶ Organization of functions and tasks as a causal factor. While the majority of the gap in productivity can be explained by differences in capital and scale, and by product mix/variety, a portion of the gap is attributable to the organization of functions and tasks.

Over 80 percent of the processed food produced finds its way into retail outlets. For a number of reasons, the efficiency of this distribution channel can have a strong impact on the productivity of food processors. The primary reason is the added labor needed to organize the logistics and

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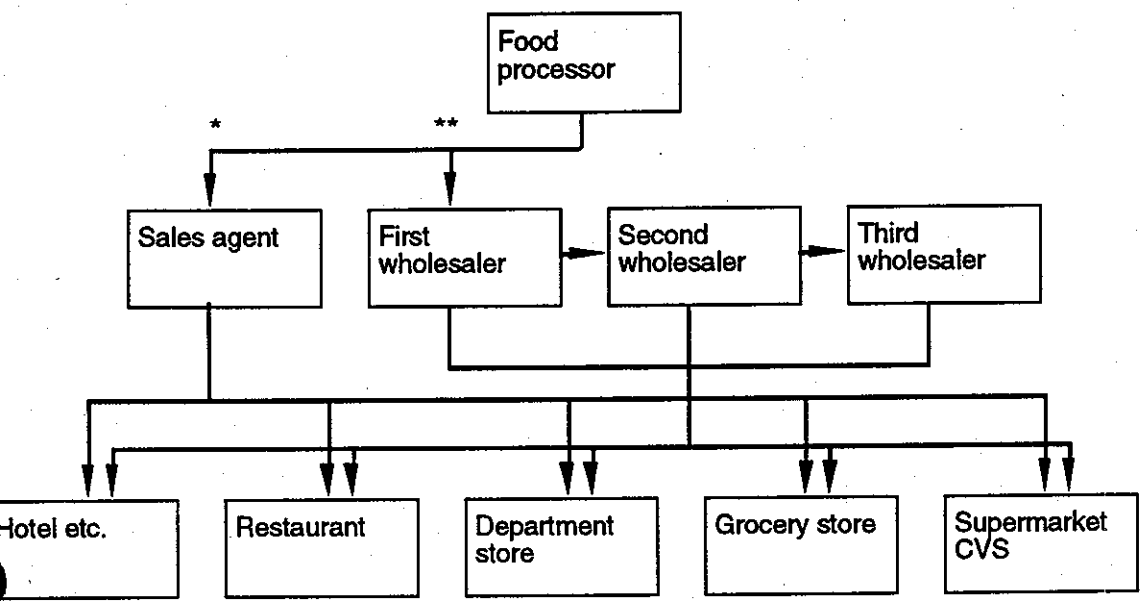
1 The PPPs take into account quality differences to a large extent.

hibit G - 18

RGANIZATION OF FUNCTIONS AND ASKS: DISTRIBUTION PENALTY

APANESE FOOD INDUSTRY



	NUMBER OF ESTABLISHMENTS	
	Japan	U.S.
Food processor	~ 68,000	~ 21,000
Sales agent, First wholesaler, Second wholesaler, Third wholesaler	~ 57,000	~ 42,000
Hotel etc., Restaurant, Department store, Grocery store, Supermarket CVS	~ 623,000	~ 190,000

* Most products sold through sales agent are low preservability ones (e.g., Meat Products, Milk and Dairy Products, Bread)

** Most products sold through wholesaler are high preservability ones (e.g., Dried Noodles, Canned/Butter Food, Snacks)

Source: *Food Processing*; Nihon Keza Shimun; Census of Manufactures; McKinsey analysis

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handling associated with fragmented retail channels. These costs tend to be high in Japan as a result of smaller delivery and production lot sizes caused by the large number of retailers and products.

In the case of Japan, food processors must deal with a retail food industry which has over 620,000 outlets, as compared to the U.S. with 190,000 outlets for a population twice as large. In addition, in Japan there are 57,000 food wholesalers compared to 42,000 in the U.S. (Exhibit G-18). The problems created by the large number of stores in Japan is made worse by the need to make two or sometimes three deliveries per day to the same store. This frequency is due in part to the freshness demands of consumers as well as to the retailers' inventory space constraints. In the U.S., high turnover rates can burden operations with additional training requirements which can temporarily lower labor productivity.

External Factors and the Nature of Competition

Why is it that the food processing operations in the U.S. and Germany to a large extent, have been able to consolidate while those in Japan have not?

¶ The nature of competition. Part of the reason why industry consolidation is so different among the three countries is that the nature of competition is very different across the markets. The most apparent difference is in the number and size of players in each market. The U.S. (and Germany to some extent) is dominated by large or at least medium-sized industrial processors. By contrast, Japan appears to have two types of competitors, differentiated by product category. On the one hand, the vast majority of firms are small and unconsolidated, using craft-based production techniques. These tend to produce traditional Japanese products. On the other hand, large firms in categories such as dairy and meat processing hold large protected market positions, and as such face limited competition.

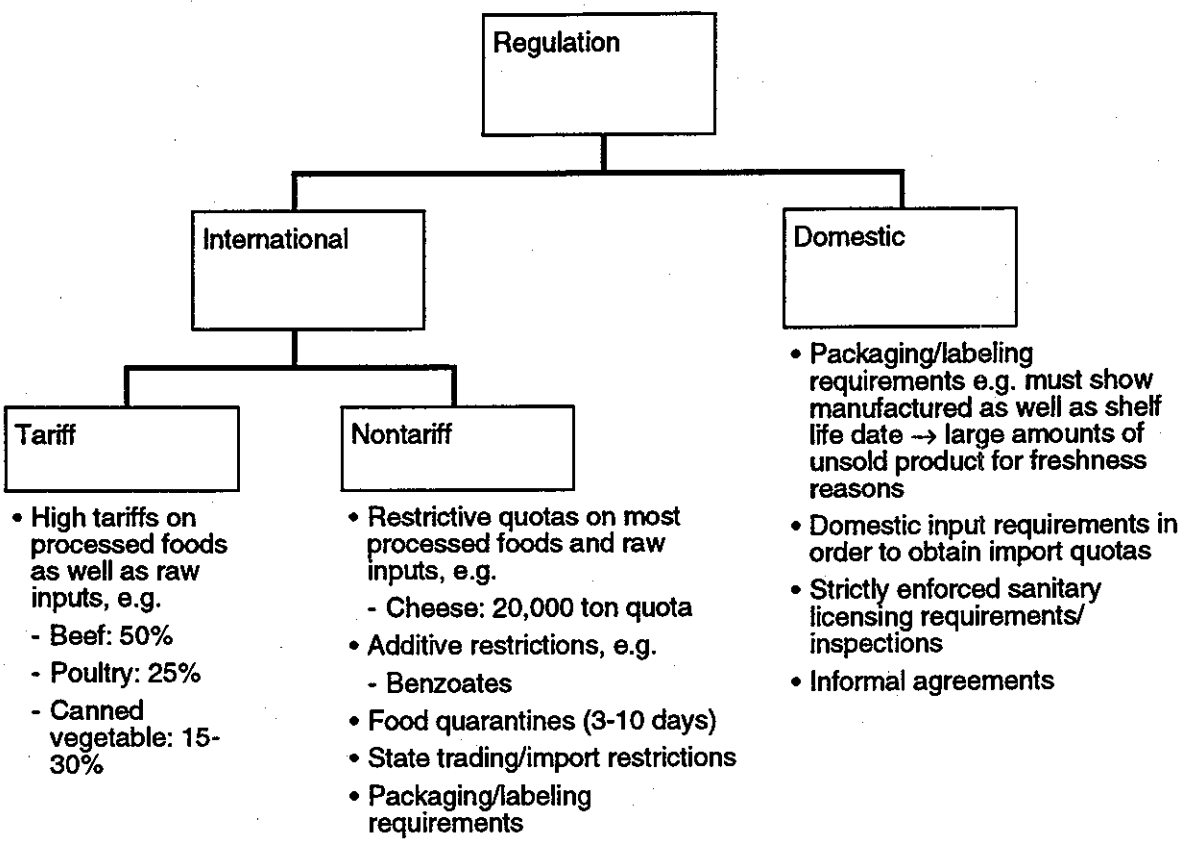
In addition, Japan, in contrast to Germany and the U.S., has a relatively small share of its market controlled by global companies with leading edge productivity, thus reducing the incentive of other firms in the market to increase productivity. Rather, most firms operating in Japan tend to compete on a national or more often local basis.

Furthermore, the U.S. industry and much of the German industry have reached a level of product standardization which makes price competition an important factor, and in turn puts pressure on companies to reduce costs. In Japan, the effect of price competition is much less pronounced. Rather, product differentiation forms the basis for competition. The latter system, because of its constant change over and its effect on production line scale economies, is inherently less productive.

Exhibit G - 19

SPECIFIC GOVERNMENT REGULATION 1990

JAPAN



Source: USDA; literature search

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The Japanese industry is also forced to compete much more on the basis of product "freshness," which, as will be discussed later, has a number of implications for the production process. Freshness is also an issue in Germany, but primarily for bakery and seafood products.

Competition among the large Japanese firms is also controlled through the use of manufacturer rebates. Retailers are given rebates based not only on volume but also on loyalty. As such, the retailers help to preserve the status quo amongst the manufacturers.

¶ The regulatory environment

- Domestic regulation. Of the three industries, the one which has been most affected by regulation is in Japan (Exhibit G-19). In Japan the government has been active both at the domestic and international levels. On the domestic side, the government has input requirements which force food processors to purchase domestic inputs before they are granted licenses to import raw materials. This can pose problems for processors in that in addition to being more expensive than imported inputs, domestic inputs can pose logistics complexities in terms of getting access to remote agricultural areas. Furthermore, some domestic products, e.g., wheat, are of lower quality than imports and can cause quality consistency problems as well as production problems from adjusting machinery for different levels of input quality.

  In addition to input requirements, the Japanese government imposed until very recently, strict labeling requirements which mandate that the date of production as well as expiration must appear in large letters on the container. This labeling allows consumers to choose only the freshest product and thus adds to the problem of unsold merchandise. In this same vein, the government regularly conducts strict sanitary inspections.

  In Germany, the domestic regulation which could potentially have an impact on productivity is the requirement that processors take back packaging material and arrange for its recycling. This increase in materials handling results in higher labor costs and as such lower labor productivity.

- International regulation (tariff and nontariff). On the international side, the Japanese government has a number of tariff as well as non-tariff barriers to imports. Tariffs range from 15 to 30 percent for canned vegetables up to 50 percent for beef. Aside from tariffs, there are quotas on food imports, both raw as well as finished products. While Japan agreed that starting in 1988, these quotas would be gradually increased and eventually done away with, many categories such as beef and cheese were still subject to import quotas in 1990. Japan is not the only

one of the three countries which has regulations regarding its food imports. Both Germany and the U.S. also have tariff systems. However, they do not serve to restrict competition to nearly the same extent.

Another form of import restriction which is equivalent to an import quota is state trading. Certain products such as rice, wheat, and beef can only be bought by governmental or quasi-governmental agencies, which use this power to control domestic prices.

A further means by which the government restricts imports is through the use of food quarantines for imported products. These quarantines can range from 3 to 10 days and sometimes 100 percent of the product will be inspected. This quarantine period imposes a stiff penalty on the ability of imports to compete on the basis of freshness. Pressure from importers has forced the government to experiment with inspecting product in the country of origin before it is shipped rather than placing it in quarantine in Japan. However, it is not clear whether this practice will take hold.

Aside from the bureaucratic obstacles described above, the Japanese government also imposes content restrictions on imported products. The most significant of these restrictions regards the use of additives and preservatives. Several chemicals used in the U.S. and Europe for preservation such as benzoates are banned in Japan at any level of concentration. As such, foreign processors are forced to reformulate their products, thus increasing their costs, in order to comply with the Japanese additive restrictions. In certain cases, however, even reformulation is not sufficient as some of these chemicals form naturally, e.g., benzoates in dairy products. Even though the levels are very low, the product is not allowed into the country, though products produced domestically have similar levels of benzoates. Germany, and the U.S. for that matter, also has strict requirements regarding additives and preservatives. However, they apply uniformly to both domestic and foreign producers and as such do not necessarily disadvantage foreign competitors.

¶ Relations with other industries. One of the major environmental differences between Germany and the U.S. on the one hand and Japan on the other is the level of pressure processors feel from the retailers and wholesalers to compete on price. On the one extreme is the German case in which the retail trade is highly concentrated, with the top five food chains accounting for 43 percent of sales. The overall U.S. figure stands at half that of Germany, 21 percent. However, if taken on a market-by-market basis, concentration levels are over 70 percent in major areas in the U.S. By contrast, in Japan the top five food retailers account for

approximately 5 percent of market sales. The retailers in Japan cannot impose on the processors the pricing demands which U.S. and German retailers can. Furthermore, the German and U.S. processors face much more competition on the basis of price from private label than is the case in Japan. Roughly a quarter of sales in Germany and 14 percent in the U.S. are private label while in Japan the figure is 5 percent. This low level of concentration amongst retailers and the minimal degree of competition from private label impart little pressure on Japanese food processors to improve their productive efficiency.

The fragmentation and complexity of the Japanese distribution system not only restricts the level of pressure processors feel from retailers, but also helps to set up informal barriers to foreign competition. As is widely known, it is very difficult for new firms regardless of their scale to establish the distribution network needed to be successful in Japan. The same difficulties exist on the input side, where relationships with the agricultural producers require time to develop. There have been instances in which foreign processors have set up operations in Japan only to be forced to close them down, not because they were unproductive, but because they were unable to get access to the distribution channels.

¶ Product demand. In the previous discussion on product mix and variety, we showed that differences in products could account for part of the gap in productivity. Here, however, we address the consumer preferences behind those differences. This effect is most apparent in Japan where the emphasis on quality, freshness, and variety is extremely high. This emphasis is partly rooted in the Japanese lifestyle. Consumers tend to make small shopping trips but do so every day. As such, they become accustomed to buying fresh products. This preference is strong, and food processors are required by law to put not only the expiration but also the manufacturing date on the product. In the case of some products, the time of delivery to the store is even stamped on the package. For dairy products, this has caused the production of milk to start at midnight so as to be able to put the most recent date on the label.

These freshness demands and preferences for traditional as well as new products imposed on the processors by the consumers help to keep the industry unconsolidated. Because in order for the product to be fresh, one needs to locate plants near the individual metropolitan areas, thus discouraging centralization of production. This is especially true when manufacturers make multiple daily deliveries to the same store often because of lack of inventory spaces in stores. Preferences for both traditional and new products lead to high product variety, making it difficult for food processors to capture scale economies in production as well as marketing.

Daily demand is also affected by freshness requirements, through the weather of all things. In bad weather, people tend to shop less and as such stores sell fewer products. While in the U.S. this would not necessarily affect the purchasing of retailers, as it is often done on a weekly or monthly basis, in Japan it can add a full day to the age of the product and thus reduce the likelihood of its being sold. As such, order changes from retailers occur frequently on a daily basis, with the difference in sales between the best and worst days being as much as 50 percent of production. For this reason it is said that the best factory managers of milk production are also the best weather forecasters.

The result of this system is a potential for high levels of unsold product. If a product is not sold within a few days of being put on the shelf, it will not be sold at all. And, given that the processors are obliged to repurchase unsold product, the cost to the processor can be quite high. As such, they may end up producing a good deal more than what they actually sell.

In the future, however, we would expect the freshness demands to be reduced as the buying habits of consumers change, and more choices become available. As the time families can devote to shopping declines, the frequency of trips to the supermarket should also drop, thus reducing the freshness expectations.

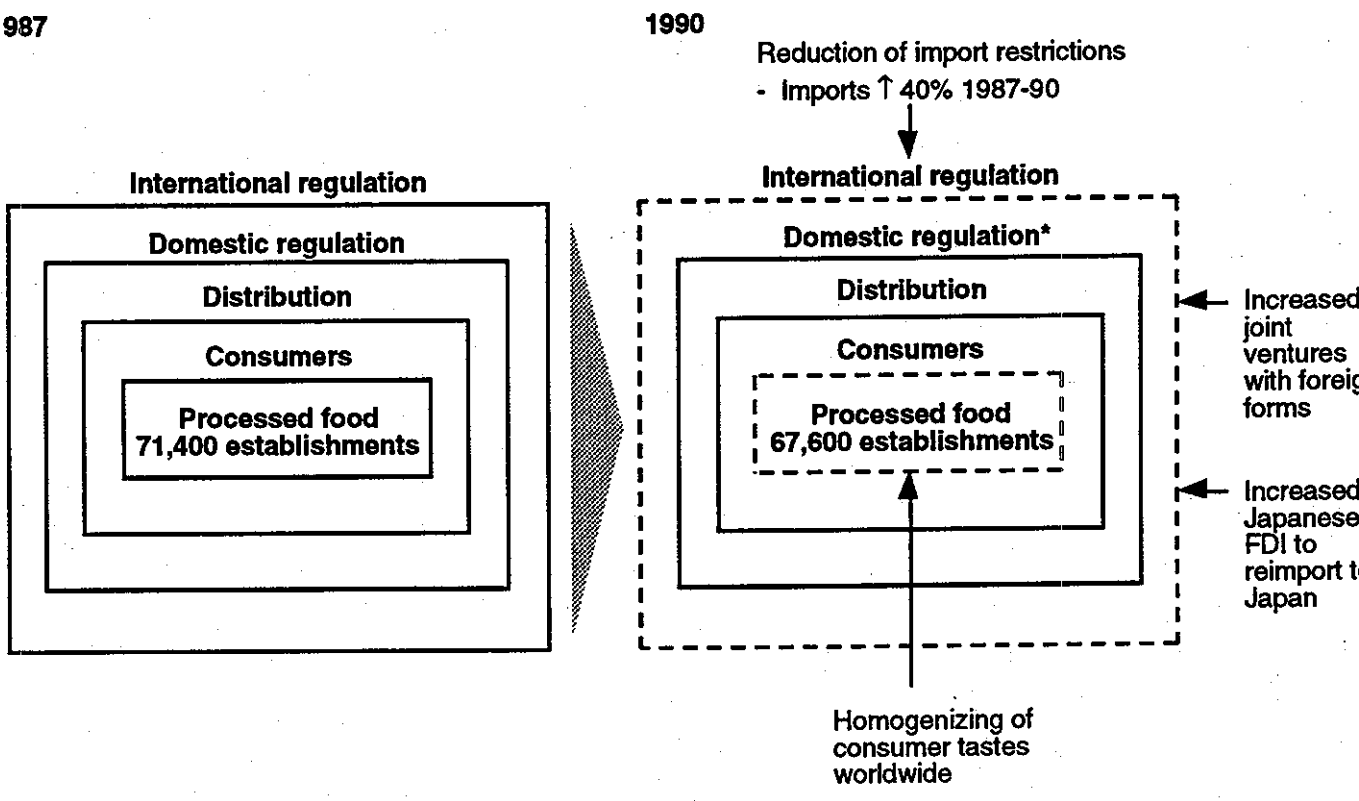
The issue of freshness is also of concern in certain German food categories, particularly bakery, which is still dominated by craft-based enterprises. However, some baking companies in Germany have been successful in making the transition to industrial production while continuing to meet the freshness demands of the consumers. The Wendeln Group is such an example. With sales of roughly 1 billion DM, this firm has been able to consolidate its production while providing fresh German-style bread (with no preservatives) to its customers. In exchange for the benefits of industrialization, however, it must incur high distribution costs, but the net effect is a big advantage.

¶ Corporate governance. An issue related to the proliferation of craft production is ownership structure. While the large industrialized processors are usually publicly traded, this is not the case of small craft businesses, which tend to be privately and most often family owned. This makes it more difficult for an industry to consolidate as there often exist incentives other than economic ones for maintaining the integrity of a business. As such, the ownership structure in Japan and somewhat in Germany help those industries remain unconsolidated.

Exhibit G - 20

JAPANESE MARKET LIBERALIZATION

1987-90



* Some changes of domestic regulations are beginning to happen (e.g., deregulating manufactured date stamping)

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OUTLOOK

The future outlook for the three countries analyzed here is quite different, as each appears to be at a different stage of consolidation. On the one extreme is the U.S. market. As mentioned, the 1980s saw a wave of mergers and acquisitions in the U.S. food processing industry, with giants such as Kraft and General Foods being merged into international powerhouses. While there may still be room for further consolidation of production facilities, the focus of attention in the 1990s will more than likely shift to rationalizing the selling and trade relations side of the business. Firms will need to find ways of reducing the advertising and trade promotion expenses which swelled in the 1980s. They will also be facing growing pressures from the retail channel, as it attempts to streamline in the face of mounting competition from non-traditional store formats such as Wal-Mart which are entering the food market.

Firms based in the U.S. will also have to turn to foreign markets for future growth. With the domestic market mature and population growth minimal, foreign markets pose the best opportunity for growth. This growth, however, will more than likely entail increased foreign direct investment and as such growth in domestic production may lag that of U.S.-based firms overall. To be successful in foreign markets, however, firms in the U.S. will need to explore ways of obtaining the craft-like quality of Japanese and German products while not losing the efficiencies of industrialized production.

Germany, while closer to the U.S. in terms of consolidation, still has a few industries such as meat and bakery which more closely resemble their Japanese rather than U.S. counterparts. While consumer tastes will continue to slow this convergence, experiments in industrial bread production in Germany show that these preferences can be met without having to continue craft production techniques. The further consolidation of food operations in Germany will also be helped by the reduction of intra-EC trade barriers as well as by a potential increase in competition from Eastern Europe. These factors will create pressure for a rationalization of production by multinationals on a pan-European basis. This rationalization holds the potential for increased productivity, though it will also be accompanied by substantial reductions in employment levels, especially in Germany where labor costs are high.

The Japanese market is likely to undergo the most extreme changes in the coming years. This change will be due in large part to the increase in price competition accompanying a reduction in trade barriers. To prepare for this new wave of competition, the larger Japanese food processors like Ajinomoto are increasing their levels of foreign direct investment in countries such as Australia and the U.S. for the purpose of exporting product back to Japan (Exhibit G-20). From 1982 to 1987 annual Japanese foreign direct investment in the food industry increased over 350 percent to $320 million. While this investment is being done in large part to take advantage of lower factor prices and is far below the levels of the

Exhibit G - 21

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES
PROCESSED FOOD INDUSTRY

● Important
O Secondary
X Undifferentiating

External factors

• Market conditions	
- Demand factors	●
- Relative input prices/factor availability	X
- Other industries	●
• Policy and regulation	
- Macroeconomic conditions	X
- Competition rules and concentration rules	X
- Corporate governance rules	O
- Labor rules and unionism	X
- Other regulations (tariffs, nontariffs)	●

Nature of competition ●

Production process

• Output	
- Mix, variety, quality	●
• Production factors	
- Capital (intensity, vintage, technology) }	●
- Scale }	
- Design for manufacturing	O
- Basic skill of labor, intrinsic motivation	X
- Raw materials, parts	X
• Operations	
- Capacity utilization	X
- Organization of functions and tasks	O

LABOR PRODUCTIVITY

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U.S., it should still have a positive impact on the productivity of firms based in Japan as they adopt production processes used in the countries in which they are investing.

The effect of this shift in investment abroad on the productivity of operations in Japan is unclear in the short run, however. If this investment replaces low value-added domestic production, one could see a rise in average productivity. However, the opposite could also be true in the short run if the larger firms simply move their production off-shore, leaving only the small, craft-based firms to produce domestically. In the long run, though, these too will be eliminated or transformed by foreign competition. Either way, the reduction in trade barriers will put pressure on producers located in Japan to close the productivity gap between themselves and their counterparts in the U.S. and Europe.

In addition, as the retail trade in Japan becomes more consolidated, as is happening, downstream pressure to increase manufacturing productivity will increase.

SUMMARY AND POLICY ISSUES

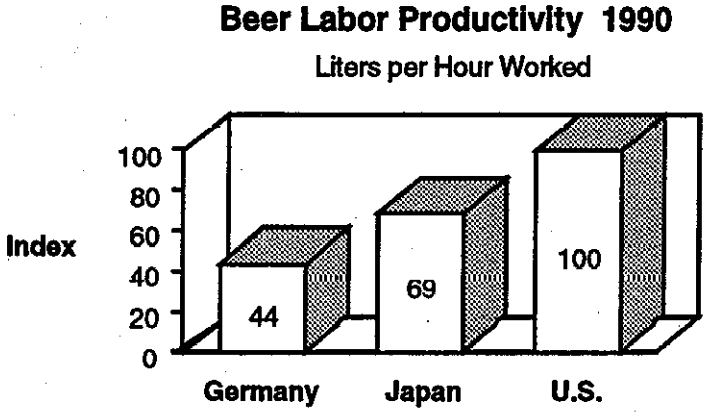
As mentioned in the introduction, the processed food case was chosen as an example of a major consumer goods industry. As it turns out, it is also one of the cases with the largest gaps in productivity. Between Germany and the U.S., there is a gap of over 20 percent, which would undoubtedly be larger if small company statistics were available. With Japan, however, the contrast is even more striking. With productivity levels of roughly one-third those of the U.S., the major difference in the industries is attributable to the proliferation of craft-based production in Japan as opposed to industrial forms of production in the U.S. Part of the gap can be accounted for by differences in product mix/variety and another part is attributable to inefficiencies in non-production functions such as distribution.

These differences in production techniques are primarily the result of two factors. On the one hand, the food processors in Japan have not faced the degree of price competition which exists in the U.S. and German markets. This situation is due in part to their having been relatively stable and insulated from foreign competition. Furthermore, competition in Japan has tended to revolve around new products rather than price. Also, while there was strong domestic pressure for cost reduction from the retailers in the U.S. and Germany during the 1980s, the same was not true in Japan. These factors combined to reduce the degree of price competition in the marketplace. The other major factor affecting the production process is the preference of consumers, particularly their concern for freshness and variety (Exhibit G-21).

The opening up of the Japanese market to imports and foreign companies, along with a gradual consolidation of the retail channel, should help increase the competitive pressure in the industry to improve productivity. Thus, the challenge

these firms will face will be how to move from craft to industrial production while continuing to satisfy the preferences of the consumer. This process will necessitate both a consolidation of production facilities as well as a molding of consumer tastes, processes which have already begun.

BEER INDUSTRY CASE STUDY SUMMARY



Small size of breweries in Germany and regulation in Japan cause productivity to lag the U.S. Scale of packaging, not brewing itself, explains the difference.

Much like the U.S. 30 years ago, the **beer industry in Germany** is highly fragmented. Germany has over 1,000 breweries that produce 12.5 billion liters per year. This is in contrast with the U.S., where 67 plants (excluding microbreweries) produce 23.1 billion liters per year. German beer drinkers remain fiercely loyal to their local brews, resisting efforts of big brewers to launch pan-German brands and consolidate production. The fragmentation means that breweries in Germany are far too small to duplicate the economies of scale, and hence the productivity, of their counterparts in the U.S. and Japan.

While the **breweries in Japan** are large enough to capture most scale economies, their productivity lags behind the U.S. because the Ministry of Finance – which sets prices and issues operating permits for breweries, distribution centers, and retail outlets – has consistently protected the weakest brewers from competition. Because the prices are high, the brewers in Japan compete by introducing new products aimed at small market niches. Kirin, for example, despite producing four times less beer than Anheuser-Busch, sells 17 brands of beer, compared to the latter's 14. Smaller volumes and more products mean shorter bottling runs as well as increased logistical complexity, exacting a considerable toll on productivity.

While the case examines labor productivity in brewing and bottling, fragmentation and product proliferation cause further inefficiency outside the factory gate. Trucks have to be loaded for small deliveries to retail outlets, making logistics and administration less efficient than in the U.S. and thus, contributing to the productivity gap.

PRODUCTIVITY IN THE BEER INDUSTRY

The beer industry illustrates how mass production for large markets leads to high labor productivity. It shows how strong preferences for local products can provide barriers to efficient competition, leading to industry fragmentation and low productivity, and it makes a case for deregulation.

This case provides a good example of consumer goods manufacturing. It shares, indeed, many characteristics with food products: beer-making starts with basic agricultural commodities, involves rather simple processing and packaging, is distributed through retail outlets, and requires an intensive marketing effort.

Beer-making has evolved into a highly capital-intensive industry in which economies of scale and scope determine productivity and profitability. As with many other packaged goods, these economies are tied to marketing even more than to manufacturing; it is access to the national market that makes it economical to mount the advertising campaigns that sell beer, which in turn, makes it possible to build efficient-scale plants using labor-saving technologies and to operate them at full capacity.

This report is organized into four parts. After defining the scope of the industry, we turn to measuring productivity. Then we will shed light on the reasons for the large productivity differences among the U.S., Germany, and Japan. Finally, we will outline our conclusions concerning the outlook for the industry and the implications for national industrial policies.

THE BEER INDUSTRY

Beer is a product with four principal components:

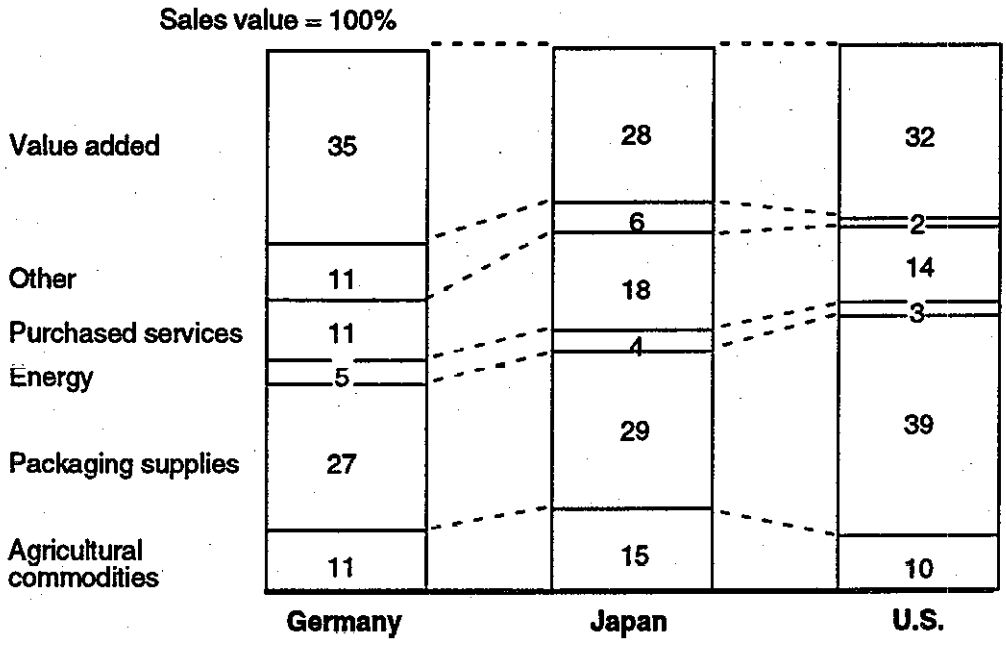
- Malt, which is barley that is allowed to germinate and is then dried
- Yeast, which causes barley to ferment and is thus responsible for beer's alcohol content
- Hops, which give the brew its distinctive flavor
- Water.

In addition, brewers sometimes use other flavoring ingredients, such as rice, corn, or even fruit juices.

The process that produces beer consists of letting the mixture of ingredients, called liquor, ferment until the desired alcohol content is reached. It is then decanted and filtered, sometimes diluted with water, pasteurized, and packaged in

Exhibit H - 1

STRUCTURE OF INPUTS



Source: Census of Manufactures; McKinsey analysis

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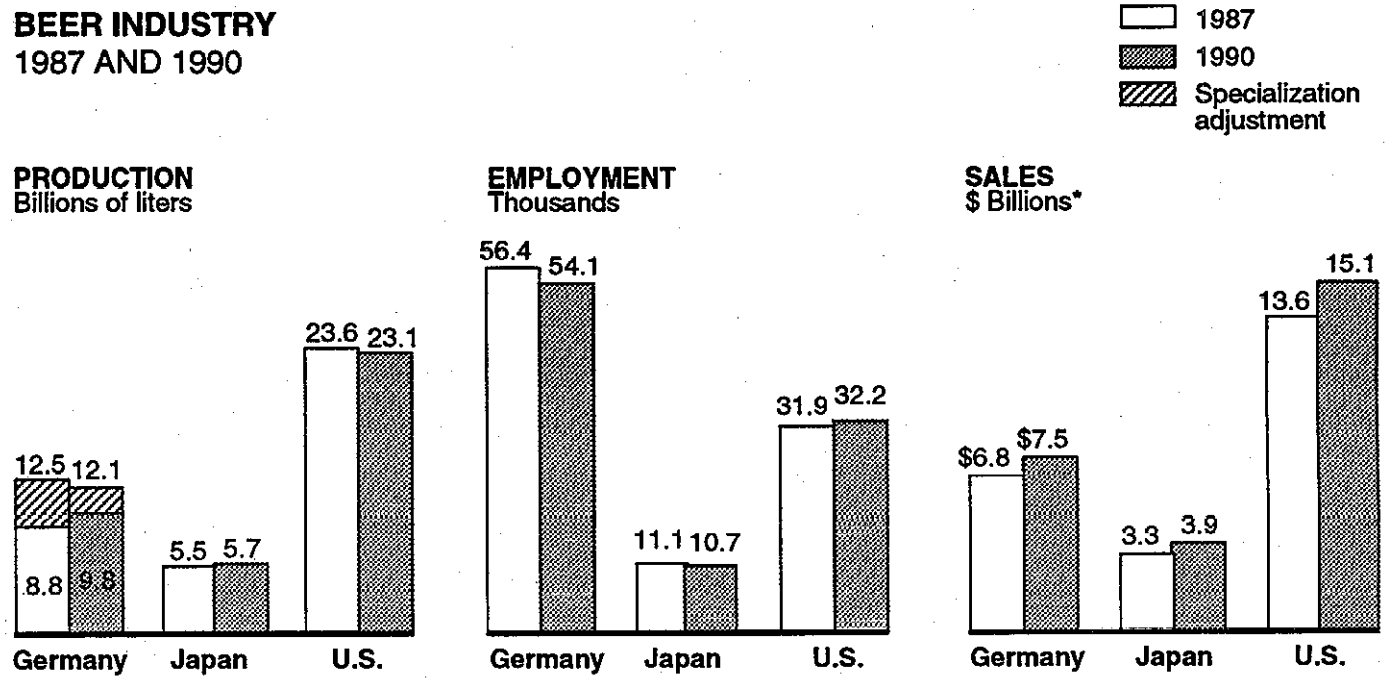
Exhibit H - 2

BEER INDUSTRY

1987 AND 1990



* At PPP

Source: Census of Manufactures; McKinsey analysis

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kegs, bottles, or aluminum cans. Several variants of the process are sometimes used.

Until the mid-nineteenth century, beer was made using the "top-fermenting" process, in which the liquor is allowed to attain the high temperature naturally produced by fermentation. This process results in heavier beer, such as ale and stout, which is still popular in the U.K. but accounts for only about 5 percent of the market in the U.S. and Germany, and even less in Japan.

Modern lager beer is made by "bottom-fermenting," which requires cooling the liquor during the process. Bottom-fermenting became the process of choice when mechanical refrigeration made large-scale production possible.

After reaching the target alcohol content, the liquor is decanted and filtered to remove most of the solid matter. It is also necessary to remove all active yeast at this stage to stop further fermentation and maturing, which would spoil the beer. This can be done by passing the brew through a fine filter, producing "draft" beer, or by pasteurization, which was actually invented for this purpose.[1]

The equipment used in brewing is specialized, which is why breweries generally produce nothing but beer, making it one of the "purest" industries. Where capacity exceeds demand, bottling equipment can be employed for other purposes, as it frequently is in Germany and, to a lesser extent, in Japan.

Beer closely resembles other packaged goods, and particularly food products. Its raw materials are agricultural commodities (Exhibit H-1), processing is very simple, and business success depends more on developing a consumer franchise than on securing cost advantage in manufacturing. Moreover, consumer franchise has often little relationship with the country of origin. Little do American drinkers of Kirin know that their favorite Japanese beer is manufactured by Molson in Canada. In addition, beer does not travel well, which is why the volume of international trade is insignificant. This is why vast differences in productivity between faraway countries can persist, but manufacturing economies can permit consolidation of the industry once the brewers learn to use marketing effectively.

Finally, the beer industry is not a big business. In 1990, all American breweries combined employed 32,200 workers to produce 23.1 billion liters of beer valued at $15.1 billion (Exhibit H-2). If it were a monopoly, the company would place 24th on Fortune's list for that year. The outputs of the German and the Japanese beer industries are even smaller, and in none of the countries is demand growing rapidly (Exhibit H-3).

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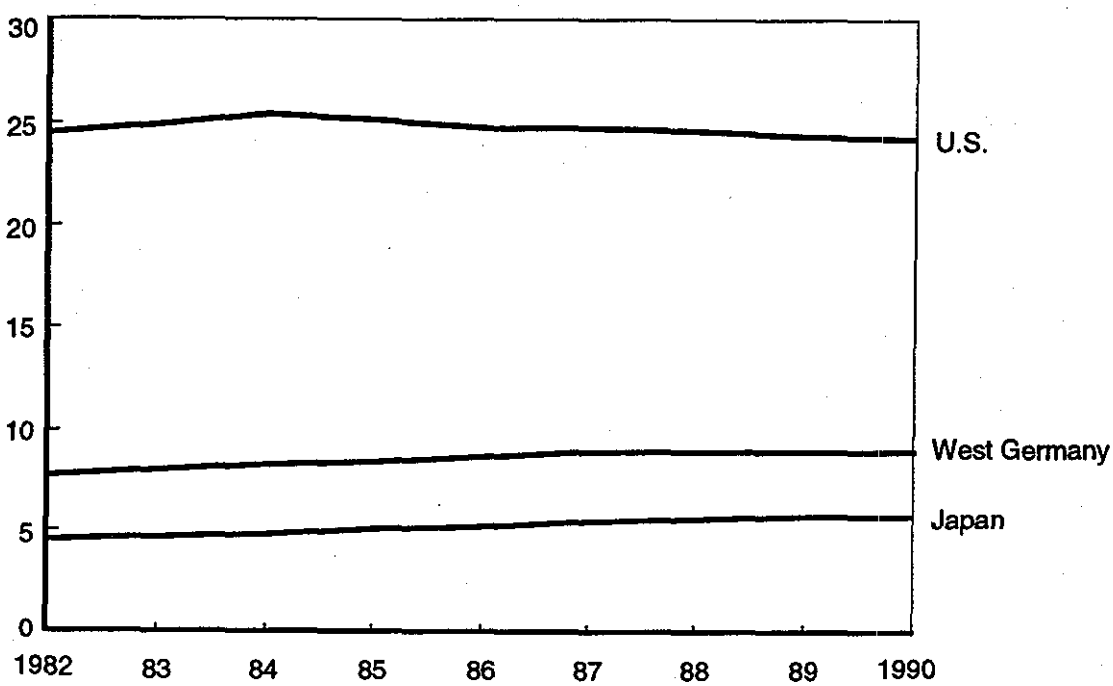
[1] Pasteur's goal was to increase what we would call today the shelf life of wine and his methods were aimed at killing residual yeast. Universal application of the technique to milk and other foods came later.

Exhibit H - 3

BEER MARKET DEMAND

Billions of liters per year



Source: McKinsey analysis

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ADJUSTMENTS

Specialization of Industrial Operations in Germany

Breweries in Germany have more bottling capacity than the demand for beer can support. They have developed a profitable sideline in bottling soft drinks and fruit juices. Value added from these activities represented 30 percent of the total value added realized by the industry in 1987 and 20 percent in 1990. To make a fair comparison of manufacturing productivity, we adjusted the output by treating all value added as if it came from bottling beer. We have thus added 41 percent, or 3.7 billion liters to the reported output for 1987 and 25 percent, or 2.3 billion liters for 1990.

Quality of German Beer

The issue of the quality of German beer seems to arise in every discussion of this subject. The usual argument invoked to extol the quality of imported beer is that American consumers willingly pay more than twice the price of Budweiser to sample Beck's or Paulaner. Also, everyone has a story of a really superb brew tasted in an unnamed Bierstube in Munich. However, the price of imported beer in an American supermarket reflects the marketing decision to sell imports to the small segments of the public that value the different taste and, above all, the image of foreign beers the most. This segment exists in Germany as well – Corona, a mass market Mexican beer, sells in Germany at a 50 percent premium over local brews where it is available. Also, for every exceptional brand such as Stuttgart's Dinkelacker, there is a Red Hill in the U.S., and all agree that there is little difference between the more popular Dortmund Union and American Miller.

More importantly, most of the beer sold in Germany can be made using large-scale production methods. The ingredients and the processing are the same, and Beck's brewery in Bremen is as large as the average plant in the U.S. Therefore, we made no adjustments to the output or the productivity data based on quality.

Differences in Distribution Systems

The distribution systems in the three countries are different (Exhibit H-4). In the U.S., manufacturers sell to distributors, who in turn service retailers. In Germany and Japan, between 50 and 70 percent of the output is delivered to the restaurants and stores directly, resulting in smaller, more complex shipments, and requiring more delivery manpower. Since we decided to compare manufacturing productivity only, we removed the estimated number of employees engaged in delivery of finished goods from the analysis. These numbers were estimated at 10 percent in the U.S., 14 percent in Japan, and 21 percent in Germany. The result of this adjustment is that we are comparing the products at the factory gate. The relative inefficiency of the distribution systems in Germany and Japan has another effect on productivity inside the factory, which we will discuss in the following section.

PRODUCTIVITY RESULTS

In this study, we decided to measure physical productivity expressed in liters per hour worked. This is possible because both the output and the input of the industry are nearly identical in the three countries studied. Despite somewhat different methods of production, there are no significant tangible differences among the beers. Furthermore, breweries' purchases are also almost identical. Other than the beside the usual raw materials, they buy energy (in the form of fuel oils, gas, and electricity), packaging materials, such as bottles, cans, paper boxes, and services, such as advertising. If we measure productivity at the factory gate in order to adjust for the differences in the distribution systems, liters per person-hour is a reliable gauge of productivity.

Adjustments

Before comparing productivity of the industries, we had to make some adjustments reflecting subtle differences in the products, the delivery systems, and the reporting methods used by the three countries examined in this study. There were three such adjustments: specialization of industrial operations in Germany, quality of German beer, and differences in distribution systems (see box entitled "Adjustments").

Labor Productivity

After these adjustments, U.S. brewery workers produced 436 liters per person-hour in 1990, compared with 300 liters in Japan and 193 in Germany (Exhibits H-5 and H-6). During the preceding 3 years, productivity in Japanese breweries improved by 4 percent annually, German breweries improved by 1 percent annually, while it remained unchanged in the U.S.

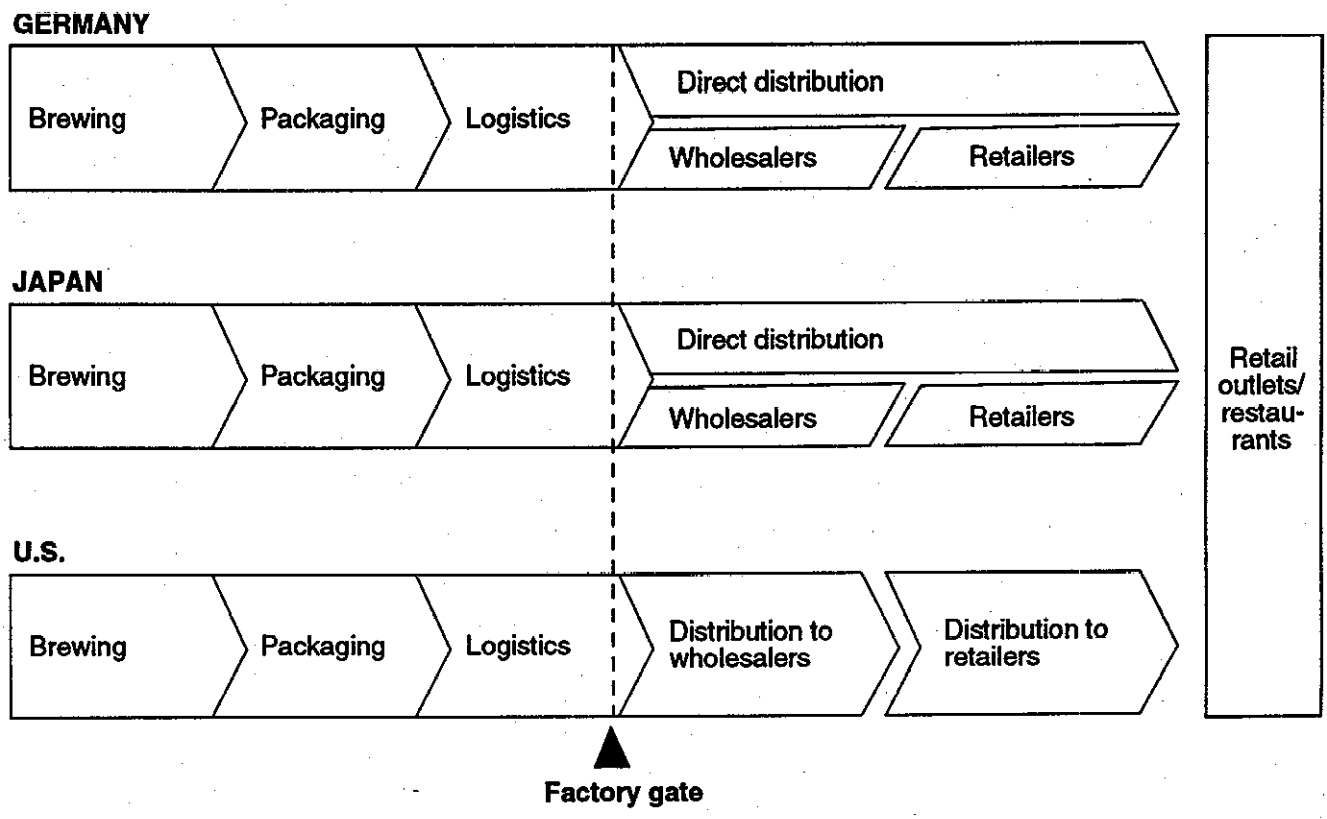
In this study, we are concerned only with labor productivity, but were we to consider capital as well, the results would not be very different. The Japanese use more capital per hour worked than the U.S. breweries, so the gap between their joint factor productivity and that of the U.S. must be wider than the 31 percentage points that we found in labor productivity in 1990. On the other hand, the German breweries are not as capital-intensive as those in the U.S., so the joint factor productivity gap between these two countries is smaller than the 55 percentage points observed in labor productivity.

CAUSES OF PRODUCTIVITY DIFFERENCES

Using the general framework for this study, we will examine the reasons for the observed productivity differences at three levels.

Exhibit H - 4

BEER INDUSTRY BUSINESS SYSTEM



Source: McKinsey interviews

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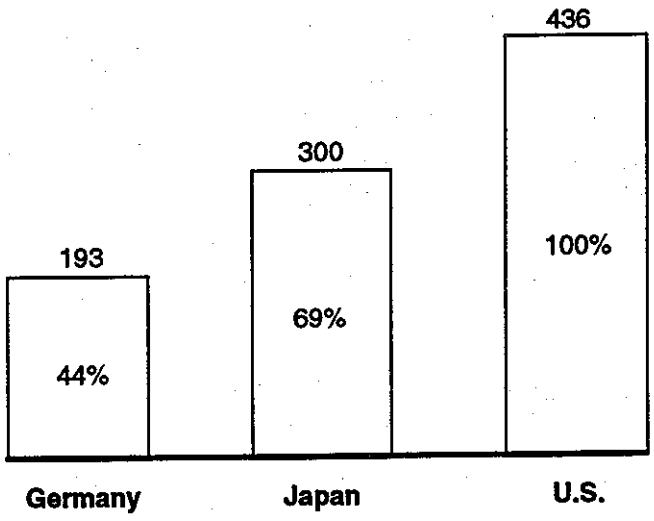
Exhibit H - 5

BEER LABOR PRODUCTIVITY 1990

LITERS PER HOUR WORKED

Index: U.S. = 100



Source: Census of Manufactures; McKinsey analysis

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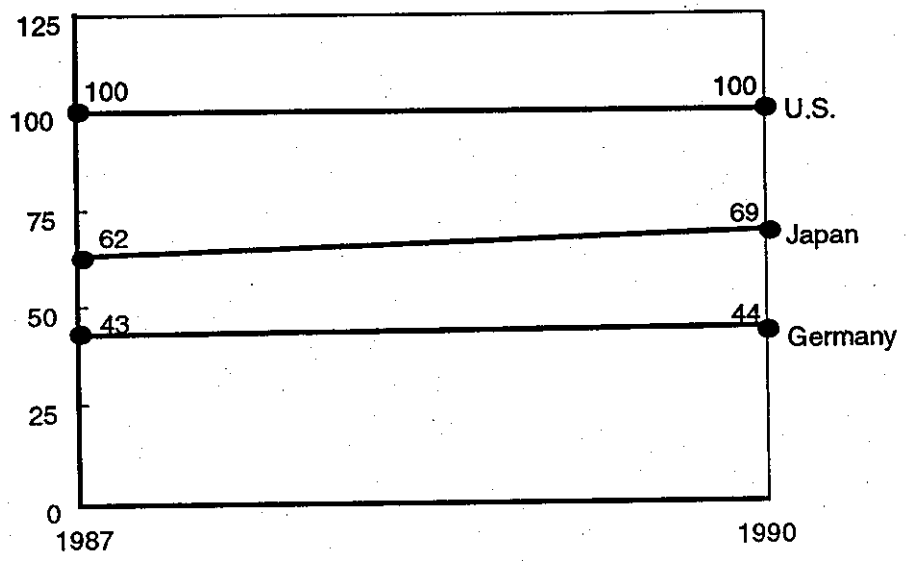
Exhibit H - 6

REAL LABOR PRODUCTIVITY CHANGE IN THE BEER INDUSTRY 1987-90

LITERS PER HOUR WORKED

Index: U.S. 1987 = 100



	Real annual productivity change 1987-90
U.S.	0%
Japan	4
Germany	1

Source: Census of Manufactures; McKinsey analysis

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Exhibit H - 7

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES 1990

BEER INDUSTRY

External factors	Nauture of competition	Production process	Labor productivity
Germany: Strong customer preferences for local product and local production	Local monopolies and near-monopolies, recent unsuccessful attempts at consolidation	Insufficient scale for efficient operations and for utilization of modern technology	Large productivity gaps - Germany = 44% - Japan = 69% - U.S. = 100%
Japan: Regulation of prices, production, and distribution through permits; inefficient distribution system	Concentrated industry competing for ever smaller market niches with a wide product variety	Short bottling runs, inefficient logistics, high degree of mechanization	
U.S.: Large national market, permitting unique economies of scale in marketing	Concentrated industry competing for nationwide markets	Large-scale plants, high degree of mechanization	

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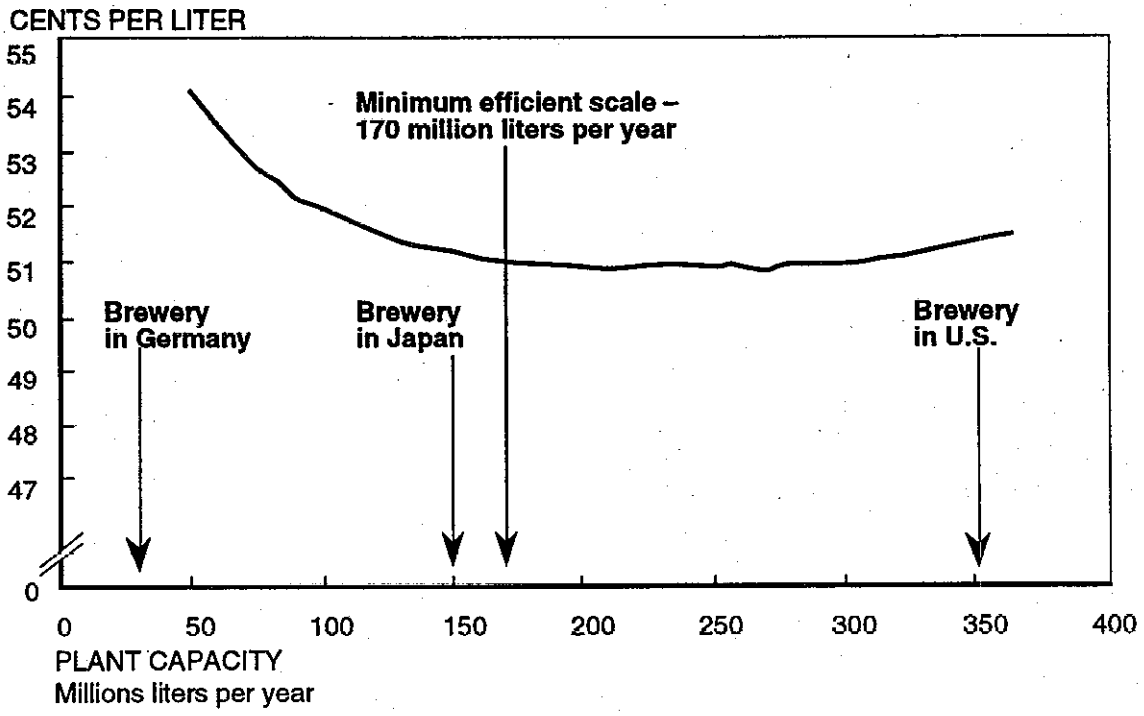
Exhibit H - 8

SHORT-TERM AVERAGE COST



Source: Kenneth G. Elzinga

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First, we will examine the differences in the production processes, that is, in the way the companies organized themselves to do business, their scale, efficiency of utilization of resources, and their ability to take advantage of the best technologies. The main cause of the low productivity in Germany is the scale of the breweries – they are too small to be efficient. In Japan, productivity lags behind the U.S. mainly because of the product variety and less efficient organization of functions and tasks.

Second, we will analyze the differences in the industries' structure and behavior, that is, in how the companies compete. The small size of plants in Germany is the result of local near-monopolies enjoyed by breweries, while the product variety in Japan comes from the way in which the companies are trying to expand their customer base.

Finally, we will direct our attention to the external factors in which the industries operate, such as the characteristics of the markets and the nature of the governments' intervention in the business. Here we find that the local near-monopolies in Germany are the companies' response to the peculiarities of demand, while the companies in Japan compete in the manner that they do mainly because of their government's regulation of the industry. The causes of the productivity differences are summarized in Exhibit H-7.

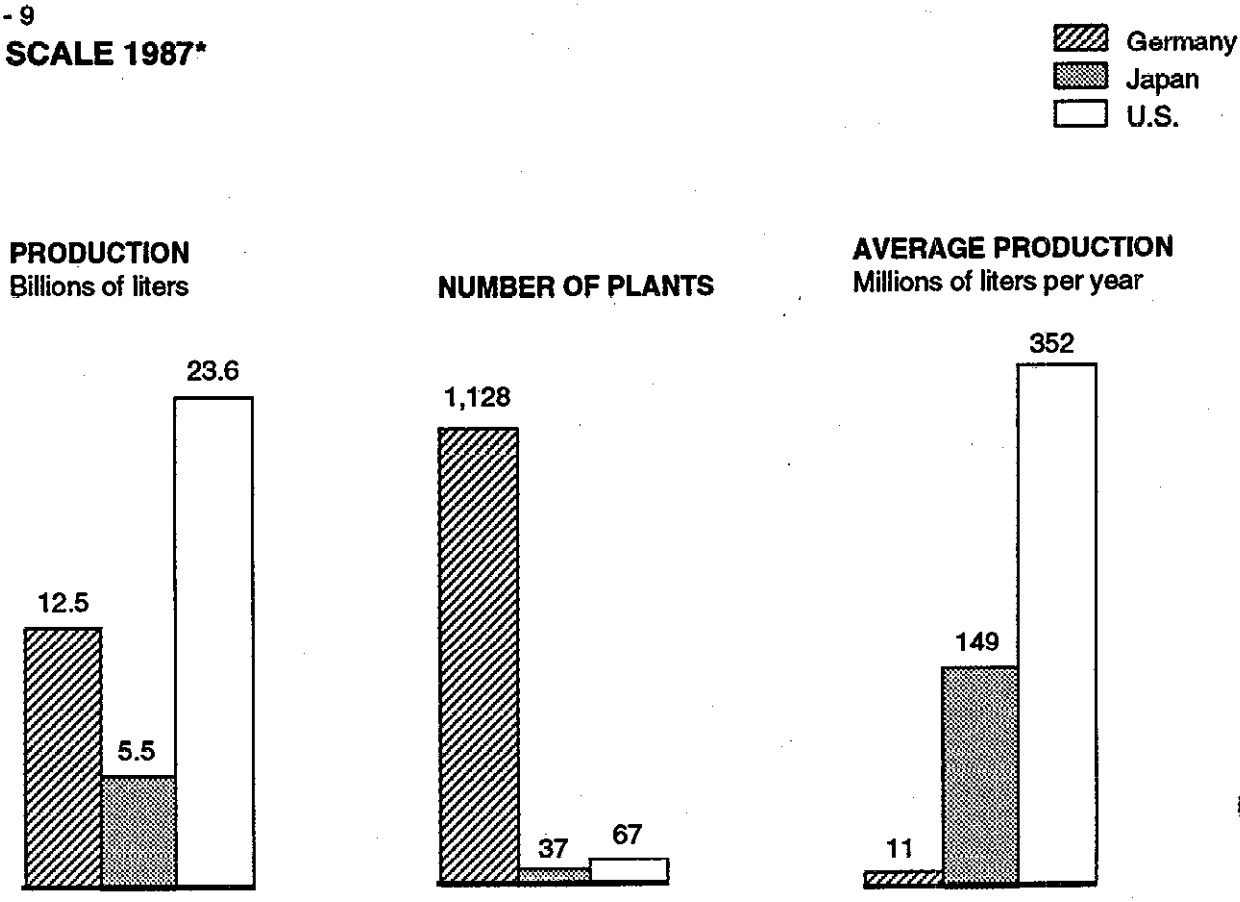
Causality at the Production Process Level

¶ Capital and scale as causal factors. In the beer industry, as in many other process industries, capital and scale are important determinants of profitability. Appropriate scale of the plant is crucial to being able to use efficient packaging technology. For example, a modern filling line processes 1,200 bottles per minute. Aluminum can filling lines operate at the speed of 2,000 12-oz. (0.355 liter) cans per minute. This is why the beer industry requires scale. Analysts estimate that plants with capacity below 170 million liters per year are at an inherent and insurmountable cost disadvantage compared to larger breweries (Exhibit H-8). An elementary calculation shows that to utilize even one canning line at 80 percent of capacity requires annual volume of over 130 million liters, assuming a two-shift operation. Because most brewery workers are employed in bottling, the ability to use the most efficient technology there determines labor productivity.

Yet, while the average production capacity of a brewery in the U.S. is on the order of 350 million liters per year, its counterpart in Japan is less than half that size, while a typical plant in Germany produces only 11 million liters per year (Exhibit H-9). This is one reason why aluminum cans are

Exhibit H - 9

PLANT SCALE 1987*



* Excludes microbreweries

Source: Census of Manufactures; McKinsey analysis

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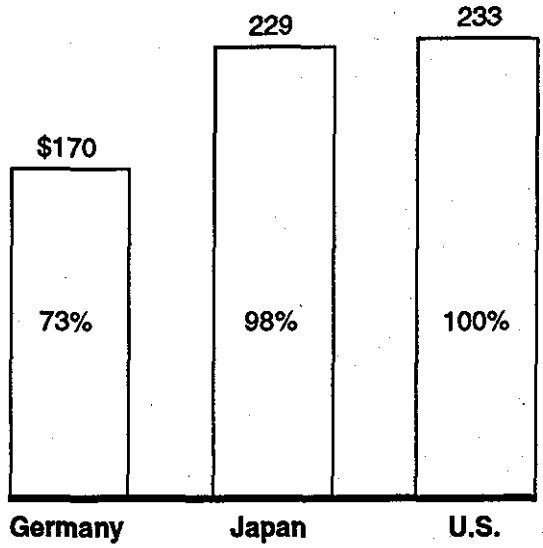
Exhibit H - 10

CAPITAL INTENSITY

BEER INDUSTRY

1987 CAPITAL STOCK $ PER HOUR WORKED AND PERCENT

Index: U.S. = 100



Source: Census of Manufactures; National investment statistics; McKinsey analysis

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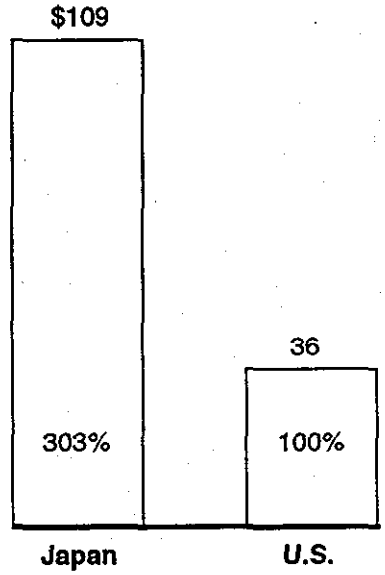
Exhibit H - 11

ACCUMULATED CAPITAL INVESTMENTS 1987-90

1987 $ PER HOUR WORKED AND PERCENT

Index: U.S. = 100



Source: Census of Manufactures; McKinsey analysis

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very rare in Germany[2], and even in Japan they are used much less than in the U.S.

There are other labor-saving methods that are commonplace in the U.S. and in Japan, yet are only infrequently seen in Germany. Examples are large-scale refrigeration and automated cleaning. Increasing the capacity of a refrigeration unit by a factor of 10 increases its cost by a factor of 6, and doubles its energy efficiency. Yet the two units require virtually the same maintenance. At a large-scale plant, cleaning can be automated and done less frequently than is required at a plant in Germany.

These are examples of how the scale of operations explains most of the relative inefficiency of German plants. Other, less important factors include the breweries' strategies to produce a full assortment of beers (regular, dark, etc.) in a variety of bottles (0.33 liter, 0.50 liter, and sometimes 0.67 liter and 1.00 liter) and the logistical difficulties of assembling mixed shipments for individual retail outlets.

Some breweries have pooled their resources and invested in central bottling plants, to which the filtered product is shipped for packaging. This solution, however, requires additional transportation of the product and frequent set-ups of the bottling lines (for different products, bottles, and breweries). In all, the choices that breweries in Germany have made explain why their productivity is less than half that of the U.S.

In 1990, productivity in Japan was at 70 percent of the U.S. level. As we noted earlier, the plants there are close to the minimum efficient scale, so that insufficient scale explains only a part of the gap. In addition, the Japanese beer industry, almost equal in capital intensity to the U.S. in 1987, embarked on a massive investment campaign during the 1987 to 1990 period (Exhibits H-10 and H-11). That, however, does not mean that scale and technology differences do not exist. For example, we have already noted that canned beer is nowhere near as common in Japan as it is in the U.S., which is one consequence of smaller-than-optimum scale plants. Also, canning lines in Japan require as much maintenance as in the U.S. but have lower output, which has an obvious effect on productivity.

¶ Product variety as a causal factor. The strategies of Japanese breweries call for constant introduction of new products. For example, Kirin, despite being four times smaller than Anheuser-Busch, markets 17 brands of beer, compared with the latter's 14 (Exhibit H-12). Even if these products meet with only limited acceptance (Asahi dry beer was a notable exception), the

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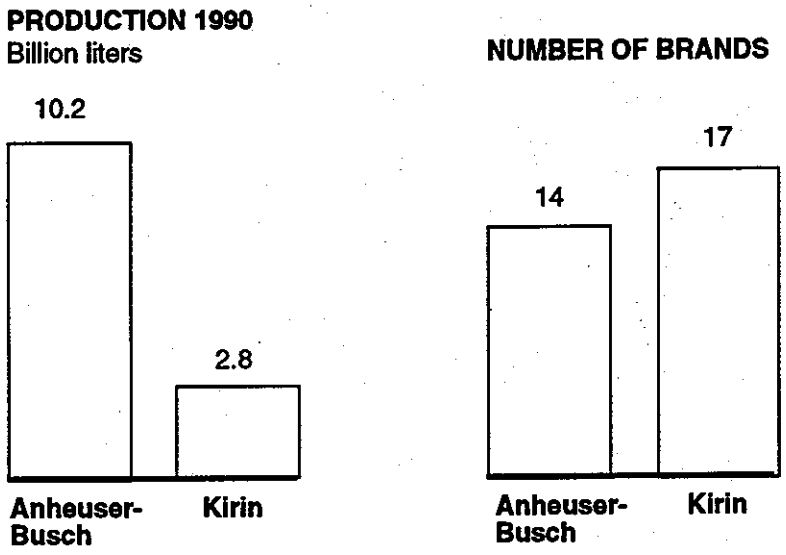
[2] Another reason is a popular perception that aluminium is harmful to the environment.

Exhibit H - 12
PRODUCT VARIETY
BEER INDUSTRY



Source: Annual reports; McKinsey analysis
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Exhibit H - 13
CAUSES OF LABOR PRODUCTIVITY DIFFERENCES PRODUCTION PROCESS LEVEL

Factor	Japan	Germany	Impact on productivity
Product			
Product mix and variety	High product variety Many new products	Many small volume products	Inability to take advantage of canning efficiency Inability to bottle efficiently
Production factors			
Scale economies	Plant scale barely sufficient for efficient bottling	Scale insufficient for efficient operations	Explains most of the difference between U.S. and Germany
Machinery and equipment	Modern lines, but slow canning	Many manual and batch processes	High maintenance and low throughput
Operations			
Organization of functions and tasks	Distribution penalty Inefficient use of labor	Distribution penalty	

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high prices (and margins) make the strategy profitable. However, the necessarily short bottling runs and the logistical complexity caused by the proliferation of products exact a considerable toll on productivity.

¶ Organization of functions and tasks as a causal factor. About half of the output in Germany and Japan leaves the plant for retail outlets, such as shops and restaurants. This means that instead of loading uniform pallets on 18-wheelers, much beer in Japan and in Germany has to be loaded for retail delivery. But assembling truckloads for delivery of small amounts of diverse products requires more labor than putting homogeneous pallets on a truck bound for one distributor. These practices cost 4 percent in excess employment in breweries in Japan and 11 percent in breweries in Germany. In the U.S., these costs are born by distributors and wholesalers.

The complexity of the Japanese distribution system exacts a further penalty on the brewers' productivity. Dealing with hundreds of wholesalers and thousands of retailers requires much more labor than the American breweries employ to administer transactions and to maintain relationships with the distributors. Japanese beer industry executives claim that having to deal with the distribution system lowers their total productivity by 10 percentage points.

As we noted earlier, breweries in Japan are as modern and as automated as those in the U.S. However, they have not been able to capitalize on the technology fully. Because of the lifetime employment tradition, they have not been able to lay off the redundant employees and have had to create new jobs for them, often in sales and public relations (e.g., dealing with visitors and conducting plant tours).

In summary (Exhibit H-13), scale and technology are the most important determinants of beer industry productivity. The complexity arising from product and package variety adds to manpower requirements, and thus, lowers the observed productivity further. Inefficiency of distribution systems, which is to some extent beyond the control of the companies in the industry, also contributes to the productivity gap. Ineffective use of labor may also be a consequence of labor policies, such as lifetime employment, where the technology was upgraded only recently and led to excess employment.

Industry Behavior

Why have the American brewers been able, unlike the Germans, to build some of the world's largest plants? How do they manage to compete without introducing proportionally as many new products and packages as their Japanese counterparts?

Exhibit H - 14

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES
INDUSTRY LEVEL

Factor	U.S.	Japan	Germany
Horizontal			
Concentration	5 players controlling 88% of the market	5 companies controlling 100% of the market	Over 1,000 companies, none with more than 5% of the market
	67 plants, 43 of which with capacity of over 100 million liters per year	37 plants, most at about critical mass	1,128 plants, few over 100 million liters per year
Competition behavior	Intensive advertising of national brands; deals to trade	Regulated and concentrated industry	Local monopolies Full product lines
	Competition from imports and licensed products	Some competition from licensed products	Intensive distribution Little imports or licensed products
Vertical			
Distributors	Long-term contracts for virtually entire production	Self-distribution of half of the volume	No infrastructure
Suppliers	Arm's length purchases	Domestic contracts for small quantities of raw materials	Predominantly local purchasing

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¶ The nature of competition. In both the U.S. and Japan, the beer industries are concentrated. In the U.S., five companies are responsible for 88 percent of the output, with Anheuser-Busch controlling 45 percent of the market and producing almost 10 billion liters per year, more than the total consumption of the former West Germany. In Japan, there are only five beer companies, of which Kirin is the largest with half of the market, while Orion, the smallest, is virtually undistributed outside the island of Okinawa.

In contrast, more than 1,000 separate companies operate in Germany, with only a few nationally distributed brands, the largest of which had under a 4 percent share of the so-called national market in 1987. In a truly national market with 1,000 competitors, the availability of the economies of scale would create a powerful incentive to consolidate production, build modern plants, and change the dynamics of competitive interaction, leading to a more concentrated industry. But Germany has only a limited national market. It is a collection of local monopolies or near-monopolies, in which virtually all producers distribute their output within a 30-mile radius of the plant. This structure of the industry enables the breweries to charge prices sufficient for survival.

There is no convergence between the U.S. and German productivity levels, and there can be none without a massive restructuring of the industry. We will discuss the impediments to such a restructuring in the following section.

In Japan, beer has been the beneficiary of the decreasing trend in alcohol consumption, because the trend has manifested itself as a switch from higher alcohol content beverages to beer. In part, this is due to the competitive tactics of Kirin and Asahi, who compete for shelf space and customers by introducing new products and new packages, and by offering the trade a high level of service through salesmen's attention to retail outlets. Prices are relatively high, for reasons explained later in this report. The recent Japanese manufacturing productivity increase is mainly due to demand growth.

Because of lack of an efficient distribution infrastructure in Japan and because of the nature of the consumer franchise in Germany, breweries as well as other consumer goods manufacturing companies, must perform many tasks that are not necessary in the U.S. Most of the penalty on productivity can be seen in distribution, i.e., the delivery to the immediate buyer, which lies outside the scope of this study and is often performed by a subcontractor.

Exhibit H-14 gives an overview of how the conduct of the industry participants influences productivity in the three countries.

Finally, exporting beer is not the mainstay of breweries' strategies. Transportation of beer over long distances is expensive, so the product must be able to command a high price relative to the local offerings. This is possible only if the import is positioned at the high end of the market, thus limiting the volume that can be shipped. Since vigorous international competition is one of the forces that make production methods converge, lack of it in the beer industry explains the persistence of the productivity gaps.

¶ The vehicles of productivity convergence. Despite the low level of international trade in beer, there are mechanisms with the potential for causing productivity levels to converge. The most powerful of these mechanisms is the universal availability of modern manufacturing equipment. Interestingly enough, most of the hardware is supplied by European manufacturers, among which the German suppliers are the largest. The recent productivity gains in breweries in Japan are in no small measure due to the installation of state-of-the-art German equipment.

There is also a new wave of foreign ventures by brewers, of which the recent Anheuser-Busch–Kirin agreement is the most prominent. Such joint ventures may influence both the organization of plants and the structure and behavior of the industry, but, for the reasons outlined in the next section, we do not believe that they will have an effect on productivity soon.

External Causal Factors

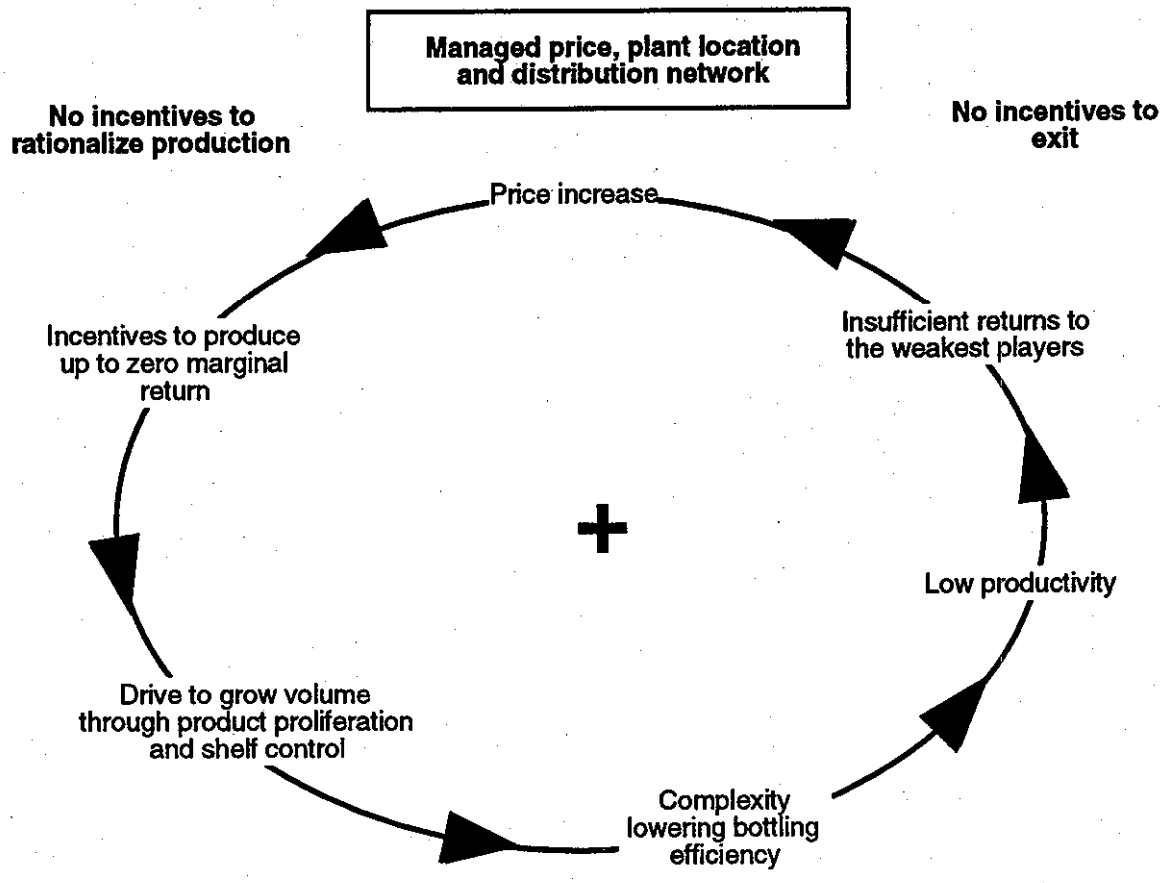
The beer industries in the three countries operate in very different environments. Other than taxation and some restrictions on labeling, advertising, and retail sales (for example, no sales to minors or, in some states, on Sundays), the U.S. beer industry is free from regulatory constraints. In addition, there are few constraints on the market for corporate control, which explains how the industry was transformed from 490 plants in the early 1960s to 67 today. The efficient and productive beer industry that we see in the U.S. today is a direct consequence of these conditions. We will discuss in this section the very different external factors that the Japanese and German industries face.

¶ Market conditions and the regulatory environment in Japan. Even though the structure of the Japanese industry, with five players, resembles that of the U.S., its history is different. Prior to the end of World War II, the beer industry was a state monopoly. As a part of decartelization, it was divided into two companies: Asahi was given the west of the country, and Sapporo's franchise lay in the east. Kirin started out after the war, while Suntory, a wine and spirits company, entered the beer market only in the 1970s.

Exhibit H - 15

INFLUENCE OF REGULATION ON INDUSTRY CONDUCT

JAPAN



Source: McKinsey interviews

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The Japanese beer industry has always been strictly regulated by the Ministry of Finance (MOF), and so remains to this day. Companies are allocated plants, and permission is needed to open distribution points, and even retail outlets. All this is accomplished by the MOF, which is trying to create the tax base for the local administrative regions (prefectures). Because of the competitive dynamics, permission to build a plant or to open a distribution outlet is equivalent to an order; if the competitor with such permission declines to invest, another competitor will. The process is motivated by local politics; breweries pay taxes equal to almost 30 percent of sales value to the prefectures in which they are located. There are 37 breweries and 57 prefectures, with some prefectures sharing the benefits of a brewery.

Moreover, prices are negotiated with the MOF. The central planners' goal has been to protect the weakest player. The result of this environment is a regulatory "spiral of death." If a weak player is threatened, he/she petitions the MOF for a price increase for everybody. The new price, which is granted more often than not, changes the other competitors' economics, because they always want to produce up to zero marginal return. However, the only way to grow in volume is to create new products aimed at smaller and smaller market niches. This creates inefficiencies in manufacturing, particularly in bottling, threatening productivity. But the real problem is in logistics and distribution, where the complex product line requires more investment and manpower. As a result, weak players get weaker, requiring another round of price increases (Exhibit H-15).

Because the regulatory mechanism forces the competition to serve smaller market niches, demand in Japan has also been evolving differently from that in the U.S. The Japanese consume much more bottled "draft," i.e., unpasteurized beer. This product has to be consumed fresher than ordinary lager, which arguably places additional stress on the logistics.[3]

¶ Market conditions and the regulatory environment in Germany. The German business environment is different still. Operation of breweries is left to brewers. The salient fact determining the shape of German industry today is tradition. And tradition requires that beer drunk locally be produced locally, hence local monopolies.

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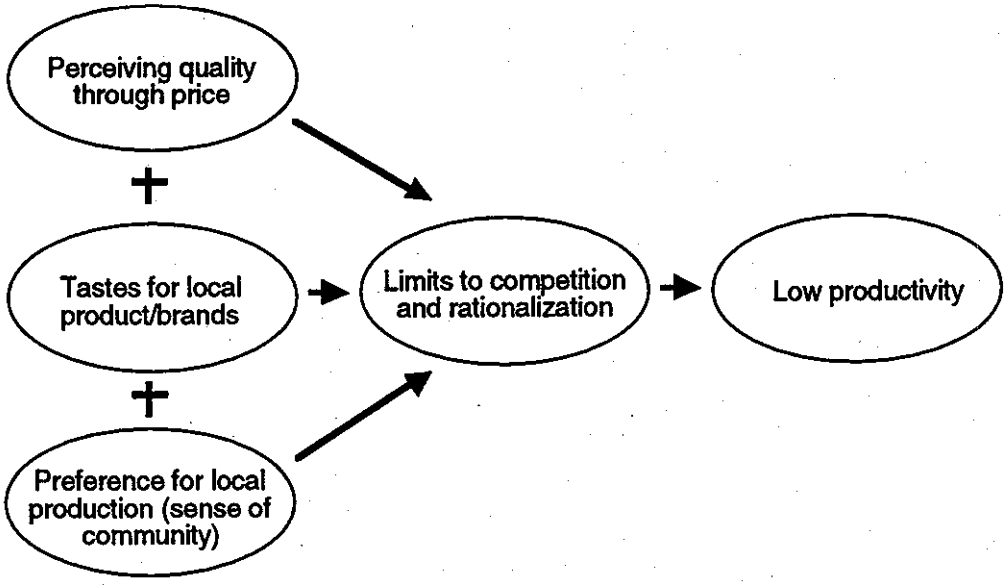
[3] Most modern management theories proclaim that shorter throughput time increases efficiency and productivity. However, when the production system is conceived for political, rather economic benefits and when the distribution system is antiquated, shorter service time imposes additional rigor on all factors and may thus require additional effort.

Exhibit H - 16
INFLUENCE OF DEMAND STRUCTURE
GERMANY



Source: McKinsey interviews
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Exhibit H - 17
CAUSES OF LABOR PRODUCTIVITY DIFFERENCES
ENVIRONMENTAL LEVEL

Factor	U.S.	Japan	Germany
Regulation	Alcohol content Licensing and taxation	Plant, distribution center, and retail location licensing Price regulation Domestic starch	Purity (ingredients)
Demand	Homogeneous Shaped by advertising Stagnant	Homogeneous Growing	Locally fragmented/ preferences for local production Growing slowly
Market for corporate control	Antitrust	Control by financial institutions and keiretsu	Family ownership Foreigners unwelcome
Labor market	Decreasing unionization	Lifetime employment	Hidden unemployment

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In general, German beer consumers equate quality with price, making a low-price strategy self-defeating. This is reinforced by the preference for locally-produced beer. The only reason for buying a product from far away would be a lower price combined with at least equivalent quality, which, for most consumers, is a contradiction. This situation creates limits for competition and for rationalization, leading to low and stagnant productivity (Exhibit H-16).

Adding to the productivity dilemma in Germany is the control structure of the industry. Many small breweries are locally owned, often by the descendants of the original founders. Local banks may hold shares in their portfolios, and they certainly hold the debt. As long as the debt performs, there is no easy way to acquire the local producers.

In the last few years, several companies tried, or at least formulated plans to carve a profitable niche for themselves by consolidating local brands. So far, all have failed. Brau und Brunnen, a Dortmund-based company and the corporate parent of Dortmund Union Bier, became the largest German brewer by acquiring some 30 companies. Yet, Brau und Brunnen did not manage to consolidate production. Similarly, Heineken, the market leader in Europe, found out that even owning a German brewery did not help to build acceptance for the company's flagship brand.

In the 1970s, Anheuser-Busch, Miller, and Heileman consolidated the U.S. beer industry. Their strategy did not rely on price. Their value proposition relied on product differentiation and their products were priced higher than those of the local competitors. The economies of national advertising, the real driving force of the beer industry strategy, is what made it possible. Duplicating this strategy in Germany is difficult, because advertising may be the only means of convincing German consumers that there are acceptable alternatives to their local beers. Yet, advertising is not as pervasive in Germany as it is in the U.S.

Exhibit H-17 is a summary of the environmental factors' effect on productivity.

OUTLOOK

Barring a major technological innovation in packaging, we do not foresee much further convergence between the Japanese and the U.S. beer industries. The gains so far have been due to the growth in production and to massive investment. The growth was achieved at a cost of increasing product complexity, thus setting a limit to productivity improvement. A new wave of investment is unlikely until attrition solves the problem of the lifetime employment tradition. The relative inefficiency of the distribution infrastructure, the other major impediment to productivity, is an

Exhibit H - 18

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES

BEER INDUSTRY

● Important
O Secondary
X Undifferentiating

External factors	
• Market conditions	
- Demand factors	●
- Relative input prices/factor availability	X
- Other industries	O
• Policy and regulation	
- Macroeconomic conditions	X
- Competition rules and concentration rules	●
- Corporate governance rules	O
- Labor rules and unionism	O
- Other regulations (tariffs, nontariffs)	X
Nature of competition	●
Production process	
• Output	
- Mix, variety, quality	O
• Production factors	
- Capital (intensity, vintage, technology)	●
- Scale	●
- Design for manufacturing	X
- Basic skill of labor, intrinsic motivation	X
- Raw materials, parts	X
• Operations	
- Capacity utilization	X
- Organization of functions and tasks	O
LABOR PRODUCTIVITY	

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economywide problem in Japan. The beer industry is too small and inconsequential to tackle this obstacle by itself.

Improvement of productivity in Germany holds a brighter promise. With the creation of a European market, local acceptance of national and transnational brands may increase. The influence of advertising, the key factor to consolidation in the U.S. industry, may increase, thus making it more attractive for some producers to create these brands. Consolidation of the industry and the improvement of productivity will follow, as it did in the U.S. 20 years ago. The changes have already begun to happen. The Warsteiner and Bitburger breweries have doubled their output during the years 1990 to 1992. They achieved this growth through a national advertising campaign.

SUMMARY AND POLICY ISSUES

We have discussed the beer industry as a case example of consumer goods in general, and of beverages in particular. We found large differences in productivity between the U.S. and Germany and smaller differences between Japan and the U.S. We discovered that scale and technology are the most important determinants of productivity. Product line complexity arising from strategies aimed to serve small niches in Japan is a consequence of regulatory restrictions on other forms of competition, such as price. In Germany, product lines are complex relative to the markets because of the fragmentation of the latter. Complexity contributes to the relative inefficiency of these industries, as does the lack of a large-scale distribution system in Japan, though the latter is beyond the control of beer companies. In Japan, ineffective use of labor may be the consequence of the lifetime employment policy (Exhibit H-18).

The analysis of the causes of productivity differences between the U.S. and Japan suggests that the type of regulation selected by the MOF exacts a heavy price on productivity. More open competition, including price competition, together with operational freedom to open and close plants and distribution centers, would probably result in lower prices, consolidation of production, and productivity gains.[4] Preserving the local tax benefits would, however, require replacing current production taxes with a larger consumption tax. In addition, building an efficient distribution system for consumer goods would benefit the entire economy.

The German productivity lag is largely caused by barriers to rationalization, which are a consequence of the peculiarities of demand. Overcoming these barriers involves more cultural than policy issues. Once these issues are resolved, productivity would benefit from letting the distribution of beer be handled by the system that already distributes other consumer goods efficiently.

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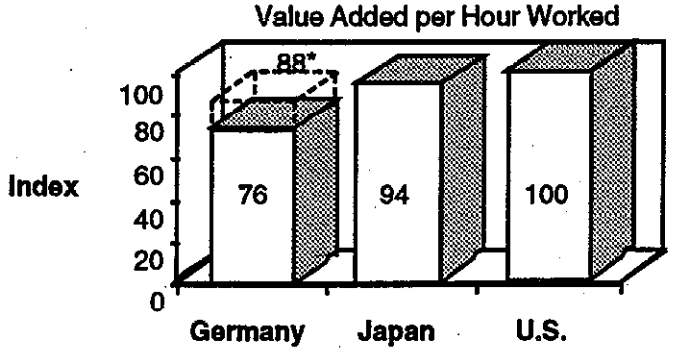
[4] Recent developments in Japan suggest that pricing of beer may become more flexible.

SOAP AND DETERGENT CASE STUDY SUMMARY

Soap and Detergent Labor Productivity 1990



* Dotted line shows German productivity at U.S. share of liquid detergent in total laundry detergent

Global companies drive productivity convergence in soap and detergent market. Low productivity in Germany partially reflects consumer preference for powdered detergents.

Although the economies of scale and organization of labor play a role, **productivity differences in the soap and detergent business arise largely from variations in consumer tastes.** German consumers have a preference for bleach in their detergents. Until very recently, bleach could only be incorporated into a powder product. For purely technological reasons, the process of making powdered detergent is less productive than the process for making liquid products. A liquid detergent plant employs about 30 percent less labor than a comparable powder plant. As a result, Germany's productivity lags behind that of the U.S. and Japan. In addition, the cost of complying with differences in antipollution regulations across the three countries affects labor productivity.

In 1987, Japanese productivity stood at only 76 percent of U.S. levels. Today, U.S. and Japanese productivity have virtually converged, driven by increased competition and foreign direct investment. The convergence of U.S. and Japanese productivity, and the eventual convergence of German productivity, can be traced to a rapid transfer of manufacturing know-how within the handful of global giants that lead this industry: Colgate Palmolive, Procter & Gamble, Unilever, and, to a lesser extent, both Kao in Japan and Henkel in Germany. These firms are highly competitive with one another, and therefore innovations rapidly diffuse within multinational companies and also within the industry. The players, especially Colgate, Procter & Gamble, and Unilever, are so large and globally dispersed that the competition between them is enough to drive a convergence in national productivity numbers. All these firms devote considerable effort to rotate staff among countries and have cross-country organizational structures. Global productivity is converging because these companies are, in essence, producing similar products with similar state-of-the-art technologies in different locations.

PRODUCTIVITY IN THE SOAP AND DETERGENT INDUSTRY

The evolution of this industry serves to illustrate how large-scale foreign direct investment by several global companies has led to considerable international convergence at high levels of labor productivity. The differences that do remain are explained in almost equal proportion by differences in the product mix demanded by consumers and by other factors.

The soap and detergent industry provides a case study example of productivity in a chemical process based industry. The major products of this industry play a central role in the non-food part of the consumer goods sector, and some part of the output is sold for industrial use. The consumer part has similar characteristics to the processed food industry in terms of packaging and distribution through retail outlets, but it involves an even more intense marketing effort.

The soap and detergent industry has evolved into a highly capital-intensive industry in which the major participants either are, or are trying to become, established in the three major economic regions of Europe, North America, and Asia. In recent years, marketing has become more important to the economics of the business; regional product formulation (which can be sold either under the same or different brand names in different markets) and advertising has made the construction and efficient utilization of plants that more fully exploit scale economies possible.

THE SOAP AND DETERGENT INDUSTRY

The soap and detergent industry produces cleaning agents for both household and industrial use. In the U.S. the split is 20 percent industrial, 80 percent household. On the household side, products include both solid and liquid laundry detergents and soaps of various sorts (bars, liquids and so forth). On the industrial side, the products are primarily detergents but also include specialty soaps for industrial use: formulations designed to assist in the removal of heavy industrial oils and greases, for example (Exhibit I-1).

Output value, at industry purchasing power parity (PPP) exchange rates calculated from unit value ratios ranged in 1990 from about $2 billion in (the former West) Germany (detergents only) and about $3 billion in Japan to around $15 billion in the U.S. The industry employs around 8,000 people in Germany – counting, as is standard in the German census data, only firms with more than 20 employees – and on the order of 9,000 in Japan and 36,000 in the U.S.

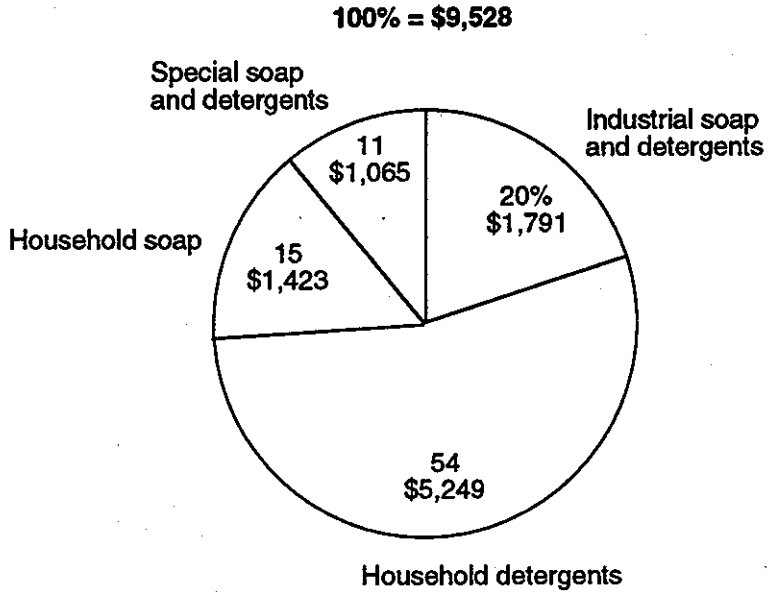
Value added is typically around 50 to 55 percent of output value with only minor variations across both time (from 1987 to 1990) and geography. This

Exhibit I - 1

PRODUCT CATEGORIES IN THE U.S. SOAP AND DETERGENT INDUSTRY 1987

VALUE OF SHIPMENTS OF MAIN PRODUCTS

Percent, $ Million



Source: Census of Manufactures; McKinsey analysis

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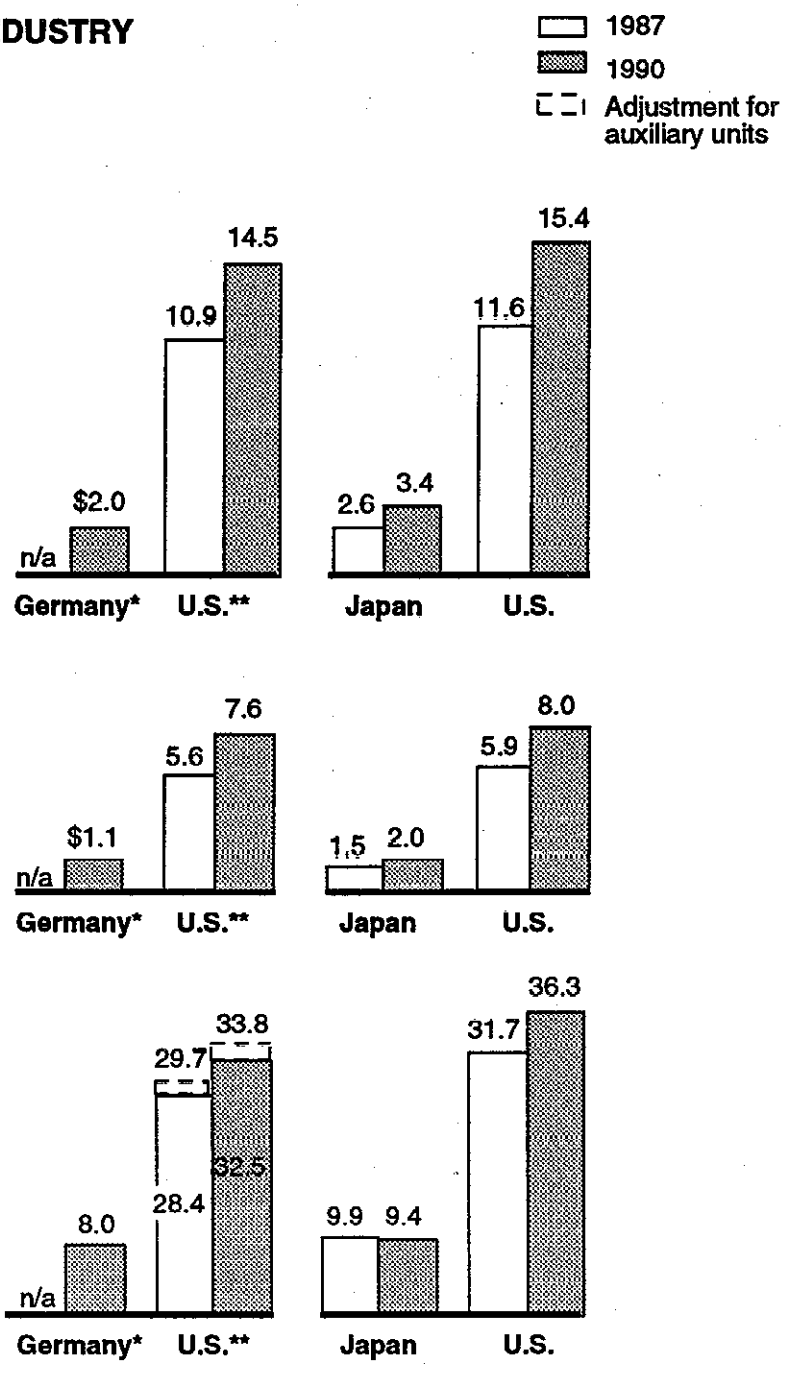
Exhibit I - 2

SOAP AND DETERGENT INDUSTRY
1987 AND 1990



* Detergent production only; output from census, other data is McKinsey estimate
** Only establishments with more than 20 employees

Source: Census of Manufactures; McKinsey analysis

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translates into 1990 value-added figures of a little over $1 billion (at PPP) in Germany, about $2 billion in Japan and about $8 billion in the U.S. (Exhibit I-2).

The soap and detergent industry's products are distributed to both household and industrial users. For household end users, the route from the factory to the kitchen or bathroom usually involves both a wholesaler and a retailer, although in the case of many larger supermarkets (e.g., Aldi in Germany), the wholesale stage can be effectively bypassed. Large industrial users typically obtain supplies directly while smaller users are likely to work through a wholesaler.

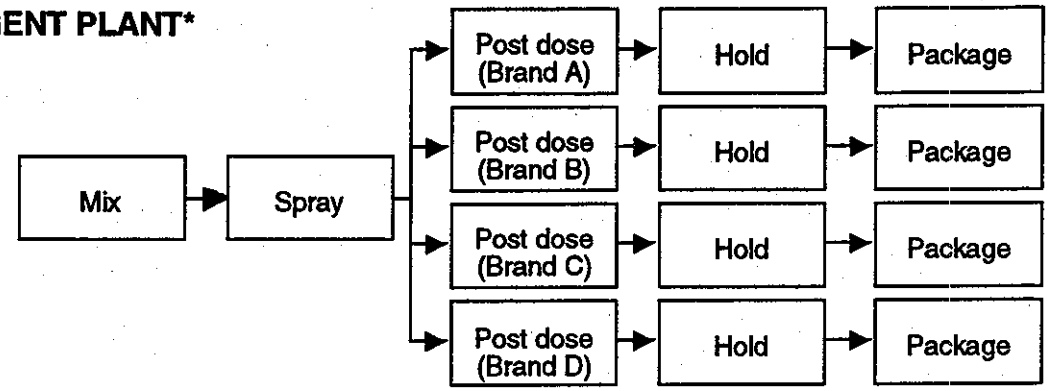
Soap and detergent companies include such household names as Colgate-Palmolive, Henkel, Kao, Procter & Gamble and Unilever (Lever Brothers). Indeed, the industry is led by these giant multinationals in almost all markets. It is quite common for these firms to be vertically integrated, owning businesses at all stages of the production process. In the case of Unilever, for example, this includes everything from plantations in developing countries that produce palm oil to the plants that finally wrap and crate bar soap for shipment to wholesalers or supermarkets.

In terms of the production of detergents, there are essentially two processes: one for producing powder detergents and one for producing liquids. Powder detergents are produced by the process illustrated schematically in Exhibit I-3. Inputs are saponified fats of either vegetable or animal origin, and various other chemicals, for example, sodium sulfate. In a standard modern powder plant, a basic detergent formulation will be made up into a slurry. This slurry will then be passed through a spray dryer. The dryer is a large and expensive piece of capital equipment which serves, by passing the slurry through heated air under the influence of gravity, to cause the formation of regular and uniform flakes or crystals of detergent that have reasonable shelf stability and flow properties. This mother powder is then passed to one of several post-dosing stations where enzymes, perfumes, and coloring agents are added to produce the individual brands that will finally reach the public. The various powders are now held before being passed to the other capital intensive part of the process: the automated packing lines. The holding bins serve the function of optimizing utilization of the packing lines. After packing (typically in cardboard boxes, but since 1990, increasingly in recyclable refill containers made of paper or plastic) the detergent powder is cased and readied for shipping.

The process for producing liquid detergents is a little different and somewhat less capital intensive. At its simplest, it consists solely of vats for mixing the inputs and then some means of packaging, typically in plastic bottles. A larger-scale plant will, instead of using this batch process, employ a continuous flow process using static mixers and computer-controlled, metered pumps to produce the detergent. Compared to the typical powder production process, a modern liquid detergent plant will employ approximately 30 percent fewer workers per ton of output (Exhibit I-4). The main areas of difference between powder and liquid production are a smaller requirement for labor at the goods inward end of the process as there is less need to

Exhibit I - 3

TYPICAL POWDER DETERGENT PLANT*



Function	Mix inputs for spray drying	Produce mother powder	Modify mother powder to produce individual brands	Buffer	Package for shipping	Total
Labor**	30-50	10-15	40-50	-	150	**230-265**
Capital intensity	Medium	High	Medium	Low	High	

* Scale = 150,000 tons per year
** Including indirect labor

Source: McKinsey interview

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Exhibit I - 4

RELATIVE LABOR USAGE

Workers; efficient scale plant*

ESTIMATE

	Receiving/handling	Production	Packaging	Total workers**	
Powder	30-50	50-65	150	**230-265**	**100%**
Liquid	20-40	10	130-140	**160-190**	**70%**

* 150,000 tons powder, 150,000 tons liquid per year
** Including indirect labor

Source: McKinsey interview

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Industry Coverage

A more involved adjustment concerned the coverage of German SIC[1] 4036. Unfortunately, this classification contains parts of Germany's cosmetic and haircare industries. These industries are characterized by smaller scale, less capital-intensive production and larger direct sales forces than soap and detergent production per se, and so serve to depress artificially German productivity levels relative to those of Japan and the U.S. The solution adopted was to use estimates by those familiar with operations in Germany within McKinsey in place of census employment data while relying on the disaggregated (five-digit SIC) census data for output value of detergents, which gave greater detail than for employment. We derived value added as a proportion of output value at a level based on the knowledge of McKinsey consultants and consistency with the observed values in other countries.

PPP

The data was now ready to be translated into U.S. dollars at industry purchasing power parity (PPP) exchange rates based on factory gate prices.[2] These PPP exchange rates were derived from weighted averages of unit value ratios for detailed matches of census categories across the three countries. We concluded that our PPP rates were perfectly acceptable for the purpose of international productivity calculations as we were able to both match a reasonable percentage of each SIC's output and, in contrast to many other industries, determine that the matched products really were very similar across countries; a spray dried powder detergent really is not very different across Germany, Japan and the U.S. It is, of course, entirely possible that one should use different PPPs for the translation of inputs and outputs in the production process. This would arise when, for example, the market for a key input is distorted by, say, government intervention, such as the EC's Common Agricultural Policy or U.S. agricultural price supports, in one country but not in others.

Double Deflation

We investigated the need for separate PPP rates for inputs and outputs in the soap and detergent industry and concluded that it did not significantly enhance the value of our analysis. Our conclusion was based on examination of price data for packaging materials, both plastics and cardboard, across the three markets and discussion with chemical industry experts. On the packaging material front, it was found that U.S. and German plastics prices for the relevant types of plastic aligned quite well with the PPP, as did U.S. and Japanese cardboard/ paperboard prices. Furthermore, on the chemicals side of the input equation, our discussions suggested price relativities across the three countries that were strikingly in line with the PPP rates.

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1 Throughout our studies we will use the U.S. English abbreviation SIC to refer to all countries' systems of industrial classification. There are, of course, subtle and not-so-subtle differences in the way that industries are defined by each data gathering authority.

2 DM:$ 1987 2.21; 1990 2.07; ¥:$ 1987 210; 1990 188.

monitor multiple input feeds, a much smaller need for labor in the automated heart of the process, and a slightly reduced labor requirement in packaging as bottling lines require somewhat less oversight than cardboard packaging lines.

PRODUCTIVITY RESULTS

Adjustments

Before a meaningful comparison of productivity levels could be made across countries, it was necessary to make a few adjustments to the data (see box entitled "Adjustments").

Results

Our comparison of PPP-translated data on value added per hour worked[3] shows that in 1990, productivity in Germany stood at about three quarters of U.S. levels while productivity in Japan was close to that of the United States (Exhibit I-5). If we adjust for product mix difference, German productivity reaches almost 90 percent of the U.S. level.

In 1987, productivity in Japan stood at 76 percent of the U.S. level, implying that a considerable catching up has occurred since then (Exhibit I-6). Unfortunately, because we have not been able to obtain reliable estimates of German detergent employment for 1987, we have not calculated productivity levels for that year. Our research suggests, however, that we would find lower levels relative to the U.S. in Germany in 1987 than in 1990 because major European industry participants were still at an early stage of the process of restructuring themselves to meet the expected challenges of the single European market.

Analysis of value added per employee hour by size of establishment for Japan and the U.S. reveals a pattern surprisingly similar to that seen in other industries. While productivity shows a definite decline in the U.S. as establishment scale is reduced, productivity in Japan declines much more than scale effects would suggest (Exhibit I-7). This can be construed as further evidence of the dual economy in Japan. Two distinct tiers exist in many Japanese industries: the large-scale, unionized, capital-intensive, lifetime-employment firms; and the small-scale, non-unionized, family-run, low-wage and low-benefit firms. These smaller firms both

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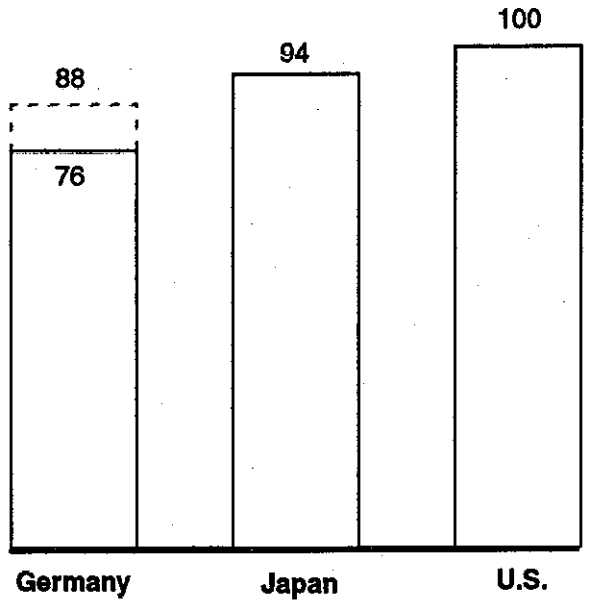
[3] For productivity comparisons, per hour worked data adjusts for differences in average hours. For example, in 1990, average annual hours worked were the following: Germany, 1606; Japan, 1969; USA, 1942. In the German and Japanese cases, these figures represent a decrease in hours worked relative to the 1987 situation, especially in Japan where average hours fell by 52 hours.

Exhibit I - 5

SOAP AND DETERGENT LABOR PRODUCTIVITY 1990

VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED

Index: U.S. = 100



Source: Census of Manufactures; McKinsey analysis

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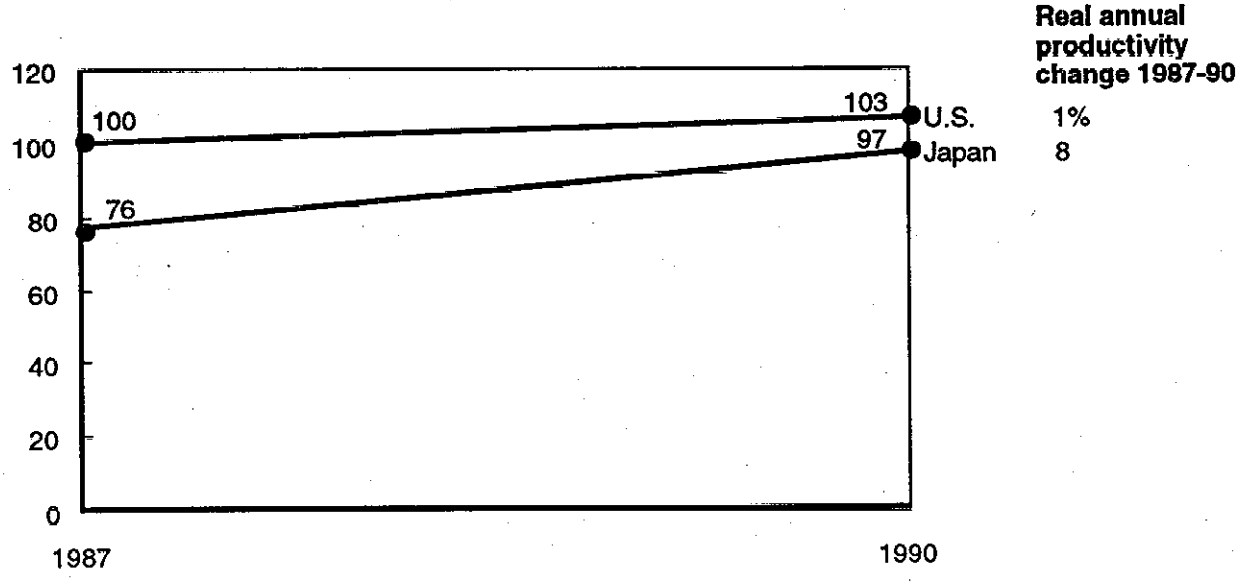
Exhibit I - 6

REAL LABOR PRODUCTIVITY CHANGE 1987-90

VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED

Index: U.S. 1987 = 100



Source: Census of Manufactures; McKinsey analysis

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Exhibit I - 7

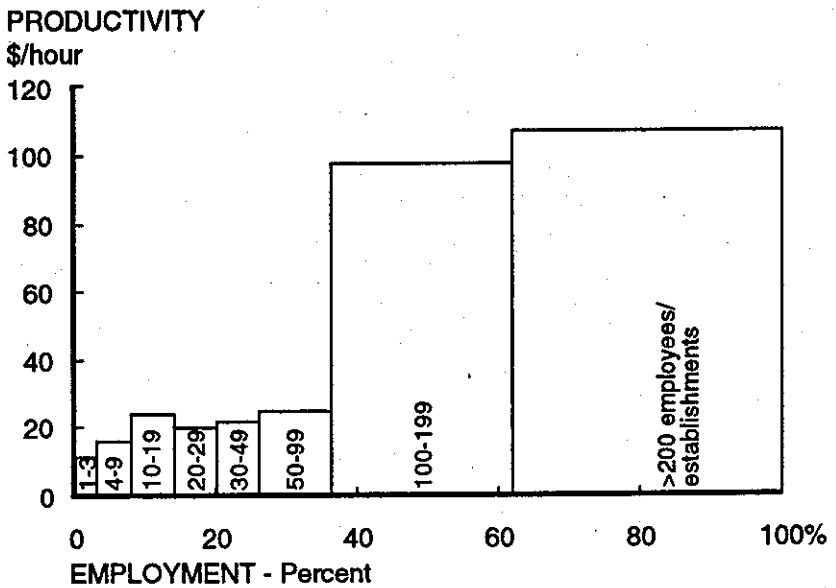
LABOR PRODUCTIVITY DIFFERENCES BY ESTABLISHMENT SIZE 1987

SOAP AND DETERGENT INDUSTRY

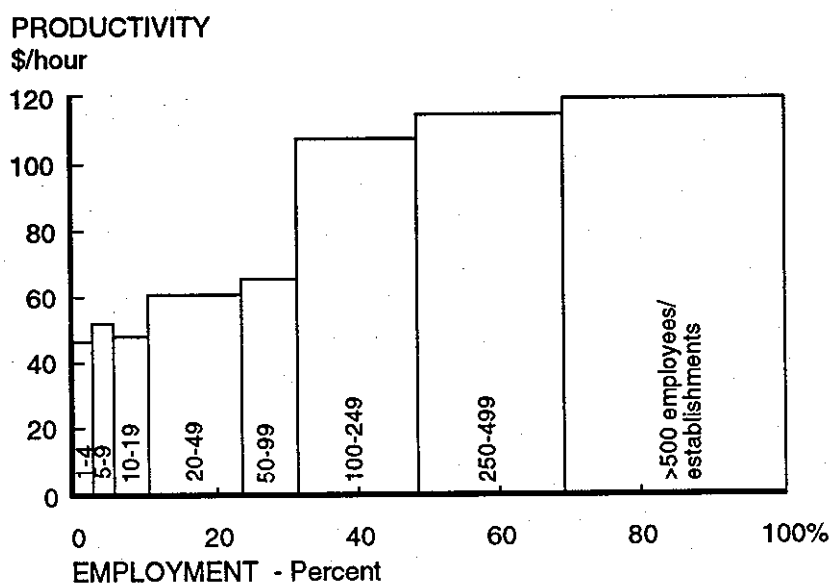
VALUE ADDED PER HOUR WORKED

U.S. dollars

JAPAN



U.S.



Source: Census of Manufactures; McKinsey analysis

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Exhibit I - 8

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES 1990

SOAP AND DETERGENT INDUSTRY

External factors	Industry structure and behavior	Production process	Labor productivity
Consumer demand in Germany favors powder High entry barrier caused by complex distribution system	Global competition through Foreign Direct investments (both Joint Ventures, Merger/Acquisitions) Dominant market position may lower competitive intensity Unilever/P&G culture emphasize intensive competitiveness (market share, product innovation)	German product mix biased toward powder holds down productivity Distribution penalty in Japan Less efficient operations in Germany (scale, capacity utilization, organization of functions and tasks) Newer equipment in Japan	Small productivity gap Japan/U.S. Large gap Germany/U.S. - U.S. = 100% - Japan = 94% - Germany = 76%

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provide flexibility in the manufacturing process and also engage in low productivity production activities that the larger plants wish to avoid. In particular, we found that some small companies are engaged in specialty soap production using different, and perhaps more traditional, oil and fat ingredients.

CAUSES OF PRODUCTIVITY DIFFERENCES

In this report we are focusing on both the reasons why productivity differences persist and the mechanisms of convergence that have served to bring about some degree of productivity leveling across countries. We first consider the reasons for the remaining differences in labor productivity. Exhibit I-8 summarizes our hypotheses regarding the differences between the three countries.

First, at the production process level, we believe that the principal reason for the 1990 productivity gap between Germany and the other countries lies in that country's different product mix: much more low labor-productivity powder detergent and much less liquid than in Japan or the U.S.[4] Moreover, there are four ancillary reasons for the lower level of labor productivity: more limited exploitation of economies of scale, lower levels of capacity utilization on the part of some firms, less efficient internal organization, and less optimal utilization of labor resources across functions and tasks.

Second, at the industry level, we see extensive evidence of global competition in the industry pushing companies toward equal levels of productivity. Hence, there is little remaining productivity difference to explain.

Third, at the level of the overall market environment, the preference of German consumers for powder detergents containing bleaches has, given the inherently lower labor productivity of the powder process, held down German productivity. Secondary external reasons are twofold: the complex Japanese distribution system continues to impose an employment penalty – and hence, labor productivity – on producers in that country, and environmental regulation pressures affect producers in various countries to differing degrees.

In the following section, we examine the reasons for differences in labor productivity in more detail, beginning at the level of the production process and moving on to the industry and external factors and their impact on management behavior and production.

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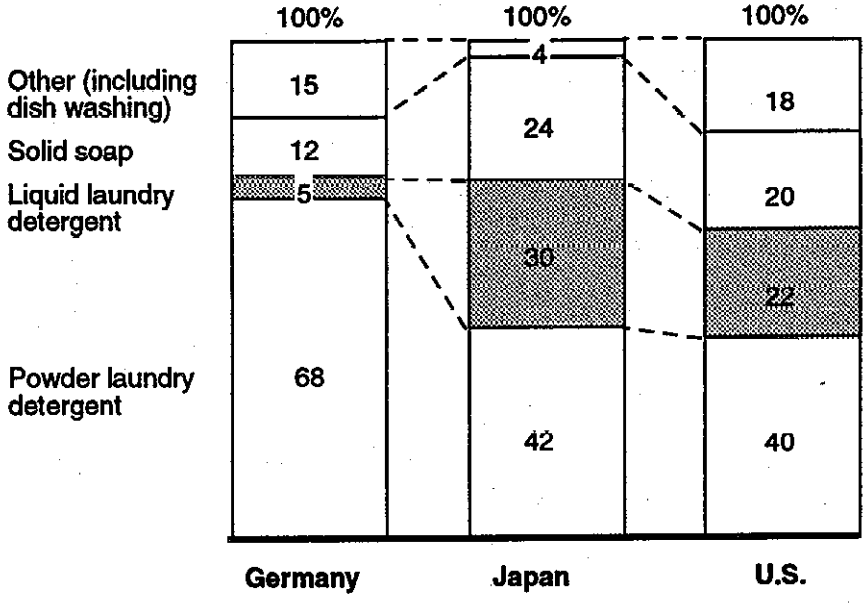
[4] Liquids have never accounted for more than 15 percent of German detergent sales; U.S. and Japanese levels are more than twice as high.

Exhibit I - 9

PRODUCT MIX

FINAL SALES 1987

Percent



Source: McKinsey analysis

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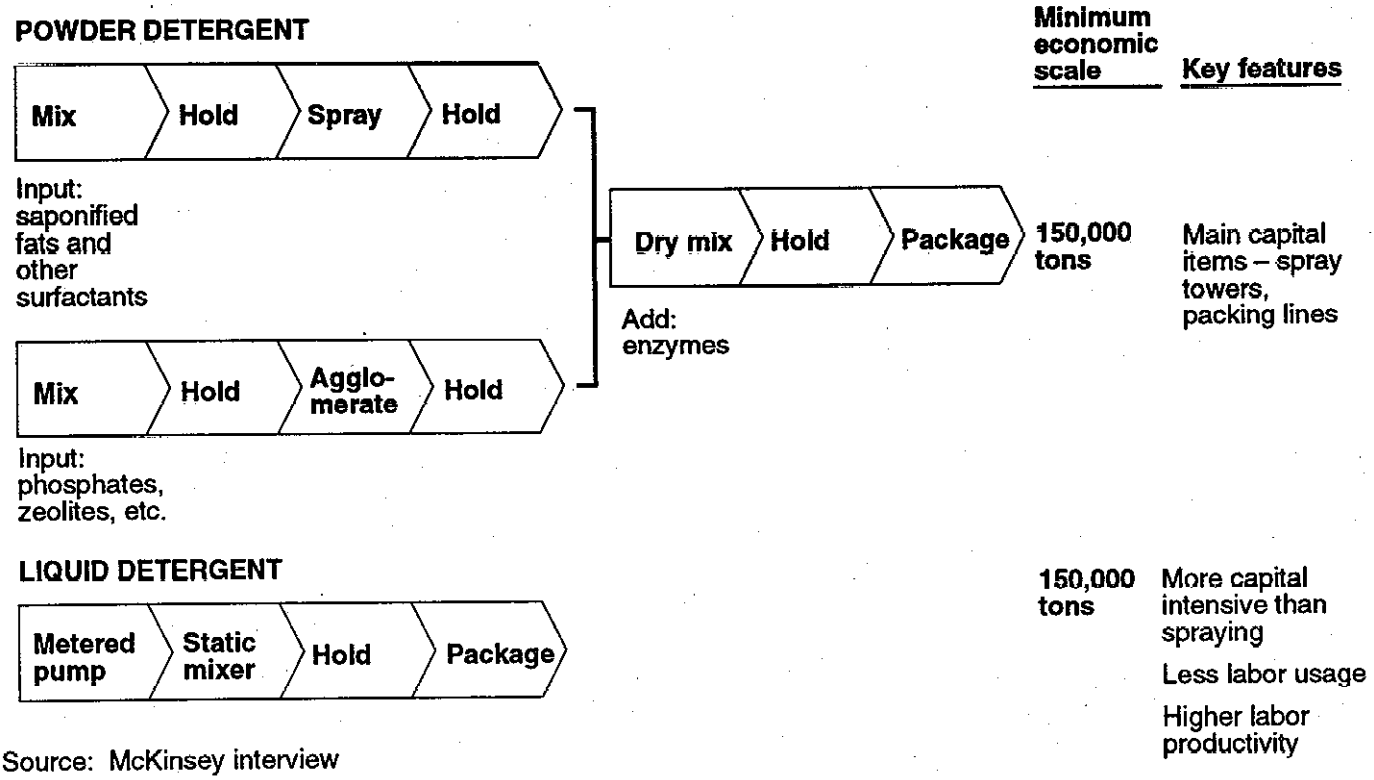
Exhibit I - 10

EXAMPLE

PRODUCTION PROCESSES



Source: McKinsey interview

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Causality at the Production Process Level

Why then, do German firms show such low productivity levels relative to their U.S. and Japanese counterparts in 1990? Our view is that the primary cause of differences operating at the company level is the intrinsic productivity difference between powder and liquid production processes.

¶ Product mix as a causal factor. German consumers have historically shown a marked preference for powder detergents, and the process by which these are made is simply less productive than that by which liquid detergents are produced. On the basis of interviews with industry experts, we estimate that about 30 percent less labor is required by a 150,000 ton liquid detergent plant than by a comparably-sized powder plant (Exhibit I-4). This translates directly into a physical productivity advantage of up to 40 percent for those firms operating in markets where liquids have attained a considerable share (Exhibits I-9 and I-10).

There are four less important reasons for lower German productivity levels: more limited exploitation of economies of scale, lower levels of capacity utilization, less efficient internal organization, and less optimal utilization of labor resources across functions and tasks.

¶ Scale economies as a causal factor. German producers lack market scale equivalent to that enjoyed by most firms in Japan[5] and the U.S. This affects both plant-level economies of scale and the ability to exploit the lesser scale advantages in advertising and marketing.

¶ Organization of functions and tasks as a causal factor

- Utilization of equipment matters primarily because spray drying towers and automated packaging lines are expensive pieces of capital equipment that should be as fully utilized as possible. We have already seen that plant designers take steps to ensure efficient use of packaging assets and the same is true of spray dryers. Today it is not uncommon for dryers to run for 24 hours a day, 5 days a week. While spray drying looks at first glance like a batch process, companies have striven to make it continuous; for example, the production of a mother powder that is post-dosed to give individual formulations rather than running each formulation through the dryer in as close to final form as possible (some inputs, such as enzymes, are rather heat sensitive and so cannot be spray dried). We believe that, in 1990, some companies operating in

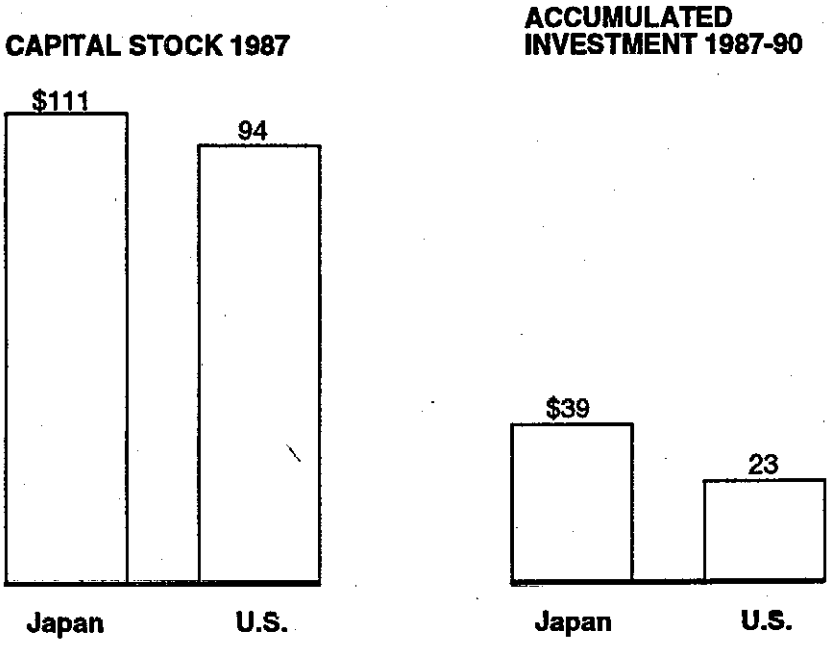
[5] Note, however, the existence of small Japanese firms with very low productivity and, it is hypothesized, very low – and most definitely well below minimum efficient scale – plant and equipment levels.

Exhibit I - 11

CAPITAL INTENSITY

SOAP AND DETERGENT INDUSTRY

1987 $ per hour worked



Source: van Ark and Pilat 1993; national investment statistics; McKinsey analysis

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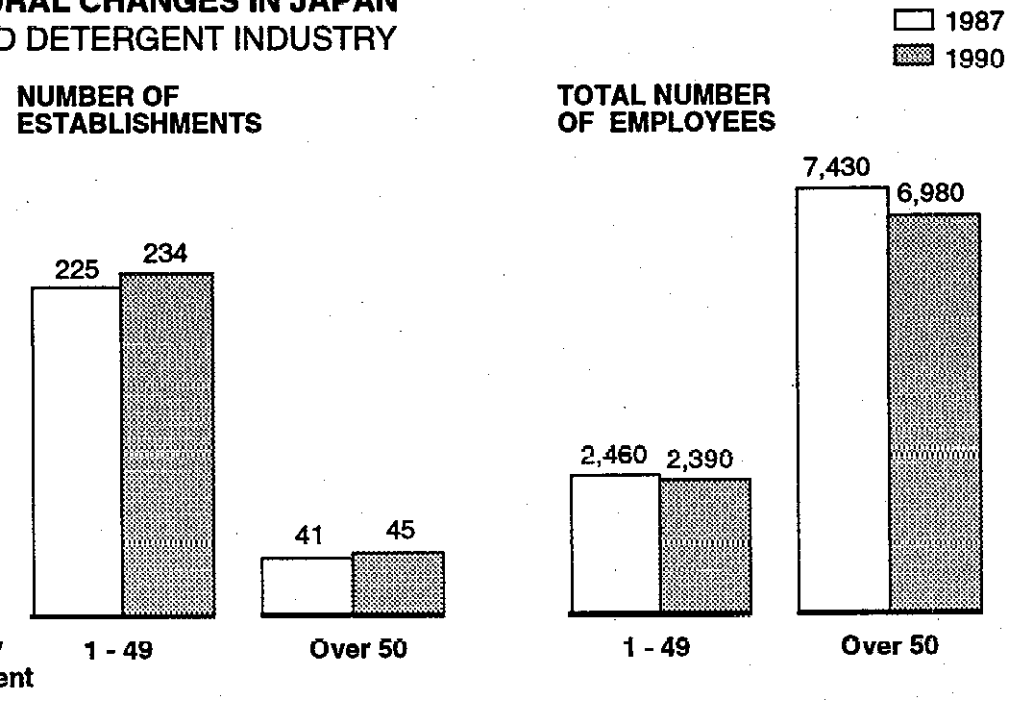
Exhibit I - 12

STRUCTURAL CHANGES IN JAPAN

SOAP AND DETERGENT INDUSTRY



Source: Census of Manufactures; McKinsey analysis

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Germany were not able to reach as high levels of equipment utilization as those in Japan and the U.S. Consequently, their productivity level suffered.

- Some evidence suggests that management in the three countries have had different degrees of success in flexibly and efficiently employing their labor resources. First, in Germany, resistance by the traditionally strong unions and worker councils (*Betriebsräte*) has limited the extent to which it is possible to rapidly redeploy workers as shop floor situations change. Second, in Japan, the complexity of the distribution system forces producers to retain large numbers of workers to both administer the transaction flow with the myriad distributors (often literally hundreds of firms), and to maintain appropriate relationships with them. It is not unheard of to sell to parts of the Tokyo market through an Osaka distributor and vice versa.

- The Japanese census does not cover all workers in overhead functions. We estimate that, taking full account of all attributable overhead, labor not captured in the Japanese census would lower the 1990 Japanese productivity level by approximately 5 percentage points.

Capital intensity does not appear to be a differentiating factor across countries. Soap and detergent operations in Japan were more capital intensive than those in the U.S. in 1987 while productivity was lower. However, productivity in Japan improved quite dramatically, relative to the U.S. between 1987 and 1990. This achievement seems, at least in part, attributable to large-scale investment in new plants. Overall, Japanese investment during the period was much higher than that of the U.S. (Exhibit I-11). One might also expect consolidation of the industry, through the exit or acquisition of some of the many smaller firms, to have played a part, but this does not seem to have been the case (Exhibit I-12).

External Factors and Industry Behavior

Factors at the industry/environment level of causality served, in 1990, to determine competitive intensity, multinational presence, and features of corporate cultures. In addition, these factors set the stage for the different productivity levels.

Turning first to the nature of competition in this industry, we see that there seem to be few structural impediments to productivity convergence at the level of external factors. Thus, we would expect similar competitive conditions across the three countries. At this point we should note that advertising plays an essential role in competition in the soap and detergent industry: it often consumes 30 percent and even up to 50 percent of the value added in production. This investment in advertising forms a barrier to entering the market, but it also forces existing competitors to exploit their brand investments to the fullest extent possible. One

means of more fully exploiting a brand or formulation is international expansion, particularly into areas in which consumer tastes are relatively homogeneous.

¶ The nature of competition. The handful of large companies that lead this industry are in global competition with one another. Each of these players is exposed to the best practices found outside of their own company. However, the nature of competition is not uniform across regions. In the U.S., despite the leading market share of Procter & Gamble, the big companies are in head-to-head competition, focusing strongly on beating each other. In Germany, both Unilever and Procter & Gamble lie behind Henkel in market share, and neither is close to catching up. Brand loyalty may have served to dilute effective competitive intensity in the eighties. In Japan, Kao's market position originates from its advantages in distribution as well as its focus on technology. The usual path to top management at Kao is through the engineering function rather than through sales and marketing (as is most often the case at Unilever and Procter & Gamble). This focus has led Kao to many technological innovations and market leadership. However, other players have advanced to the point where competition is now as intense in Japan as in other regions.

¶ Market demand as a causal factor. At the environment level, differences in consumer buying patterns serve to handicap German soap and detergent productivity. German detergent buyers have traditionally favored the incorporation of bleaching agents in their laundry detergents. Until 1991, the addition of bleaches to liquid detergents was rendered impossible due to the fact that such detergents were universally water based and strong bleaches and water react chemically together in an undesirable way. Given the preferences of the German consumer for bleaching agents, liquid detergents were more or less assured of a distant second place to powders in that market (Exhibit I-9). Given the labor productivity relation described above, the German soap and detergent industry could only be less productive per labor hour.

Since the development of anhydrous bleaches in the last year or two, the share of liquids in Germany has grown somewhat and seems set to continue climbing, although competition from super compact powders and component-based detergents remains strong.

¶ Distribution system as a causal factor. The Japanese system for the distribution of consumer goods is labyrinthine. As noted above, manufacturers sometimes sell detergent to Tokyo retailers through an Osaka-based distributor/wholesaler. Managing, maintaining, and administering this tangled web of relationships imposes a labor penalty on Japanese detergent companies that does not have to be borne by firms operating in the relatively simple and streamlined distribution

environments of Germany and the U.S. The example of Procter & Gamble, which experienced considerable difficulty in securing adequate distribution in Japan, illustrates that this complex distribution system can form a formidable barrier to any foreign and domestic new entrants although the situation has recently shown signs of change.

The lesser factors affecting productivity are regulation, labor markets, and relative factor prices.

¶ Regulation as a causal factor. Another environmental factor is the government regulation of effluents and other pollutants. Germany has extremely strict rules on environmental impact, banning not only phosphates but also certain other chemicals traditionally used in soap and detergent manufacture. Such regulations tend to impose costs on producers and will negatively impact productivity in the short run. The long-run effect of environmental regulation is less clear, as firms may be spurred to develop more efficient technologies. In the particular case of Germany, consumer pressure also contributed to shifts away from the use of chemicals that cause environmental problems.

The U.S. also has reasonably strict environmental standards. The majority of states has instituted phosphate bans. Operations in Japan have had a slightly freer hand but environmental legislation is becoming an issue for producers there also.

Much of the regulation in Japan and the U.S. was imposed after 1990, and this may have contributed somewhat to Germany's relatively poor showing in the 1990 productivity comparisons.

¶ Labor markets and unions as a causal factor. Some evidence suggests that, at least in the recent past, labor usage was somewhat less flexible in Germany than in the U.S. and Japan. Unionization rates were higher and work rules more strict; thus, efficient labor utilization was impeded.

¶ Relative input prices/factor availability. Have different factor-price ratios in the three markets contributed to differential increases in capital-labor ratios, and hence, to different levels of observed labor productivity? Japan certainly saw a shift in the domestic factor price ratio in favor of capital and against labor in the late 1980s. Furthermore, evidence from our discussions with those knowledgeable about the industry suggests high levels of investment in Japan during that period.

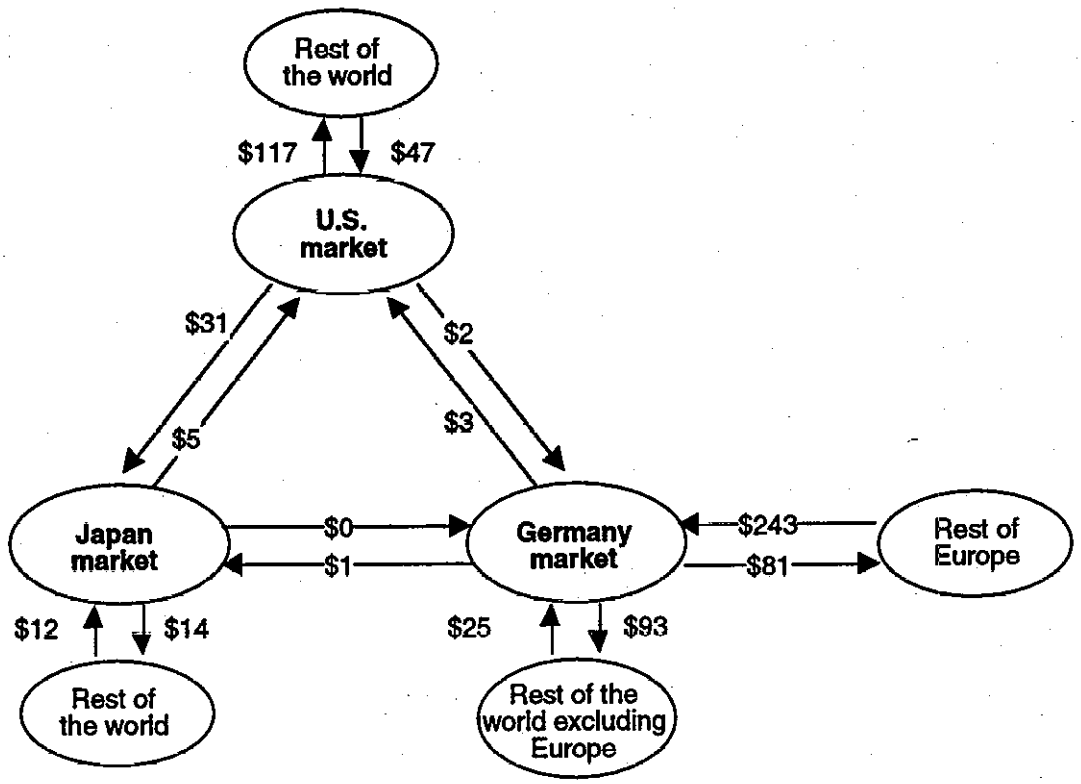
As noted above, our investment data shows that Japanese investment was high during the late 1980s. Thus, relative factor price shifts may have helped boost labor productivity levels in Japan towards U.S. levels. However, the U.S. factor-price ratio also moved in favor of capital, but there is much less evidence of an investment spurt.

Exhibit I - 13

TRADE FLOW

SOAP AND DETERGENT INDUSTRY

1987 $ Millions at industry PPP



Source: National statistics; McKinsey analysis

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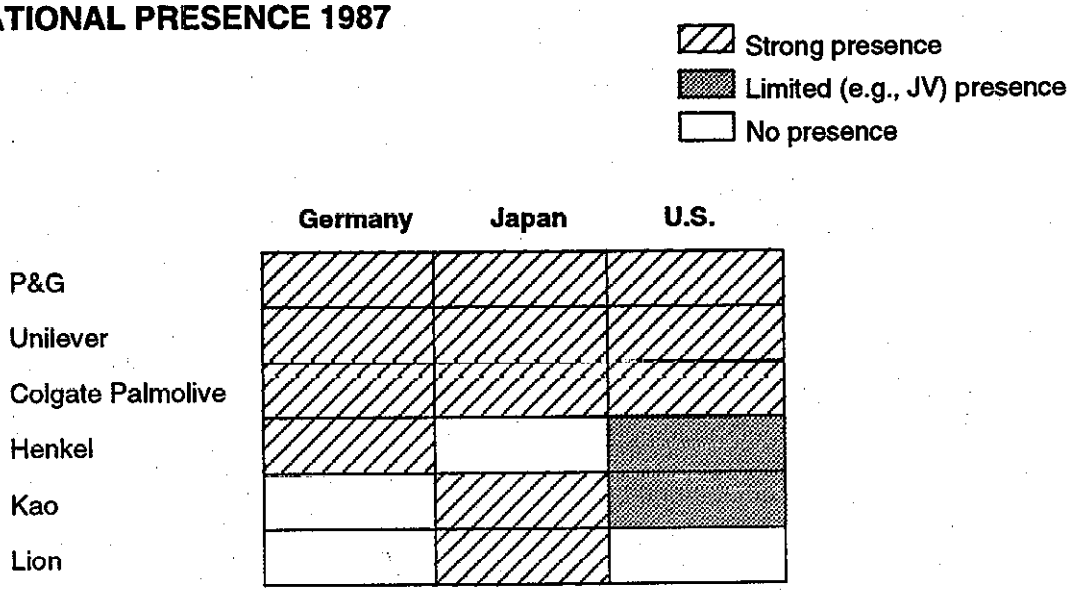
Exhibit I - 14

INTERNATIONAL PRESENCE 1987



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Productivity levels in soap and detergent manufacturing have been converging. This process is definitely occurring between Japan and the U.S., and from our discussions, it appears to be occurring between Germany and the U.S. Why has productivity converged? Possible hypotheses include international trade, differing relative factor prices leading to changing capital-labor ratios, transfer of skills through personnel movement, and technological transfers within corporations.

¶ The mechanisms of productivity improvement and industry dynamics. The trade hypothesis can be quickly discarded. Detergents are not a good candidate for international trade, having a rather low value to volume ratio. As Exhibit I-13 shows, trade flows are miniscule relative to domestic consumption in Japan and the U.S., and only appear large in Germany when trade with EC neighbors is included. Trade within the EC does not expose producers to productivity levels in other regions, so for our purposes it is interregional, not merely international, trade which is important. Since interregional trade is negligible, the threat of foreign firms shipping detergent into one's home market does not appear to spur productivity improvement and convergence.

Transfer of skills through personnel movement between companies appears to be a weak factor in productivity convergence in this industry. Remarkably, few personnel move between companies in either the sales and marketing or the engineering functions. However, technological breakthroughs still seem to be replicated quite quickly through a mix of patent inspection and reverse engineering of molecules in a field that does not have especially complex chemistry.

We are left with internal diffusion of innovation. This diffusion, facilitated by the global presence of the companies (Exhibit I-14), has, we believe, been the primary driver of productivity convergence. Each of the firms has a reputation for devoting considerable efforts to diffusing innovation internally through such policies as regular staff rotations among countries and cross-country organizational structure.

The main reason that we see productivity convergence is that the same companies, are in essence, producing the same products using the same technologies in different places. Germany continues to lag behind Japan and the U.S. because its consumers continue to demand lower-productivity powder detergents rather than liquids.

OUTLOOK

Barring a major technological innovation in detergent production, we foresee further steady, but slow, convergence of productivity levels between soap and detergent industries in Germany, U.S. and Japan.

Exhibit I - 15

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES
SOAP AND DETERGENT

● Important
O Secondary
X Undifferentiating

External factors

• Market conditions	
- Demand factors	●
- Relative input prices/factor availability	X*
- Other industries	O
• Policy and regulation	
- Macroeconomic conditions	X
- Competition rules and concentration rules	X
- Corporate governance rules	X
- Labor rules and unionism	O
- Other regulations (tariffs, nontariffs)	O

Nature of competition O

Production process

• Output	
- Mix, variety, quality	●
• Production factors	
- Capital (intensity, vintage, technology)	X
- Scale	O
- Design for manufacturing	X
- Basic skill of labor, intrinsic motivation	X
- Raw materials, parts	X
• Operations	
- Capacity utilization	X
- Organization of functions and tasks	O

LABOR PRODUCTIVITY

* Influence is moderate in opposite direction

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In Japan, the relative inefficiency of the distribution infrastructure continues to be an issue. This economy-wide problem is an impediment to productivity improvments that the soap and detergent industry is too small to tackle fully alone. However, there are signs that large companies based in Japan are engaged in a process of encouraging the wholesaler system to enhance its efficiency.

A future issue for companies in Japan may well be the extent to which they may have overinvested during the late 1980s. Will firms be able to raise total factor productivity and earn their cost of capital?

Productivity improvement in Germany depends substantially on the behavior of consumers. If Germans shift their purchases toward liquid detergents and away from powders, then German productivity levels will rise. If they remain with their traditional powders, the gap will persist. Current evidence is that consumers are not moving towards liquids, indeed, the liquid share of the market fell in 1992; the gain went largely to the new *Komponenten Waschmittel* or *Baukasten Systeme* (component-based detergents).

SUMMARY AND POLICY ISSUES

The case study of the soap and detergent industry serves to illustrate consumer goods in general, and a chemical process-based industry in particular. Our overall conclusions are that productivity in Germany remains below that of the U.S., and that Japan has made great strides in closing its labor productivity gap with the U.S., almost achieving parity in 1990. At the production process level, we find the principal reason for the continuing lower German productivity figure to be the requirement to make relatively more powder detergents than liquids in response to consumer tastes and demands. Other secondary reasons at the production process level are lower capacity utilization, and less flexible and efficient use of labor resources. At the level of external factors, we find that operations in Germany continue to be hampered by the preferences of German consumers, while operations in Japan are held back by having to work through a complex distribution system. Other secondary external factors are the environmental regulations and relative labor market inflexibility in Germany, and a shift in factor price ratios in favor of capital during the late 1980s in Japan (Exhibit I-15).

In the soap and detergent industry, the large multinational firms that are present in key markets make strenuous efforts to ensure internal diffusion of innovation. Their activities are central to the process of convergence of national productivity levels. Thus, the present case example shows the positive power of open and global markets in which global companies can produce and sell in a decentralized manner, capturing the benefits from fully leveraging both product research and development costs, and, to some extent, the costs of advertising.

A possible future global industry structure is developing that might limit competition in the years ahead. Nevertheless, barring major shifts in corporate

culture at each of the major companies, this threat is minimal. Indeed, a global industry structure has already arrived and competition shows no sign of abating, given the particular nature of the industry participants.

CHAPTER 3: SYNTHESIS

Each of the case studies in this report provides a discussion of cross-country productivity comparisons and the reasons for the differences. While this level of detail provides a picture of the industries studied, general lessons across industries are not so easily observed. In this chapter we try to summarize what we found in the case studies and draw out these broader lessons.

The most striking results that emerge from the case studies are:

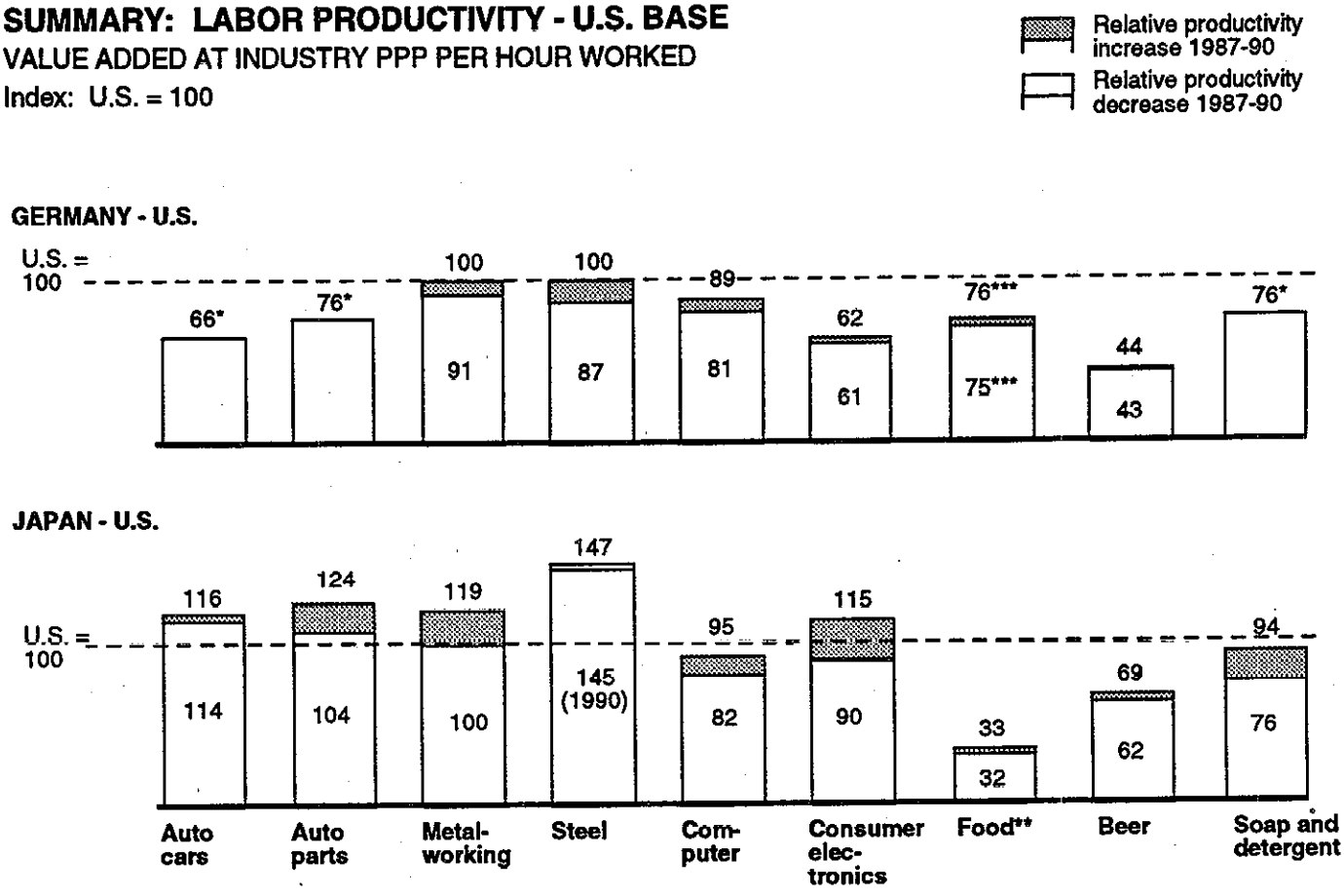
- Large productivity differences exist at the industry level.
- Achieving and maintaining high relative productivity seems to require that companies compete directly against the best practice production in the global economy.
- Management can transfer or acquire best practices to take advantage of productivity differences. The differences in industry productivity are caused primarily by differences in the technology used, the design of products for manufacturing and the way functions and tasks are organized.

Exhibit 3 - 1a

SUMMARY: LABOR PRODUCTIVITY - U.S. BASE

VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED

Index: U.S. = 100



* Only 1990

** Based on shipment

*** Could be 5 to 10 percentage points lower if precise data for companies with less than 20 employees available

Source: McKinsey analysis

816M295D.ZXE

CONCLUSIONS

SUMMARY OF THE QUANTITATIVE RESULTS

Case Study Results

Exhibits 3-1a, 3-1b, and 3-1c show a summary of the case study comparisons for all nine of our industries. (Each exhibit uses a different country as the basis for its index. In the interest of clarity and consistency with the case studies, we will refer in this chapter to Exhibit 3-1a). Looking first at the German-U.S. comparisons, there are two industries (metalworking and steel) in which labor productivity in 1990 was virtually identical and where a convergence of productivity occurred. Such equalization of productivities is not, however, because the industries in the two countries are identical in their production processes, but rather because of offsetting differences, as we will see shortly.

Exhibit 3-1a also reveals that productivity in Germany is substantially lower than productivity in operations in the U.S. in six of the industries. And since the exhibit also shows that productivity in operations located in Japan is ahead of those in the U.S. in five of these industries, it is clear that productivity in some operations in Germany is far lower than the international productivity leader. One of the important questions addressed in this report is why manufacturing operations in Germany have failed to catch up to best practice or have fallen behind in many industries.

Turning to the U.S.-Japan comparison, the wide variations in productivity relative to the U.S. are striking. In food processing, for example, operations in Japan have only a third of the U.S. level of output per hour, whereas in the steel industry, operations in Japan are 45 percent above the U.S. level.

Another notable feature of this bilateral comparison is that operations in several industries in Japan have made productivity gains relative to the corresponding U.S. industries from 1987 to 1990, despite the brief time period (Exhibit 3-1a). Furthermore, the average labor productivity in automotive assembly, automotive parts, metalworking, computer and consumer electronics in Japan was already close to, or above, the average of plants in the U.S.

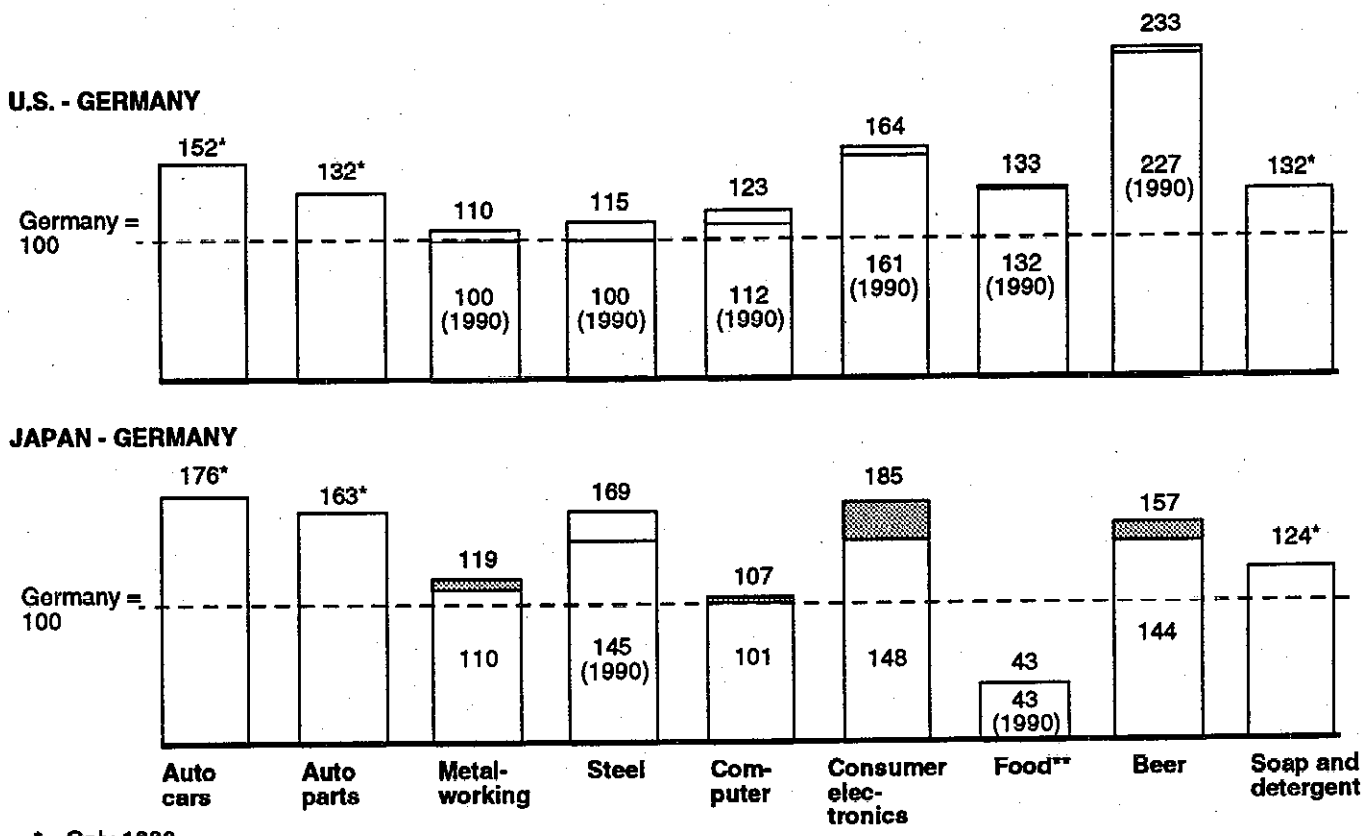
One possible explanation for this growth pattern is that the economies were at different points in the business cycle. The U.S. economy was weakening in 1989 and went into recession in 1990, while in Japan, output was low in 1987 and very high in 1990. To address this, we examined capacity utilization data, and adjusted the auto, auto parts, and metalworking figures for the business cycle. These adjusted figures are reported in Exhibit 3-1a. In steel, capacity utilization in the U.S. remained high

Exhibit 3 - 1b

SUMMARY: LABOR PRODUCTIVITY - GERMANY BASE

VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED

Index: Germany = 100



* Only 1990

** Based on shipment

Source: McKinsey analysis

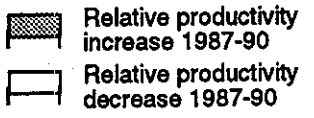
901M295D.ZXE

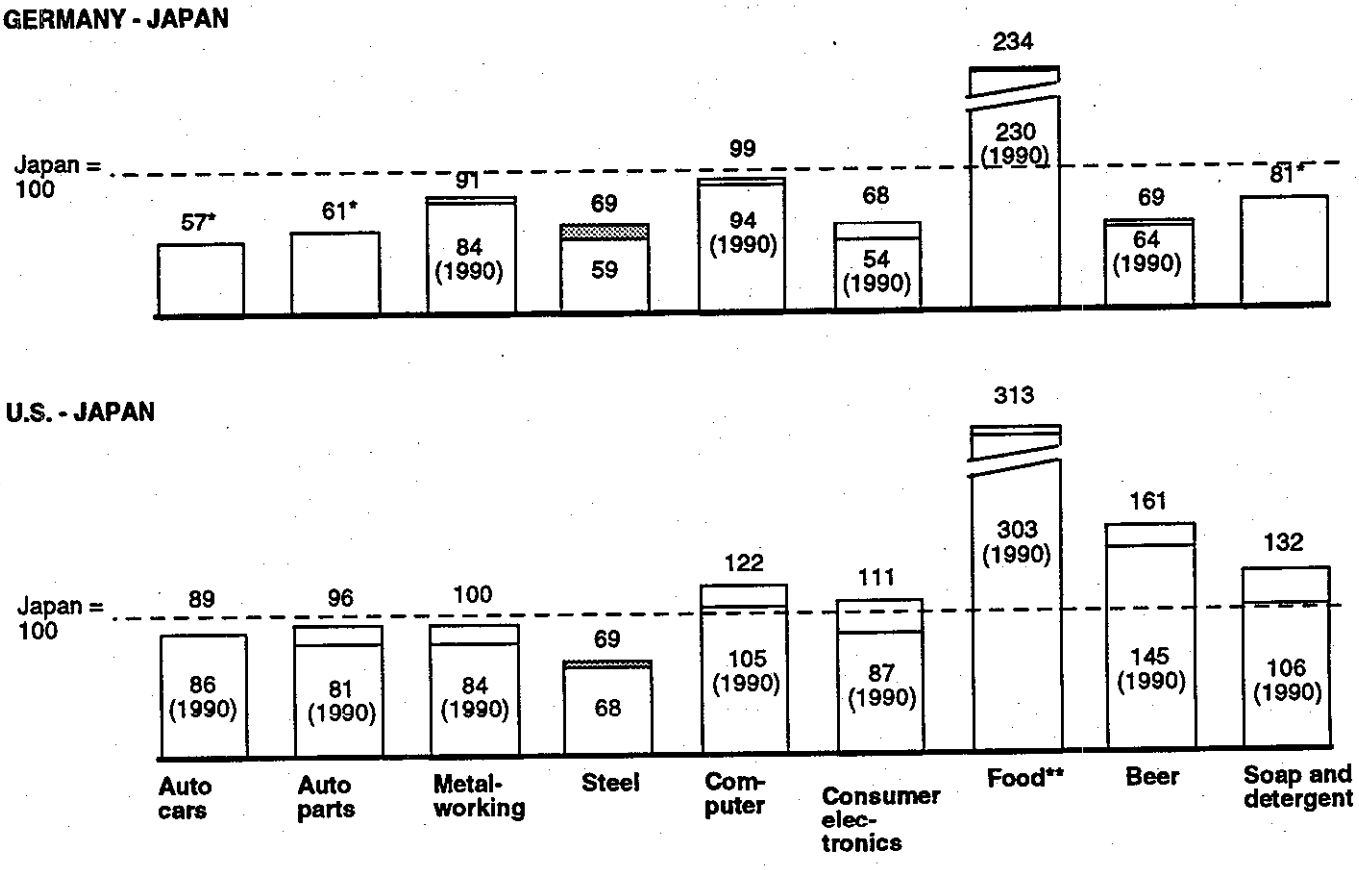
Exhibit 3 - 1c

SUMMARY: LABOR PRODUCTIVITY - JAPAN BASE

VALUE ADDED AT INDUSTRY PPP PER HOUR WORKED

Index: Japan = 100





* Only 1990

** Based on shipment

Source: McKinsey analysis

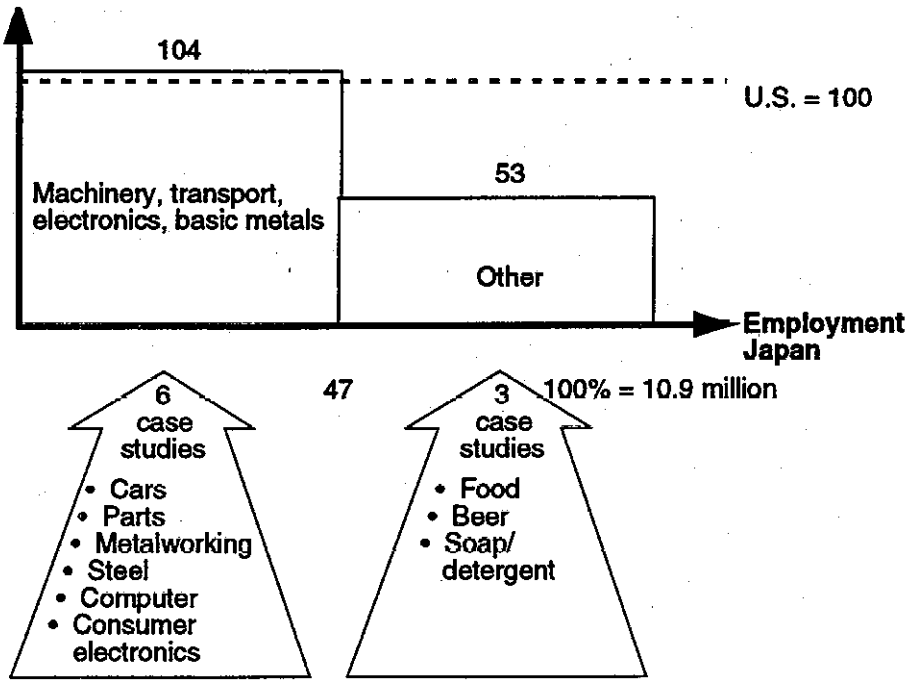
902M295D.ZXE

Exhibit 3 - 2

MANUFACTURING PRODUCTIVITY 1990
U.S. AND JAPAN

VALUE ADDED PER HOURS WORKED

Index: U.S. = 100



Source: van Ark, 1993

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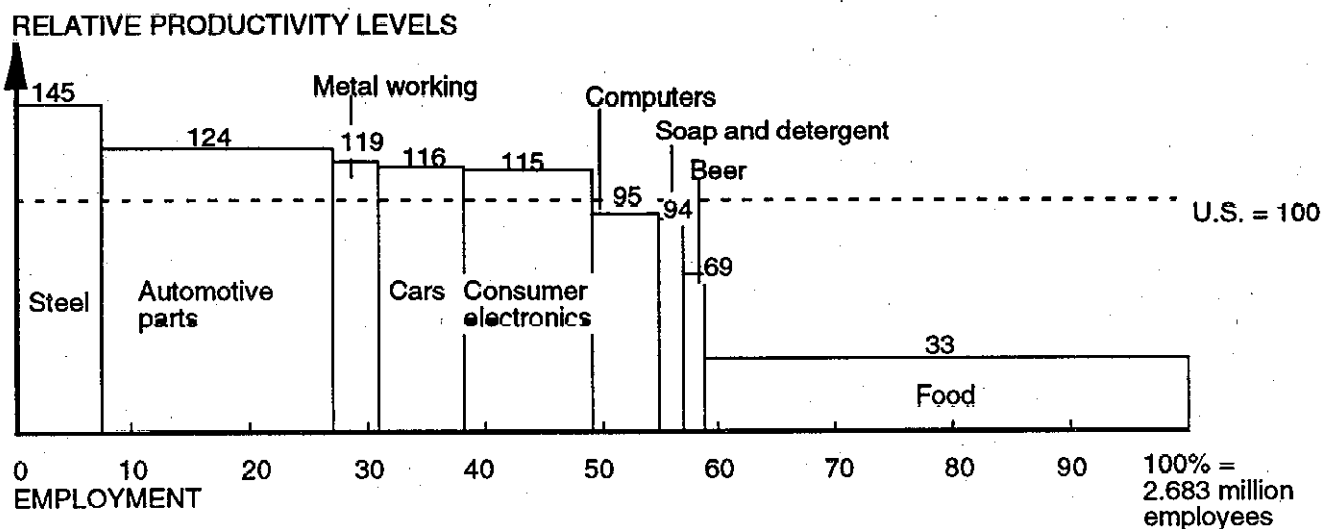
Exhibit 3 - 3

EMPLOYMENT SHARE AND RELATIVE PRODUCTIVITY LEVELS IN JAPAN 1990 FOR NINE CASE STUDIES

Index: U.S. = 100



Source: McKinsey analysis

841M295D.ZXE

in 1990, so that a cyclical adjustment was not appropriate. Since we have removed the effects of the business cycle, it follows that the Japanese auto parts, metalworking and consumer electronics industries must have achieved large gains in productivity by changing their production methods.

Relationship of Case Study Results to Aggregate Results

In the Objectives and Approach chapter, we reported estimates of labor productivity for the manufacturing sector as a whole. The aggregate manufacturing productivity numbers of the ICOP group in Groningen, prepared by van Ark and Pilat, are the ones most directly comparable to those used in this report; we relied on census data on output and employment, and their industry PPPs were the starting point for our case study work. From a casual examination, the case studies in Exhibit 3-1a look inconsistent with the aggregate figures for the Japan/U.S. comparison reported in Chapter 1 (Exhibit 1-13) because a majority of industries in Japan show higher productivity. That impression is misleading, however, because six of the case studies were in industries in the branches of Japanese manufacturing where productivity is thought to be high and only three in the branches where productivity is thought to be low (Exhibit 3-2). We chose case studies that covered a range of different types of industries, but did not select an equal number of industries in each part of the Japanese manufacturing sector. In fact, it is apparent in Exhibit 3-3 that the case studies represent very different shares of employment as well as different levels of productivity. For example, food processing in Japan has more employment than the combined total of steel, auto assembly, auto parts, and metalworking. Therefore, when we calculate the weighted average of our case study productivity results, the employment and productivity of food processing substantially affect the outcome.

As Exhibit 3-4 shows, the weighted average of our case studies results shows rough comparability between our findings for a sample of industries and the aggregate results of labor productivity for total manufacturing (as reported by van Ark and Pilat, 1993). The results are comparable despite the fact that we made changes in some of the original van Ark and Pilat industry PPPs on the order of 40 to 50 percent. Thus, our results tend to confirm that productivity in Japan and Germany is lower than in the U.S. on average.

Our sample of industries does not allow us to make a precise estimate of the aggregate labor productivity differences in manufacturing. However, the estimates from various studies we reviewed in the Objectives and Approach chapter agree that the U.S. had higher productivity in 1990. At the aggregate level, no one appears to know exactly how much higher the U.S. is or whether labor productivity in German manufacturing operations is above or below productivity in Japanese operations on average.

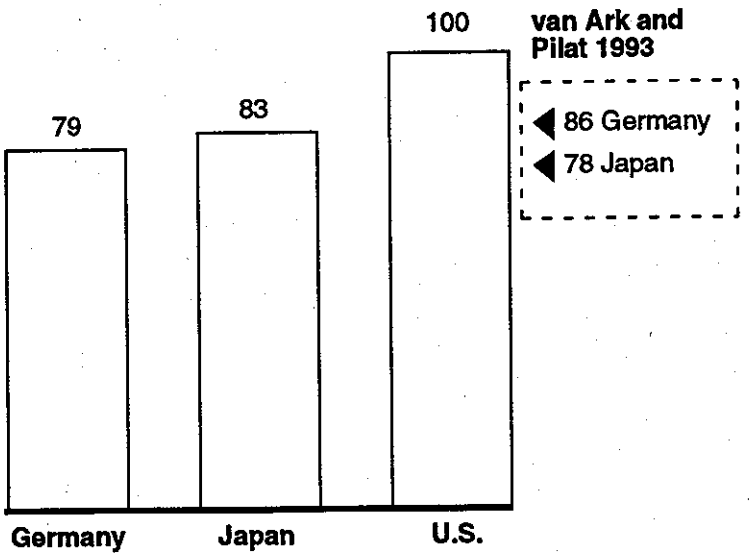
Exhibit 3 - 4

AVERAGE PRODUCTIVITY 1990

WEIGHTED AVERAGE OF CASE STUDIES

Value added per hour worked

Index U.S. = 100



Source: Census for Manufactures; McKinsey analysis

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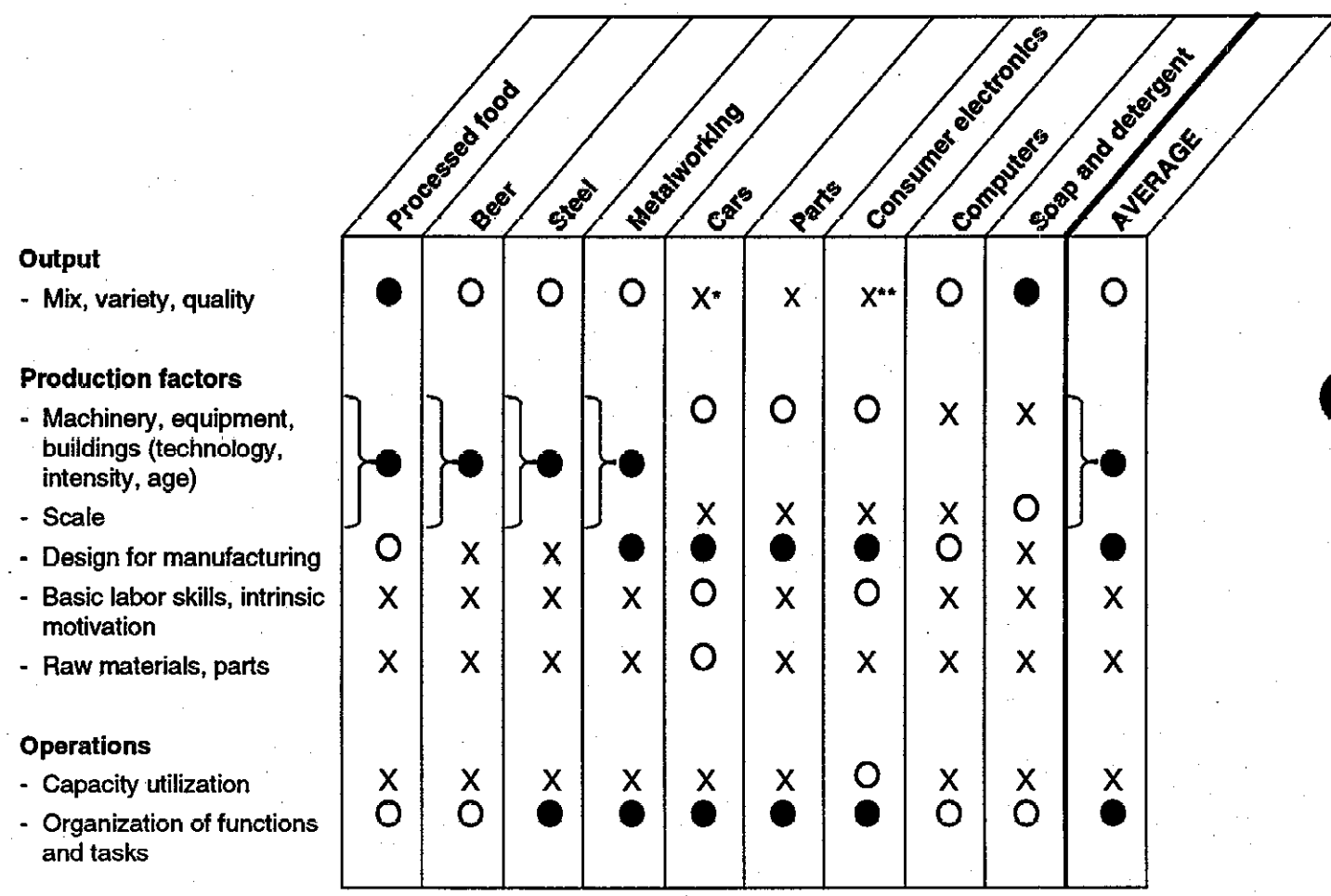
Exhibit 3 - 5

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES AT THE PRODUCTION PROCESS

SUMMARY

● High
○ Low
X Undifferentiated



* Adjustment for quality made to the productivity data
** Influence is high in opposite direction

573M295D.ZXE

To see what has led to the pattern shown in Exhibit 3-1a, we will now review the proximate causes of the differences at the production process level for our case studies.

CAUSES OF PRODUCTIVITY DIFFERENCES AT THE PRODUCTION PROCESS LEVEL

Exhibit 3-5 shows a summary of the factors at the production process level that led to productivity differences in the nine industries studied. These causes have been collected into three groups. The products produced within an industry differ across countries and the way these differences affect productivity (because of mix, variety and quality) are given in the *output* row. The items under *production factors* reflect intrinsic differences in the factors of production – such as the skills of labor or the amount of capital available or the nature of the technology. And the *operations* rows reflect differences in the way the factors are actually used or combined in production.

Shaded circles indicate factors that are of major importance for at least one of the bilateral productivity comparisons, clear circles indicate factors that are of lesser importance and crosses indicate factors that were not important sources of productivity differences. A cross next to some factor does not imply that this aspect of the production process is unimportant to overall performance. It simply indicates that we did not find that this factor to be a source of productivity difference across the countries.

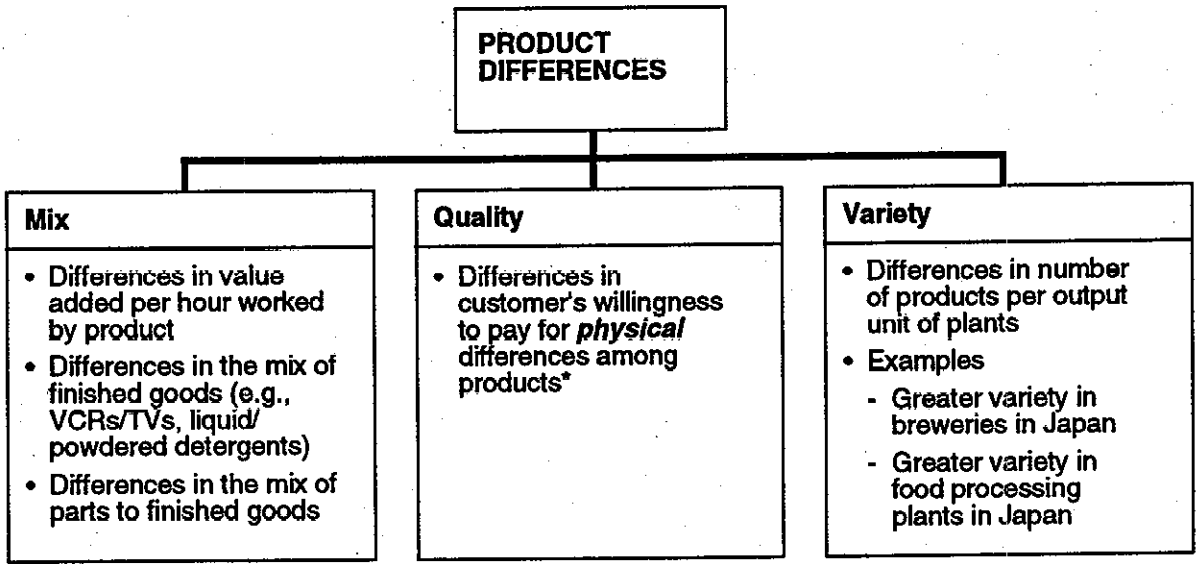
The assignment of circles and crosses was done at the case study level. It was made on the basis of the relative importance of each of the elements of the production process in explaining the productivity differences for that industry. By looking down a column, therefore, the reader can determine which are the one or two key causes of productivity difference within that industry. For example, design for manufacturing and organization of functions and tasks are the two most important sources of productivity difference in auto parts. In this synthesis chapter, however, we will draw out the common themes across the case studies, indicated along the rows in Exhibit 3-5.

For this purpose, we have constructed an average column which summarizes the overall importance of each factor. The organization of functions and tasks is an important source of productivity difference in steel, metalworking, auto assembly, auto parts, and consumer electronics, and it is also of some importance in all of the other industries. We therefore judged it to be of high importance on average. Output mix, variety, and quality, by contrast, are very important in the consumer goods industries, but they are of significantly less importance to the other industries and were therefore judged to be of only some importance on average. In the next sections of this chapter, we examine each row in turn in order to understand the most important production process factors which account for differences in productivity in manufacturing operations across the three countries.

Exhibit 3 - 6

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES AT THE PRODUCTION PROCESS LEVEL

PRODUCT DIFFERENCES



* We have used a methodology that incorporates these quality differences in our productivity measure

406M295D.ZXE

Output Mix, Variety and Quality

As a practical matter, we used census data for our productivity comparisons. These data provide information on the outputs and inputs of a group of plants that are defined to be in the same industry. Industries and products are not synonymous, however, since all of the industries in our case studies produce a variety of products. For example, TVs and VCRs are different products, but are both manufactured within the consumer electronics industry.

The productivity results reported in Exhibit 3-1a therefore reflect, in part, the impact of differences in product mix, variety and quality. The role of these three elements on the case study results is summarized in Exhibit 3-6.

¶ Output mix. Within a given industry, some products have higher value added per hour worked than others. As a matter of simple arithmetic, the value added per hour for the industry is the average of the values added per hour by each product, with the products weighted by their share of the industry's total employment. This means that if the mix of output is different among the countries, then overall value added per hour will differ, even if the productivity in the production of each good viewed separately were exactly the same in the countries.

We did find that product mix differences were of some importance in several case studies.

- In the soap and detergent industry, Germany suffers a significant productivity disadvantage because German consumers demand much more powdered detergent than is the case in the other countries. If the German productivity figure is adjusted to remove this product mix penalty, then it would increase to 88 percent of the U.S. figure.

- In consumer electronics, mix differences were also important, but they do not help explain why productivity is so high in Japanese operations. The production of VCRs and audio equipment has lower value added per hour than the production of TVs, and operations in Japan have a larger share of production in VCRs and audio equipment than do operations in Germany or the U.S. If productivity were calculated on a comparable product by comparable product basis, therefore, the productivity advantage for operations in Japan would be even greater than the industry average figure shown in Exhibit 3-1a (see the consumer electronics case study for a comparison of productivity in TV production).

- In food processing, even though product mix is not the most important source of productivity difference, it still has a significant effect. Japan has lower productivity, in part, because of its high share of output in

product categories such as seafood, which have relatively low productivity in all countries.

- In metalworking, product mix differences were also somewhat important, but this effect is tied to the changes in technology that are taking place in that industry and to the way products are designed. Output per hour is higher in standard machine tools than in customized tools, and the output of Japanese operations contains a larger share of standard machine tools. Productivity differences due to these factors are attributed to technology and design for manufacturing and discussed later in this chapter.

¶ Output quality. As we explain in Chapter 1, our methodology takes most quality differences into account in the calculation of productivity levels. We did not find any remaining quality differences that caused significant differences in productivity.

¶ Output variety. Product variety on the plant level was a source of productivity differences in two industries, beer and food, and in both cases it helped explain lower Japanese productivity. A remarkable proliferation of products in the food industry in Japan hurts efficiency. In the beer industry, producers in Japan have introduced a large number of new products to try to build market share. These new products reduce lot sizes for production and delivery, creating inefficiency (e.g. by increasing set-up time).

Production Factors

Within the category of production factors there were two main sources of productivity difference: capital and technology associated with different generations of manufacturing equipment on the one hand, and design for manufacturing on the other.

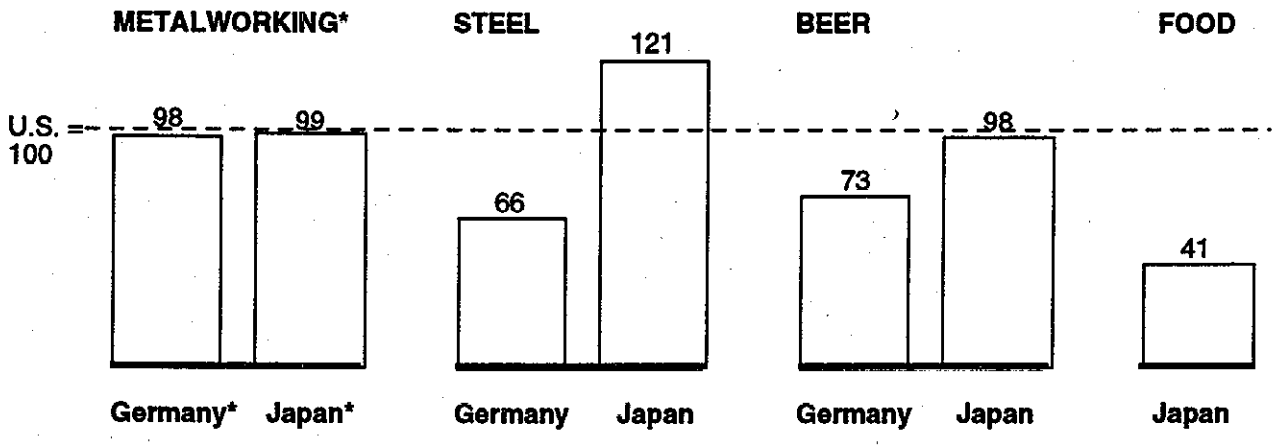
¶ Capital, technology and scale. Periodically the process technology in an industry undergoes a major transformation that results in large increases in productivity. In the industries studied there were large variations in the extent to which such new technologies have been adopted across countries. In one country there may be a substantial fraction of output that is manufactured using a process that has been largely superseded elsewhere. Since productivity varies with these different generations of technology, we found that the mix of generations of technology is an important source of productivity difference across the countries.

- Industrial-scale food processors dominate the industry in the U.S., but account for only a small fraction of output in Japan. German output comes heavily from multinational food companies, but a sizable craft industry remains in certain food categories (e.g., bakery, meats).

Exhibit 3 - 7

CAPITAL INTENSITY 1987

Capital stock per hour worked



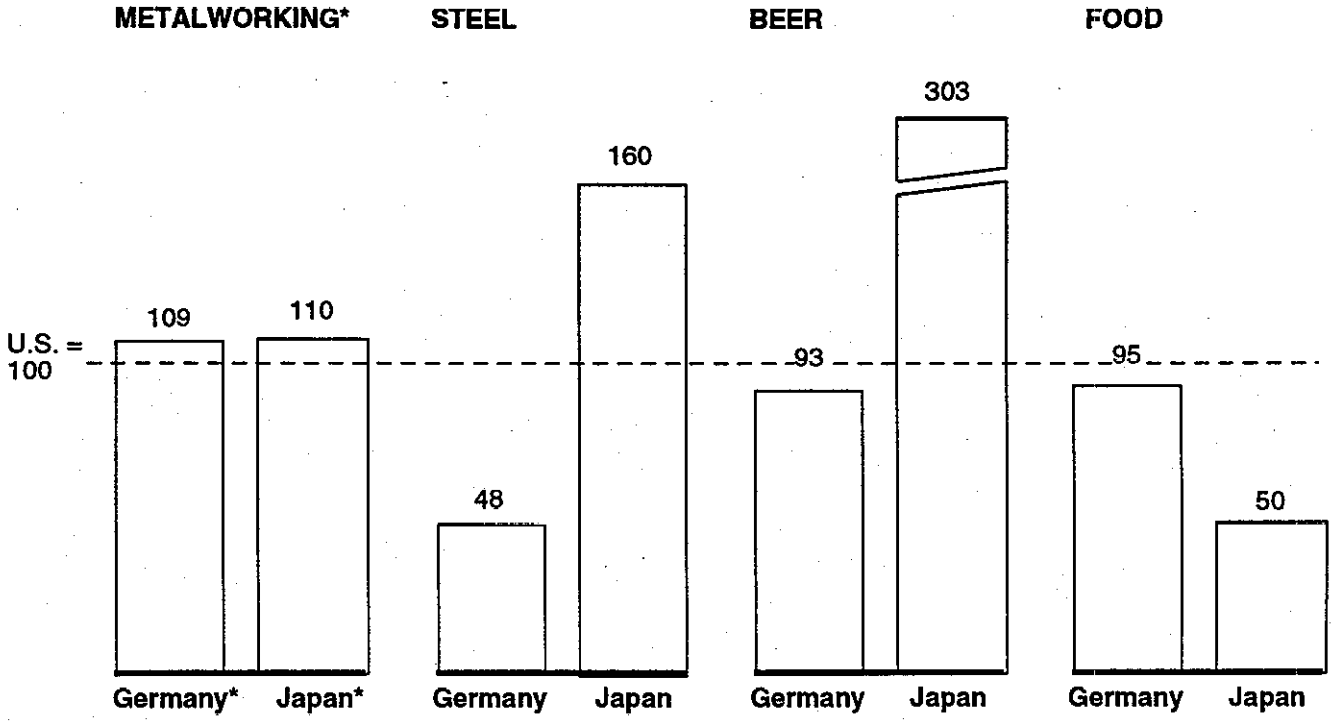
* Per employee

404M295D.ZXE

Exhibit 3 - 8

INTENSITY OF CAPITAL INVESTMENT 1987-90

Investment per hour worked in 1987 dollars



* Per employee

817M295D.ZXE

- Large-scale breweries have taken over the beer industries in the U.S. and Japan, but beer production in Germany remains largely in small plants. U.S. plants have been able to take full advantage of the high speed canning and bottling lines that require very large volumes.

- Minimills were developed as an industry in the U.S. and are now widely used there and in Japan. Very little minimill production existed in Germany in 1990.

- Most metalworking plants located in Japan have introduced methods for producing standard machine tools on production lines. Many machine tool makers in Germany have not yet adopted this innovation.

We found that shifts to new generations of technology in our case studies were usually accompanied by large increases in capital intensity, as measured by the amount of capital per worker employed (or by the amount of capital per hour). Modern food processing plants are highly automated compared to traditional food processing methods, for example. But the amount of capital required per unit of output (the capital output ratio) is often not higher with the new generation of technology. For a given level of output, the innovation may save capital, and it saves even more labor. For example, minimills in the steel industry require less capital per dollar of value added than integrated mills (even though they are more capital intensive). Thus, from a business investment point of view, a new plant of given capacity can actually be less costly than continuing to run the old plant and technology.

In Exhibit 3-7 we show capital intensities in metalworking, steel, beer and food to illustrate the fact that the technology shifts described above for these industries usually involved a substantial increase in capital per hour or per employee (higher capital intensity). The main exception to this rule was metalworking, where the industry in Germany was just as capital intensive as that in Japan, but few companies in Germany had linked machines into a production line, resulting in lower productivity. The same picture is also reflected in investment intensity from 1987 to 1990 (Exhibit 3-8). The only exception is beer where operations in Japan embarked on a massive investment campaign during this period, an investment surge that helped their productivity move closer to the U.S. level. Because of inefficient labor organization, however, labor productivity remained substantially lower than in the U.S.

¶ Design for manufacturing. An important source of productivity advantage for many companies has been their ability to create product designs that are less complex, use fewer parts and are easier to assemble, without producing products that are different from the customer's

BASIC LABOR SKILLS AND LABOR PRODUCTIVITY

In recent decades, the average years of education completed by the workforce in Germany and the U.S. has increased. In both countries, however, there is a growing concern over the performance of the education system and the relative skills of those educated. Companies in both countries echo these concerns and stress the difficulties of recruiting workers. In the U.S., there has been a sharp increase in the wage premium associated with skill and education.

Against this backdrop, our conclusion that basic labor skills are not an important causal factor for explaining productivity differences in any of our 9 case studies seems somewhat surprising. In this box we provide a reconciliation of the popular view with our findings.

Our measurements and findings

The "basic skills" we measured refers only to the **basic, pre-hiring skills** of production workers. Differences in post-training worker skills and in management and engineering skills are largely accounted for in the "organization of functions and tasks" and in "design for manufacturing". Furthermore, we were interested only in the skills of workers actually hired, not those rejected.

We found that the industries we studied required skill levels that were widely available in the labor markets of all three countries. We found no observable differences in the basic, blue-collar labor skills that explain the differences in productivity observed in our 9 case studies. Furthermore, we found no differences in the "trainability" of the blue-collar laborers that explain productivity differences in our cases.

For example, we found cases where transplants achieved productivity levels similar to those in their originating countries (e.g., cars, metalworking, computers, and soap and detergent). In addition, auto companies originating in the U.S. have achieved best-practice productivity levels in the U.S. using the existing – often unionized – workforce (e.g., Ford-Atlanta, GM/Toyota-NUMMI). Finally, these findings were confirmed in our interviews with companies across the Triad. Managers in all three countries (even those managing transplants) confirmed that the basic skills of their production workers were not an obstacle to achieving best-practice productivity levels.

With the exception of computers, the industries we studied did not include any small, high-tech or rapid-growth manufacturing industries. By and large, we chose developed industries, operating in slowly growing or stable markets, that hired few new workers.

Labor reliability and flexibility, not skills

In some of our cases, we found that different levels of labor reliability affect labor productivity. Specifically, companies operating in Germany experienced higher levels of absenteeism than companies operating in Japan and the U.S. and, in some industries, companies operating in the U.S. experienced higher turnover rates than companies operating in Germany and Japan. This lack of reliability reduced productivity by as much as 10 percent.

In all three countries, companies (including transplants) screen potential new employees to find the most attractive. They find large numbers with the necessary basic skills. The critical factors that drive their hiring decisions, however, are attitudinal factors that make workers more flexible, less likely to call in sick, and committed to remaining on the job for a long period of time. Others often define these attributes as "skills". In our study, employee screening and motivation are captured under the "organization of functions and tasks".

perspective. Innovations in this area have usually been introduced first in manufacturing operations in Japan.

Techniques that are used to raise productivity through product design include standardizing components, optimizing the number of parts, and designing the product so that its manufacture can be automated and its assembly done with no or few tools. The industries where this has been important are metalworking, auto assembly, auto parts, and consumer electronics. While companies based in Japan have been the leaders, some in the U.S. have been changing as a result of transplants and the adoption of the new methods. The Ford Taurus is one of the most successful examples of a product designed for easy manufacture by a U.S.-based company.

Operations in Germany have been slow to adopt the innovations in product design. German-built cars, for example, required more parts and more complex assembly than cars designed in Japan. We observed similar disadvantages in product design in both the consumer electronics and metalworking industries in Germany.

¶ Basic labor skills and intrinsic motivation. We did not find evidence that intrinsic motivation and basic labor skills were major explanations for the cross-country productivity differences that we observed in our case studies. As we noted earlier, this finding does not mean that managers can ignore these factors, but rather that manufacturers were able to recruit workers that could be trained and motivated adequately to achieve international productivity standards. We reached our conclusions mainly by looking at transplants (see the box entitled, "Basic Labor Skill and Labor Productivity"). This general conclusion about the lack of impact of labor skills and motivation is subject to two qualifications:

- Japanese transplants in the U.S. do report a small productivity disadvantage with U.S. workers, resulting from higher turnover than in Japan.

- Some companies in Japan have achieved higher levels of worker motivation that give them a small productivity advantage. For example, some auto workers in Japan work additional unpaid time devoted to meetings and discussions about ways to achieve higher productivity and quality. This behavior is partly because of incentives generated within the company (e.g., quality circles) and partly because of intrinsic motivation. Toyota selects workers who devote themselves to the company in a way that is not seen in the U.S. or Germany, or even in other Japanese companies.

¶ Raw materials and parts. The use of raw materials and parts only played a role in explaining productivity differences in auto assembly. In auto

assembly in Japan, the lack of defects and high quality in parts helps companies avoid inspections of incoming parts and rework and thus achieve higher labor productivity.

Production factors tell us about the equipment, parts and labor which are available for use. We now turn to a comparison of operations. Operations describe how the factors of production are combined to produce the output.

Operations

Within operations, there are two main sources of productivity differences: capacity utilization, and the organization of functions and tasks.

¶ Capacity utilization. Metalworking, autos, auto parts, and consumer electronics are all industries that are rather sensitive to the business cycle. And, as we noted in the introduction, these industries in the U.S. experienced the effects of a downturn in 1990. We made rough estimates of the likely effect on productivity from differences in utilization that were caused by the recession and the unusual upturn in Japan. The resulting cyclical adjustment reduced the gap between Japan and the U.S. In the case of autos, the cyclical adjustment was about 8 percent, but in the other cases the effect was smaller. We have reported the cyclically adjusted figures for metalworking, cars, and parts since the influence of the business cycle turned out to be significant.

¶ Organization of functions and tasks. Somewhat surprisingly, there are very large differences in productivity among plants that look similar and that produce similar products (after accounting for differences in design for manufacturing). These productivity gaps result from the way in which work is organized. The most productive operations in Japan have refined and refined their production methods in order to pull as much labor out of the process as possible. There is no one large change that has been implemented, so that the nature of the improvements seems mysterious. It is the accumulation of thousands of small changes, to the point where the placement of every small part and every machine and the movements of every worker are optimized for productivity. It not only includes the optimization of time and motion, but also the management structure. For instance, the delegation of responsibilities, such as production worker empowerment and suggestion systems where improvements are directly implemented, played a large role in the way operations in Japan were able to achieve high productivity. In addition, these advances in organizational efficiency can only be achieved by cross-functional training in multiple tasks as well as on-the-job training in specific tasks.

The Toyota production system is predominantly a method of organization, not a new patented or proprietary technology. Other

Japanese companies and some U.S. companies have been able to adopt similar innovations and have achieved very large productivity increases. The U.S. minimills are run with very lean methods; one firm with over $1 billion in sales operates with fewer than 20 employees in their headquarters, a much lower ratio than for the integrated mills. The high productivity of minimills has much to do with their organization of functions and tasks.

The organization of functions and tasks was seen as a factor affecting relative productivity in all of our case studies. It is particularly important in steel, metalworking, autos, auto parts and consumer electronics. Based on McKinsey benchmarking studies and surveys, it is clear that there are many companies in all three countries that can make large improvements in productivity by improving the organization of their factories.

Not all manufacturing operations in Japan score high on the organization of functions and tasks. Beer producers in Japan adopted process technologies in recent years that are similar to those used in U.S. operations, but many workers were retained in spite of these labor-saving investments and are now being used for labor-intensive marketing programs. Other examples of inefficiently organized functions and tasks in Japan are the food, and soap and detergent industries, where sales administration requires more labor than in the U.S.

In the automotive industry, we concluded that the subcontracting system used with parts suppliers in Japanese operations creates efficiency advantages. There is a "pyramid" structure, in which the small plants supply simple parts to the large plants, and the large plants then assemble more complex parts to be sold to the OEMs. This appears to be a better way to organize functions and tasks when final products are highly complex and when the first tier suppliers have the ability to manage the second tier suppliers. It facilitates the transfer of technology from the OEMs to the first tier suppliers and it simplifies the OEMs' supplier relationships.

PRODUCTIVITY DIFFERENCES AND THE NATURE OF COMPETITION

Defining the Nature of Competition

As we examined the results of the nine case studies, a relationship emerged between the competitive environment in which industries operate, and their productivity performance. To explore the ways in which competition has affected productivity in our case studies, we set up a three-way classification, depending upon whether the manufacturing operations located in a given country are managed by companies that compete only locally, in regional markets, or globally.

¶ Local competition. Companies that compete locally are part of unconsolidated national industries, where small companies serve local markets. In some locally competitive industries there are several small companies serving the same local market which provides some pressure for cost cutting. In other cases, companies are essentially the sole suppliers to different local markets.

¶ Regional competition. Companies that compete regionally sell directly against the most productive companies in their own national or regional market, but do not face the best external producers. Regionally competitive companies may export, but they do not export substantially to third markets where they have to compete against the best external producers. For companies that operate primarily in the U.S., regional competition means that the companies are selling in the U.S. or North America; in Germany it means that they are selling in Europe; and in Japan it means selling in Japan. An industry is regional if most of its production is managed by regionally competitive companies.

¶ Global competition. We classify companies as globally competitive if they compete in their own region and also against the best external producers. Such companies have an external, global orientation and the nature of this global competition can take several forms. (i) Globally competitive companies can sell in their domestic market against transplant production or imports from the best external producers. These external producers must have a substantial market share. External competitive pressure is weakened if trade restrictions, particularly VRAs, limit import market shares. (ii) Globally competitive companies can export a substantial share of their production to the home market of the best external producers. (iii) Globally competitive companies can set up transplants that compete directly against the best external producers. (iv) Globally competitive companies can compete against the best external producers, either through trade or transplants, in third countries. An industry is global if most plants are run by global companies.

The Nature of Competition in the Case Studies

Using the information from the case studies, we made a subjective judgment and assigned each of the twenty-seven industries in our study (9 industries times 3 countries) to one of these three broad classifications. The specifics of our assessment of all of the industries in the three countries are described as follows.

¶ Japan. The steel, metalworking, autos, auto parts, consumer electronics, and computer industries in Japan are globally competitive. These industries sell worldwide and build transplants in other countries; they meet their best external producers in a substantial manner.

We also view the soap and detergent industry in Japan as heavily exposed to global competition because transplants from the U.S. and Europe in this industry have a significant market share in Japan and now set the competitive environment for the industry as a whole.

The beer industry located in Japan has consolidated and competes regionally; however, the government regulates prices and prevents full competition, even in the regional market. In the food industry a consolidation process is just beginning with the growth of some national companies and the entry of multinational food processors. The bulk of the industry competes locally, however.

¶ Germany. Two of the nine industries in this country compete intensively with world productivity leaders: computers and soap/detergents. The bulk of mainframe computer production is either produced in transplants from multinationals originating in the U.S. or assembled by companies headquartered in Germany using parts imported from Japan. The personal computer market faces worldwide competition. The soap and detergent industry consists of a large Germany-based producer competing head-to-head with multinational companies.

The majority of industries in Germany – processed food, steel, metalworking, autos, auto parts, and consumer electronics – have most of their production managed by companies competing regionally in Europe. Auto companies originating in Germany did not compete extensively in the main segments of the industry against Japanese producers until recently, and the auto parts suppliers were tied to the OEMs in Germany with no large segment competing globally. Germany had the world's leading metalworking companies in earlier decades but these companies retreated to the European market in the 1980s. Multinational food processing companies produce and sell in Germany to a certain extent and are growing, but there is also a substantial unconsolidated segment of the industry.

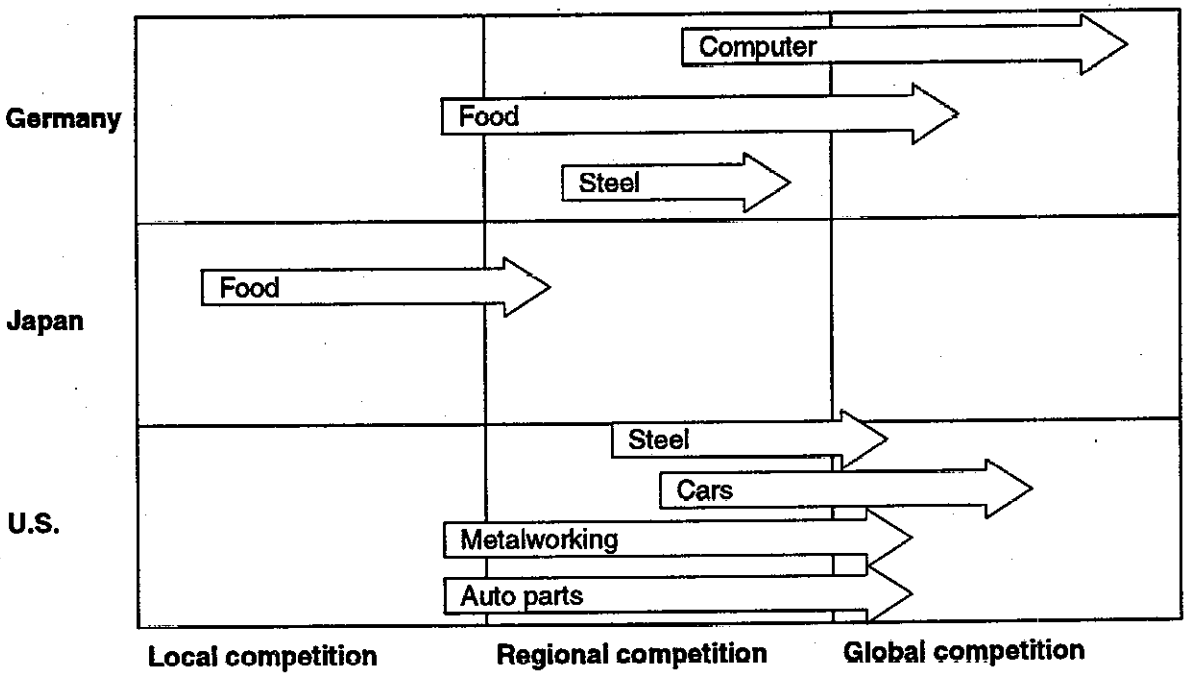
Beer is the only industry in Germany that we studied that faces only local competition. Small breweries are either the sole local supplier or face competition from other small local breweries.

¶ United States. The processed food, auto, computer, soap and detergent and consumer electronics industries in the U.S. compete globally. The major domestic operations in food processing, consumer electronics, and soap and detergents belong to multinationals that have transplants in the leading economies in the Triad. The computer industry in the U.S. also has transplants overseas and competes worldwide in export markets.

The U.S. beer industry has thus far competed mainly in the regional North American market. Beer is a product where exports are uneconomic

Exhibit 3 - 9

CHANGING NATURE OF COMPETITION



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except to serve niche markets because of transportation costs. Transplants, until recently, have been uncommon.

The bulk of output in the metalworking, steel, and auto parts industries in the U.S. is produced by companies that compete regionally. There are some companies that are global. The metalworking industry is in transition. Substantial production is performed by companies originating in the U.S., but transplants managed by globally competitive companies headquartered in Japan also play an active role. Steel operations located in the U.S. are a mix of globally competitive minimills and integrated producers that still use work practices that date from a time when the industry was not globally competitive.

In making these assignments, however, we judged that there is an important dynamic component that is still missing. Several industries are in transition as they adjust to changes in the competitive environment and thus our assignments represent an "average."

The case studies in which the evolution of an industry was important in 1990 are shown in Exhibit 3-9. The arrows indicate that companies in these industries are facing increasing competitive pressure. The lengths of the arrows indicate the extent to which the competitive environments facing the various companies within each industry are changing.

- In Germany, some computer production is still moving towards global competition. In the food processing industry small craft companies are consolidating and the multinationals are expanding. The steel industry is facing increased competition as the EC restrictions are breaking down.

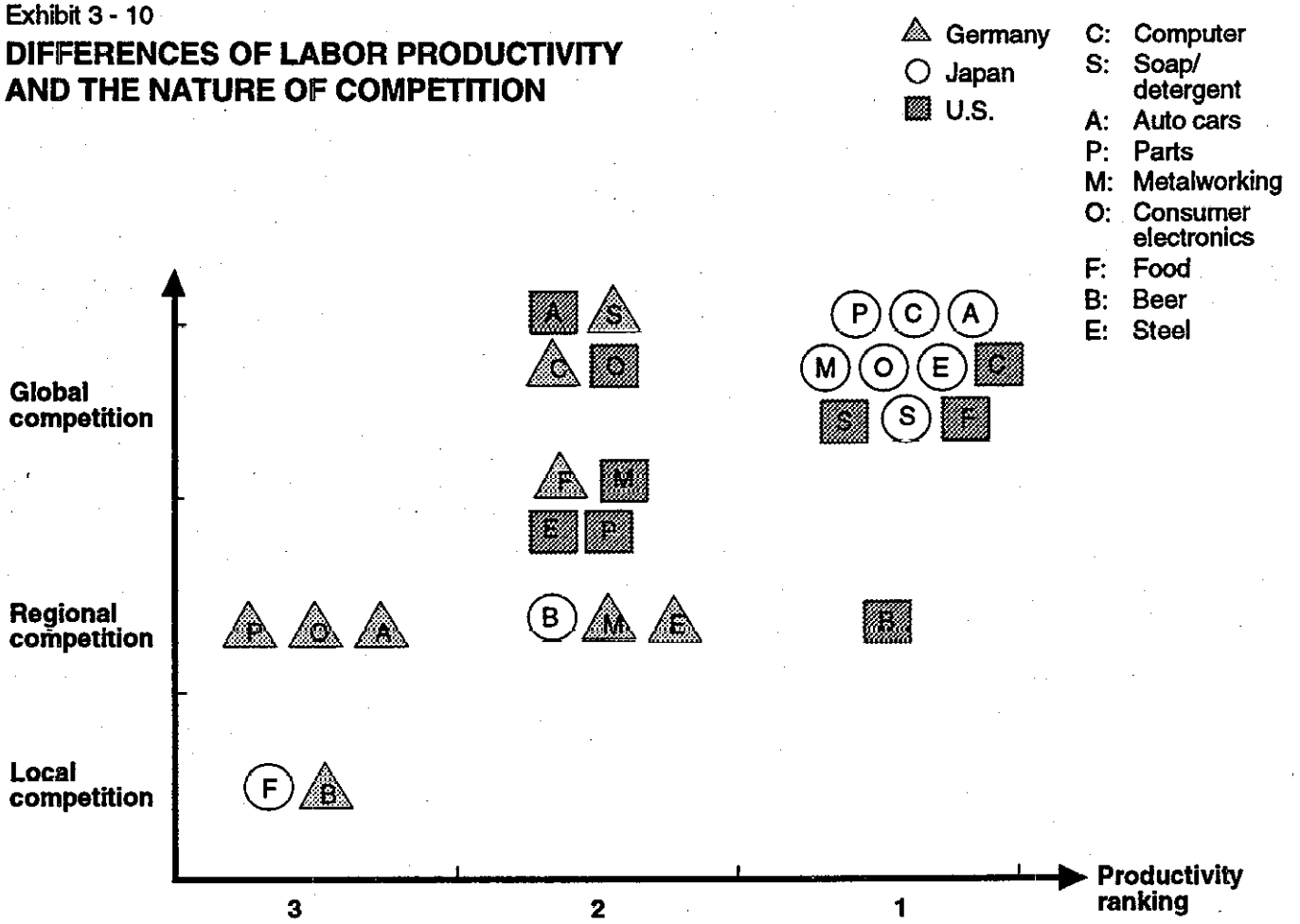
- In Japan, the food processing industry is gradually consolidating and multinationals are entering.

- In the U.S., the steel and auto industries have a legacy from the era of regional competition where 2-3 large companies were slow to adjust to the challenge of global competition. These large companies still have a significant share of total output. In metalworking the transplants are growing and will influence industry productivity within a few years. The auto parts industry is also still in transition. Transplant production is growing, but the group of companies originating in the U.S. have not yet responded to the increased global competition with improvements in productivity.

Consideration of how the industries had evolved in recent years led us to adjust their classifications. An industry may be largely global, but may have a regional component if it is in transition.

Exhibit 3 - 10

DIFFERENCES OF LABOR PRODUCTIVITY AND THE NATURE OF COMPETITION



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Productivity and the Nature of Competition

To see whether our classifications of the industries were related to their productivity, we plotted them against the industries' productivity rankings. The results are summarized in Exhibit 3-10. The exhibit suggests that there is a strong relationship: local or regional industries are lower in productivity than the same industries competing globally.

A few cases deserve special mention. The soap and detergent industry in Germany is ranked lowest of the three in productivity within the industry despite being globally competitive. The low productivity is largely the result of its large share of powdered detergent, not weak competitive intensity.

The food industry in Japan and the beer industry in Germany are ranked third in productivity, similar to several regionally competitive industries. In fact, their productivities (at 33 and 44 percent) are by far the lowest of the group (see Exhibit 3-1a). Local competition with its associated lack of consolidation exacts a large productivity penalty. This penalty is not fully revealed by a simple productivity rank ordering within an industry.

To clarify our hypothesis and to create a more quantitative and objective measure of the intensity of competition, we refined this analysis with two definitions.

- The **productivity leaders** are the most productive manufacturing operations within the Triad. In each of the nine industries there is a productivity leader: metalworking, steel, autos, auto parts, and consumer electronics in Japan; computers, soap and detergents, beer and food in the U.S.

- The **productivity followers** are the manufacturing operations whose productivity on average is below that of the leaders. The productivity followers are the remaining eighteen industries.

Dividing the industries into these two groups allows us to see more clearly the effect of the competitive environment on productivity. We start by looking at the productivity leaders.

Globalization Among the Productivity Leaders

Maintaining Leadership

With the exception of beer, all of the industry productivity leaders studied are exposed to both the best internal and external producers. Through continuous

improvement in their production processes, they have been able to develop and maintain their labor productivity lead.

¶ Exposure to best external and internal producers. The companies exposed to the best external competition compete head-to-head through transplants, exports and, to a lesser degree, imports.

- All of the operations in Japan that are leaders export large fractions of their output to sell in direct competition with their best external producers. In the cases we studied this has meant competing in the U.S. market. Several companies in these industries have established transplants in the U.S. and Europe.

- The large computer companies originating in the U.S. have long exported around the world, set up transplants, and faced competition from imports. The companies that manage soap and detergent and food processing operations in the U.S. are multinationals, meeting competitors around the globe.

- The beer industry based in the U.S. is the only exception where the North American operations mainly compete regionally. However, operations in Germany and Japan are not exposed to greater global competition than the U.S.

¶ Continuous improvement of the production process. The nine industry leaders have maintained their productivity advantage by continually improving their production processes. This improvement is achieved through either increasing efficiency within the existing process or incorporating innovations.

- In the automotive industry, Toyota has maintained its productivity lead through refining its lean manufacturing process. The beer industry in the U.S. uses the same production process as years ago, but increasingly with the addition of computer controls.

- Productivity improvements have also come through innovations in the product or in the production process itself, and can originate from suppliers. The productivity leadership of computer companies originating in the U.S. has been maintained largely through product innovations such as new standards of workstations and client-server networks.

- Leadership in integrated steel has required innovations in continuous production systems and in the size of blast furnaces. Integrated plants in Japan are newer than in the U.S. and Germany, and by virtue of their youth they have been productivity leaders since they were built.

But these plants have maintained their leadership through further innovations in the production process.

Becoming a Leader

In the computer, soap/detergent, food and beer industries, productivity leadership has not changed, but has remained with the U.S. for a long period of time. In the other five cases Japan overtook competitors in productivity within the last two decades.

¶ Exposure to past leaders. Prior to becoming productivity leaders, most of these operations in Japan were competing against their best external producers in Europe and the U.S.

- When the metalworking, autos, auto parts, and consumer electronics industries in Japan were followers, they were exporting and competing extensively with the productivity leader at that time.

- During this period, operations in Japan were well below the highest productivity operations worldwide, and imports and transplants were discouraged. This "protection" lasted well beyond the point where operations in Japan could be described as infant industries. However, given their external orientation through exports, the limits to competition did not prevent these operations from becoming productivity leaders.

¶ Reasons for becoming leaders. Followers improve their productivity by competing with and learning from the leaders. However, revolutionary innovations appear to be important in leap-frogging the leaders. Innovation is intrinsically hard to predict and the reasons why particular leaders became leaders may be impossible to determine. However, we do have a few concrete examples of how operations in Japan surpassed the leader at that time through a significant innovation.

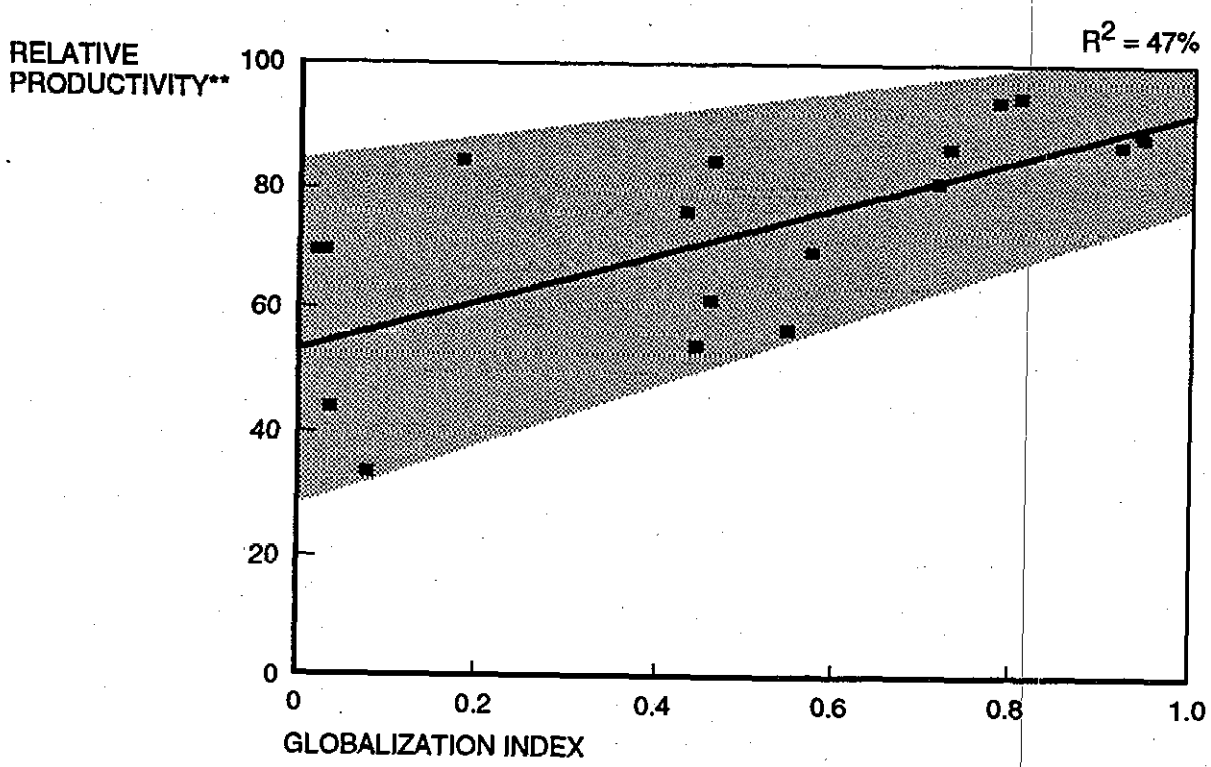
- Lean manufacturing and design for manufacturing, which originated in auto operations in Japan, have proven to be enormously significant innovations. They use continuous incremental improvement and integrate product design engineering and process engineering. They also utilize suggestions from line workers. These innovations have spread among the auto makers, to auto parts and metalworking (all major suppliers to autos) and have been adapted by other industries for their own production.

- Sweeping innovations such as standardization and automation in metalworking were largely responsible for the operations in Japan overtaking those in Germany and the U.S. for productivity leadership.

Exhibit 3 - 11

GLOBALIZATION vs. RELATIVE PRODUCTIVITY*

TRANSPLANT, TRANSPLANT EXPOSURE, AND TRADE



* Data points are nine case study industries in countries without productivity leading edge

** Relative to industry leader at 100

Source: McKinsey analysis

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Exposure to the best internal and external producers and innovation appear to be important for maintaining leadership, and innovation appears to be important for gaining leadership in the first place. Innovations may well be triggered by the pressure generated by the competition with the productivity leader, although we do not have data to confirm this. We do argue, however, that the intensity and scope of competition greatly affects the speed of diffusion of innovations, and hence the size of the gap between follower industries and the productivity leaders that are observed across countries at a point in time. We turn now to an examination of the productivity followers among our case studies in order to show this.

Productivity and Globalization
Among the Productivity Followers

Our hypothesis for the productivity followers is that, the greater the exposure of a productivity follower to competition with the productivity leader, the closer this industry's productivity will be to that of the leader.

We constructed a globalization index for each of the eighteen productivity followers in the case studies and found that the evidence supports our hypothesis. Our index is highly correlated with relative productivity levels.

Exhibit 3-11 presents the result. The horizontal axis measures the degree to which a country's production volume comes from the productivity leader (transplants), or is exposed to competition with the productivity leader. The vertical axis is the productivity for each industry normalized to the leader at one hundred. Exhibit 3-11 suggests that all of the industries where the globalization index was above about 0.7 have productivities very close to the productivity leaders.

The globalization index for a domestic industry takes the following factors into account:

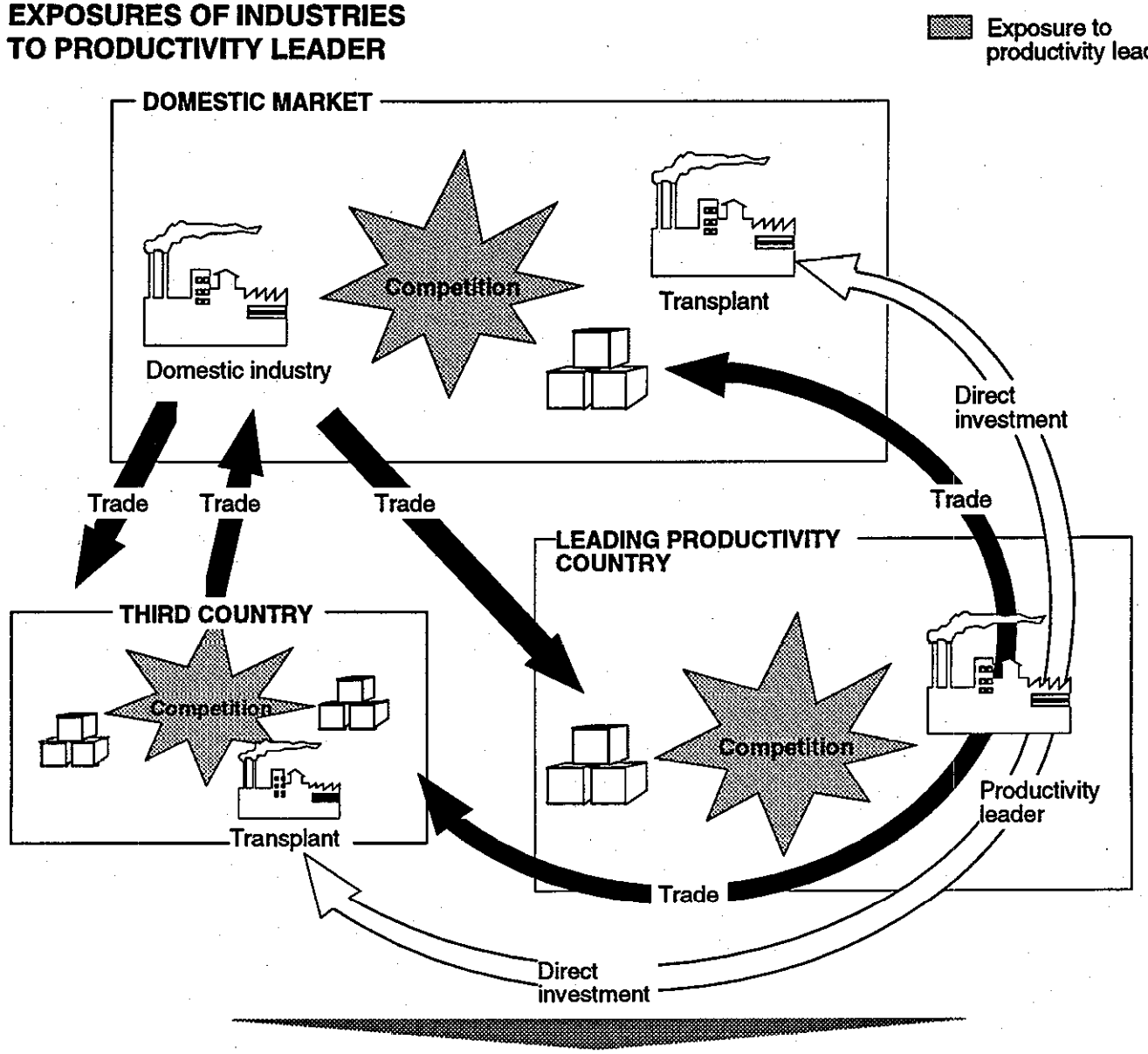
- The volume of production in transplants operated by productivity leaders;
- The exposure of domestic operations to the productivity leader's transplants;
- The exposure of domestic operations to competition with the productivity leader through trade: imports from the leading country, exports to the leading country, and exports to third countries where head-to-head competition with the productivity leader exists.

Exhibit 3-12 shows the factors considered in calculating the index, which is a weighted sum of all the components. Other factors were also taken into account:

- The extent of trade protection, as measured by the difference between the PPP and the market exchange rate, was included in the import component.

Exhibit 3 - 12

EXPOSURES OF INDUSTRIES TO PRODUCTIVITY LEADER



VEHICLE OF EXPOSURE

Trade	Foreign direct investment
• From leader • To leader • From transplant of leader in third country • To third country with transplant of leader • To third country with trade from leader	• Into domestic market • Into third country

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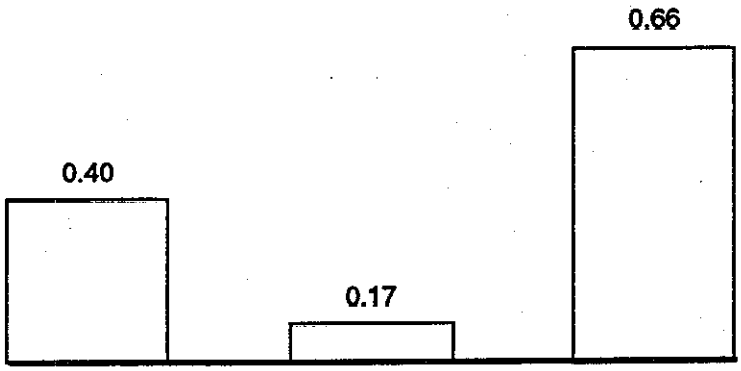
Exhibit 3 - 13

GLOBALIZATION OF PRODUCTIVITY FOLLOWERS

Globalization index weighted by employment share for followers



	Germany	Japan	U.S.
	Autos Auto parts Metalworking Steel Computers Consumer Electronics Food Beer Soap and Detergent	Computers Food Beer Soap and Detergent	Autos Auto Parts Metalworking Steel Consumer Electronics
Productivity gap* of followers	34	59	20

* Weighted by employment with leader at 100

Source: McKinsey analysis

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- Transplants from third countries added to the globalization of domestic company production if operations in the third country have higher productivity than that of the domestic industry, even if it was lower than the productivity leader.

- The globalization of the auto parts industry was adjusted for the globalization of the auto industry (the OEMs), due to their strong influence on supplier productivity.

We have constructed country-level globalization indexes for productivity followers, with each industry's globalization index weighted by its employment share. The results of these calculations are shown in Exhibit 3-13. We find that productivity followers in the U.S. have the highest overall level of globalization, with follower industries in Germany next. Productivity followers in Japan are low in overall globalization, held down by the large food industry. Some German industries have faced limited direct competition with productivity leaders. We believe that this has been an important reason for the lower productivity found in those industries.

Determining the Direction of Causality

It seems clear that there is a strong association between productivity and degree of competition with the productivity leaders. However, we need to probe carefully into the reasons why this association exists and why we believe that competition with the productivity leader determines productivity rather than vice versa.

A possible criticism of our conclusion is that the direction of causality is the opposite of that stated above. This would imply that competitive industries became highly productive first and then started to export or to make foreign investment in order to exploit their cost advantages. We disagree with this alternative perspective for the following reasons.

- It is possible to be externally oriented and to export well before levels of productivity are achieved that rival the world frontier. This is certainly the case for countries in South East Asia today and was true for Japan and Germany in the 1960s and 1970s. The decision to participate in the global economy typically preceded the high productivity levels rather than vice versa.

- In those German industries that were competing against the leading edge in the 1960s and 1970s, productivity growth was very rapid. As German manufacturing turned to its protected regional market, productivity growth slowed down.

These arguments about why we believe that it is globalization that leads to high productivity, rather than vice versa, can be greatly strengthened by examining

Exhibit 3 - 14

RESPONSES OF U.S.-BASED INDUSTRIES TO JAPANESE COMPETITION UNTIL 1990

Industry	Faced	Reaction
Cars	√	Reform
Parts	√	No major improvement
Steel	√	Reform (minimills)
Metalworking	√	Partial exit
Computers	√	Reform, partial lead
Consumer electronics	√	Exit, no growth
Processed food	–	–
Beer	–	–
Soap and detergent	–	–

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what actually happened to U.S. industries that faced leading edge competition from Japan.

Exhibit 3-14 summarizes the impact of increased competition on industries operating in the U.S. Six of these have faced strong competition in recent years from industries in Japan with high productivity.

- ¶ Of these six, there are two that have clearly responded to the Japanese challenge and improved the productivity of their operations – computers and autos.

- ¶ A third industry, steel, has changed dramatically. The U.S.-integrated mills did not invest heavily to upgrade their facilities, but they have responded, albeit slowly, by streamlining their operations and retiring many integrated mills. Minimills entered the industry, which can be seen as a response to the need for lower-cost production in the face of increased international competition.

- ¶ At present there is still a large auto parts industry consisting of plants that originated in the U.S., but transplants are being set up to compete with these. Our data suggest that the original U.S. plants have fallen well behind the average of Japanese operations in productivity. This industry may be one where existing plants adjust in response to the increased competitive intensity, or it may be one where these plants exit. Either way, we expect productivity to rise in U.S. operations in auto parts.

- ¶ Companies founded in the U.S. have almost completely exited the consumer electronics industry, and to some extent, left metalworking too, as transplant entry and import competition has occurred.

To the extent that there is a pattern in these findings, it is that U.S. companies exited from low value-added-per-hour-worked industries, but increased their productivity in other industries. This pattern is to be expected, given relatively high U.S. wages, since U.S. production can only be profitable if there is enough value added during production to pay for wages.

Local Competition and Productivity

In the case studies we found that two industries, beer in Germany and food in Japan, showed large productivity shortfalls compared with the productivity leaders. They have a common feature which distinguishes them from the rest of the productivity followers: they have remained local and unconsolidated with mostly small companies serving local markets.

These two industries also lack the scale and technology of the productivity leaders. But to achieve high productivity it may be necessary for most of the

Exhibit 3 - 15

IMPORTANCE OF FACTORS IN THE GLOBALIZATION INDEX

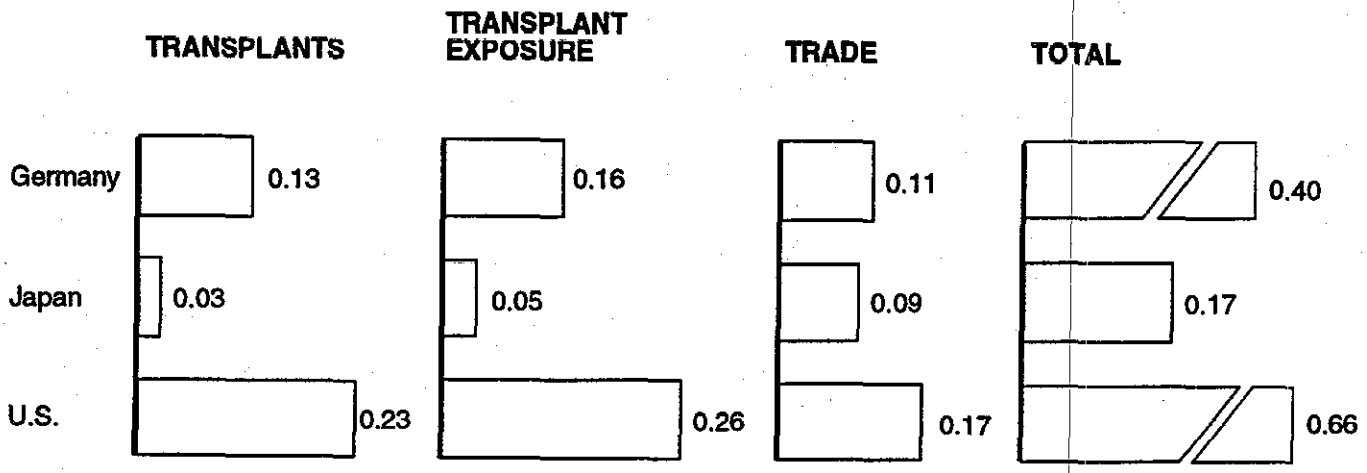

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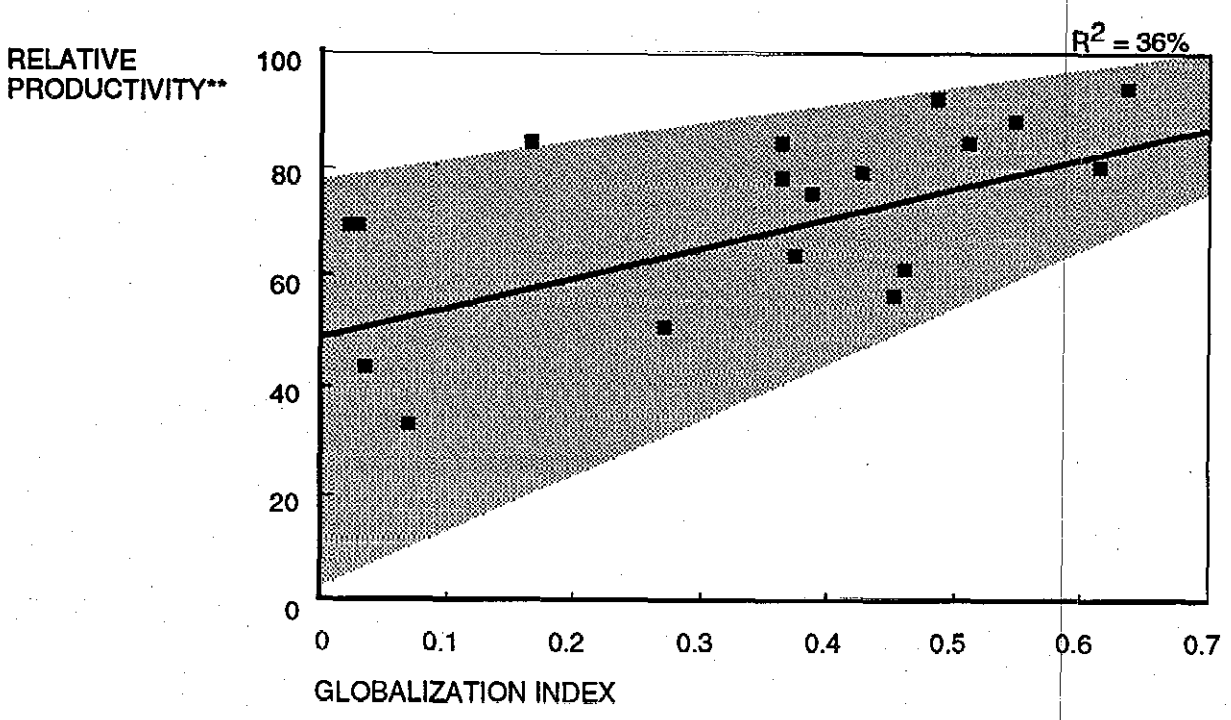
Exhibit 3 - 16

GLOBALIZATION VS. RELATIVE PRODUCTIVITY*

TRADE AND TRANSPLANT EXPOSURE OF DOMESTIC OPERATIONS



* Data points are nine case study industries in countries without productivity leading edge
** Relative to industry leader at 100

Source: McKinsey analysis

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companies in the industry to go out of business, creating worker dislocation and lower total employment in the industry. Opening up these industries to greater competition is likely to force this type of change; thus we might expect those who would be potentially affected to resist increased competition.

We conclude that within the productivity followers, there are essentially two groups: unconsolidated industries which show a substantial gap and which are at most competing on a local basis, and others which are consolidated nationally or regionally and serve national or regional markets.

Importance of Factors in the Globalization Index

If we look at the three main components of the globalization index in Exhibit 3-15 (leading edge transplants, exposure to leading edge transplants, and exposure through trade to the productivity leader), we can see that the U.S.'s high overall globalization index is mainly due to the high level of transplants. The exposure factors contribute similarly to Germany's overall index value, but at lower levels. In those industries where Japan is a productivity follower, however, there is significantly less transplant production relative to trade as well as low exposure to the productivity leader through trade.

To examine whether the relationship between exposure to productivity leaders and relative productivity holds without the influence of transplant production volumes, the globalization index was recalculated for domestic production volumes only. The productivity levels were recalculated for domestic operations excluding leading edge transplants. The result is plotted in Exhibit 3-16. Although the relationship is not as strong as when the transplants were included, a high correlation between globalization and relative productivity remains.

CAUSALITY CONCLUSIONS

The main effort to understand causality in this report has been directed at the production process level. We wanted to know what companies were doing differently in these countries. Several themes have emerged from the case studies. First, the products manufactured are somewhat different and this helps explain some of the productivity gaps. Second, very different production technologies coexist within a given industry and productivity varies greatly among these generations of technologies. Third, innovations in product design for manufacturing have sharply reduced cost and raised productivity for companies that have adopted the new techniques. Fourth, even with a given technology and product design, there are very large increases in productivity that can be achieved through the efficient organization of functions and tasks. Fifth, we did not find that intrinsic motivation and skill differences were a major source of the productivity

gaps, although improved organization of functions and tasks will require on-the-job training.

Moving beyond the production process level we found a strong association between the degree of competition with the world's productivity leader and relative productivity. It is also the case that unconsolidated local industries have very low productivity. Global competition appears to be very important in achieving and sustaining best practice productivity levels.

IMPLICATIONS FOR POLICY

We have argued that the pressure of competition leads managers and companies to adopt the most productive methods. In this section we look at those factors, external to companies, that increase or decrease competitive pressure and, based on this analysis, we suggest policies that could be used to increase competition and hence raise productivity.

We recognize that raising productivity is not the only goal of policy and that there are trade-offs that have to be made by policymakers and voters. We are concerned, however, that these trade-offs are not well understood, and so we start this section by looking at what they are.

POLICY TRADE-OFFS

The trade-offs involving productivity can be divided into three groups: productivity and employment; productivity and domestic ownership; and productivity and other public interests. As we examine these trade-offs, we will argue that some of them are real, so there is a real cost to raising productivity. However, we also find that some trade-offs are only perceived. In these cases, we find little or no real cost to society as a whole from policies that would raise productivity.

Productivity and Employment

The source of most productivity increases is innovation, defined as new ways and technologies for producing goods and services. Innovation changes the production process and the nature of output, and to increase labor productivity these changes must increase output, decrease labor input, or do both. Policymakers often believe that productivity increases involve a reduction in labor input. At the end of the road they fear a society plagued with unemployment, homelessness, crime and social unrest. We believe, however, that these social ills are not the result of productivity increases, so the fear of productivity increase is not well-founded.

- ¶ Productivity and Total Employment. There is widespread misunderstanding about the nature of the trade-off between productivity and overall employment; high productivity does not generally go along with high unemployment. For an economy as a whole, rapid productivity growth need not mean slow employment growth or rising unemployment, because output is not fixed and can expand enough to generate new jobs and sustain high employment. Provided the appropriate macroeconomic policies are followed, GDP will grow faster over the long term when productivity growth is faster. For example, unemployment in the U.S. and Europe was lower in the 1950s and 1960s,

when productivity growth was relatively rapid, than it was in the 1970s and 1980s, when productivity growth was slower. Workers displaced from one job by productivity increases will generally find other jobs in a dynamic and growing economy with strong job creation performance. They will contribute to the growth of GDP in their new positions. The prime responsibility of government is to maintain a macroeconomic environment in which this process can succeed.

Even though the trade-off between productivity and total employment is not a real one, there are situations where there is a trade-off between productivity and the preservation of existing jobs.

¶ Productivity and existing jobs. For workers in a particular plant or office, a productivity increase can be either good or bad news. Productivity increases allow companies to hold down production cost and prices, which can stimulate demand for the goods and services they provide. This, in turn, can lead to higher employment. For some companies or industries, however, if demand is not very responsive to price or if the price level is falling, for example, due to intense international competition, productivity increases will end up displacing workers. While there are clearly costs associated with the disruption of individual lives when market forces are allowed to operate without policy mediation, these costs have to be weighed against the benefits of higher productivity and higher average standards of living.

One outcome of increasing productivity in a company may be that employment stays constant while labor is redeployed within the same company (or within affiliated companies) in ways that increase output. This approach is taken by large companies in some industries in Japan, and it is an approach that worked well. Productivity is increased and workers move to new positions. In general, however, this is a second-best approach, one that carries the danger that the productivity benefits of innovations will reduced or even lost.

When innovation leads to reduced labor requirements, this creates an opportunity. Human resources can be returned to the labor market to find the most productive alternative uses for those resources. Productivity will thus be higher when management has the option of releasing workers from the company. If an economy restricts itself to increasing productivity without displacing labor from its current company location, the economy is unlikely to achieve all possible gains in productivity. The creative and productive use of people is restricted to the next best ideas within companies instead of the next best ideas within the whole economy. We found in beer operations in Japan that investments had been made to improve productivity in the core processes of the industry, but the companies had retained their employees, using them in very low

productivity marketing positions. This led to a substantial productivity penalty.

While we believe that it would be a mistake to force companies to redeploy workers internally, we recognize that employers will often choose to provide some job security to their workers. This can be good for morale and will reduce workers' resistance to change. There is probably an optimal degree of job security within companies, high enough to reduce resistance to innovation and productivity increases but not so high as to make innovation unprofitable or impossible. The optimum may change over time as the globalization of the economy makes capital and technology more mobile. We cannot say from our case studies what that optimum is, but we think that extreme job insecurity and extreme rigidity are undesirable.

We believe that historical experience does not support the contention that there is a trade-off between productivity and total employment. We do conclude that there is a real trade-off between productivity and existing jobs, but we are concerned that in practice, policies may favor existing jobs too much when assessing this latter trade-off. The policies that preserve existing jobs may only preserve them temporarily and may do so at the expense of future jobs.

¶ Productivity and Future Jobs. One of the consequences of trying to tame market forces is the proliferation of regulations and other policies whose explicit goal is the protection of specific jobs and incomes. Most often, although not always, it is manufacturing employment that is protected, even when service employment is more common and more promising. This practice is more frequent in Europe and Japan than in the U.S., although it can be found everywhere. Such policies may occasionally be defensible, if they are intended and implemented only to preserve social harmony and cohesion by smoothing the shocks associated with rapid economic change, and if the benefits are large compared with the costs. However, the policies and regulations often have complex effects not foreseen by policymakers. In particular, they may be a bad bargain because they give temporary shelter to existing jobs and incomes at the expense of future jobs and incomes.

European policies, which have achieved greater income equality than in the U.S., may have discouraged employment. By contrast, the U.S. economy over the past 30 years has shown a remarkable ability to create new jobs, many of which have been well-paid. Rapid job creation has enabled the U.S. to move from having the lowest percentage of working age population employed among the leading economies in 1973 to having the highest percentage in 1989. This has led to lower total unemployment and – consistently over time – to lower long-term unemployment in the U.S. than in Europe.

Until recently, these policy trade-offs have not been part of the national debate in Japan. With the restructuring and reform now underway, however, some of these issues may arise.

Productivity and Domestic Ownership

Perhaps the most important way in which productivity can be increased, especially in an industry where productivity is lagging, is through the entry of transplants managed by companies that have best practice methods. However, allowing or encouraging transplants is seen by some as a loss of national sovereignty. Companies owned by "foreigners" are seen as less likely to act in the interest of the home economy and as less subject to national policy control. Some policymakers argue that it is a mistake to use transplants as a vehicle for productivity improvement.

The argument for protecting domestic ownership should be challenged. Governments have legal authority over transplant operations, just as they do over domestic companies. Some multinational companies have been willing to promote talented people, even up to the CEO level, without regard to national origin. We think that voters should question what they are really getting when politicians propose laws to defend domestic companies against either transplants or takeovers. Often it is a special interest that is at stake and not a national interest.

Productivity and Other Public Interests

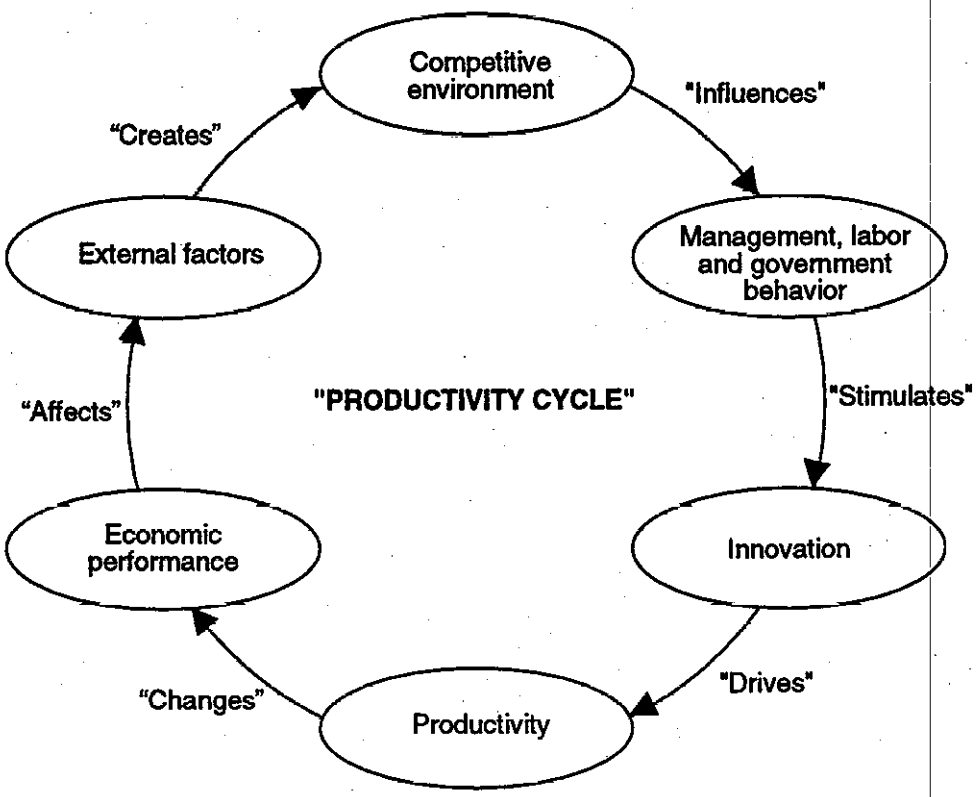
The two areas where we see real trade-offs between productivity and other public interests are in the health and safety area, and in working conditions.

- ¶ Health and safety Environmental protection (pollution and emissions), ensuring public safety (e.g., airlines maintenance regulation) or consumer protection (e.g., deposit insurance, food and drug purity) are examples of regulations concerning non-marketed industry outputs and production processes. If market forces alone cannot control undesirable outputs, government regulates the output directly. This regulation can affect productivity. There is, however, a broad consensus across the OECD countries that governments play an important role in trading off these goals against more narrow "economic" gains.

- ¶ Working conditions Labor laws regulate job conditions and industrial safety and some of these will involve a productivity sacrifice. Any loss of productivity from these laws can be weighed against the benefits. Moreover, harsh or unsafe working conditions are not generally conducive to productive operations, so there may be no productivity penalty from regulations to alleviate such conditions.

Exhibit 3 - 17

DYNAMICS OF MANAGEMENT BEHAVIOR AND PRODUCTIVITY



Source: McKinsey

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Laws that regulate normal working conditions are not as easy to defend if they reduce productivity. In a market system, employers must provide appropriate work conditions in order to attract good quality employees and a productive workplace. And workers can join unions to represent them. There may be no need for special laws to govern normal working conditions. We discuss the impact of labor laws and union rules on productivity later in this section.

We have examined the trade-off between productivity and other social goals from a societal point of view, and found that the trade-offs between productivity on the one hand, and health and safety and working conditions on the other, are real. However, the trade-offs between productivity and total employment, and between productivity and domestic ownership, are not real social trade-offs.

In the remainder of this chapter, we review the external factors that we believe have affected the nature of competition in our case study industries and suggest the kind of policy changes that would raise productivity. Policymakers have the responsibility to decide which trade-offs they are willing to make between productivity and other objectives.

EXTERNAL FACTORS AND POLICY IMPLICATIONS

Our productivity findings show that there are unexploited opportunities for productivity improvement in the manufacturing sector across the Triad. The achievement of these gains would mean a measurable narrowing of the existing difference in real per capita income between the U.S. and other large, advanced, industrial nations, and an increase in per capita income in the U.S. Therefore, the stakes are not trivial.

We believe that there is a "productivity cycle" operating over the long run that connects the critical drivers of productivity to exploit these opportunities (Exhibit 3-17). External factors, especially policy and regulation, create a competitive environment which, in turn, heavily influences management objectives and behavior. Pursuing its objectives, management creates and changes the production process through innovations and higher capital investment, which improve the labor productivity of the company and ultimately, the industry. The productivity cycle then provides a feedback loop to the external factors through assessments of economic performance.

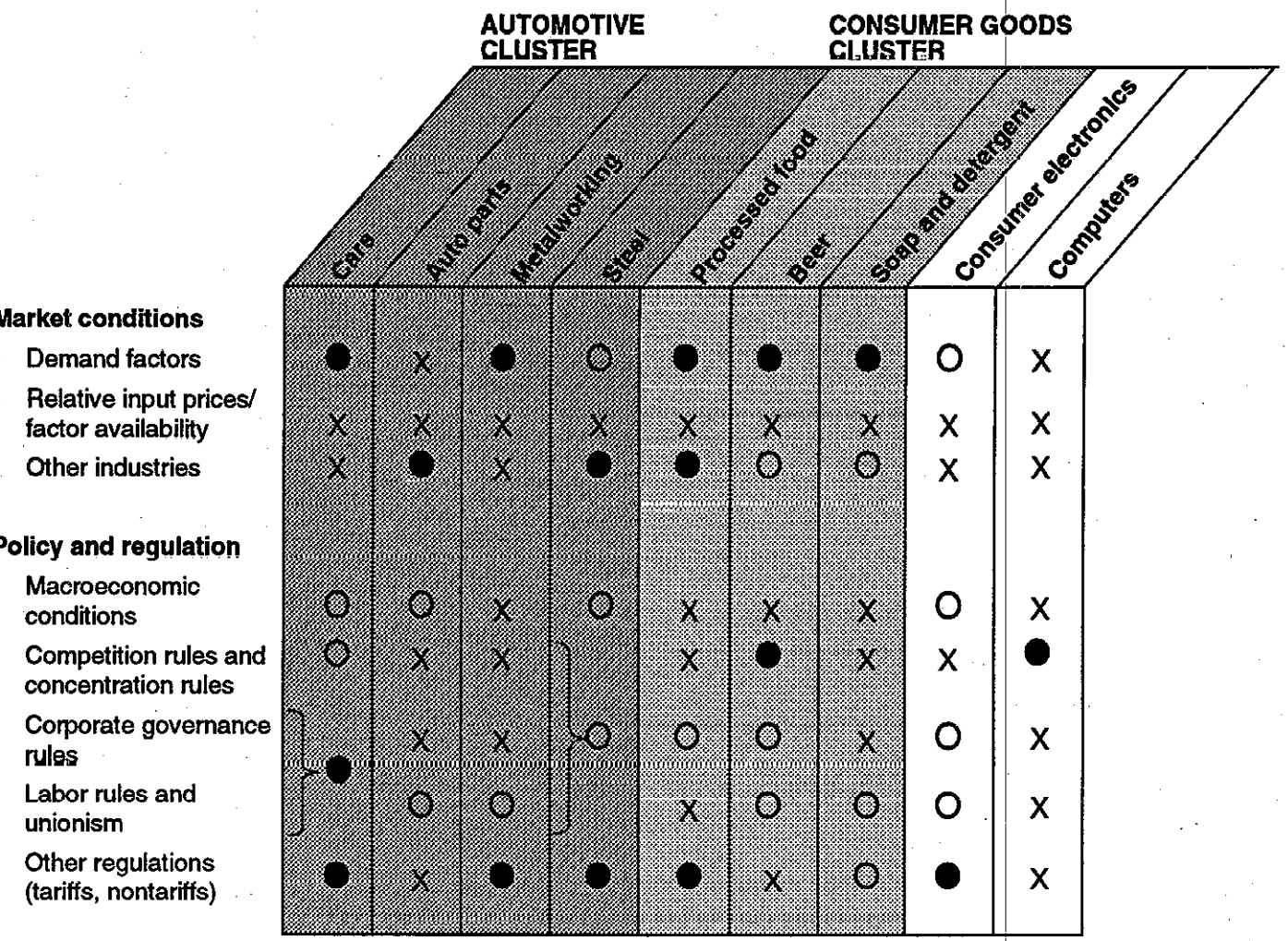
Our purpose in this chapter is narrow. We will judge a policy only on whether it is favorable or unfavorable to labor productivity, and will not make judgments on other objectives. Having stated this, we will now discuss the influence of external factors on productivity. Exhibit 3-18 summarizes our conclusions. Looking along the rows we can see the importance of each external factor in determining the competitive environment in the case industries.

Exhibit 3 - 18

CAUSES OF LABOR PRODUCTIVITY DIFFERENCES BY EXTERNAL FACTORS

SUMMARY

● High
○ Low
X Undifferentiated



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The industries in Exhibit 3-18 can be grouped in three clusters. First, there is a cluster of companies around the auto industry. The car industry influences labor productivity as an important customer for the metalworking industry (the "demand" factor), and in its use of materials from industries such as auto parts and steel (the "other industries" factor). Restrictions on competition in the auto industry thus have an indirect effect outside that industry, as illustrated in Exhibit 3-19. Labor rules, corporate control, customer preferences and trade restrictions in the car industry end up affecting indirectly the metalworking, steel and auto parts industries.

The consumer goods industries (beer, processed food and soap and detergents) form another cluster. As shown in Exhibit 3-20, common factors like customer preferences and the distribution system for consumer goods (the "other industries" factor in Exhibit 3-18) explain productivity differences in these three industries.

Many of the external factors that affect the nature of competition are interrelated; some of these external factors would diminish in importance if the industry in question were fully exposed to the leading edge in productivity. For example, if there is full global competition in the product market then work rules may have to adjust if companies are to survive. This means that the policy implications that we develop here should always be viewed in the context of this interrelationship.

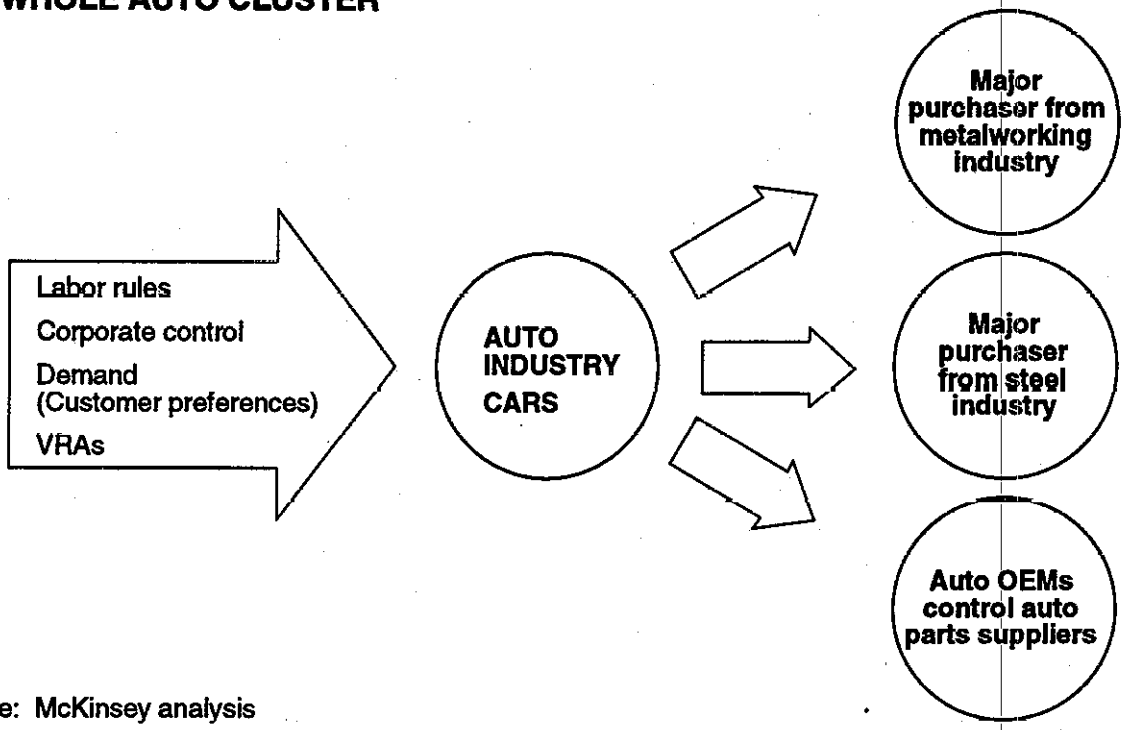
An important policy issue that cuts across many of the categories shown in Exhibit 3-18 concerns transplants. What are the consequences of policies that encourage or discourage transplants?

- ¶ We have found that transplant production from companies that are using best-practice methods contributes positively to average domestic productivity in four ways. Transplants from leading edge producers: (1) directly contribute to higher levels of domestic productivity, (2) prove that leading edge productivity can be achieved with local labor and many local inputs, (3) put competitive pressure on other domestic producers, and (4) transfer knowledge of best practice to other domestic producers through the natural movement of personnel. Moreover, the politics of foreign direct investment has been good because it creates local jobs, whereas the politics of trade has been bad because it destroys local jobs. As Exhibit 3-21 shows, transplants in the U.S. have the highest impact. We have seen this particularly in the U.S. auto industry, but also in metalworking, and consumer electronics.

- ¶ There are significant barriers to the introduction of transplants in all countries, but particularly in Japan and Europe. Companies setting up transplant operations may experience differences in the labor force or in the business relationships of the country in which they are investing. In addition to such natural hurdles, however, there are often formal and informal barriers that restrict foreign ownership. In many cases,

Exhibit 3 - 19

EXTERNAL FACTORS: CAUSES OF PRODUCTIVITY DIFFERENCES FOR THE AUTO INDUSTRY AFFECT THE WHOLE AUTO CLUSTER



Source: McKinsey analysis

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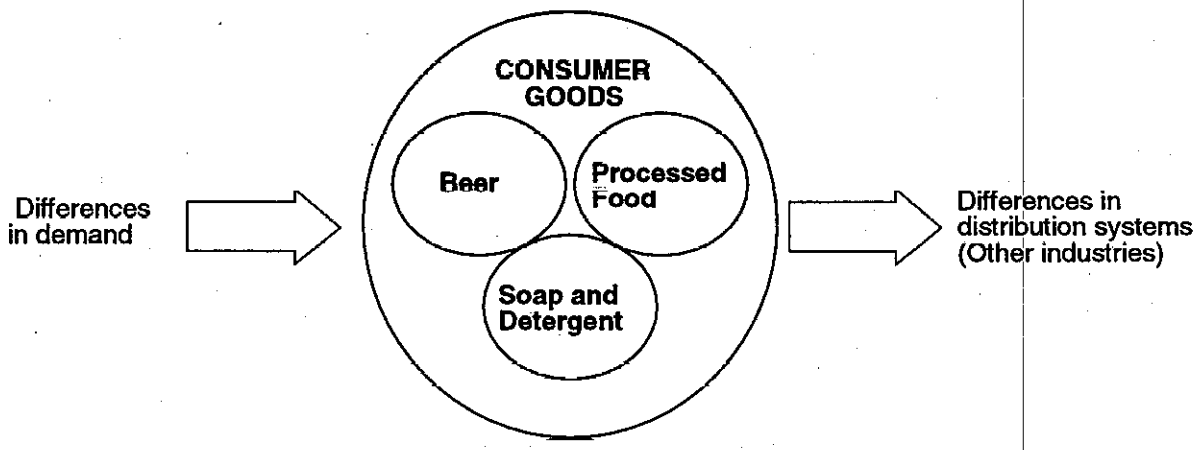
Exhibit 3 - 20

EXTERNAL FACTORS: CONSUMER GOODS INDUSTRIES FACE COMMON CAUSES OF PRODUCTIVITY DIFFERENCES



Source: McKinsey analysis

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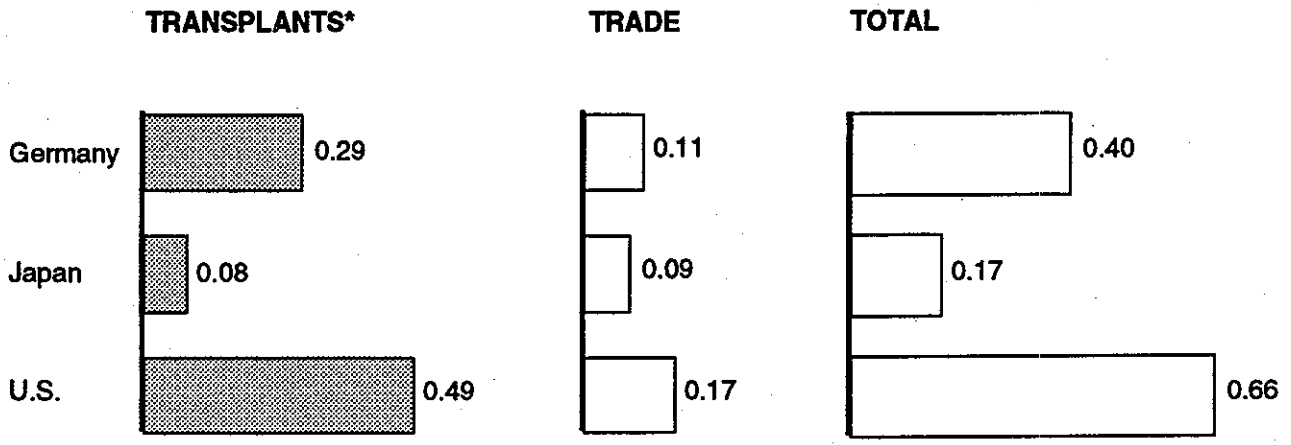
Exhibit 3 - 21

IMPACT OF TRANSPLANT AND TRADE ON PRODUCTIVITY

Weight in Globalization Index



* Transplant and transplant exposure

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government permission has to be obtained before setting up new operations. If a government or interest group chooses to discourage transplants, it can find ways to delay them or raise the costs of entry. In addition, there can be barriers created because of the market for corporate control. For foreign companies wanting to buy existing enterprises rather than building new greenfield plants, share purchases may be limited either by law or because voting shares are held by banks and other companies that choose not to sell. Both Japan and Germany have significant barriers of this kind. A final barrier to transplants is that they may be affected by other industries in the economy. If access to the distribution system is difficult to get, this raises a transplant's costs compared to existing operations.

¶ Our findings suggest that barriers to transplants are, in fact, barriers to productivity improvement. Governments that want to increase productivity should seek to remove such barriers, as the positive impact far outweighs the problems that foreign ownership allegedly creates.

We now leave aside any interrelationships among the remaining external factors and discuss each in turn and their policy implications. We will go over them in the order they appear in Exhibit 3-18 with one exception. Because we have found global competition to be so important, we discuss specific regulations and trade restrictions first.

Specific Regulations and Trade Restrictions

Domestic and trade regulations were a major reason why there were limits to competition in many of our case studies. We believe that these restrictions hurt productivity growth.

Apart from tariffs, the most common trade restriction (one that has become widespread in the last few years) is the Voluntary Restraint Agreement or VRA. These agreements are set up once imports start to take a significant market share. They are usually negotiated government to government, but the exporting companies are often willing to go along with the plan because they are then able to raise their prices. The losers in the short run are consumers, who are forced to pay above world market prices for their goods.

A question remains whether temporary protection from foreign competition might not have a positive effect on a domestic industry's performance by providing it with time to reform. In principal, the answer could go either way. We found evidence of beneficial effects in only one industry in one country: car production in the United States, where trade protection led to improved productivity in existing facilities. The VRA on Japanese car imports in the U.S. provided Chrysler and Ford

Exhibit 3 - 22

EFFECT OF TRADE PROTECTION ON PRODUCTIVITY IN EXISTING FACILITIES

1980s

+ Possibly helped
X No effect
– Hurt

	Metal-working	Steel	Beer	Pro-cessed food	Cars	Parts	Consumer electronics	Computers	Soap and detergent
Germany	–	–	X	X	–	–	–	X	X
Japan	X*	X	–	–	X*	X	X*	X*	X
U.S.	–	–	X	X	+	X	X	X	X

* Helped in earlier period

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Exhibit 3 - 23

CASES WHERE TRANSPLANTS HELPED PRODUCTIVITY

PRELIMINARY

+ Possibly helped
X No effect
– Hurt

	Metal-working	Steel	Beer	Pro-cessed food	Cars	Parts	Consumer electronics	Computers	Soap and detergent
Germany	X	X	X	+	X	X	+	+	+
Japan	X	X	X	+ (small)	X	X	X	+	+
U.S.	+ (small)	+ (small)	X	X	+	+ (small)	±*	+ (small)	X

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with the time they needed to become competitive with Japan. We found no other recent example (Exhibit 3-22).

If one goes back far enough, there are other examples. The Japanese government's protection of its infant auto, computer, metalworking and consumer electronics industries very likely helped those industries develop to the point where they could compete on their own. Moreover, in knowledge-intensive industries like computers and metalworking, the Japanese government used the power of market access to require the transfer of technology to companies in Japan, thereby increasing domestic and eventually global competition. But as a general rule, protection, once given, is hard to withdraw. Persistent inefficiency is its most likely result.

The public case for trade protection is usually made in terms of protecting producers that are headquartered domestically, but one could also make a case for trade protection on the grounds that it encourages transplants. If the leading global companies invest in a protected market, they bring high productivity facilities into the domestic industry. We look at this issue in two steps. The first step of the argument is illustrated in Exhibit 3-23. It shows the case studies where transplants have helped productivity and there are plenty of examples where this happened. The country that has been most helped by transplants is the U.S. (although, as yet, the share of transplants is small). The general conclusion is that transplants do help domestic productivity.

The second step of the argument is illustrated in Exhibit 3-24, which shows whether or not transplants were encouraged by trade restrictions in the 1980s. For the U.S. there were some signs that transplants were encouraged in the auto, steel, metalworking, and consumer electronics industries. But based on our interviews, the impact of these trade restrictions on corporate decisions was small.

In summary, therefore, we conclude that there are few, if any, examples where trade restrictions encouraged productivity improvements in existing facilities and many examples where they have hurt productivity by reducing competitive intensity, as we described in the conclusions section. Productivity in a domestic industry is helped by the arrival of high productivity transplants, but trade restrictions do not appear to have been a major factor in inducing them in the 1980s.

These findings led us to the following implications:

- ¶ General trade restrictions. Given our finding that global competition leads to higher productivity, a specific step that can be taken to encourage global competition is to phase out the variety of different trade restrictions that are in effect in Europe, the U.S., and Japan. These include VRAs, subsidies and quotas.

- ¶ Global versus regional trade policy. In recent years there has been a shift towards regional trade groupings. The most important of these

Exhibit 3 - 24

CASES WHERE TRANSPLANTS WERE ENCOURAGED BY TRADE RESTRICTIONS IN THE 1980s

PRELIMINARY

● Big effect
○ Small
X No effect

	Metal-working	Steel	Beer	Pro-cessed food	Cars	Parts	Consumer electronics	Computers	Soap and detergent
Germany	X	X	X	X	X	X	X	X	X
Japan	X	X	X	X	X	X	X	X	X
U.S.	○	○	X	X	○	X	○	X	X

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has obviously been the European Community, but NAFTA has also become an important policy issue in North America. The results of our case studies suggest that while these regional groupings can improve the productivity in a region, they are not a substitute for the expansion of global trade. A regional grouping will not ensure that companies reach world-class productivity levels unless the frontier is included within the grouping.

If the EC becomes "fortress Europe," and restricts trade with the U.S. and Japan, as well as the penetration of transplant production, European companies will not be forced to adjust to the world productivity frontier in several industries. The productivity benefits that are hoped for from the EC, although they may still be positive, may not be as great as they could be.

Demand Factors

Differences in customer preferences can affect labor productivity by either causing industries to produce different products or by insulating operations from other ones. These preference differences can arise in three ways. First, consumers in one country may simply have different tastes for products from consumers in another. Second, consumers may be better informed about the characteristics of products in one country than in another. Third, some nations' consumers may prefer certain products because of formal or informal relationships with the supplier (e.g., formal vertical integration or national identity). Demand factors of these three types were important in our case studies in autos, beer, soap and detergent, processed food, and metalworking.

- In autos, the preference of German consumers for cars made in Germany has helped insulate that industry from full external pressure.

- German consumers strongly prefer beer with local brands, which allows small breweries with low productivity to remain in the market.

- In soap and detergents, consumers in Germany simply favor powder over liquid detergent. This preference has an adverse effect on productivity in that industry because powder detergent production involves a more labor-intensive process.

- The processed food industry in Japan is affected by consumer preferences for traditional items. However, since not all consumers have other types of products available to them at lower prices, we do not know how this preference would change if consumers were given such access.

- In the metalworking industries in Japan and Germany, producers often have alliances or ownership relationships with customers that affect

purchasing decisions. It was a cause of lower labor productivity in Germany.

It is important to an efficient market economy that customers have adequate information about quality and other characteristics of products in the market and that customers have access to all relevant products so that they can choose freely among them. However, the provision of independent consumer information is not an appropriate role for government for the vast majority of consumer and industrial goods. Government policy should instead make clear that independent, private consumer testing firms can substantially benefit consumers and the economy, and should not prevent consumers from choosing freely among the full range of products. Open trading and distribution systems as well as an open and competing media sector increase the range of customer choices.

Other Industries

The auto parts and steel industries are the two cases where other industries (see Exhibit 3-18) play an important role in explaining productivity differences. Both parts and steel are strongly tied to and influenced by the original equipment manufacturers (OEMs) in the auto industry (see also Exhibit 3-19). This is most dramatically manifested in the differences in how relationships between cars and parts companies are designed and managed. Since implications from this vertical relationship are mainly for corporations, this discussion is presented in the next section, "Implications for Companies".

Access to the distribution system is another way in which the factor, "other industries", affects productivity. We found that this barrier to competition is important or somewhat important in all consumer goods industries in Japan (Exhibit 3-18). For example, wholesalers often have established relationships with one or more existing manufacturers. A new entrant wishing to produce and sell in competition with these companies may find that distributors will not carry its products for fear of being cut off from the established suppliers. Through interviews we learned that it had taken 15 years of effort to establish adequate distribution for a new entrant in a major consumer goods industry.

Some industries and plants located in Japan with relatively low labor productivity are protected to some degree by the distribution system. Eliminating the regulation of the distribution system should provide additional surpluses to consumers in Japan, and would also increase domestic competition and therefore, labor productivity.

Relative Factor Prices and Availability

We did not generally find that relative prices or factor availability were important reasons why operations in one country were more productive than those

in another. This was true for physical capital (equipment and structures), energy and parts and supplies. The relative costs of energy, capital and labor are not totally equal in each of the three countries, but they had no significant impact on explaining productivity differences. However, there are two qualifications to this general statement.

First, in the late 1980s, the cost of debt in Japan was extremely low for Japanese investors. In certain industries, especially in beer, soap and detergents, and, to some extent, in steel, this led managers to finance substantial investments in plant renewal. The outcome of this investment was to narrow the labor productivity gap in beer and soap and detergents, and to sustain a lead in steel. Second, the improvements in product and process design that occurred extensively in Japanese operations required the accumulation of intangible capital. We do not believe that factor price differences were a significant cause of the more rapid accumulation of intangible capital in Japan, but we cannot rule out this possibility.

The U.S. policy debate includes much discussion about differences in the cost of capital and the role such differences may have played in economic competitiveness. Our studies do not support the common view that operations in Japan attained their leadership in productivity because of cheap capital. This issue is further explored when we look at the market for corporate control.

Labor Rules and Unionism

In a number of industries we found that labor/union rules had affected the methods of production. For example, there are labor agreements in the auto and steel industries in the U.S. that prevent the reduction of employment and the reassignment of workers to new tasks that could increase productivity.

German labor laws contain restrictive practices that reduce productivity. Rigid job classifications and universal work rules are examples of such restrictions. Adjustments to the policies that sustain these practices are necessary for productivity improvement in many of our case study industries. Furthermore, companies in Germany must pay large severance settlements to workers laid off. These rules raise the cost of economic adjustments and delay the adoption of best practices that have been developed outside the region.

Wage and work practice negotiations in Germany are now carried out at the branch level where, for example, steel, auto, and metalworking unions negotiate together. This arrangement gives effective veto power to the most restrictive union rules and perpetuates rigidities. Rigidities like this sustain the tight arrangements in which coal, steel, auto, metalworking and other economic interests refrain from forcing competitive adjustments on each other.

But we also found examples where competitive pressure led to substantial changes in labor rules. When unionized plants in the U.S. were faced with the

necessity of changing in order to survive (as at Ford and Chrysler), changes to work rules were made. The Toyota-GM joint venture (NUMMI) has achieved very high productivity, and its work force is unionized. Other examples include transplant operations in Germany in such industries as computers, soap and detergent and processed foods. These plants have also operated at or close to world-level productivity despite restrictions created by the German labor market.

In our case studies we did not find evidence that the lifetime employment system in the Japanese labor market had impeded productivity growth except in breweries. In fact there is some evidence that this system encourages workers to make suggestions for productivity improvements.

There are several reasons why the Japanese labor market has been able to achieve the benefits of what is called lifetime employment without the costs of increased rigidity. First, the Japanese labor market has always had more flexibility than appears from the practice of lifetime employment. The arrangement applies only to a minority of workers and only up to age 55; after that age, workers must move to affiliated plants or out of manufacturing altogether. Within large plants, contract workers or part-time workers are often released if there is not enough work for them.

Second, employment and output in Japanese manufacturing has been growing over time, not shrinking. Companies can more easily guarantee employment during a period of industrialization than during the shift to services and tertiary employment. As the Japanese economy matures, it will face more difficulties in ensuring stability in existing jobs. In fact, this is happening in the current recession in Japan as plants are being closed.

As Japan faces the economic challenges of an advanced economy, labor market institutions will be pressured to become more flexible while, at the same time, trying to maintain high morale and motivation among workers to increase performance.

If adequate competitive intensity does not exist, policy should encourage greater labor market flexibility in the rules that govern contracts between labor and industries.

Corporate Governance Rules, Market for Corporate Control

Differences in Corporate Governance Rules

An open and competitive market for corporate control can also be an independent source of competitive intensity. Powerful shareholders can impose

discipline on managers and create pressure for increased profits. This pressure encourages the adoption of more productive processes.

The system of corporate governance in Germany, called an insider system, is built on the idea of committee governance. The key characteristic of the German system is a supervisory board which leaves management a high degree of discretion and only intervenes if there is clear evidence of managerial failure. Labor has a substantial stake in the supervisory board. Ownership and control of companies is infrequently traded, and supervisory boards are often connected by formal and informal networks through holdings and house banks. These banks could facilitate information transfer and the screening of managers. This system helped finance large investments after World War II, but the lack of competition in recent decades among controlling agents has given managers little incentive to make substantial improvements in productivity. While some companies are so large that they are immune to hostile takeover, even small companies face few threats in this system.

Japan has a system of corporate governance similar to that of Germany. However, a high proportion of its most productive industries are subject to global competition. As a result, corporate governance rules play less of a role in protecting weak players in these industries, but may play a more significant role in others not studied.

The U.S. system, by contrast, relies heavily on the capital market for corporate governance. As a result, the U.S. market for corporate control is relatively open. In most cases large shareholders can wield a great deal of power, which puts pressure on managers to increase profits. Companies that do not perform well can be taken over in many cases and the managers replaced.

On the basis of our case studies, we found that differences in the market for corporate control were a factor in determining overall competitive intensity in some industries. The auto industry in the U.S. was passed in productivity by that in Japan in part because some U.S. firms were too large to be disciplined by owners through the capital markets at the time. In Germany, the limited market for corporate control in Germany was a major factor in lowering competitive pressure in the automotive industry.

The market for corporate control is also important for an industry which is fragmented with many small privately held companies. The ownership structure creates a barrier preventing buyouts and takeovers that would consolidate the industry. This is the case for the beer industry in Germany, where family ownership makes small breweries more difficult to acquire. A similar story holds in processed food in Japan. The price that a purchaser must pay for the assets of the small fragmented companies can greatly exceed any reasonable present value calculation of the returns that will be generated.

Policies that limit the power of shareholders and discourage changes in ownership weaken the pressure on managers to improve productivity. Banks are

Exhibit 3 - 25

SOURCE OF PRODUCTIVITY ADVANTAGE IN JAPANESE INDUSTRIES

	Cars	Parts	Metal-working	Steel	Consumer electronics
Demonstrated superiority in productivity	√	√	√	√	√
Source of advantage over U.S.					
- Investment	No	No	No	Partially	No
- Other	√	√	√	√	√
Source of advantage over Germany					
- Investment	Small	Small	No	Partially	No
- Other	√	√	√	√	√

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often not a good substitute for shareholder pressure, especially when there is limited competition among banks and their own customers sit on their boards.

Time Horizons and Investment Decisions

It is often argued that, in the U.S., managers cannot concentrate on raising productivity by means of long-term investments or restructuring programs because of the short-sighted market for corporate control in the U.S. Managers concentrate instead on ensuring that quarterly earnings keep rising, often because their personal compensation and job security is tied to short-term performance. In Germany and Japan, it is argued, managers are able to undertake investments with long run payoffs.

Based on our case studies we found that differences in long-term physical capital investments are not the main reasons why operations in the U.S. have lower productivity. Our results on this issue are summarized in Exhibit 3-25. In five of the industries we studied, operations in Japan have demonstrated superior productivity compared to those in the U.S. and Germany. Among these industries, however, the only case in which higher productivity in Japan was achieved substantially through investment was in the steel industry. In the other cases, it was superior product design and superior organization of functions and tasks that were the key drivers.

In the auto industry, those plants operated by companies founded in the U.S. were the ones which made heavy investments in highly automated plants. These investments often failed to achieve targeted productivity results. Toyota, on the other hand, economized on capital spending and achieved much better productivity results. In metalworking, and to a small extent, in the auto parts industry, the superior performance of Japanese plants was also based on a shift to newer technology. We found no evidence, however, that the decision of the U.S. manufacturers not to make the same shift was based on differences in investment hurdles.

When it comes to investment in R&D, the problems that U.S. companies in our case studies had in the 1970s and 80s were not generally the result of too little R&D; rather, they were because the R&D funds were not well spent. Product design teams in operations in Japan were much more successful in improving design for manufacturing and in improving product function and reliability.

It is true that the nature of the OEM-supplier relations in U.S. auto operations seem to be based on considerations of short term cost saving, perhaps at the expense of longer term reductions in the cost of parts and components. But even there, the case that short time horizons were a problem can be questioned. Some suppliers were integrated with the OEMs, so that their incentives to raise productivity for the

long term should have been excellent. And yet these suppliers have not improved productivity any more than did the independent suppliers.

There are examples of U.S. managers whose compensation is based on short term profitability and there may be adverse consequences of this that we have not observed. We are simply reporting the results of our case studies, where short time horizons did not appear to be a major factor in productivity differences. Arguments about short term behavior should not provide an excuse for resisting the introduction of a more competitive market for corporate control.

Competition Rules

Policy can also act to encourage competition, which is the purpose of antitrust policy. Our case studies point to two industries located in the U.S., autos and steel, where a single company became so large that it was able to avoid the normal discipline of the market for corporate control for a long time.

There were two industries in our case studies where policy interventions in the past increased later competition. The first is the computer industry, where MITI made IBM share its patents in the 1960s as a condition for entering the Japanese market. The government negotiated this knowledge transfer to develop a domestic industry. This, in turn, allowed for the development of a more competitive world-wide industry.

The second industry is the metalworking industry in Japan, where MITI forced standardization of many machine tools, and the consolidation of many machine tool companies. The immediate goal of this policy was to facilitate innovations that greatly increased productivity and export performance. In the long run, however, this policy also encouraged greater competition and knowledge transfer among the local, consolidated companies. It is unlikely that MITI anticipated these further consequences, however.

Government policy can and also does limit competition in some industries. This has been true in many instances in service industries, such as telecommunications. It is less common in manufacturing, but not unknown. The Ministry of Finance in Japan regulates beer prices in order to protect the weak players and prevent the stronger players from competitive pricing. This regulation discourages the full evolution of the industry to a state in which only the strongest companies survive. It distorts the nature of competition, encouraging a proliferation of different brands. It also allows companies to retain excess employees that would be forced out by competition.

The computer industry based in Germany is affected by the fact that public procurement favors local suppliers and keeps some production facilities in the industry that would probably be forced to change more rapidly.

The high competitive intensity in many Japanese industries is not the result of stronger antitrust regulation in Japan. It reflects, on the one hand, exposure to the global market place, and on the other, a history of cultural attitudes among the leading Japanese companies, arising from the way the government set up large, competing corporate groups to industrialize Japan.

Encouraging global competition among several companies is the best anti-trust policy. But if one or two companies come to dominate a developed industry, nationally or globally, to the point where its managers no longer face pressure to perform, then anti-trust action (broadly defined) may be appropriate.

CONCLUSIONS ON EXTERNAL FACTORS AND POLICY IMPLICATIONS

This section concludes the discussion of the external factors that determine the competitive environment faced by the industries and the policy implications that we see as following from these findings. We have identified a variety of such factors that are very important in creating the particular competitive environments that we found in our case studies. Demand factors, driven by consumer tastes and the nature of tied sales, are very important in several industries and play some role in almost all of the studies. Labor rules and unions are of some importance in several industries, although not decisive in our judgment. Corporate governance can limit competition in the capital market and stifle a source of competitive intensity that is separate from the product market. Finally, competition rules and specific regulations are very important in a number of our industries.

Each of these external factors is important, but the combination of all of them together can be much more powerful than any one by itself. If there is intense competition in the product market, then labor rules or the ties of vertical integration or the market for corporate control will not exert control over the production process. Without the pressure of competition, these other external factors can become important for determining productivity.

The implications that we have drawn for policy from our findings are straightforward. Where policy is impeding global competition, we propose that voters and policymakers consider whether the loss of productivity is really worthwhile. We find that the arguments that have been made to support protectionist policies are generally weak. It is not surprising that managers and workers resist policy changes that will expose them to more competition. But in the long run it is better to face the competition and make the necessary adjustments sooner rather than later. Widespread foreign travel and increased communication encourage consumers to press for the destruction of barriers to competition. The walls of fortresses ultimately are vulnerable.

IMPLICATIONS FOR COMPANIES

The most important implication of this study for companies is that management can transfer best practices in technology, product design and organization of functions and tasks from one geographical location to another. Companies that have achieved best practice levels in one region have been able to replicate the same productivity advantage in other regions, and companies that were behind have been able to improve by acquiring best practices. The differences we observed in productivity suggest that there are still significant opportunities to transfer best practices. This section will focus on locating these opportunities and on identifying ways to exploit them.

OPPORTUNITIES ARISING FROM PRODUCTIVITY DIFFERENCES

Our productivity comparisons suggest that manufacturing companies in Germany, Japan, and the U.S. face significant opportunities and risks in competing with each other in the ever-expanding global market. In all but one case (computers), we observed pronounced productivity differences in 1990. We found two cases where the gap between the most productive and least productive operations was around 25 percentage points (metalworking, soaps and detergents), two cases where the gap was closer to 50 percentage points (consumer electronics, steel), three cases where the gap was almost 60 percentage points (automobile assembly, auto parts, beer), and one case where the gap was well over 60 percentage points (processed food). Moreover, we observed large labor productivity differences even within an industry in a country. In some cases, e.g., automotive, computer and steel, the productivity differences within each industry in one country were almost as large as the differences found among countries. These figures represent significant threats and opportunities for the companies operating in these regions.

Exploiting these productivity differences or improving low productive operations can be very profitable (see box entitled "Productivity and Business Success"). Although innovative products or production processes may require modification in order to cross geographic and cultural borders, the productivity results of our case studies in automotive, metalworking, steel, consumer electronics, food, and beer suggest that they can be transported successfully and adopted by labor forces in every part of the Triad. For companies that are able to transfer or adopt such innovations, the productivity advantage should translate into superior performance and higher profits.

The fundamental reason why best practices can be transferred or acquired across the three countries we studied is that the basic skill of labor and intrinsic motivation are not a major reason for productivity differences. Managers of companies in Germany, Japan, and the U.S. (including managers of transplants) confirmed that the basic skills and "trainability" of the workers they hired were

PRODUCTIVITY AND BUSINESS SUCCESS

Although the focus of this report was productivity, we did take note of the financial performance of the factories and companies we studied. Our findings confirm the long held view that there is a strong correlation between productivity and business success if two or more companies operate in the same unregulated market. As a general rule, therefore, companies that seek to maximize shareholder value should always look for ways to increase their manufacturing productivity. The more productive a factory, the lower its costs and the higher its profit (or the smaller its loss).

There are three ways to achieve higher productivity and improve business performance. The first two are obvious: one can either produce more output with the same number and cost of inputs, or, if market conditions do not allow sales to increase, the same output can be produced with fewer inputs (and lower costs). Another way to achieve higher productivity is to get a higher price premium. If one can supply a product that is perceived by customers to be superior to anything else on the market, but does not require additional or more costly inputs, one can also increase value added (through higher mark-ups), and thus productivity, relative to other companies in the same market. In addition, higher value added per hour worked and business success may result from business functions other than manufacturing. For example, in industries requiring substantial amounts of advertising (e.g., consumer goods), business success is heavily dependent on establishing brand premiums and on developing a consumer franchise. Therefore, the highest priorities of such companies might be to focus resources on developing successful marketing, distribution, or R&D.

There are situations where raising productivity may not be the first priority of management, and even situations where higher productivity does not translate into greater business success. Although raising manufacturing productivity will always improve a company's relative competitive position within a single market (e.g., higher labor productivity will translate into lower costs), there might be little correlation between productivity and success for companies operating in different markets. We found an example of this in our case study on the auto industry: the productivity of assembly operations in Japan and the U.S. was higher than that in Germany (and have been for some time), but auto companies in Germany had much higher profits in the 1980s than auto companies in the U.S. Similar examples can be found in consumer goods industries like beer and food.

One set of reasons for the breakdown in the relationship between productivity and business success is that companies in different markets may experience large differences in the cost of their inputs or swings in the exchange rate. This effect was certainly visible during the appreciation of the Japanese yen in the mid-1980s. For example, the operating profits of many productive, export-oriented machine tool makers were wiped out in Japan, while less productive companies in Germany still experienced satisfactory profit margins. The more common cause of the breakdown between productivity and business success, however, is differences in global competitive intensity resulting either from customer loyalty or market protection. For example, a relatively unproductive company could still be profitable in a closed market. In other words, productivity is the main basis of competitiveness, but only when there is competition.

The globalization of product markets and the convergence of consumer preferences are eliminating the distinctions between national markets, however. As markets become more global, the relationship between productivity and profitability is becoming stronger across markets, and is putting pressure on less productive companies. This process may accelerate, especially if highly productive companies establish new production facilities (i.e., transplants) in markets dominated by less productive companies.

similar in all three countries (in most cases, workers were hired only after careful screening of applicants). In addition, the high productivity of transplants and of some local operations suggests that operations in all three countries are capable of achieving best practice levels of productivity with the current work force.

For productivity leaders, the basic message is obvious. Companies with high manufacturing productivity should exploit their advantage within their local market, but should also look abroad to see if their advantage can be transferred. Companies that have a productivity advantage can use it as a strategic weapon in international competition, whether through trade or foreign direct investment.

Companies that have a disadvantage in productivity also have opportunities within their domestic market – if they are quick to exploit them. Companies whose productivity is below the global leader should consider redesigning their core processes before they are forced into open competition with more productive companies. Innovations from abroad can be imported to help weaker players compete successfully within local or regional markets. In general, importing innovations is much better for raising productivity and maintaining employment than importing products: new technologies and operating processes can be used to close productivity gaps, but importing products does not shore up local manufacturing weaknesses, and often displaces workers in the industry.

HOW TO EXPLOIT OPPORTUNITIES

In order to adopt or transfer best practices, one must first determine two things. First, it is important to determine what innovations are causing the productivity differences. Second, one has to determine how to best transfer or acquire these innovations.

Which Best Practices to Transfer or Acquire

The causal factors that had the largest effect on productivity differences in our case studies were related to differences in technology, design for manufacturing, and organization of functions and tasks (Exhibit 3-5). In each of these areas there are opportunities to transfer best practices. While managers of manufacturing companies often search the world for innovations in technology (i.e., new manufacturing equipment), they may spend less time searching for innovations to improve their product-design or organizational capabilities. Our findings suggest that there are significant opportunities for innovations on all three fronts. Listed below are the key areas where opportunities are available.

Technology/Automation

In our case studies, we found that there are differences in the amount and type of machinery and equipment used in some industries (e.g., small scale production in beer and food, lack of minimills in steel, and automation in metalworking). State-of-the-art technology is generally known to managers and is widely available. In industries such as food and beer, however, best practices in other business functions are required to take advantage of productivity differences. In consumer goods industries, applying new technology to achieve a scale advantage depends on developing a successful consumer franchise. That in turn depends on the development of, and access to, the distribution system as well as mounting successful advertising and marketing strategies. In spite of such obstacles, some of the multinationals we studied have demonstrated that it is possible to transfer technological innovations across the whole Triad.

Automation, as an example of technology, was important for explaining productivity differences. In Japan, metalworking operations have consolidated and redesigned their products so that they can now be assembled from standard parts, components, and modules. The result has been higher volumes of superior, standardized products which have opened the door to extensive automation.

Design and Redesign
For Manufacturing

In many of our cases, we observed that design (and redesign) of products for manufacturing is an important vehicle for productivity improvements. This is especially true of assembly industries such as cars, auto parts, metalworking, consumer electronics and computers. In recent decades, there has been a growing emphasis on product design and a revolution in the technology used to capture these opportunities (e.g., CAD/CAM). Our cases illustrated that standardization (especially when it can be coupled with automation) was one practice that helped productivity. Moreover, extensive product proliferation imposed a penalty on productivity.

- In the cases we studied, we found that the growth of standard products or components was important in computer, automotive and metalworking. Products that could previously only be assembled from specialty or custom-built parts and components are now often assembled in a modular fashion from standard parts and components. This change translates into lower costs and greater flexibility for users; traditional manufacturers are losing their market power (and sales premiums) as a growing part of the market is served by commodity products. In metalworking, for example, one can imagine a pyramid of products, with high volume, commodity products at the base, and low volume, specialty products at the top. What we have observed is the flattening of the pyramid: while the area has

remained the same, the base is growing bigger while the space under the point is shrinking.

Standardization trends are important, especially with regard to niche strategies. All niches can be eventually exposed to competition from commodity producers and thus represent temporary advantages. Successful niche players will continually seek or create new niches, keeping well ahead of the pack. Less successful ones will see competition increase and their market share erode. Even niche players should seek to be as productive as the best commodity player. Examples of a failure to do this are visible in the auto, metalworking and computer case.

¶ Just as the standardization of products was important in the industries mentioned above, extensive product variety often explained productivity differences in the consumer goods industries we studied, such as beer and food. The productivity penalty arises from the overly complex production process required to produce a wide variety of products (e.g., smaller production and delivery lots, and additional set-up time). In such cases, the extensive variety of products resulted from the nature of competition in some markets (e.g., food in Japan and beer in Germany).

Organization

In many of our cases, we observed that the organization of functions and tasks was one of the most important causes of productivity differences (e.g., automotive assembly, parts, metalworking, steel, consumer electronics). Unlike other factors, this tended to be true both in assembly and process industries.

¶ Organization within companies. Factories that have similar machinery and equipment and produce similar products may exhibit different levels of labor productivity, depending on how their functions and tasks are organized. In recent decades, most of the industries we studied have developed new forms of organization. The mass production model is slowly being replaced by flexible manufacturing that emphasizes quality, speed, responsiveness to market conditions, and the adaptability of the work force. These new forms of organization are defined by how employees work together, how the execution of tasks is continuously improved, and how communication is organized. An example of this development can be found in auto operations in Japan which emphasize labor integration (e.g., teamwork, front line empowerment) rather than labor specialization, as found in industrial operations in Germany and, to some extent in the U.S. This approach, combined with numerous, continuous, bottom-up improvements, results in significant labor savings.

Behind many of the differences in manufacturing productivity is an ongoing revolution in the collection, organization, and communication of data: computers have become more powerful and are now often linked

through networks and databases; product design and development phases have been shortened due to the emergence of computer-aided design technologies; and truly flexible manufacturing has become increasingly feasible. However, realizing gains in productivity depends as much on numerous small improvements in organization (i.e., the ability to coordinate and integrate activities in every phase of the production process), as well as the integration of manufacturing with R&D, marketing and sales.

¶ Organization with suppliers/buyers. The nature of relationships with suppliers and buyers was also a significant cause of productivity differences. In some of our cases, the most productive manufacturers depended on two way relationships with their suppliers for a broad range of products and services to a greater extent than did less productive companies (e.g. automotive, metalworking, consumer electronics).

Successful OEMs have successful suppliers. The successful supplier relationships we observed were characterized by the following: (1) a balance of pressure and incentives that forced constant cost reduction and productivity improvement while sharing the gains from improvements; (2) a partnership that divided responsibilities for quality, delivery and support, without duplicating efforts; (3) a two-way flow of technical advice and engineering support; and (4) the early involvement of suppliers and buyers in product development and design, together with the integration of functions and tasks in the manufacturing process.

As a consequence, successful OEMs were often characterized by having a smaller number of suppliers. These suppliers were often looked upon as strategic partners, however, and were often given responsibility over a significant part of the manufacturing process. In those operations where supplier relationships were less well developed (e.g., in metalworking, automotive, and consumer electronics companies in Germany and the U.S.), OEMs were often unable to raise productivity as fast as in areas where they were more developed (e.g., in Japan).

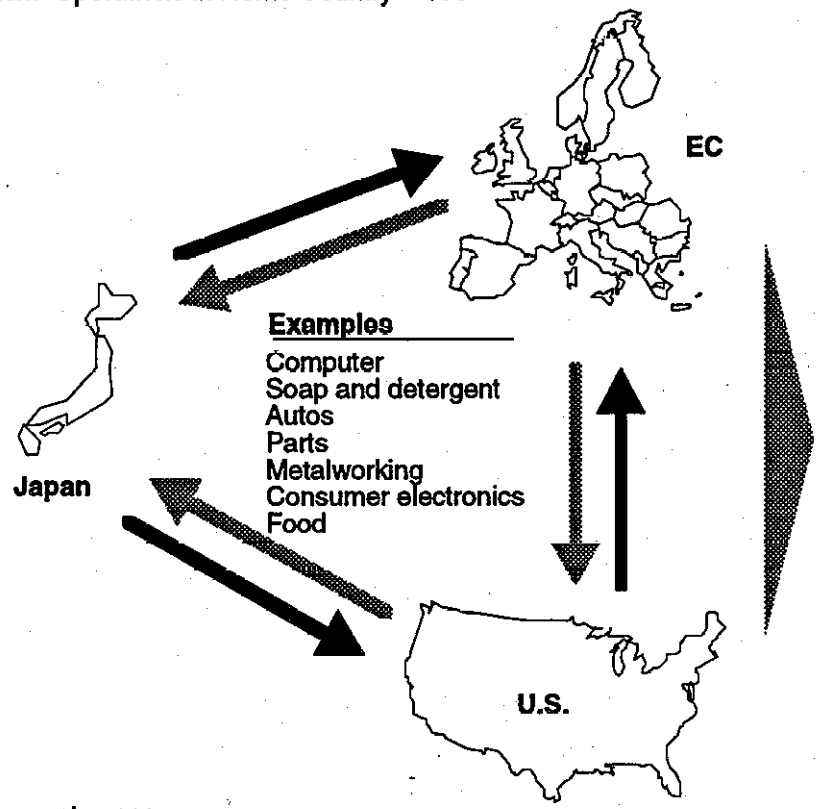
Successful OEMs work closely with their customers and end users. In many of our industry studies, we observed cases where innovations originated with the end user and fed back into the production process.

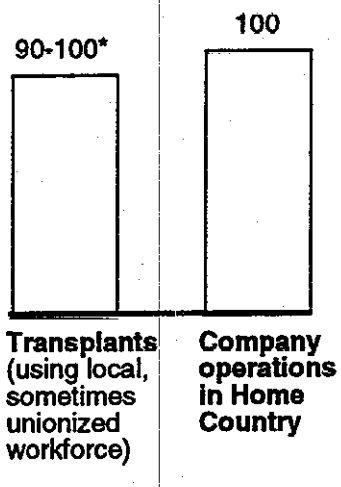
Successful relationships today are no longer exclusive. Suppliers often deliver to a number of players in the industry. This provides many challenges to managers and politicians alike, from assuring client confidentiality and protecting proprietary technology, to preventing excessive market power and potential monopoly inefficiencies.

Exhibit 3 - 26

TRANSPLANTS PRODUCTIVITY WITH LOCAL WORKFORCE

Index: Operations in Home Country = 100





* In most cases

Source: Interviews with industry and McKinsey experts; case studies

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Transferring or Acquiring Best Practices

Companies that are currently successful in their domestic market, but with much lower productivity than companies in other markets, either produce output that is not globally tradable, are being protected by trade barriers, depend on consumer loyalty, or are subject to exchange rates that allow them to price competitively despite low productivity. Nevertheless, these manufacturers are still vulnerable. International competitors with superior productivity can export their production process through foreign direct investment instead of exporting their products. For example, productive multinational companies can do the following: (1) buy existing players in the local market and make use of established brand names and distribution systems; (2) set up greenfield plants and develop their own market share over time; or (3) sell their technology to a domestic player through a licensing agreement or joint venture. These forms of international competition have taken place in the U.S. market where multinationals originating in Japan and Germany have opened (or are opening) transplants or have purchased existing facilities in industries such as automotive assembly, auto parts, metalworking, consumer electronics, and steel.

Transferring
Production and Products

Companies that have achieved best practice levels in one location have been able to replicate the same productivity advantage in their plants around the world. For example, despite very different cultures and practices, multinationals originating in Japan have now established productive operations in the U.S. and Europe (e.g., autos, consumer electronics). Multinationals originating in Europe, Japan and the U.S. have also set up operations around the world in industries such as food, computers, and soap and detergent, and are also achieving world class productivity in those operations (Exhibit 3-26).

In planning transplants, managers are often more concerned about the flexibility and reliability of workers than they are about their basic skill level. For instance, many of the transplant operations experienced differences in labor rigidity, turnover and absenteeism. This had some impact on productivity, but many transplants have overcome this friction with innovations in their organization of functions and tasks or through training. In addition, differences in management and engineering skills could have an impact on productivity. In our case studies, however, we observed that these differences can also be overcome through training and through transferring managers and engineers into transplant operations.

Productivity leaders can exploit their advantages either by producing in several regions or by exporting their output from one central location and distributing through local sales offices. The choice between the two depends on the industry. We found that foreign direct investment was often less risky, since trade

is subject to swings in exchange rates and is heavily influenced by political decision making. When trade displaces local jobs, it becomes the focus of political debates and actions. Nevertheless, in our case studies we found that operations in some industries in Japan (metalworking, automotive) have been able to successfully exploit their productivity advantages through trade. Foreign direct investment creates local jobs but raises the issue of foreign ownership. In the U.S. at least, foreign ownership is not as significant a political issue as lost jobs.

Vehicles for Transferring or Acquiring Best Practices

There are a number of ways to facilitate the transfer or acquisitions of new management processes. Benchmarking, transferring management, acquisitions, and licensing are all examples of ways to move practices from one region or company to another. In many of our cases, companies have used these methods, and their use has become vital for sustaining competitive performance.

For example, our cases suggest that companies should benchmark their operations against the leading companies of the world, wherever they are found, not just their competitors in local markets. As we saw in many of our cases, few companies were aware of their productivity disadvantage until new players began competing in their market.

In many cases, transferring management from one country to another was an important vehicle for transferring knowledge and management abilities (e.g., autos, soaps and detergents, computers). In the soap and detergent industry, some firms devote considerable effort to rotate staff on a global basis and have developed cross-country organizational structures.

Best practices in technology, product design, and in the organization of functions and tasks should be transferred and implemented. The disparity in performance along these dimensions was an important cause of the productivity differences we found. However, there are other business functions whose transfer can also be important for business success. In the consumer goods sector, for example, we found that there are large opportunities in transporting or adopting best practices in marketing (e.g. beer, food, and soap and detergents). The companies that create large national brands in the German beer industry will reap substantial benefits. Similarly, there is substantial money on the table for the companies in Japan that can convince their customers to buy industrially processed foods. We expect a substantial rationalization of plants in these industries in the next decade.

Overall, we found that the effort that many manufacturing companies put into finding and acquiring advances in management practices or software is often far less than what they spend on developing and acquiring capital equipment. Our findings suggest that many companies have a significant opportunity in redefining this balance.