

Telecommunications services

SUMMARY

The telecommunications sector was the sixth largest contributor to the acceleration in US private sector productivity growth after 1995. Although telecommunications firms represent only 1 percent of private sector employment, they were responsible for about 5 percent of the total US productivity acceleration.

Labor productivity in telecommunications grew by almost 8 percent per year from 1987 to 1999.¹ Although productivity growth did not accelerate, telecommunications contributed to the economy-wide productivity acceleration through a “mix effect”: the sector has a much higher productivity *level* than the US average and, because it grew as a share of the economy in the late 1990s, pulled up the average US productivity level.

The telecommunications services sector illustrates how technological and regulatory change can stimulate productivity growth. Technological change has encouraged telecommunications firms to invest in newer, higher-performance equipment to build network capacity and add services. Such investment has decreased the cost and labor component of existing services and has enabled entirely new services, such as mobile telephony and data communications. Meanwhile, regulatory change has helped to create more competitive environments that foster productivity growth. The seminal event in this regard, the breakup of AT&T in 1984, eased the entry of new long distance competitors and stimulated demand; more recently the Federal Communications Commission (FCC) auctions of wireless spectrum helped to increase capacity and create more competition among mobile service providers.

The steady growth rate of telecom services productivity masks considerable change within the industry. The McKinsey Global Institute (MGI) looked at three segments of the telecom services industry – local services, long distance, and mobile communications – to gain insight into the key factors underlying productivity growth.

¹ This analysis focuses on the 1987 to 1999 time period in order to be consistent with the other industry case studies, which make extensive use of Bureau of Economic Analysis data. (This span of years was selected because the BEA changed its industry definitions in 1987, and 1999 data was the latest available at the time of this analysis.)

- ¶ Local services firms (local voice and data over copper wires and fiber) improved labor productivity growth by nearly 8 percent per year in the late 1980s and early 1990s. This productivity growth was stoked by two important regulatory shocks. First, the breakup of AT&T created a long distance industry that pushed for lower-cost local access and competed with local service providers for attractive business customers. Later, a shift from fixed rate-of-return regulation to price regulation encouraged local service providers to reduce costs. In response to these incentives, local phone companies gradually weaned themselves of excess labor and steadily increased investment in communications equipment and other IT. Local services productivity growth has slowed recently – to about 5 percent annually in the late 1990s – but is still high compared to the rest of the economy.
- ¶ Mobile telephony has grown rapidly since commercial use began in the mid-1980s and has exhibited outstanding productivity performance. From 1987 to 1995, technological improvements to cellular networks and handsets drove a virtuous cycle of lower prices and higher demand, which allowed the industry to gain scale and enabled specialization and cost reductions. In the late 1990s, FCC spectrum auctions increased capacity and allowed several new entrants. Around the same time, the widespread application of digital cellular equipment enabled better use of the available spectrum. These forces reduced prices and stimulated demand, and productivity growth accelerated to over 10 percent per year from 1995-99.
- ¶ The long distance communications industry was created with the 1982 “Modified Final Judgment” that ordered the breakup of AT&T. After a burst of intense competition and rapid output growth, the industry settled into an oligopoly structure with stable prices, moderate demand growth, and heavy investment in market share retention. Productivity increased by 5 percent per year from 1987 to 1995. After 1995, slowing employment growth and continued increases in demand allowed productivity to accelerate to approximately 9 percent annual growth.

The data business became a significant component of long distance in the late 1990s as supply-side technological advances and exponential demand for new data services, fueled by buoyant capital markets, spurred investment by entrants. (This wave of investment began to have effects on labor productivity only in the very late 1990s, but a discussion is included in this report for completeness.)

MGI believes that the telecommunications sector's contribution to overall US productivity growth is sustainable and may in fact increase slightly over the next few years. Mobile communications usage is likely to increase, even as

employment growth slows and the industry consolidates. The story is similar in long distance, where rapid increases in data communications will drive productivity. Local services are likely to continue steady productivity improvements.

OVERVIEW OF TELECOMMUNICATIONS SERVICES

Because the telecommunications services industry was one of the largest contributors to the overall US productivity growth, MGI analyzed the sector in detail. The industry study is organized as follows. First, we describe the sector and its contribution to aggregate IT investment and productivity growth. Then, we dive into a discussion of the causes of productivity growth in each of three industry subsegments: local, mobile, and long distance. (Within long distance, we further distinguish between provision of voice and data services.) In each section, we describe the industry, summarize past productivity trends, review the causes of productivity improvement, and assess future productivity growth potential.

Profile of telecommunications services sector

Telecommunications represents approximately 1 percent of private sector employment and slightly over 2 percent of total value added (GDP) in the US economy. This makes it one of the smallest sectors studied by MGI. However, the industry's cumulative investment in communications equipment and physical infrastructure makes it one of the most capital-intensive parts of the economy. In 1999, the industry's capital stock amounted to more than \$500,000 per employee.

MGI's industry definition of telecom services is similar to that used by the US Bureau of Economic Analysis (BEA).² Telecommunications services incorporate both voice and data communications, over both wireline and wireless networks. For the purposes of this study we divide services into three main components: local services (voice and data lines into homes and businesses), mobile access (wireless voice communications), and long distance (the carriage of voice and data traffic between access carriers). Neither the MGI nor the BEA industry definition includes the production of communications equipment.

Approximately one million people were employed in the telecommunications services sector in 1999, only 10 percent more than in the early 1980s. This apparent stability masks considerable change in overall industry employment and in the share of employment for each of the major industry segments (Exhibit 1).

Likewise, the near-constant rate of productivity growth in telecom services belies considerable variance in the performance of local fixed-line service, mobile telephony, and long distance services (Exhibit 2). Mobile and long distance showed high and accelerating productivity growth. Local service labor productivity growth, while high, decelerated after 1995. More detail on each segment follows.

² Details of the BEA and MGI industry definitions, and MGI's productivity calculations, can be found in the appendix to this chapter.

Importance of telecom services sector to the overall question

Telecom services contributed 0.07 percentage points of the overall US productivity jump of 1.33 percent, as measured with data from the BEA. This is the sixth largest contribution of any industry in the US non-farm private sector (Exhibit 3).

The contribution of telecommunications services to the aggregate US productivity growth jump resulted from a jump in the sector's share of US employment, rather than an acceleration in productivity growth within the sector.

- ¶ Productivity growth within the telecommunications sector was similar in both periods studied (1987-95 and 1995-99).
- ¶ Telecommunications employment fell in the first period, then rose in the second. Because it is capital intensive, the telecommunications sector has a much higher level of value added per employee – labor productivity – than the US average. Therefore, as the employment share of telecommunications fell in the first period, the average level of productivity in the economy decreased. The opposite effect occurred in the second period, causing a net positive 'jump' over the two periods.

MGI analysis of the telecommunications sector relied on physical measures of output, such as the number of access lines or call minutes. This contrasts with the value-added methodology used by the BEA and in most other chapters of this report. The reason for the different approach was the availability and easy measurement of physical output, which can be compared from year to year without the need for price adjustments.³

In spite of the differing methodologies, BEA data and MGI analysis yield similar trends. We find higher labor productivity growth rates – almost 8 percent per year versus just over 5 percent for the BEA – but a similar pattern of acceleration (Exhibit 4). Because the results are similar, and the BEA does not publicize value-added data for individual segments of the industry, the remaining analysis in this report relies on the MGI output-based calculations.

³ The use of output, rather than value-added, measures requires an adjustment for changes in vertical integration over time. (Otherwise, an industry that simply outsourced labor to equally productive contractors from other industries would show high productivity growth.) To account for vertical integration, MGI examined the ratio of purchased inputs to output for major firms in each part of the industry, and where appropriate adjusted the employment figures to reflect outsourced labor.

Telecom services exhibited a significant jump in IT spending. In price-adjusted terms⁴, the amount of IT in the industry increased from \$130,000 per worker in 1995 to \$230,000 in 1999 – a growth rate of nearly 20 percent, considerably faster than the 10 percent rate of 1987-95 (Exhibit 5).

In this sector, IT investment is primarily (80 percent) in communications equipment. This includes the switching and routing equipment used to direct voice and data signals, as well as the transmission equipment that sends and receives signals across fiber optic cable and copper wire.⁵ It also includes cellular base station equipment.

The telecommunications services sector provides a microcosm of the US economy, which also exhibited both a labor productivity growth jump and an increase in IT intensity.

LOCAL SERVICES

Profile of the local services subsector

This report defines local service as the transport of voice and data within a metro area over physical links (rather than through the airwaves). This includes the provision of phone and data lines to homes and businesses as well as carriage of local telephone traffic. These activities employed approximately 500,000 people and generated approximately \$100 billion in revenue in 1999.

The dominant providers of local services are the incumbent local exchange carriers (ILECs): Verizon (comprising the former Bell Atlantic, NYNEX, and GTE⁶), SBC Communications (which acquired Pacific Bell and Ameritech), Bell South, and Qwest (which includes the former US West). Over 80 percent of the revenues of these firms come from voice services. Since the late 1990s, numerous competitive access providers (CAPs or CLECs – competitive local exchange carriers) have targeted specific customer segments – typically larger business customers. These new competitors represented less than 20 percent of revenues and employment in 1999. Recent CLEC financial woes have led to reduced growth forecasts and in some cases bankruptcy.

Local service is the most capital-intensive part of the telecommunications industry. Local exchange carriers maintain a staggering amount of physical plant:

⁴ Figures are in 1996 dollars, based on BEA data. These 'real' figures include the effect of an MGI-estimated price index for communications equipment that shows faster price declines than the official BEA price index. The details of the MGI price index are discussed in the measurement appendix chapter of this report.

⁵ Note that fiber optic cable is not included as part of IT.

⁶ GTE was the only major local exchange carrier that was not one of the original "Baby Bells."

carriers reported four million miles of aerial and buried cable, more than 200 million individual access lines, and almost 20,000 central office switches to the FCC at the end of 1999. New lines or repairs often require significant construction activity as well as installation of communications equipment.

Local service is also the most heavily regulated part of the telecommunications industry. The FCC sets rates for local phone service and determines the “access charge” that long distance providers must remit to local exchange carriers for the completion of long distance calls.⁷ In addition, it mandates “universal service”: every US household is to receive telephone service, with poor households being subsidized by a “universal service fee” on other households. Shifts in the regulatory approach of the FCC have had a significant impact on subsequent productivity growth, altering both the competitive intensity of the industry and incentives for companies to improve profitability.

Importance of local services to the overall question

Local service contributed only 0.01 percentage points of the aggregate US productivity growth jump (Exhibit 6). This contribution was the net result of slowing productivity growth within local services (which decreased the aggregate rate of productivity growth) and a leveling off of employment (see Exhibit 7).

- ¶ Although labor productivity growth within the local service sector was positive in both periods, the average growth rate was slower from 1995 to 1999. Thus, the contribution of local services productivity growth to aggregate US productivity was smaller in the second period.
- ¶ Local service contributed positively to aggregate productivity growth because of changes in its share of total US employment. Productivity in local service is approximately 3 times the US average. Employment fell from 1987-95 but thereafter remained constant as a proportion of the US economy. Therefore, the “mix effect” from local service was negative in the former period and zero in the latter, contributing to a net change of 0.06 percent (Exhibit 8).
- ¶ IT intensity grew steadily throughout the time period studied (Exhibit 9). In real terms, IT capital per worker grew at a rate of 15 percent from 1987 to 1999. Given the fall in the productivity growth rate, this leads to the question of whether the capital might have been misapplied or underutilized.

⁷ The FCC also regulates the business lines of the ILECs (for example, ILECs are forbidden from entering the equipment business and are only allowed to offer long distance services on a state-by-state basis after certain conditions have been met).

LABOR PRODUCTIVITY PERFORMANCE IN LOCAL SERVICES

By MGI's calculation, annual labor productivity growth in local service fell from nearly 8 percent in 1987-95 to approximately 5 percent from 1995-99. (The BEA does not publish an explicit measure of value added or employment for this subsector of the telecommunications industry.) MGI's output measure is based on a weighted index of the total number of access lines and the total number of call minutes. Input is based on the employment of all local exchange carriers (including both incumbent and competitive local exchange carriers).⁸

In spite of accelerating demand for second lines and an increase in local call minutes (used to access Internet service providers) in the late 1990s, productivity growth did not accelerate after 1995. Rising employment, due in large part to the entry of competitive access providers, ended a downward trend of employment and more than compensated for the increased output (Exhibit 10). Local services productivity growth was at its highest in the early 1990s – we explore the reasons for this in Box 1.

Box 1

EXPLANATION OF 1987-1995 LABOR PRODUCTIVITY GROWTH JUMP IN LOCAL SERVICES⁹

The productivity performance of local services in the late 1980s and early 1990s was a result of a step change in incentives for local service providers, caused by a shift from direct regulation of profits to regulation of prices (price caps) and by an increase in competition for some of the largest business customers. In our analysis of this productivity surge, we first examine changes at the firm level that contributed to increased productivity. Then, we examine what changes in industry dynamics (e.g., prices and competition) and factors external to the industry (such as regulatory or technological change) were responsible for the firm-level changes.

⁸ Including local minutes as a measure of output (which is not done by the BLS/BEA) has a significant impact on measured productivity, increasing annual productivity growth in the local services segment by over 2 percent from 1995-99, and consequently increasing overall productivity growth in the telecommunications sector by approximately 1%. However, this measurement change would not affect the basic pattern of productivity growth jumps within each of the three segments. See the appendix to this chapter for more details on MGI's productivity measures, and the rationale for including local minutes.

⁹ This section compares productivity growth in local services from 1987 to 1995 with the earlier period of 1981 to 1987. Although the primary focus of this report is the 1995-99 productivity growth acceleration in the US, we view other historical industry 'jumps' in productivity growth as an opportunity to learn more about the causes of, and barriers to, higher productivity. Because the highest productivity growth in local services took place before 1995, we have separated this analysis from the main body of the text.

Firm-level (“operational”) factors

At the firm level productivity was driven by reducing the labor force across a variety of job types – output growth remained steady throughout the period. Some of the labor reduction was achieved through the use of IT; other reductions resulted from managerial decisions and better organization.

- ¶ IT enabled the elimination of numerous jobs in both back-office and customer-facing applications. Service providers and third-party vendors developed operational support systems (OSS) to automate key processes such as customer care and billing, service provisioning, and network operations. The goal of these systems was explicitly to increase “flow-through” – to eliminate the manual component of routine tasks such as taking an order for a new customer, creating a billing record, and activating service for that customer.
- ¶ Management decisions also increased labor productivity. In the immediate aftermath of the AT&T divestiture, the regional Bell monopolies cut back on underutilized labor. At first, this included simple actions such as pooling central office technicians (rather than assigning one person per office) and reducing the number of company business offices in smaller towns and cities.

Later, more complex reorganizations improved productivity further. For example, McKinsey estimated that a move to integrated dispatching would improve one client's field force productivity by 15 to 20 percent. The firm pooled labor both geographically (by combining different regional offices and dispatch centers) and functionally (by asking skilled technicians who were either idle, or close to an urgent job, to perform simple provisioning jobs). Performance management, which includes tracking of employee performance, coaching, and goal setting, has improved productivity between 10 to 15 percent in a variety of field force units across several companies.

Call center operations, a significant proportion of employment in all three sectors of the telecommunications industry, illustrate both IT and organizational-related productivity improvements. Advances in “self-serve” technology, such as voice response units, have reduced the human component of many customer service interactions. Other IT innovations such as automated call distributors (which route calls to available agents), computer-telephony integration (which delivers appropriate customer information to an agent's screen based on touch tones entered by the customer), and software-based scripting have greatly increased the number of calls an agent can handle in a given time. Managerial improvements such as schedule optimization and the pooling of smaller offices to reduce call volatility have helped to balance the supply of agents with demand for their services (Exhibit 11).

Industry dynamics/external factors

Improved incentives, most notably a change in government regulation, were the key drivers of change at the firm level (Exhibit 12).

- ¶ Changes in government policy altered the incentive structure for management and led to a greater push for efficiency at the firm level. The seminal event in telephone regulation was the court-ordered breakup of AT&T following years of litigation. The “Modified Final Judgment” of 1982 required AT&T to split up into a long distance and equipment manufacturing company and a set of seven local phone companies (known as the “Baby Bells”).¹⁰ The breakup took place on December 31, 1983.

In the years of AT&T's integrated monopoly, underutilized labor existed across a number of functions. The vast organization clouded the performance of individual units, and the rate-of-return regulatory regime left little incentive for managers to reduce costs. The creation of seven independent Bell companies improved incentives somewhat, as the firms now published financial results that could be compared with each other, and were independently accountable to the financial markets.

In the years following the breakup of AT&T, the federal government and states gradually moved to a new regulatory scheme that focused on prices. Based on financial data from the carriers, the regulator would set price ceilings (or 'caps') for local phone service. This encouraged companies to cut costs where possible, as they could now retain their profits and thus reap the benefits of greater efficiency.

- ¶ Competition for the ILECs' large business customers put pressure on prices and encouraged the incumbents to manage costs more effectively. This competition came primarily from the long distance companies, which connected large businesses directly to their networks (thus circumventing the ILEC and depriving it of revenue).¹¹

These were one-time changes, which may explain the slowdown in productivity growth after 1995. By the mid-1990s, the new incentive structure had been in place for several years and managers had addressed the most obvious cases of excess labor and organizational inefficiency that were the legacy of the predivestiture era. (Exhibit 13 summarizes the 1987-95 productivity jump.)

¹⁰ The 7 independent Bell companies were formed from groupings of AT&T's 22 regional Bell operating companies.

¹¹ Later, the Telecom Act of 1996 encouraged competition in local service by forcing ILECs to lease portions of their networks to new entrants. This change receives less attention here because it had no impact on the 1987-95 jump.

LOCAL SERVICES OUTLOOK, 2001-2005

MGI analysis suggests that the 1995-99 contribution of local services to aggregate US productivity growth (0.07 percentage points, including the 0.01 percentage point contribution to the 1995-99 US productivity acceleration) will be sustainable over the period to 2005.

- ¶ Output should continue to grow and in fact accelerate. Demand for local voice services should be steady or even accelerate slightly, reflecting an uptick in line growth and minutes of use over the past few years. Wider availability of data services for both business and consumer use and the consequent accelerating adoption of technologies such as DSL should increase data usage.
- ¶ Employment, however, is likely to stagnate or even fall. The dire fortunes of many competitive local carriers have led to layoffs and bankruptcies, and incumbents are likely to continue gradual productivity improvements. This will cause a negative “mix effect,” as local services represent a flat or declining share of total US employment from 2001-05.

MOBILE ACCESS

Profile of the mobile access subsector

Mobile access is defined in this report as wireless voice communications.¹² This includes cellular, personal communications service (PCS), and specialized mobile radio communications for consumer and business use.

Mobile communications employed over 150,000 people in 1999, up from approximately 6,000 in 1987. (This includes employees associated with call center providers or tower management services for the mobile industry.) Total industry revenues were \$40 billion in 1999.

After a long series of mergers and acquisitions to build subscriber volume and national network coverage, a few large providers dominate the cellular industry. The descendants of the original Bell companies have a strong presence in the market: Verizon has its own wireless division (a combination of the Bell Atlantic,

¹² Wireless data was an extremely small part of the overall wireless segment even in 1999, and was not included in the productivity calculations. Paging also was excluded.

GTE, and Vodafone AirTouch wireless operations), and SBC and BellSouth merged their operations to form Cingular Wireless. The long distance players also have a presence: Sprint's PCS service and AT&T Wireless (built on the acquisition of McCaw Cellular). VoiceStream has rolled up a variety of companies that operate under the GSM standard.¹³ Independent player Nextel rounds out the top tier of the industry. Beyond these large players, multiple regional companies and resellers of cellular service have approximately 15 percent of the market.

Importance of mobile access to the overall question

Mobile access contributed 0.06 percentage points of the aggregate US productivity growth jump (Exhibit 14).

- ¶ Half of this acceleration was due to the increased share of mobile communications in the US economy (Exhibit 15). With almost no employment in 1987, mobile grew to 0.08 percent of US employment in 1995 and 0.17 percent in 1999 (Exhibit 16).
- ¶ The remainder of the productivity acceleration was due to productivity growth within the mobile access sector. Productivity growth accelerated from 6.9 percent in 1987-95 to 10.6 percent from 1995-99.
- ¶ Meanwhile, IT intensity rose sharply post-1995, after falling slightly over the 1987-95 period (Exhibit 17).¹⁴ Thus, mobile communications appears to embody a “New Economy” pattern of high IT inputs and high productivity growth.

LABOR PRODUCTIVITY PERFORMANCE IN MOBILE

Mobile communications exhibits a significant jump in labor productivity growth. MGI analysis indicates that annual labor productivity gains in this segment accelerated from 6.9 percent from 1987 to 1995 to over 10 percent from 1995 to 1999. (The BEA does not publish an explicit measure of value added or employment for this subsector of the telecommunications industry.) MGI measured output in this segment based on the number of mobile telephone

¹³ Deutsche Telekom recently acquired VoiceStream.

¹⁴ Although both IT and employment grew over the 1987-95 period, employment grew more rapidly, so the IT stock per worker fell.

subscribers and the number of call minutes of those subscribers.¹⁵ Labor was based on the total employment of wireless service providers, plus an adjustment for major categories of outsourced labor.

EXPLANATION OF 1995-1999 LABOR PRODUCTIVITY JUMP (VERSUS 1987-1995) IN MOBILE ACCESS

MGI's analysis attributes the acceleration in mobile productivity to two primary causes: the application of digital cellular equipment in the mid-1990s, and the auctioning of additional wireless spectrum to new competitors around the same time. Both changes greatly increased capacity and put pressure on prices, resulting in the rapid adoption and increased use of mobile services. We first discuss the improvement in productivity at the firm level, and then we trace these changes back to the root causes at the industry and macro level.

Firm-level factors

Mobile communications represents an example of “New Economy” IT in action. IT intensity growth jumped 20 percent per year in real terms, and this investment can be traced directly to improvements in labor productivity.

- ¶ Productivity growth was driven by rapidly rising minutes of use. (Exhibit 18). Labor grew more slowly, approximating the growth rate of the subscriber base (roughly 25 percent per year), rather than the more rapid growth in minutes of use (over 40 percent per year).
- ¶ The surge in minutes per customer was the result of significantly lower prices, often embodied in “bucket plans” that offered a set price for a specified number of minutes per month. Revenues per minute fell about 20 percent per year in 1998 and even more in 1999 (Exhibit 19). The average subscriber talked about 175 minutes per month in 1999 versus 120 in 1995, reversing a steady downward trend in usage per subscriber.
- ¶ Mobile service providers could offer lower prices because of a rapid increase in capacity in the late 1990s (Exhibit 20). Digital cellular equipment and related innovations allowed providers to leverage spectrum more effectively and thereby improve capital efficiency.

¹⁵ These two measures were given weights based on the implied price of a calling plan with no “free” minutes – approximately \$15 per month was allocated to access revenues and the remainder to usage.

Industry dynamics/external factors

In the early days of mobile telephony, the FCC allocated each major metro market two mobile licenses. The idea of the temporary duopoly was to give early investors time to recoup their capital investments, but the immediate effect was an environment of limited price competition. From 1995 to 1997 the auction of PCS spectrum (combined with the emergence of Nextel as a viable nationwide wireless player) greatly increased competition in most markets. In practice, four to five viable competitors existed in each of the major markets (Exhibit 21).

The mobile communications industry shifted from analog to digital equipment in the mid-1990s, driven in part by the new PCS competitors that installed all-digital networks. New standards for digital equipment allowed spectrum to be used more efficiently and helped companies to increase network capacity. The direct impact was on the capital productivity side, allowing wireless providers to provide more capacity with a given investment in equipment and spectrum than they could have with analog technology. However, there was also a strong indirect effect on labor productivity. The lower cost structure enabled lower prices, which stimulated greater usage of mobile phones.¹⁶ As most labor costs were either fixed or proportional to the number of customers, the surge in usage per customer increased labor productivity. (For a summary of the drivers of the 1995-99 productivity jump in mobile, see Exhibit 22.)

As productivity growth accelerated to over 10 percent per year, the industry grew rapidly. Employment in the mobile phone industry and related services more than doubled from 1995-99, increasing the contribution of mobile services to aggregate US productivity growth.

MOBILE OUTLOOK, 2001-2005

Productivity should continue to grow rapidly in mobile communications, maintaining and even increasing the sector's contribution to aggregate productivity growth. We estimate that mobile's 0.10 percentage point contribution to aggregate US productivity growth from 1995-1999 will increase to 0.12 percentage points from 2001-05. (This assumes a similar rate of productivity growth within the sector, magnified by the sector's larger size in 2001.)

Productivity growth within the sector should remain strong for two reasons:

¹⁶ The increased demand was due in part to other benefits of digital such as smaller, lower-cost handsets, better reception, and call services such as caller ID.

- ¶ First and foremost, voice usage should grow rapidly. This will be due both to increasing penetration of mobile and to increased usage as prices continue to fall. Industry analysts project 24 percent annual growth in minutes over the next few years to almost 500 minutes per user per month in 2004 and industry revenues of \$100 billion in 2005. Even MGI's less aggressive assumptions yield high output growth.
- ¶ New services should pass into wider use as carriers upgrade networks to provide data transmission. Projections on mobile data adoption vary widely, with analysts predicting from 20 percent to 80 percent penetration among mobile users in 2004. At the time of this report it appears unlikely that data services will have a major impact on productivity growth before 2004-05.

Employment in mobile communications has grown rapidly since 1995, increasing the impact of this sector's productivity growth on the overall economy. Further employment growth, creating a positive mix effect, also appears possible (though this depends on the speed of industry consolidation). Mobile phone penetration of the US population was only about 40 percent in 1999 and remains lower than many European countries. Subscriptions and employment have continued to grow through 2001 and are likely to do so (albeit at lower rates) for the next few years. Thus, the highly productive industry is likely to become an even larger share of the economy, pulling up aggregate productivity.

LONG DISTANCE TRANSPORT

Profile of the long distance transport subsector

The long distance transport segment employed over 300,000 people in 1999, up 20 percent from 1995 due to the growth in data businesses. Overall industry revenues (net of access charges paid to local carriers) were approximately \$85 billion.

In this report, long distance transport refers to the carriage of voice or data from one access provider to another. After the AT&T divestiture took effect in 1984, consumers and businesses have been able to choose which long distance provider to use. Consumers and small businesses purchase long distance service that is billed through the local access provider, while large businesses may bypass the local carrier through the use of "special access lines."

The key companies in long distance voice are the triumvirate of AT&T, WorldCom (including the former MCI), and Sprint. However, in the 1990s many new firms entered the industry. These firms fall into two major categories: backbone providers that have built entirely new networks, and telecommunications

resellers, which offer service directly to consumers while leasing capacity from the major providers.

Importance of long distance transport to the overall question

Long distance contributed 0.04 percentage points of the aggregate productivity growth acceleration (Exhibit 23). This change came from productivity growth within the sector – employment in long distance remained stable as a share of the economy (Exhibits 24 and 25). Meanwhile, IT intensity grew at about 20 percent per year during the latter half of the 1990s, a jump of approximately 15 percent from the 1987-95 growth rate! (Exhibit 26).

LABOR PRODUCTIVITY PERFORMANCE IN LONG DISTANCE TRANSPORT

Based on MGI calculations, labor productivity growth rose from almost 5 percent in 1987-95 to approximately 9 percent from 1995-99. (The BEA does not publish an explicit measure of value added or employment for this subsector of the telecommunications industry.) MGI measured long distance output based on voice usage and data usage. Voice usage was measured according to a weighted index of intrastate, interstate, and international calls, and data traffic was approximated using the total bandwidth of data access lines installed on major networks. On the labor side, MGI included labor associated with the major long-distance voice companies, as well as new entrants and resellers of long distance services.

Total factor productivity (TFP) analysis shows that although labor productivity growth was high during this period, TFP growth (a measure of productivity adjusted for the level of capital investment) was actually negative. This is due to the huge capital investment, and resulting capital deepening effect, of the late 1990s investment in new backbone networks.

Labor productivity in long distance was at its highest in the early-1980s. From 1984-87, productivity growth in long distance was over 15 percent per year – higher than almost any industry except for computer and electronics manufacturing (see Box 2 for a discussion).

To understand the labor productivity jump of the late 1990s, it is instructive to divide the sector into two components: voice and data.

- ¶ Voice drove the productivity growth observed in the late 1990s, showing steady output growth even as labor input leveled off (Exhibit 27).

- ¶ Data showed high but fairly steady productivity growth. This was in spite of massive investments in new infrastructure.

This division is very rough, because most providers offered both voice and data services. Without detailed time-series employment data from all of the major players, it is impossible for us to allocate labor accurately between the two segments (in fact, even the total employment figure involves some approximation). It is reasonable, however, to assume that employment in data services grew over the late 1990s, and under our estimate of flat employment for the long distance industry as a whole, this implies a drop in voice employment.

EXPLANATION OF 1995-1999 PRODUCTIVITY GROWTH JUMP IN LONG DISTANCE VOICE

The productivity jump in long distance voice was really a return to earlier high rates of productivity growth after depressed performance in the mid-1990s. A rapid buildup of marketing and customer service personnel for voice and data services helps explain the 1987-95 productivity slowdown.

Firm-level factors

A range of improvements in call center and back office productivity (refer back to Exhibit 11 for examples) occurred in the late 1980s and 1990s. While it was impossible to determine the exact productivity improvement from each, there is no question that IT enabled many productivity gains. For example, computer-telephony integration allowed customer service agents to pull up customer records more quickly, saving agent time, while voice recognition software enabled a higher proportion of customers to use self-service features, reducing the labor required to answer 411 inquiries. However, though IT clearly contributed to ongoing productivity *growth*, interviewees did not cite IT as a source of productivity *acceleration* over the late 1990s.

One cause of the late 1990s improvement in productivity growth may have been a slowdown in the marketing race between the big long distance voice providers. In the early 1990s, this competitive dynamic led to higher marketing expenditures (e.g. increased outbound call center staffing and equipment, more advertising) to capture residential and small business customers (Exhibit 28), and increasing industry employment.¹⁷

¹⁷ Part of the increase in employment during this period is attributable to the buildup of organizations to operate and sell data services, primarily to large business customers.

Industry dynamics /external factors

The nature of competition in long distance changed considerably during the mid to late 1980s. With the breakup of AT&T, opportunities for new long distance providers to interconnect with the Bells stimulated a flood of new entrants. Rapid price declines followed and an industry shakeout left a few dominant players – AT&T, Sprint, LDDS, and MCI (the latter two companies now part of WorldCom). From 1987 to 1995 this oligopolistic industry structure was fairly stable, though the three smaller companies were gaining share at the expense of AT&T. All of the companies rapidly increased their investment in marketing activities, instituting outbound calling programs and minting dozens of different calling plans. The surge in marketing activity dampened labor productivity growth between 1987-95, but abated somewhat in the late 1990s.

(Please see Exhibit 29 for an overall summary of the 1995-99 productivity growth jump in long distance.)

EXPLANATION FOR LACK OF 1995-1999 PRODUCTIVITY GROWTH JUMP IN DATA

Communications equipment for new long distance data networks represented the vast majority of IT spending in this period.

Firm-level contribution of IT spending to productivity

In the late 1990s, several new nationwide networks were built in anticipation of a rapidly growing market for enterprise data transport (Exhibit 30). The availability of new equipment with stunning performance characteristics, combined with a “land grab” attitude towards market share (i.e., the notion of first mover advantage, combined with the awareness of competitors angling for the same customer base), prompted financiers and management alike to build capacity rapidly.

Although demand for data services is growing quickly, the current capacity utilization of these networks is very low – so low that the financial viability of several companies is in doubt. While the currently lit networks will eventually fill up, it is clear that excess capacity exists for the short to medium term.

One of several reasons for the disappointing performance of data backbone providers has been slow broadband adoption by consumers and small businesses. Broadband adoption in the US was well under 5 percent at the end of 1999. Complications with the rollout of many competitive local service providers, slowed further by sluggish deployment and resistance from the major incumbents, retarded the growth of this market.

Industry dynamics/external factors contributing to IT spending

Technological innovation was the most important cause of the boom in long-haul network investment. It affected the potential supply of, as well as the demand for, data services.

- ¶ On the supply side, technological breakthroughs enabled higher capacity networks. A revolution in optical technologies vastly increased the amount of data that could be transmitted over a single fiber optic strand.
- ¶ On the demand side, the growth of the Internet and projected exponential increases in demand for data transport created a big market opportunity.

These technological changes, mixed with a booming capital market, created ideal conditions for excessive investment in the sector. While growth in data demand has been healthy, the networks of these new firms are still very underutilized. (See Exhibit 31 for an overall summary of factors explaining the unproductive IT investments.) Industry consolidation is almost certain.

LONG DISTANCE OUTLOOK, 2001-2005

MGI expects the long distance segment to contribute even more to US aggregate productivity growth (0.11 percentage points) over the next few years than it did in the late 1990s (0.10 percentage points).

The long distance transport segment is likely to exhibit high productivity growth – likely over 10 percent annually – in the coming years. Industry players already have invested an enormous amount in both capacity and in the sales/marketing resources needed to fill that capacity. Additional data volume should be quite scalable, with proportionately less labor required. In fact, the industry is likely to consolidate to cope with rapid price drops for most services.

- ¶ Output growth should be very rapid. Long distance voice output rose 8 percent per year in the 1990s. Near-term performance should be comparable or better, given significant price drops in 1999-2000 and beyond. (Recent price cuts have been driven in part by the aggressive entry of ILECs, as regulators allow the formerly restricted monopolies to sell long distance services.) On the data side, a McKinsey/J.P. Morgan securities study has estimated data traffic growth of up to 60 percent over the next few years, though data revenues will grow much more slowly due to falling prices.
- ¶ Employment should be relatively flat, in line with recent years, or perhaps even decline as the industry consolidates.

Box 2

THE 1984-1987 PRODUCTIVITY GROWTH JUMP IN LONG DISTANCE

In the mid-1980s, the long distance industry experienced a remarkable surge in productivity growth. For a short time, output increased between 15 and 20 percent per year while employment fell. This period is an example of the power of regulation – in this case the breakup of the AT&T monopoly – to affect productivity.

Firm-level factors

Before 1984, annual growth in long distance minutes hovered at 6 to 7 percent. Aggressive marketing by new entrants, together with falling prices, more than doubled this growth rate in 1984 and 1985 (Exhibit 32).

Meanwhile, the newly independent long distance business of AT&T, saddled with much of the workforce of its integrated predecessor, aggressively reduced employment. In the 5 years following divestiture, the firm cut over 50,000 workers from its payroll through attrition and layoffs (Exhibit 33). As AT&T represented the vast majority of employment in the long distance industry at this time, the cuts had a large impact on industry labor productivity. These cuts were a combination of excess labor from the monopoly years and a more aggressive application of organizational improvements and IT solutions.

Industry dynamics

The growth of real competition in the long distance market was responsible both for the increased demand and for the cost-cutting measures by AT&T. MCI, LDDS, and Sprint emerged from a group of new players to provide a serious challenge to the former monopoly. Prices dropped approximately 20 percent between 1984 and 1987, stimulating greater call volume by consumers and businesses.

External factors

The long distance competition was in turn the result of legal and regulatory support. Legal battles marked the introduction of long distance competition in the 1970s, and eventually led to the Department of Justice antitrust suit against AT&T. The breakup of the company changed the game for AT&T and its competitors. The new local phone companies were eager to see long distance competition, and FCC rules helped emerging companies to interconnect at favorable rates, giving the young industry a boost.

APPENDIX – DETAIL ON PRODUCTIVITY MEASUREMENT METHODOLOGY

This section elaborates on the data and measurements MGI used in its productivity calculations, and compares MGI's analysis with the results of productivity calculations based on BEA data (Exhibit A1).

Local service

For local service, MGI's output measure is a Fisher quantity index of the number of local access lines and the total number of call minutes.¹⁸ For the number of access lines, MGI used local loop data from the National Exchange Carrier Association. This series has an almost identical trend to the FCC's access line figures and was available back to 1981. MGI estimated call minutes as one-half of all “dial equipment minutes” as measured by the National Exchange Carrier Association, plus one-half the total volume of international calls.¹⁹ Long distance call minutes are included in this measure because they originate and terminate with local carriers.²⁰

Ideally, the output measure would include call services – both operator-assisted calls such as 411 and software-driven services such as call waiting and conference calling. Unfortunately, reliable data for these services were not available over long periods of time. Given that call services account for no more than 15 to 20 percent of industry revenue, sensitivity analysis with the data available suggests that the influence might have been on the order of magnitude of 1 percent productivity improvement over the two periods, possibly with a greater impact on the second period. Therefore, inclusion of call services would not have altered the basic pattern of productivity growth in each segment.

Price indices for access lines and minutes are determined implicitly, based on total local service and network access revenue figures from the FCC's *Statistics of Common Carriers* publication (Table 4.2). Local service revenue is split among access lines and minutes on an equal basis, while access revenues are attributed wholly to call minutes. The logic here is that access revenues are a variable

¹⁸ The measure of call minutes is based on one-half of all dial equipment minutes as reported by the FCC, plus an estimate of one-half of international call volume. Long distance calls are included in this measure, because local switching and termination is essential to the completion of these calls. (Exception: calls that terminate in special access lines, which are handled separately.) For interstate calls, terminating access minute data was used because experts interviewed by MGI felt this data more accurately portrayed total call minutes.

¹⁹ Note that the scaling factor of one-half does not affect the calculations, but simply converts equipment minutes to conversation minutes. This is an approximation, as equipment minutes (which are really switch minutes) do not translate to conversation minutes in a perfect 2:1 ratio. Some calls can pass through tandem switches, which would increase the count. Others might originate or terminate on special access (dedicated) lines, which would decrease the count. To compensate for this bias, MGI deals with special access lines separately.

²⁰ Except in the case of special access lines (as explained in the previous footnote) or international calls.

charge related directly to the number of (long distance) call minutes. Although most residences do not pay per-minute charges for local calls, businesses (and consumers in some states) do pay incremental charges for switched local calls.

Input is based on the employment of all local exchange carriers (including both incumbent and competitive local exchange carriers).²¹ Employment for LECs comes from *Statistics of Common Carriers* data on ILECs employment, with a small adjustment upward (of approximately 8 percent in each year) to reflect employment in small LECs. CLEC employment is estimated using data from the Strategis Group and a review of SEC filings for many of the larger CLECs. Because the goal of the study was to measure operational labor productivity, MGI subtracted an estimate of the number of workers involved in capital-forming (investment) activities – principally network construction and new line provisioning. This adjustment had little impact, increasing annual employment growth by 0.1 percent from 1987 to 1995 and reducing it by 0.3 percent from 1995 to 1999.

Note that local access does not include all employment from Internet-related businesses, such as Internet Service Providers (ISPs) or on-line content/commerce businesses. These firms provide services that use the telephone network, but do not provide the connectivity itself. Inclusion of ISP accounts and ISP employment would have little effect in the first period (because employment and revenues were very small as a proportion of local service or the telcom industry as a whole). In the 1995-99 period, inclusion of consumer ISP employment would have decreased productivity growth by approximately 0.5 percent to 1 percent. (A significant fraction of business ISP employment was included in the long distance segment by default – e.g., UUNet, a subsidiary of WorldCom, is the largest business ISP.)

Mobile access

MGI measured mobile output in this segment based on a Fisher quantity index of the number of mobile telephone subscribers and the number of mobile call minutes. The source for the quantity data was the Cellular Telephone Industry Association's (CTIA's) *Wireless Industry Indices* report. MGI calculated prices (needed to construct the Fisher index) from the CTIA's industry revenue figures. Based on a review of recent “bucket” calling plans from mobile service providers, 30 percent of revenue was considered access revenue and the remaining 70 percent usage (call minute) revenue. (The two measures were given weights based on the implied price of a calling plan with no free minutes – approximately \$15 per

²¹ An adjustment is made to remove installation (capital-forming) labor from the employment pool. Without such an adjustment, labor productivity would be reduced in years where the industry is growing quickly, even if nothing had changed in the underlying provision of service. Capitalized investment is incorporated into the calculations of TFP later in the discussion.

month.) Thus changes in the number of call minutes influenced productivity growth more strongly than changes in the number of subscribers – though both figures have grown rapidly since the beginning of the cellular era.

Input data for mobile productivity (e.g., employment) also came from the CTIA. This data was adjusted upward to account for three major components of outsourced labor – call center providers (such as Convergys and West), tower management companies (such as American Tower), and billing providers. This adjustment accelerates employment growth (and therefore reduces estimated productivity growth) in the first period by almost 3 percent but has a smaller effect on the second period.

Long distance

MGI measured long distance output based on voice usage and data usage. Voice usage was measured according to a Fisher quantity index of intrastate, interstate, and international calls. Quantity data for intrastate and interstate calls came from the National Exchange Carrier Association. The source for international call data, as well as revenue data for all types of calls, was the FCC publication *Statistics of the Long Distance Communications Industry*.

To get an accurate estimate of employment for long distance carriers, MGI employed a bottom-up approach. First, MGI estimated the employment of the three largest carriers using annual report and Compustat data, adjusting where possible for nonrelevant subsidiaries (e.g., an estimate of employees in AT&T's equipment subsidiary – now Lucent Technologies – was subtracted from early AT&T data). Employment for the eight largest competitive/emerging carriers was based on publicly available data and was adjusted upward to include second-tier and metro area carriers. A similar method was used to estimate the employment of long distance resellers.

Reconciliation with BEA data

The Bureau of Economic Analysis is the principal source of MGI's aggregate economic data. Because the BEA constructs value-added industry statistics that sum to total GDP for the economy, comparison with its figures is useful to gain an understanding of the impact of a given sector on the overall economy.

For the overall communications sector, the BEA uses the Census definition of communications (Standard Industrial Classification 48). The BEA then divides communications into two subsectors: “telephone and telegraph” (SIC codes 481, 482, and 489) and “radio and television” (SIC codes 483 and 484).

MGI's industry definition corresponds closely to SIC 481, which accounted for almost all of the value added in the telephone and telegraph sector.²² Both the BEA and MGI industry definitions include local voice and data traffic, long distance voice and data traffic, and mobile voice communications. Note that the Bureau of Labor Statistics also uses SIC 481 for its "Telephone Communications" category.

MGI calculated labor productivity growth in two ways:

- ¶ First was a simple calculation of value-added per worker using data from the BEA.²³ This value-added data is the same data that BEA uses to construct overall GDP for the US economy and yields a compound annual labor productivity growth rate of 5.0 percent from 1987 to 1995, rising slightly to 5.2 percent from 1995 to 1999.
- ¶ MGI arrived at higher productivity growth rates through an alternative productivity analysis: a calculation of output units per worker. Because telecommunications output consists of simple, measurable, fairly well defined quantities (such as access lines and call minutes), it is possible to construct a quantity index of output. The quantity index is then divided by a measure of the labor required to produce that output. Because output is being measured, rather than value added, labor must be adjusted for changes in the proportions of outsourcing and of capital-producing labor (e.g., construction).²⁴ This quantity analysis yielded a productivity growth rate of 7.5 percent per annum from 1987-95 and 7.8 percent from 1995-99.

MGI labor productivity calculations for the telecom sector as a whole differ from calculations using BEA data for two principal reasons:

- ¶ First and most important, the output measures differ. BEA measures value added, while MGI uses output quantities. The BEA's calculation of value added is a sum of labor compensation, profits, and several other variables. Real (price-adjusted) value added is derived based on price

²² SIC 481 accounts for more than 96 percent of value added in "telephone and telegraph" for every year from 1989 to 1998. (1999 data was not available at this level of detail at the time of this analysis.) SIC code 482 represents telegraph communications and 489 represents "communications services not elsewhere classified." Within SIC code 481 MGI does not include paging (approximately 2 percent of communications revenues in 1999) or directory advertising (less than 1 percent of industry output in 1999).

²³ BEA does not publish its own productivity calculations. MGI used BEA data on value added for the telephone and telegraph sector and divided this by "persons engaged in production" (PEP) for the sector.

²⁴ Without an adjustment for outsourcing, any move toward outsourcing would automatically increase productivity since labor would fall and output would not change. Likewise, including labor that is focused on capital formation (such as construction of new networks) would unduly penalize industry productivity, since it is not directly involved in the delivery of telecom services.

series for all of the various outputs involved, which are provided by or derived from Producer Price Indices from the Bureau of Labor Statistics. The trends in 'real' value added derived from industry revenues and these price indices differ in several cases from the trends in MGI's quantity measures.

- Local service output differs because MGI includes local minutes in its measure of output. Although many users do not incur any marginal cost for additional local minutes, they do represent an output of the industry and a value-added utilization of the network. The inclusion of local minutes increases overall measured productivity in telecommunications by 0.1 percent between 1987-95 and 1.3 percent between 1995-99.
- Long distance price indices for MGI show a much more significant drop in the late 1980s in comparison with the BLS. Thereafter the implied MGI prices and the Bureau of Labor Statistics "Toll Service" price index follow a similar trend. This discrepancy increases MGI productivity growth by 0.8 percent between 1987-95 and 0.2 percent between 1995-99 vis-à-vis the BEA data. This difference occurs because MGI uses terminating access minutes data for interstate calls, rather than NECA data on dial equipment minutes, which appears to be the source for the BEA.
- Mobile output varies as well. The BEA uses the PCE (personal consumption expenditure) series for wireless communications to deflate wireless industry revenues. MGI quantity measures imply a much steeper drop in prices in the late 1990s, which appears to be borne out by aggregate revenue and minutes data. One reason for the difference could be that MGI prices are implicitly based on minutes used, rather than minutes purchased (because of the popularity of fixed-cost bucket plans which provide a set number of minutes, these two measures can vary). MGI and BEA price trends basically agree from 1987-95, but MGI's drop is much greater from 1995-99, accounting for an additional 1.3 percent of the sector's labor productivity growth.
- MGI also adds detail on data communications and private lines. The BEA also incorporates a datacom measure, although the exact measurement used is unclear. The likely difference here is the use of delivered bandwidth (the number of access lines multiplied by the bandwidth of each) as a measure for the output of long distance data communications. The rationale for this measure is that the bandwidth of business special access lines attached to the telecommunications backbone is a reasonable proxy for the data traffic traveling over that

backbone. (At any rate, it may be the best estimate available publicly.) In comparison with the number of special access lines, unweighted by bandwidth, this measure increases productivity growth by 0.4 percent between 1987-95 and 2.0 percent between 1995-99. The sources for this information are the FCC and IDC.

- ¶ Second is the discrepancy between the BEA's real value added and real output measures. This involves an adjustment of both the numerator (value added or output) and the denominator (employment) in the productivity equation. The numerator was adjusted from BEA's deflated value added time series to BEA's deflated output time series. To make the BEA data comparable with MGI's analysis on the input side, we replaced BEA employee series with the MGI calculation of employment. (BEA calculates a "persons employed in production" measure, which includes both full- and part-time labor. MGI built a telecommunications sector employment series using a bottom-up approach, and incorporated significant chunks of labor outsourced to companies in other SIC codes. MGI also made an adjustment to remove workers involved in capital-forming activities.²⁵) The net effect of the shift to an output measure with the MGI labor input data is increased labor productivity growth by 0.6 percent per year in the first period and by 1.8 percent in the second period.
- ¶ Several smaller differences account for the remaining discrepancy between MGI results and the BEA data. For example, the MGI industry definition is slightly different (as discussed above). In this chapter, references to the telecommunications sector refer to the MGI industry definition and productivity measures, unless otherwise noted.

²⁵ In the late 1990s, demand for second telephone lines and new data services such as DSL led local telephone companies and upstart competitors to hire installation technicians in much higher numbers. Because these personnel were involved in investment rather than operational activities, they have been excluded from the employment figures for the labor productivity calculations.

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Productivity in the Telecommunications Services Sector

McKINSEY GLOBAL INSTITUTE

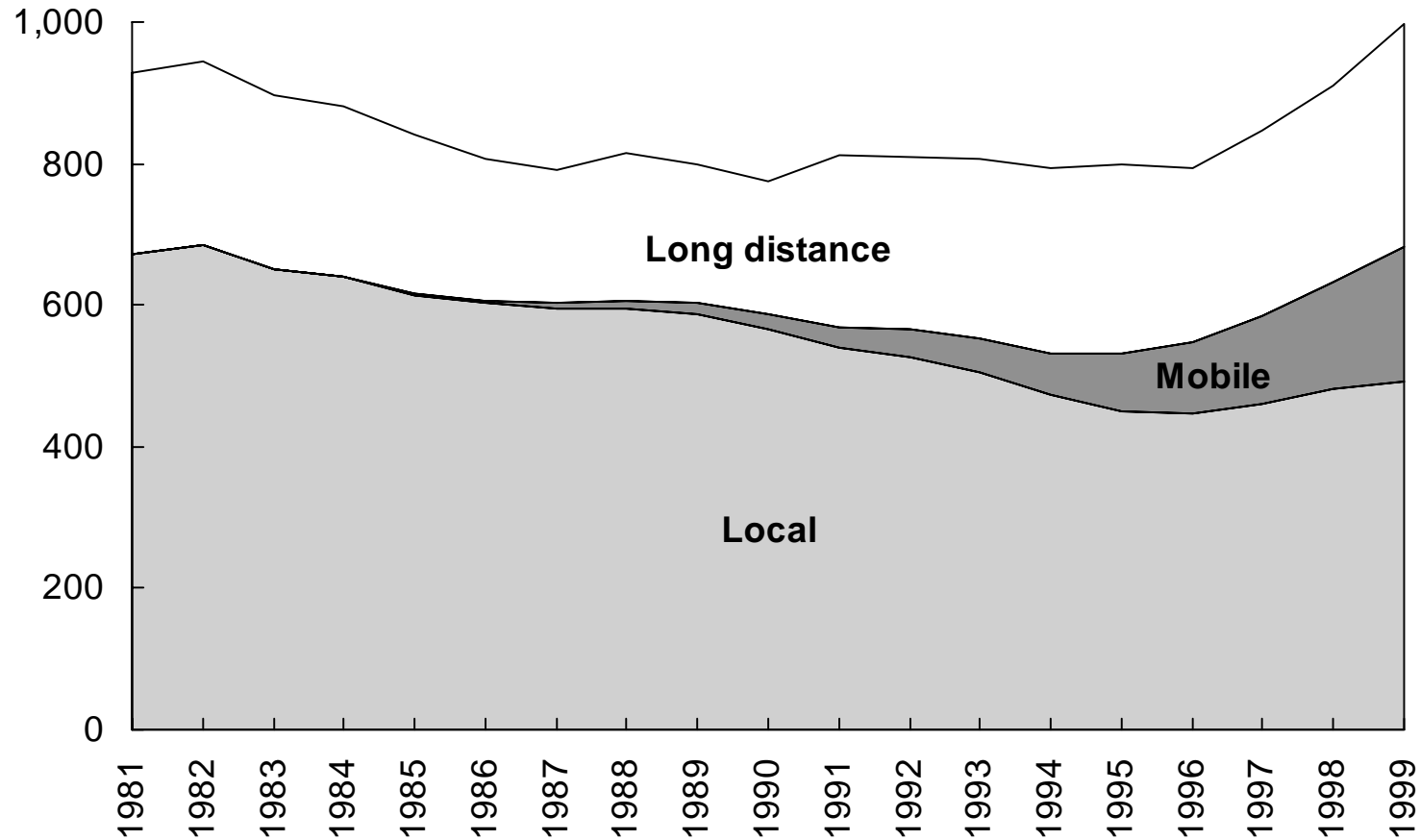
Exhibits to Accompany Telecom Services Case Study
October 7, 2001

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Exhibit 1

OVERALL TELECOMMUNICATIONS INDUSTRY EMPLOYMENT WAS FAIRLY STABLE, THOUGH ITS COMPOSITION CHANGED

Thousands of employees



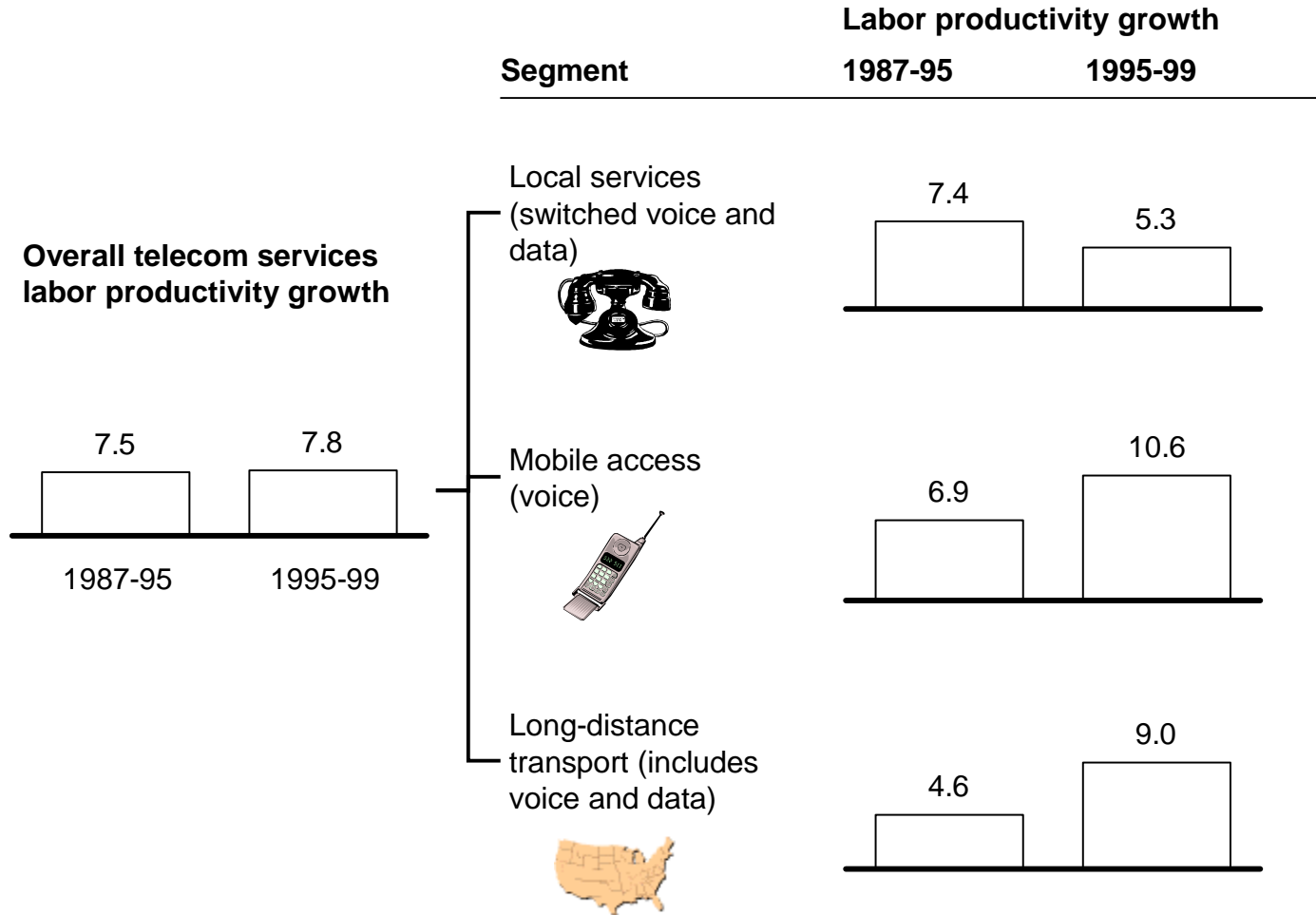
Note: The local and mobile segments include estimates for outsourced call center, billing, and tower management labor. Local services is net of estimate of capitalized labor (line installation workers)

Source: BEA, FCC, Cellular Telecommunications and Internet Association, Compustat, Census Bureau, MGI analysis

Exhibit 2

LABOR PRODUCTIVITY GROWTH VARIES BY SEGMENT

Compound annual growth rates

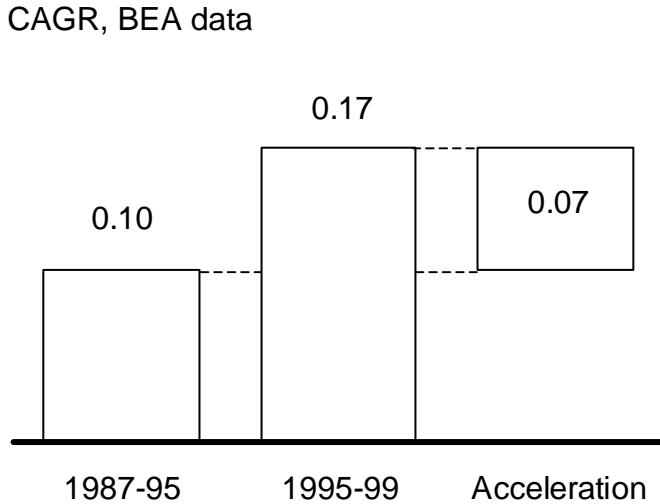


Source: FCC, CTIA, BLS, Compustat, MGI analysis

Exhibit 3

TELECOM SERVICES CONTRIBUTED TO THE OVERALL US PRODUCTIVITY GROWTH JUMP

Contribution to aggregate productivity growth
CAGR, BEA data



- Telecom services represents approximately one-twentieth (0.07%) of the total US productivity growth jump of 1.33%
- Telecom services ranks sixth among the 59 BEA private sector categories in terms of the size of its jump*

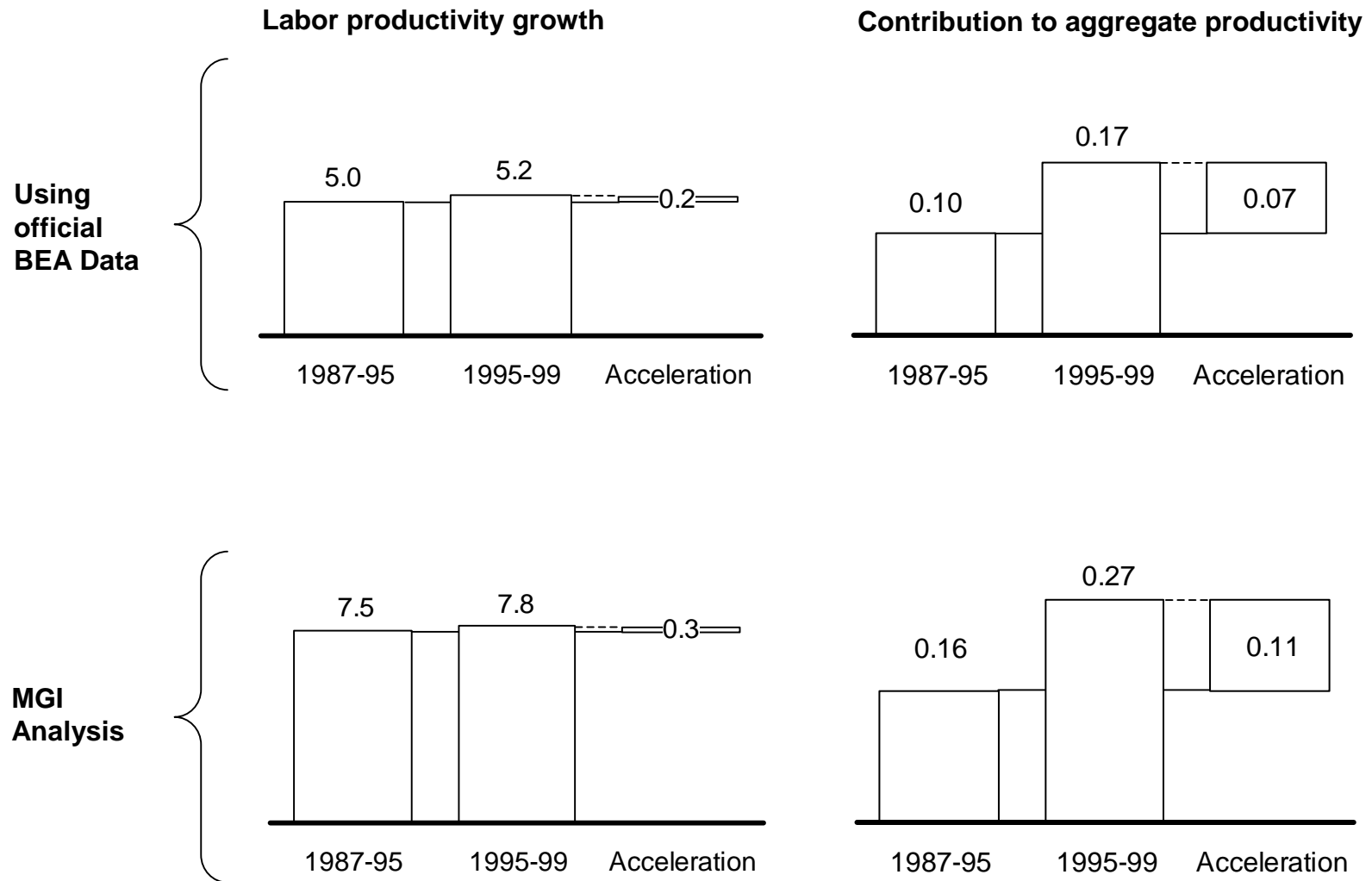
* Not including the "holding and investment offices" (due to statistical anomalies) or farms sectors

Source: BEA, MGI analysis

Exhibit 4

MGI ANALYSIS IS BROADLY CONSISTENT WITH BEA DATA

Compound annual growth rates



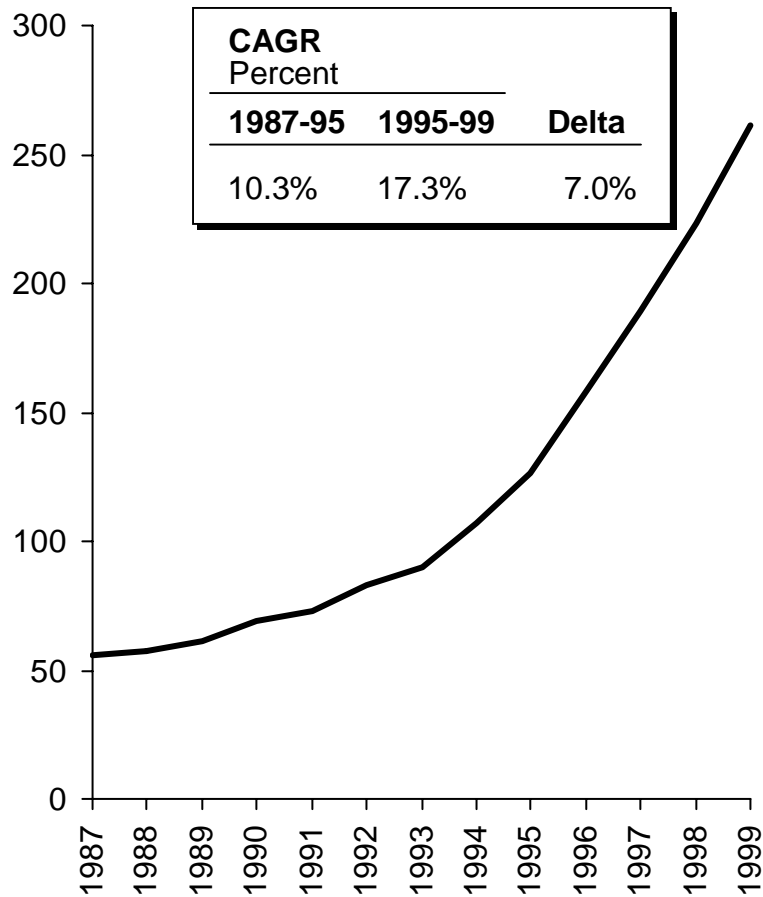
Source: BEA, FCC, CTIA, Dataquest, MGI analysis

Exhibit 5

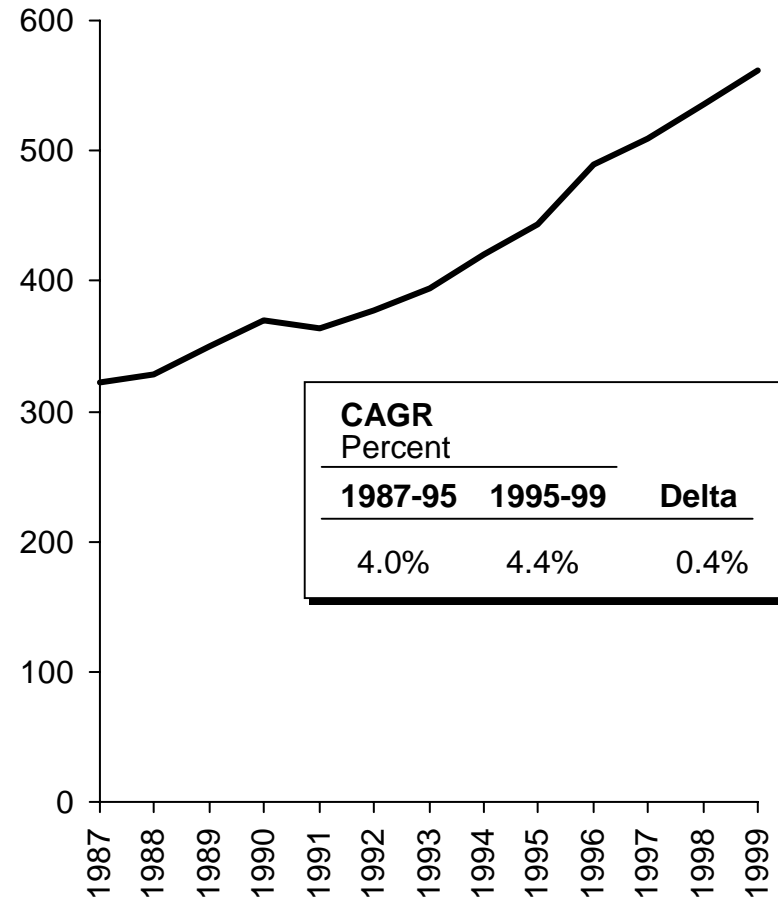
IT AND TOTAL CAPITAL INTENSITY GROWTH ACCELERATED

Thousands of 1996 dollars per employee

IT capital intensity*



Total capital intensity



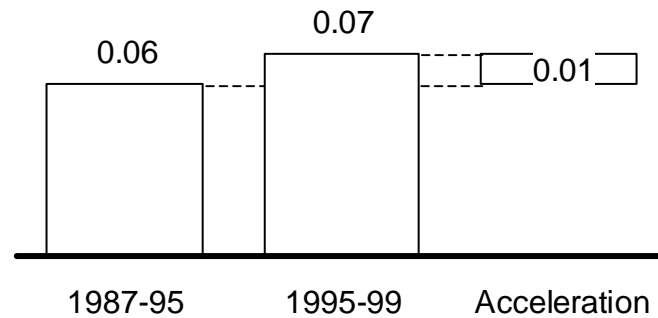
* Communications equipment is included in the MGI definition of IT (and accounts for over 80% of IT investment in the telecommunications services sector)

Source: BEA, MGI analysis

Exhibit 6

LOCAL SERVICES CONTRIBUTED LITTLE TO THE US LABOR PRODUCTIVITY GROWTH JUMP

Contribution of local services to aggregate productivity growth
CAGR, MGI analysis

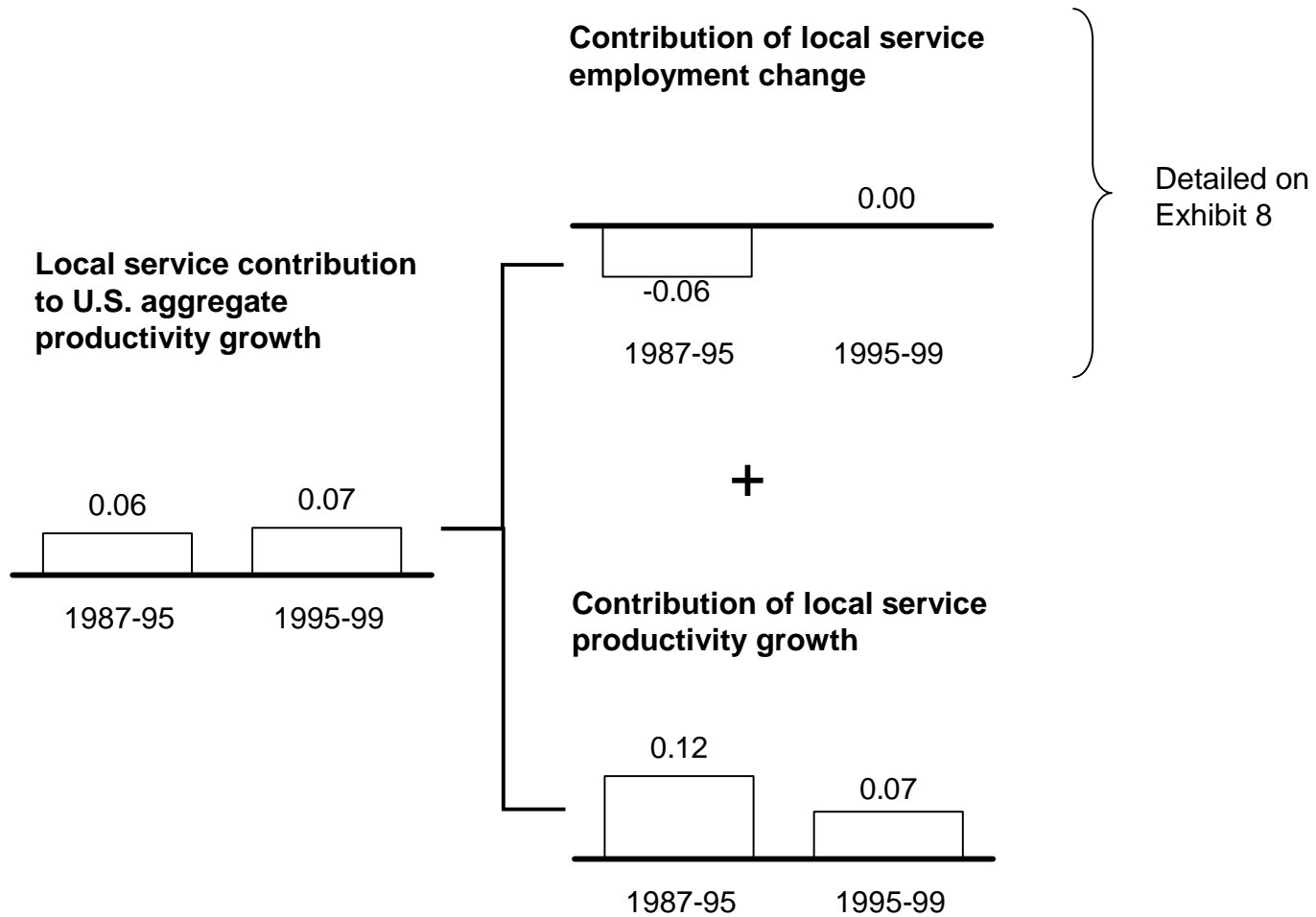


Source: BEA, MGI analysis

Exhibit 7

LOCAL SERVICE CONTRIBUTED LITTLE TO THE AGGREGATE JUMP BECAUSE ITS PRODUCTIVITY GROWTH RATE FELL

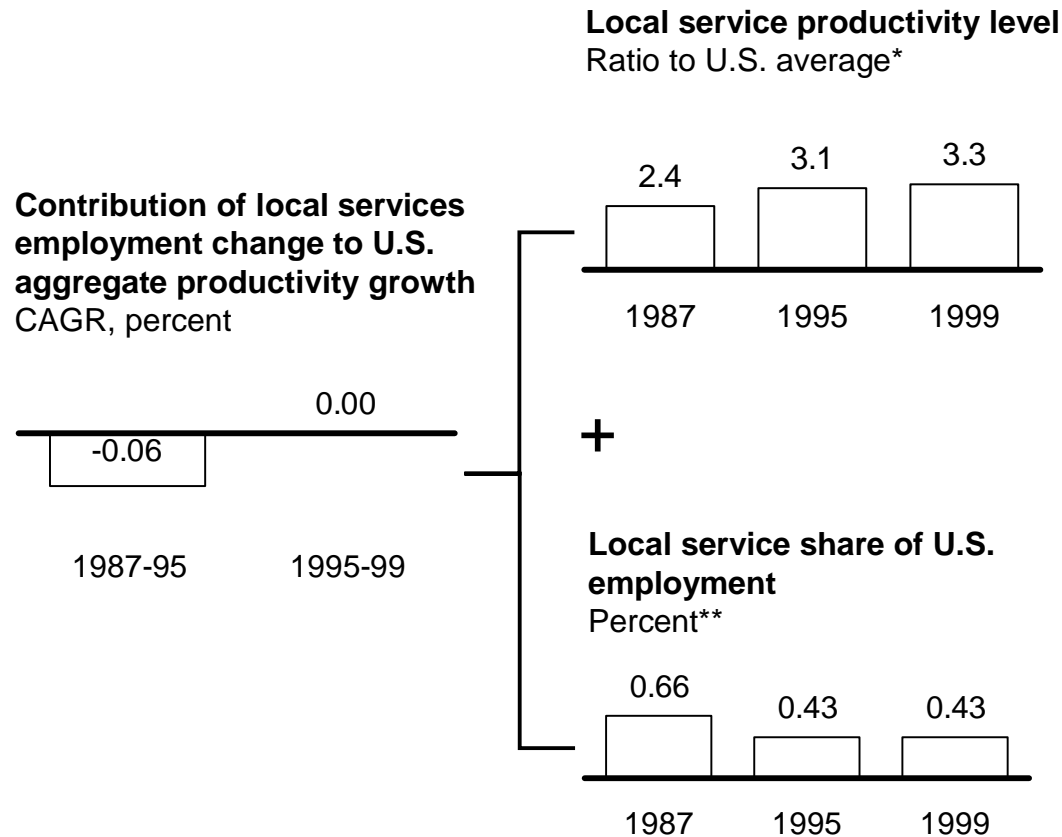
Compound annual growth rates



Source: BEA, MGI analysis

Exhibit 8

LOCAL SERVICES EMPLOYMENT FELL AS A SHARE OF THE ECONOMY IN THE 1987-95 PERIOD, AND REMAINED CONSTANT THEREAFTER



* This calculation is an approximation based on the 1987 total BEA value added for the "telephone and telegraph" sector and splitting this figure among local services, mobile access, and long distance based on the revenues of each segment

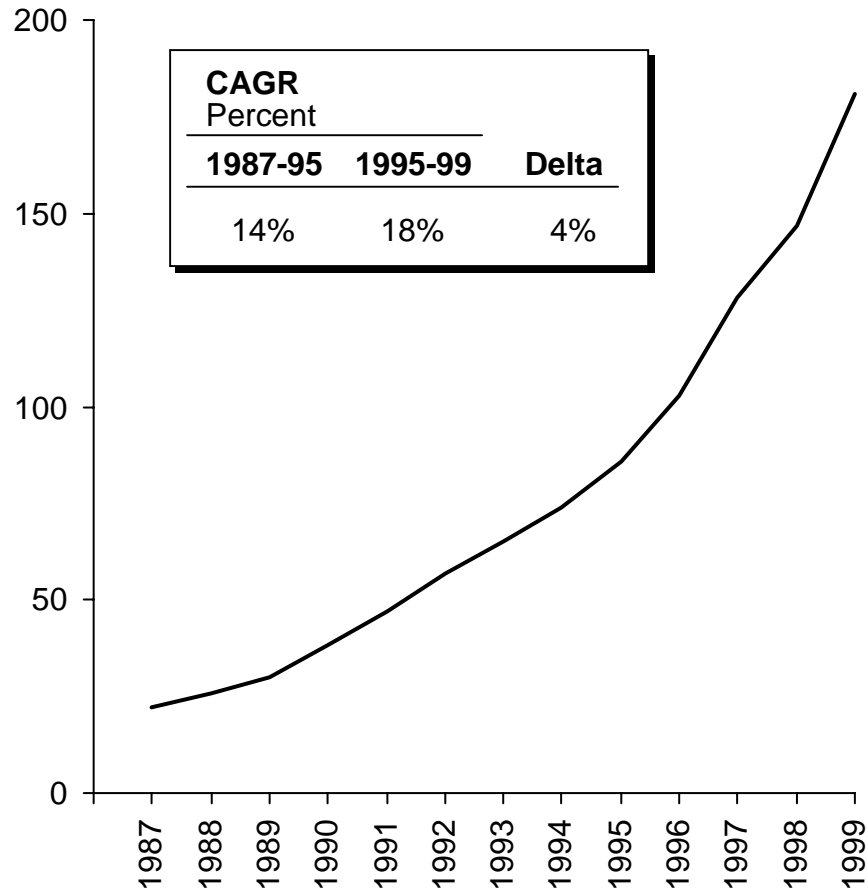
** Share of private-sector employment

Source: BEA, MGI analysis

Exhibit 9

IT INTENSITY GROWTH IN LOCAL SERVICES WAS RAPID

IT capital intensity in local services, thousands of 1996 dollars per employee



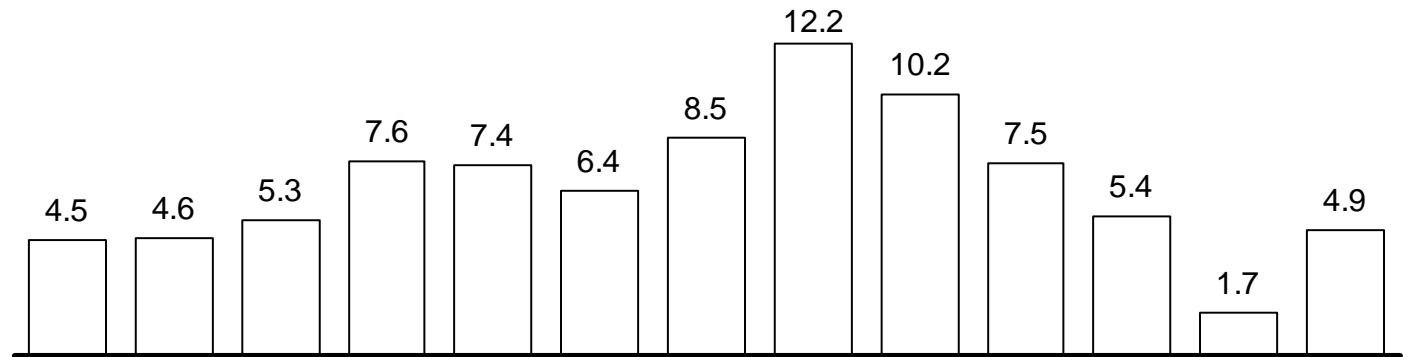
* Communications equipment is included in the MGI definition of IT (and accounts for over 80% of IT investment in the telecommunications sector)

Source: BEA, FCC, CTIA, Hoovers, Compustat, MGI analysis

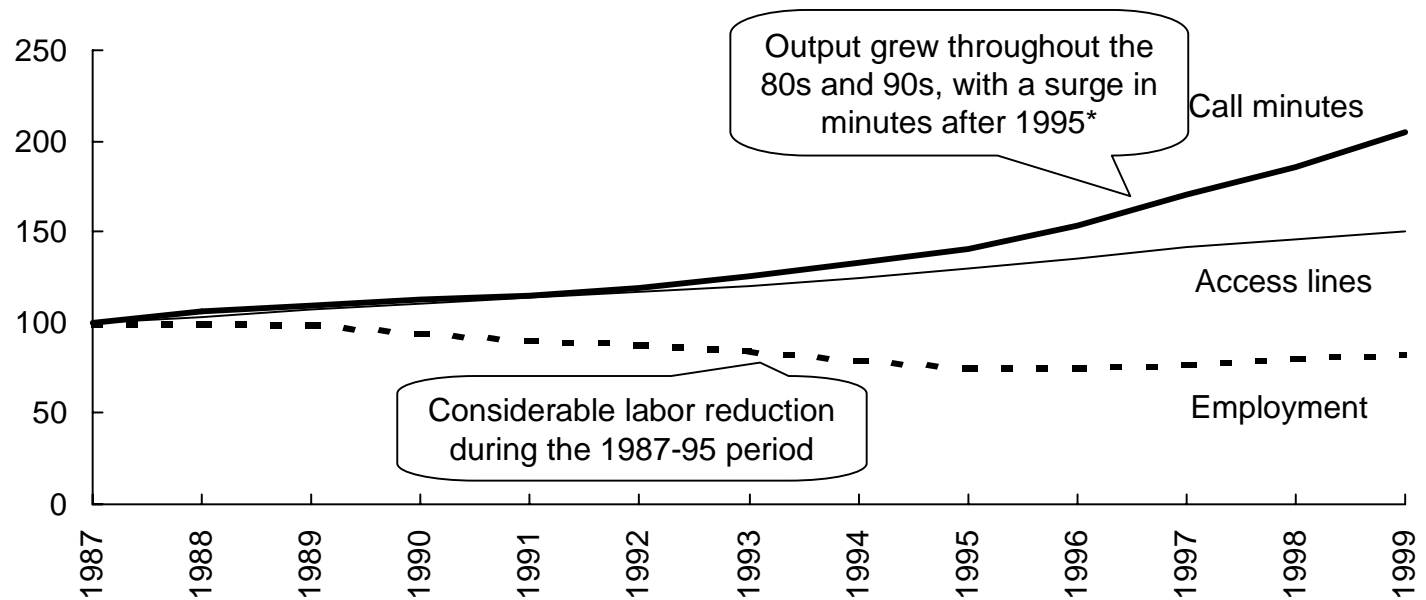
Exhibit 10

PRODUCTIVITY IN LOCAL SERVICE WAS HIGHEST IN THE EARLY 1990s

Local service annual productivity growth
Percent



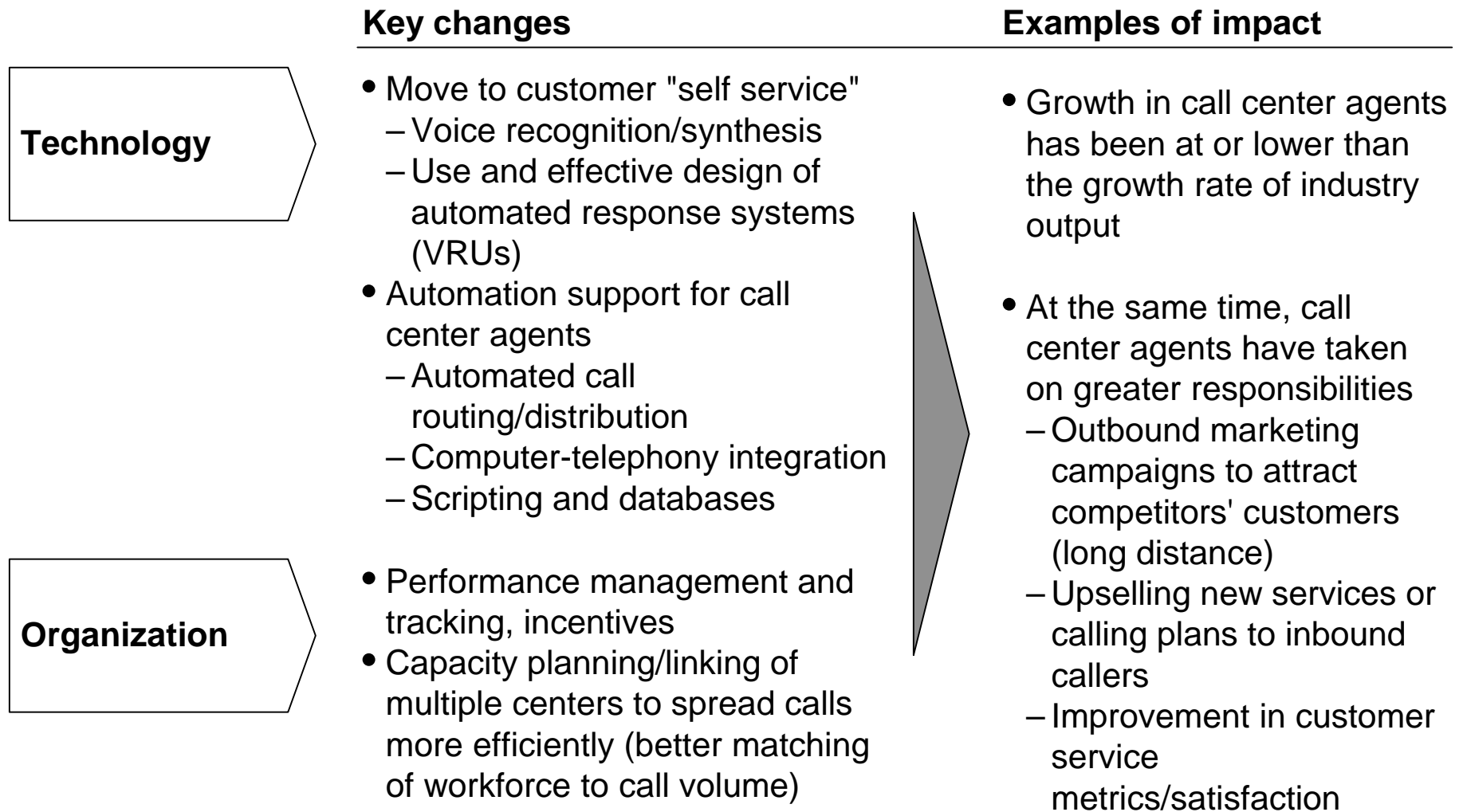
Local service output and input measures
Index, 1987=100



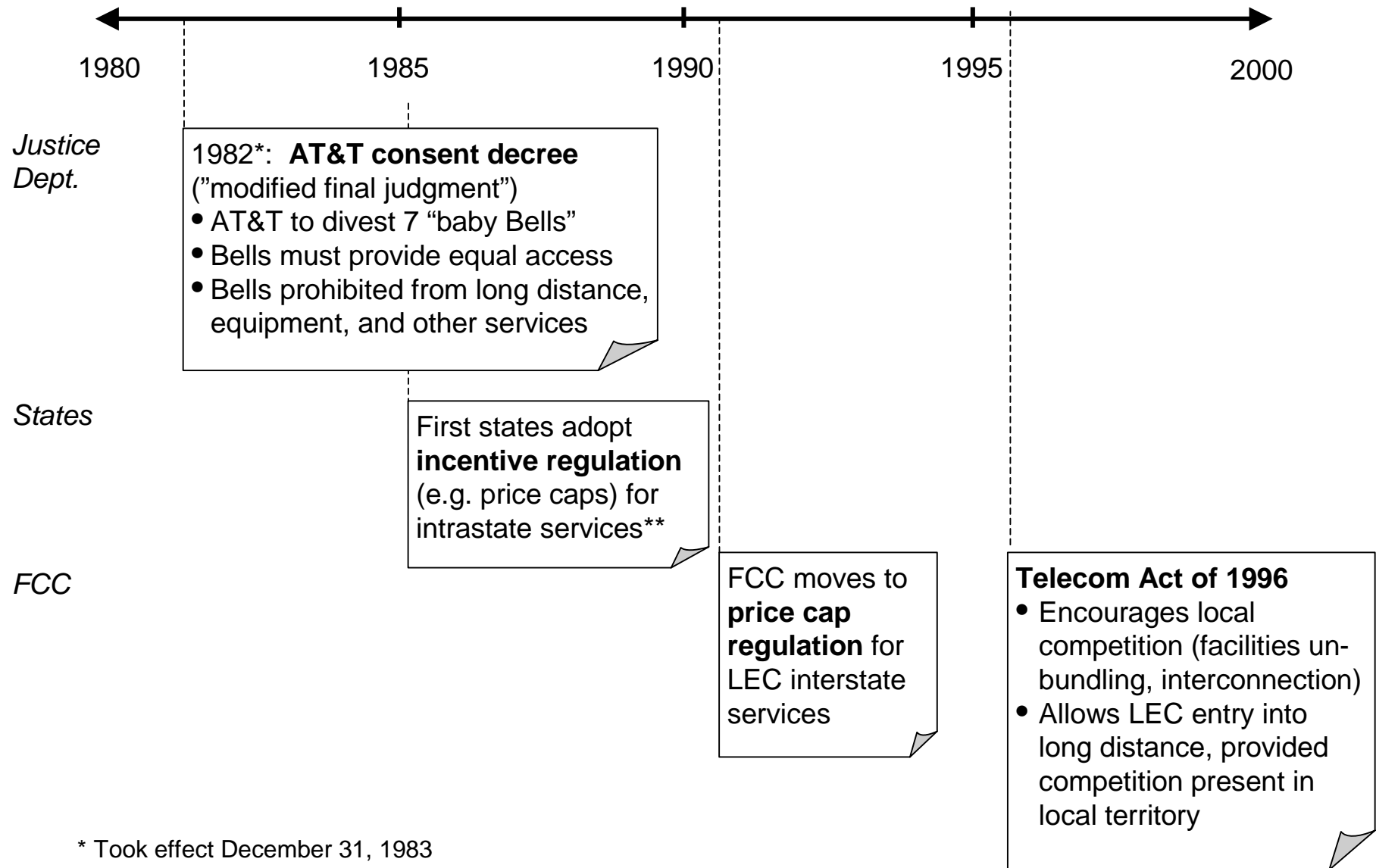
* The surge in minutes was caused by the use of voice lines for dial-up Internet access

Source: FCC, MGI analysis

CALL CENTER PRODUCTIVITY HAS IMPROVED, LARGELY DUE TO THE APPLICATION OF NEW TECHNOLOGY



SEVERAL REGULATORY EVENTS AFFECTED LOCAL SERVICES PRODUCTIVITY



* Took effect December 31, 1983

** Adoption of incentive regulation by states continued into the 1990s

REGULATORY CHANGE WAS THE KEY DRIVER OF THE 1987-95 JUMP IN LOCAL SERVICE PRODUCTIVITY

- Important (>50% of acceleration)
- ◐ Somewhat important (10-50% of acceleration)
- Not important (<10% of acceleration)

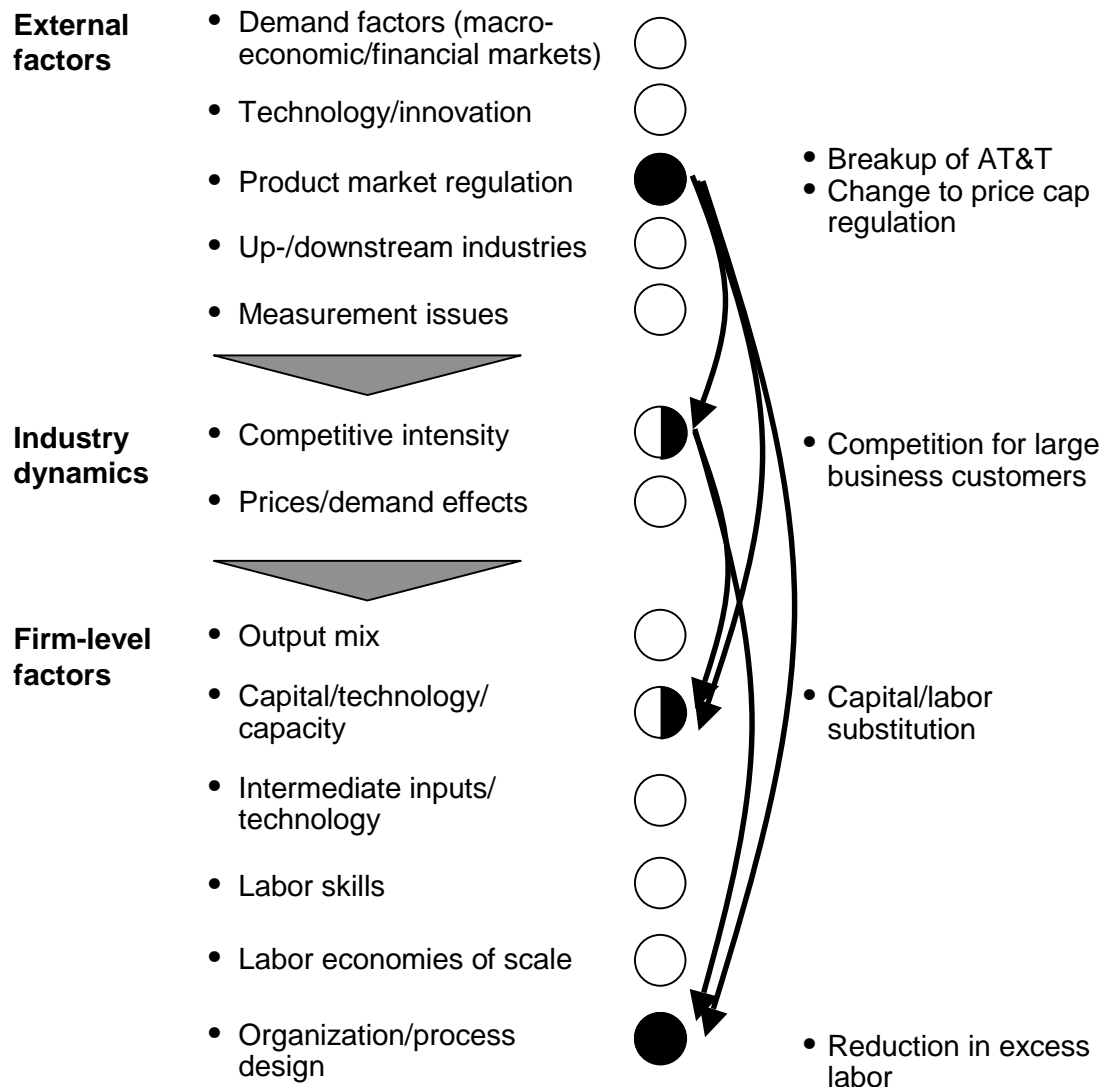
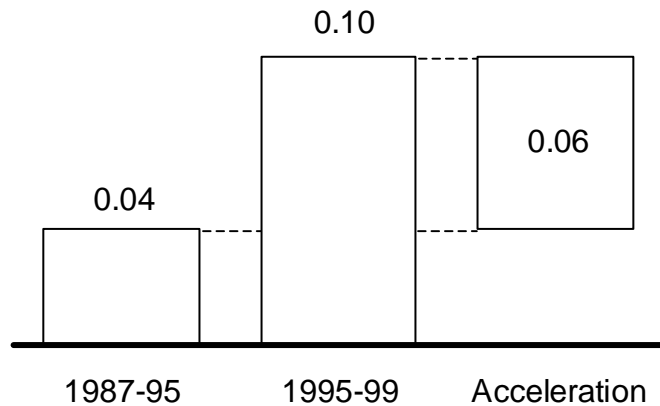


Exhibit 14

MOBILE COMMUNICATIONS WAS A SIGNIFICANT COMPONENT OF THE OVERALL US PRODUCTIVITY GROWTH JUMP

Contribution to aggregate productivity growth
CAGR, MGI analysis



- Mobile access had the largest productivity contribution of the three telecom services subsectors
- On a standalone basis, mobile would rank as the sector with the ninth highest contribution to aggregate US productivity growth jump*

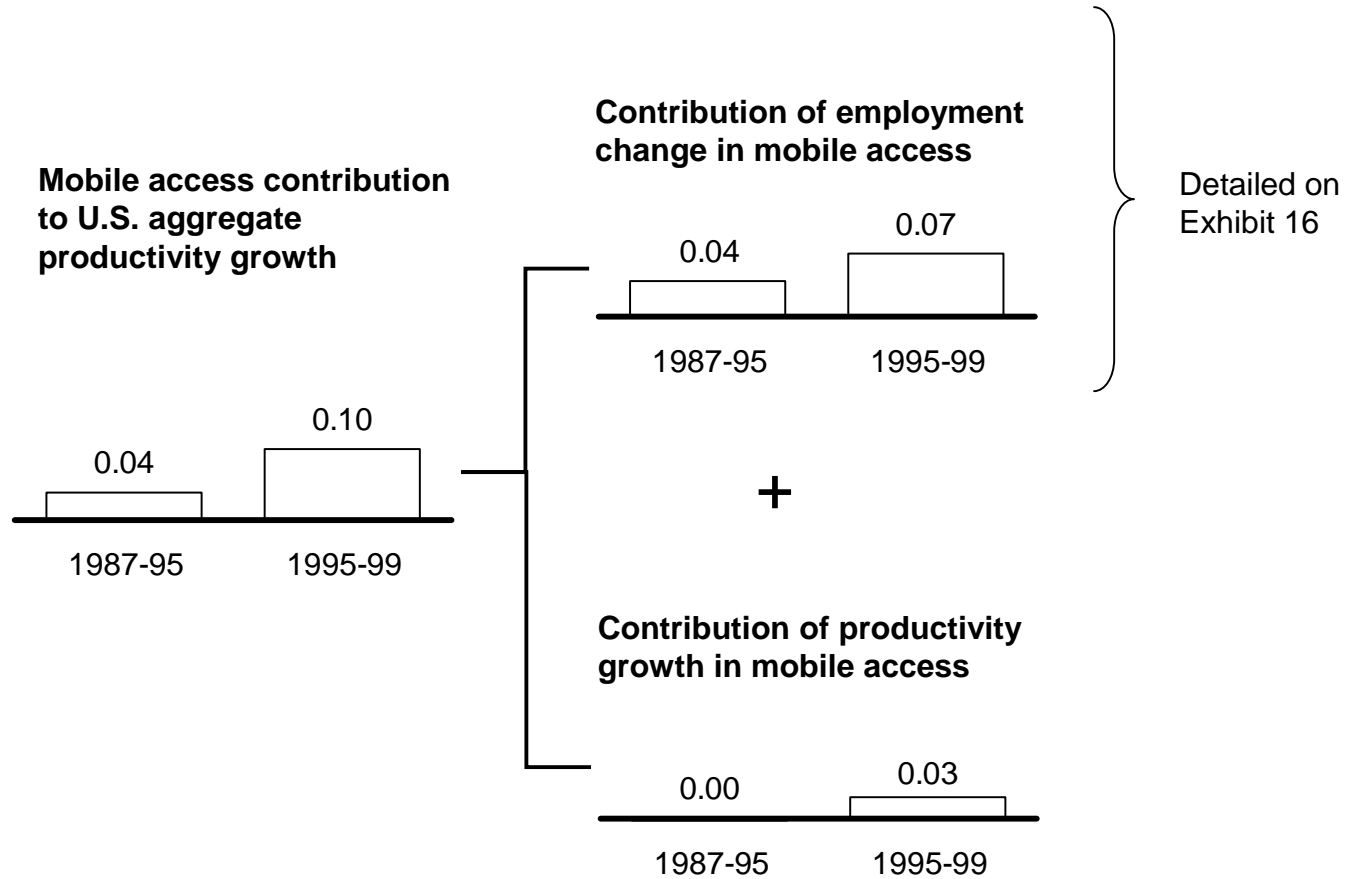
* After the five other MGI "jumping sectors", plus farms, health services, and real estate. Does not include contribution of "holdings and investment offices" because that sector's high contribution is due to statistical irregularities.

Source: BEA, MGI analysis

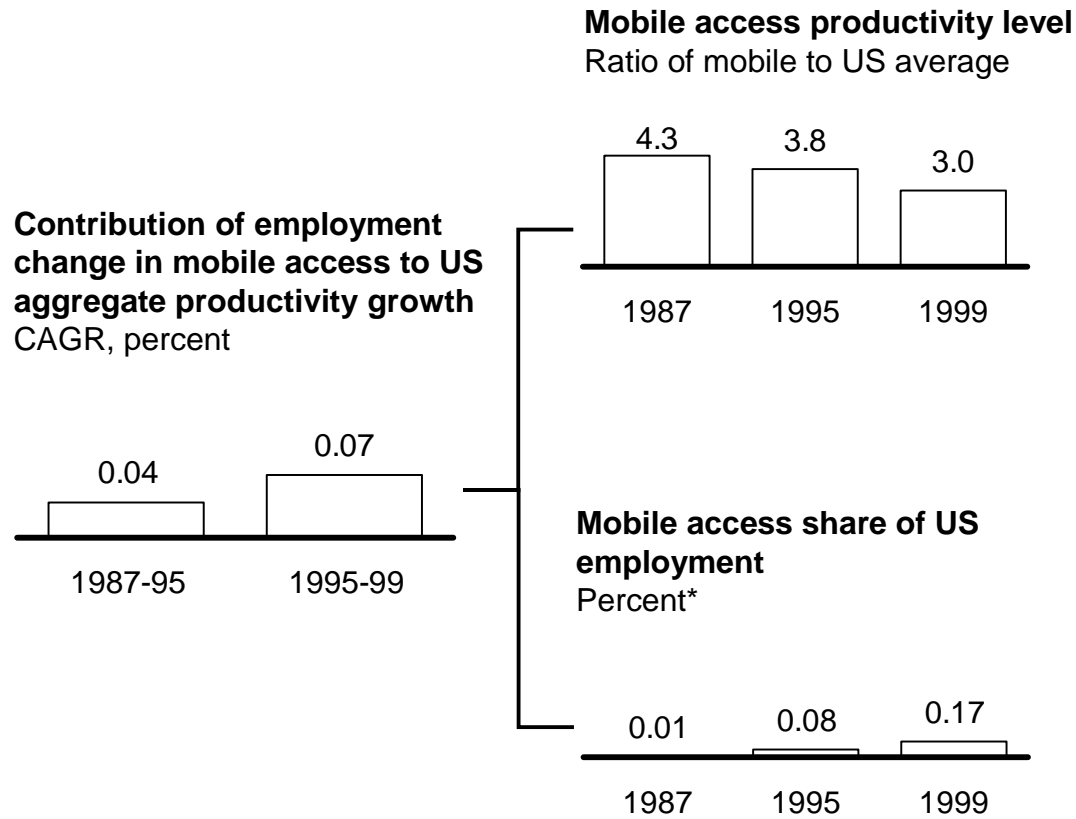
Exhibit 15

MOBILE CONTRIBUTED TO THE AGGREGATE US PRODUCTIVITY JUMP THROUGH BOTH EMPLOYMENT GROWTH AND PRODUCTIVITY ACCELERATION

Compound annual growth rates



MOBILE'S SHARE OF THE ECONOMY INCREASED

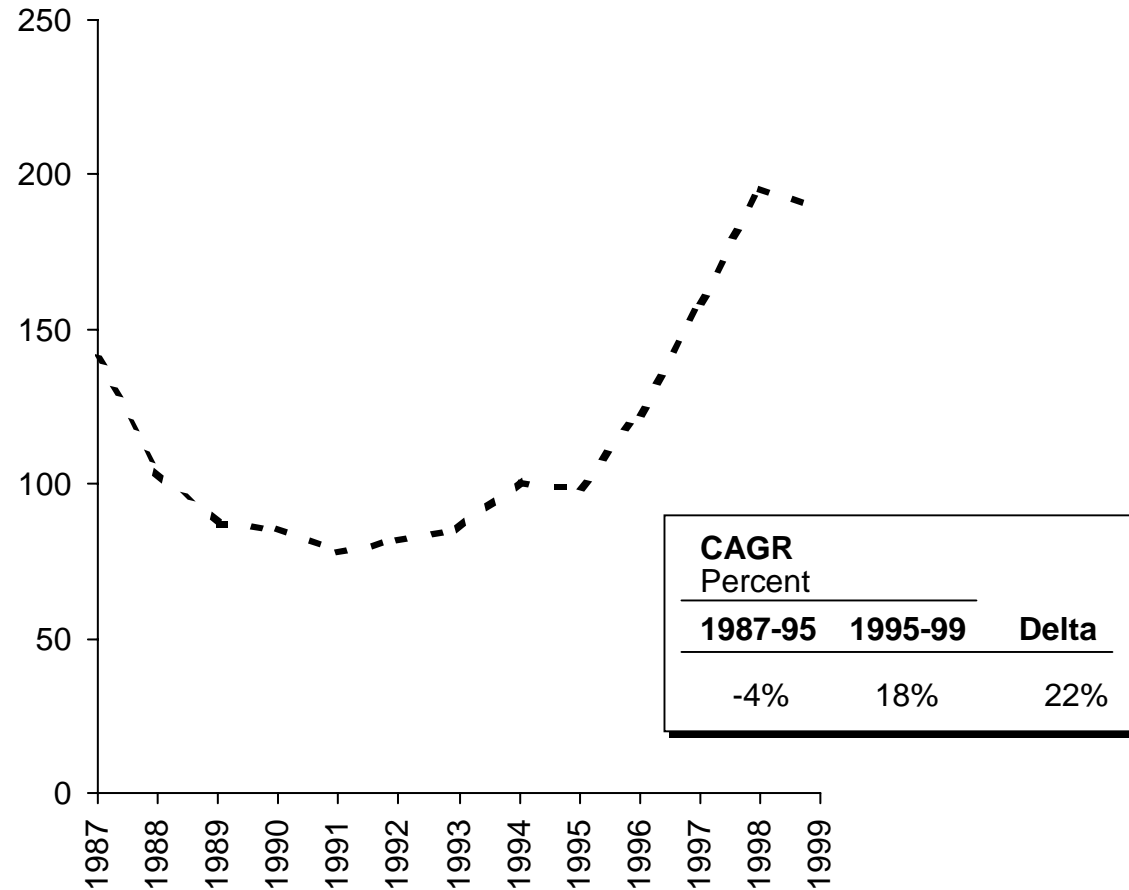


* Share of private-sector employment

Exhibit 17

IT INTENSITY GROWTH ACCELERATED DRAMATICALLY

IT capital intensity, thousands of 1996 dollars per employee*



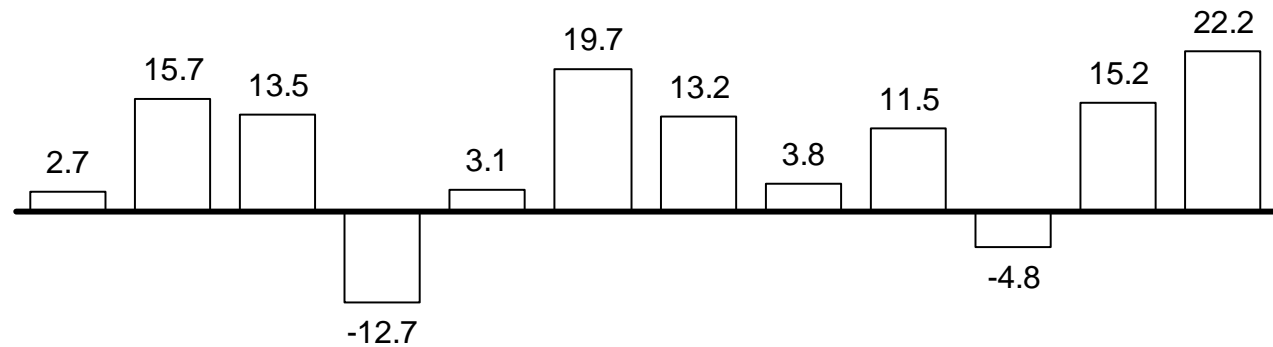
* Communications equipment is included in the MGI definition of IT (and accounts for over 80% of IT investment in the telecommunications sector)

Source: BEA, FCC, CTIA, Hoovers, Compustat, MGI analysis

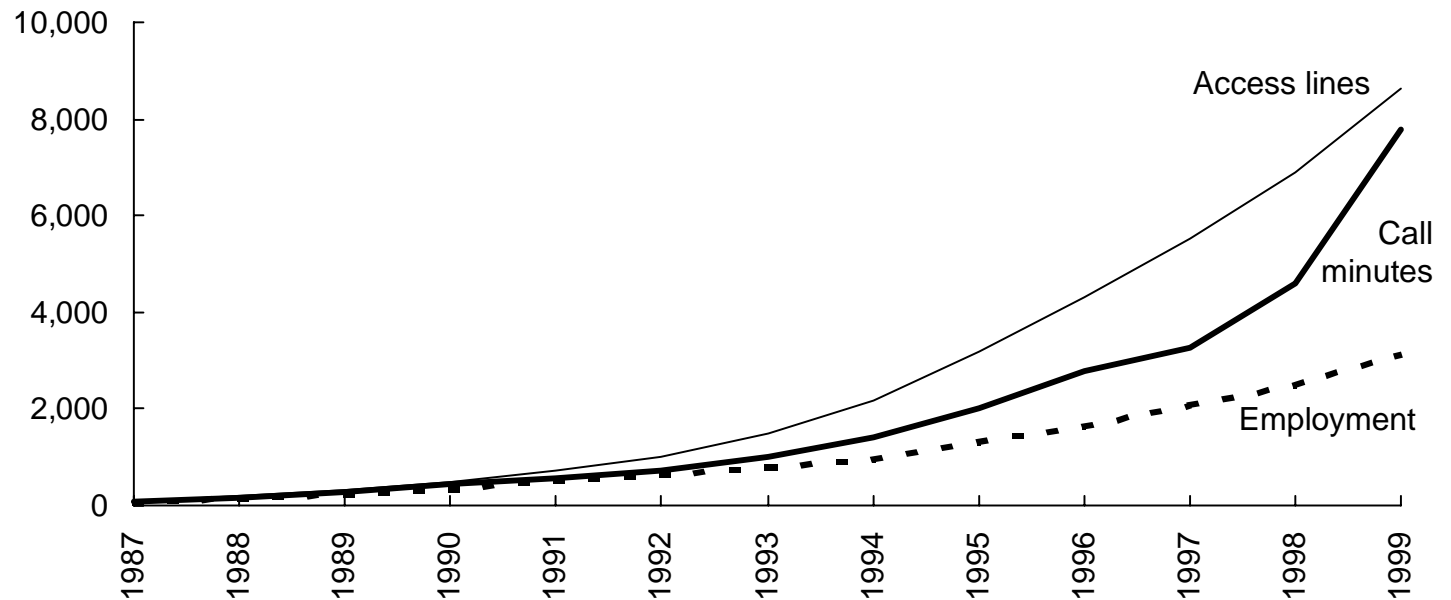
Exhibit 18

PRODUCTIVITY IN MOBILE WAS DRIVEN BY RAPID INCREASES IN OUTPUT

Mobile service annual productivity growth
Percent



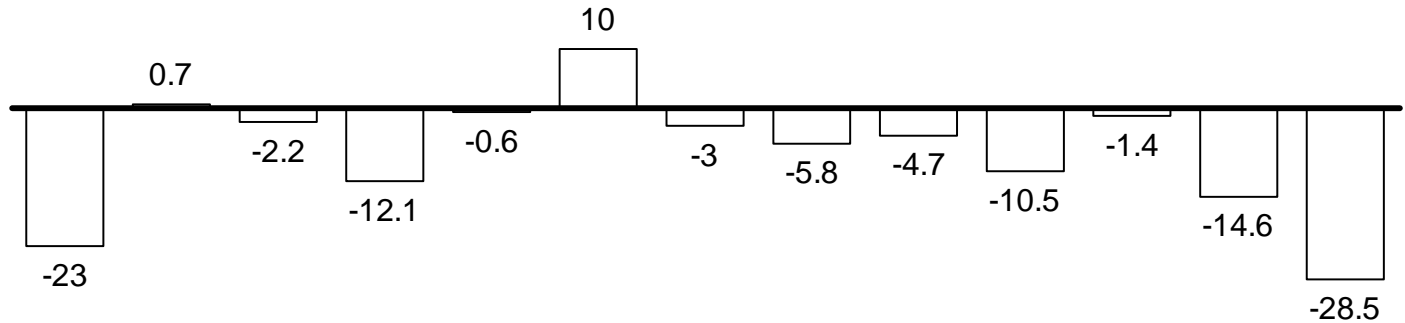
Mobile service output and input measures
Indexed, 1987 = 100



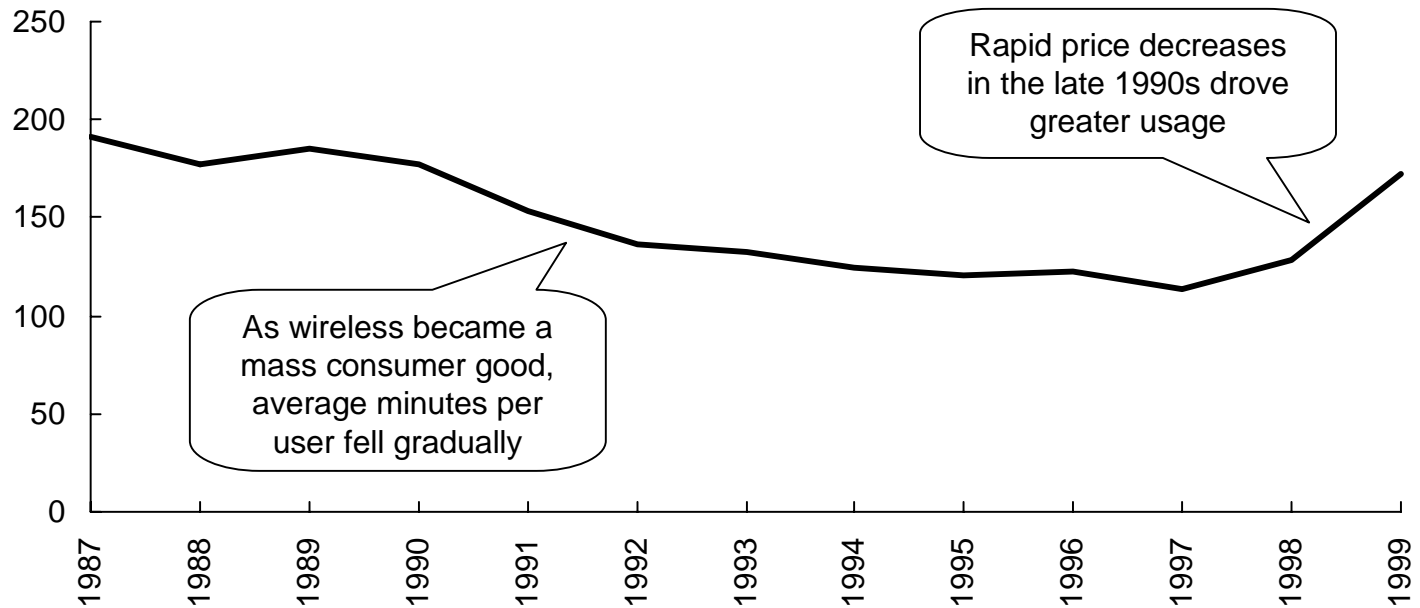
Source: FCC, MGI analysis

LOWER PRICES FOR MOBILE CALLS ENCOURAGED USAGE

Mobile phone pricing
Change in total revenue per minute*, percent



Mobile phone usage
Minutes per subscriber per month

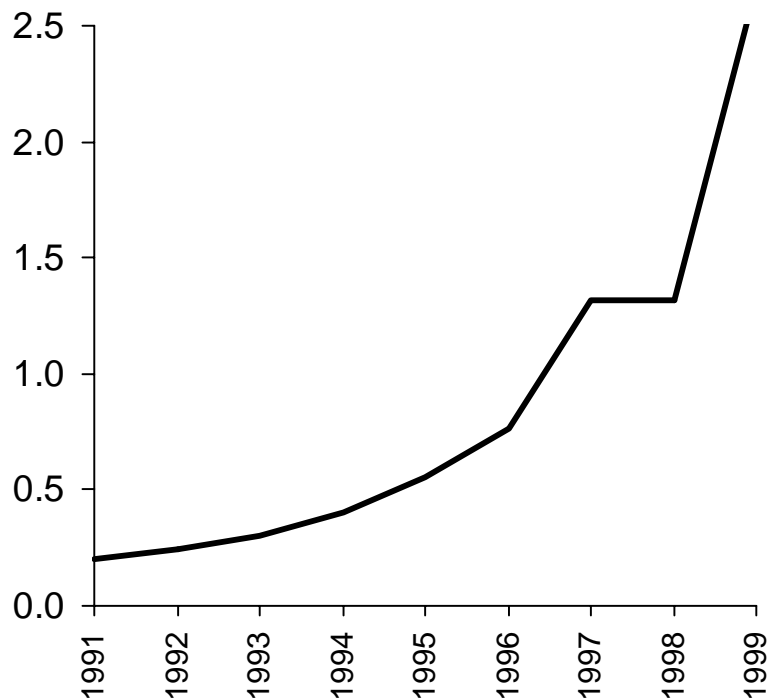


* Simple division of total industry revenues by total call minutes

MOBILE CAPACITY INCREASED DRAMATICALLY IN THE LATE 1990s

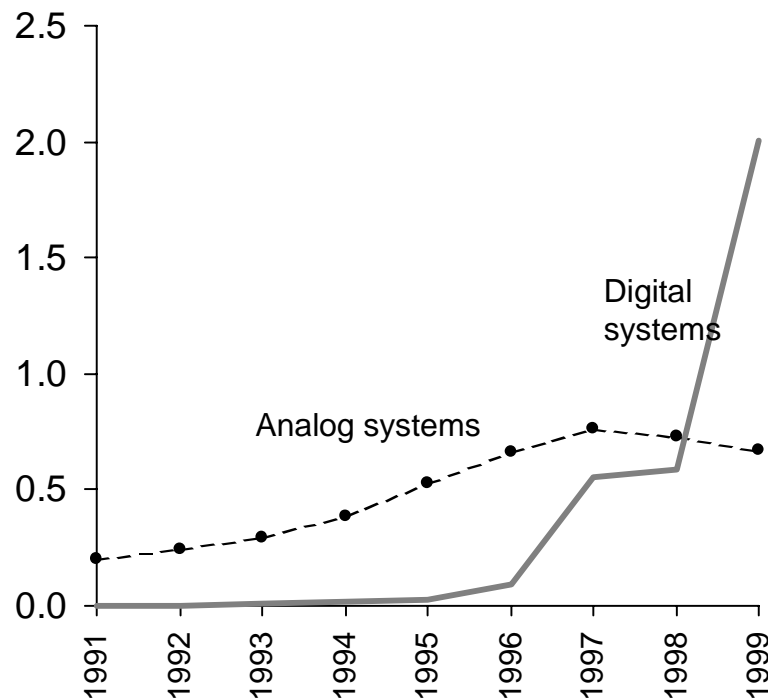
Millions of simultaneous calls (channels)

Call capacity installed



Surge in capacity made rapid increases in usage possible

Type of capacity installed

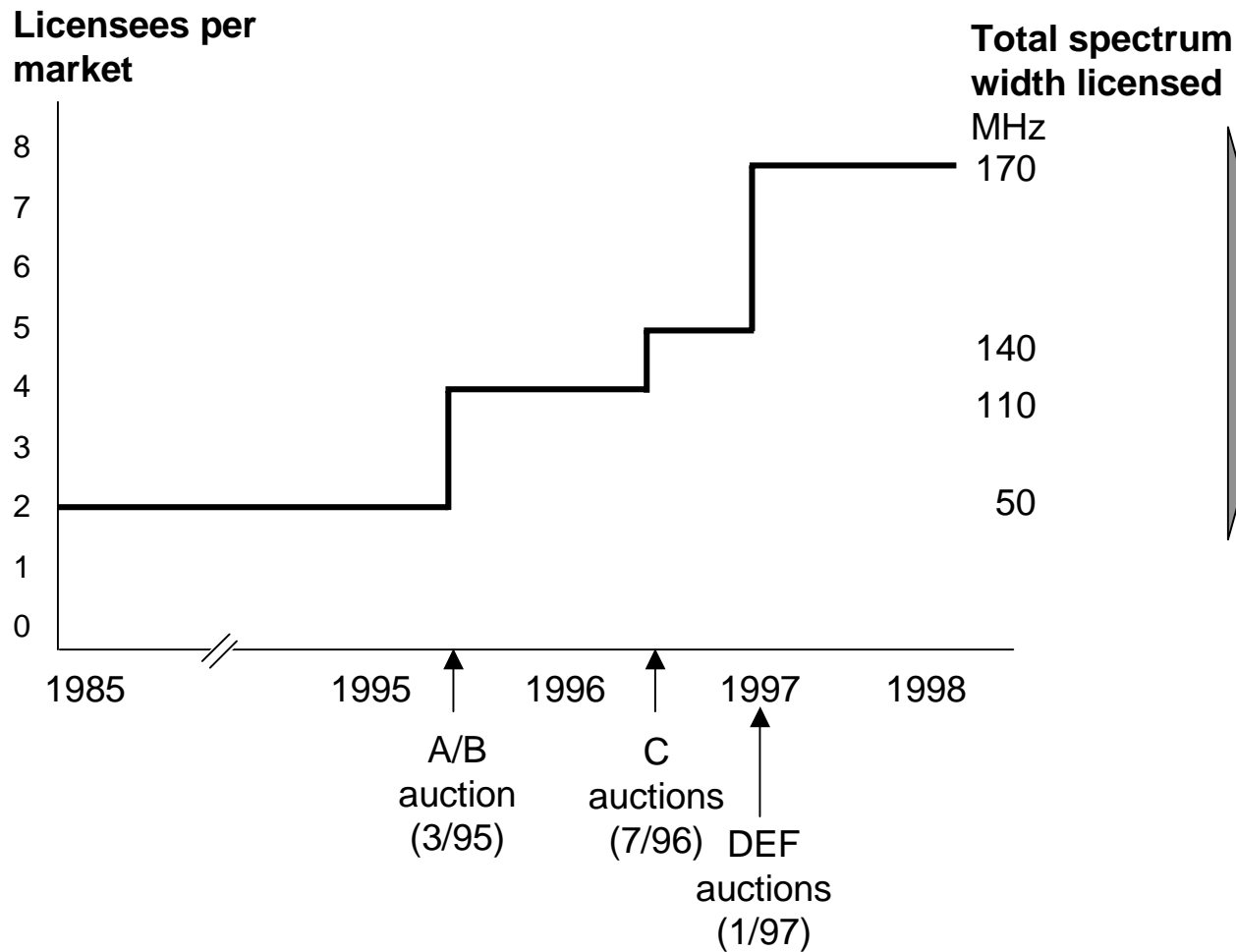


Capacity increase was driven by installation of equipment based on new digital standards

Note: Capacity utilization as measured by MGI - total call minutes divided by theoretical call minutes possible (channels x 60 minutes/hour x 24 hours/day x 365 days/year) - stayed in a fairly narrow band around 10% during this time period. (This does not correspond to typical industry measures of capacity utilization, which are based on usage measured at peak periods.)

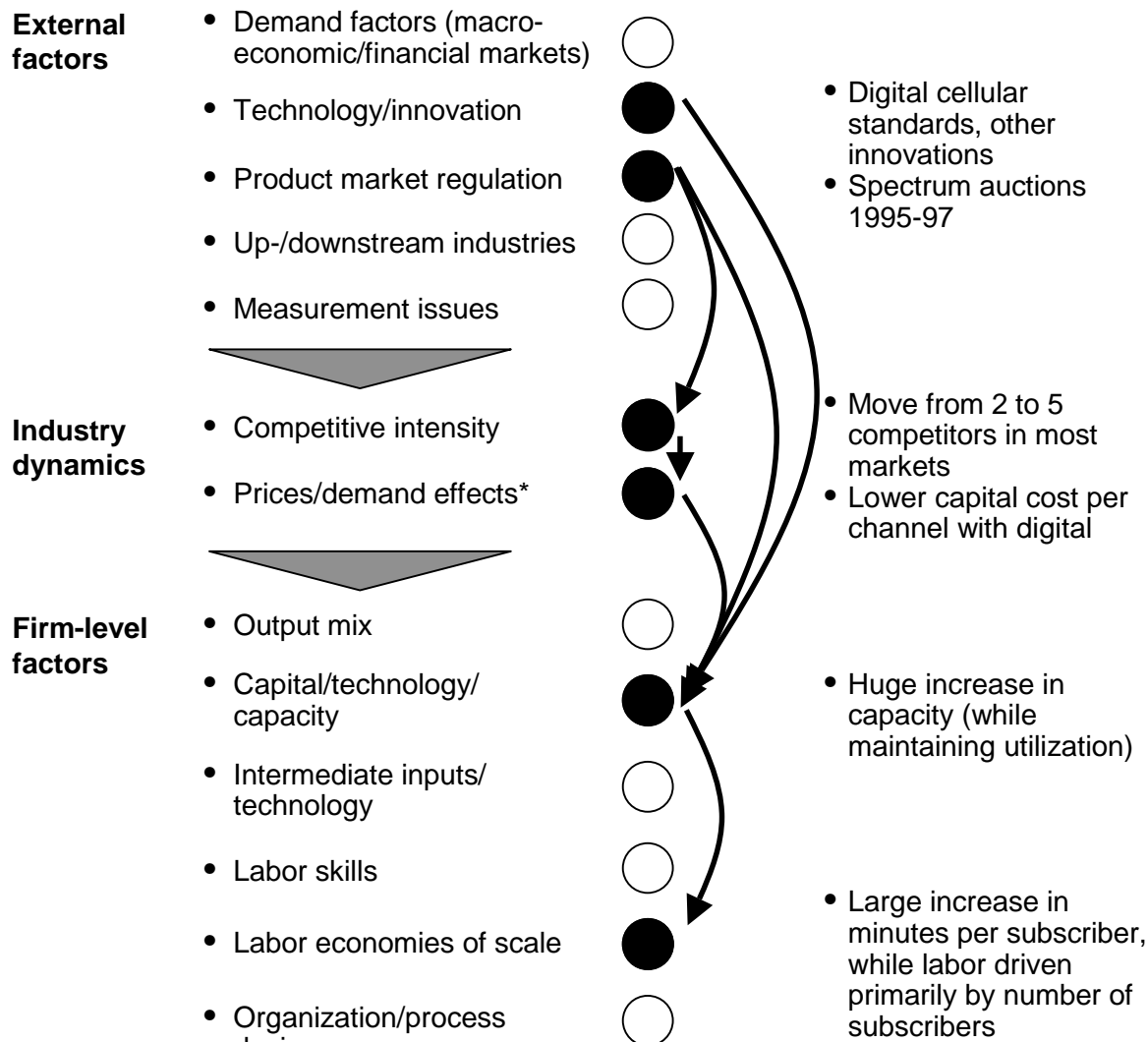
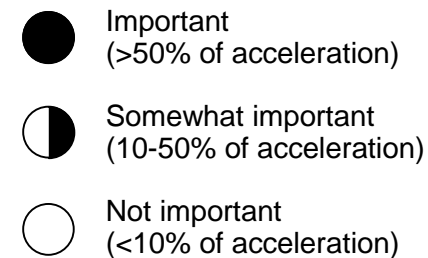
INCREASED CAPACITY CREATED BY GOVERNMENT AUCTIONS OF ADDITIONAL (PCS) SPECTRUM

Number of mobile services competitors per market in U.S., 1985-98



- Tripling of licensed spectrum from 1995-97
- Overall shift was from 2 to 4-5 competitors per market
 - A and B blocks created new PCS competitors
 - Nextel entered in the early 90s with SMR service (entirely different band)
- Remaining blocks not utilized for cellular
 - C block tied up in litigation
 - D, E, F blocks too small for viable cellular service

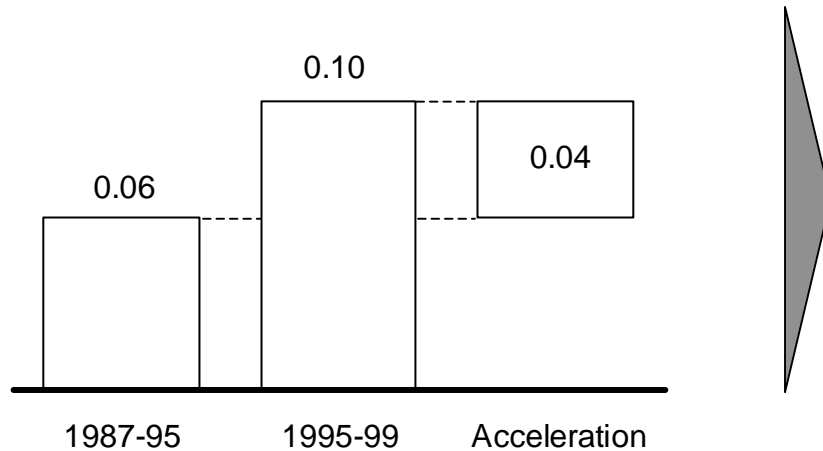
CHANGES IN TECHNOLOGY AND REGULATION WERE RESPONSIBLE FOR HIGHER MOBILE PRODUCTIVITY



* Lower prices were enabled by digital equipment's better price/performance ratio, as well as the increase in competitive intensity

LONG DISTANCE CONTRIBUTED TO THE OVERALL US PRODUCTIVITY GROWTH JUMP

Contribution to aggregate productivity growth
CAGR, MGI analysis



- The long distance segment contributed about 0.04% to the aggregate U.S. productivity growth jump of 1.33%*
- This contribution would rank long distance 10th amongst the BEA's industry sectors, if it were treated as a separate industry**

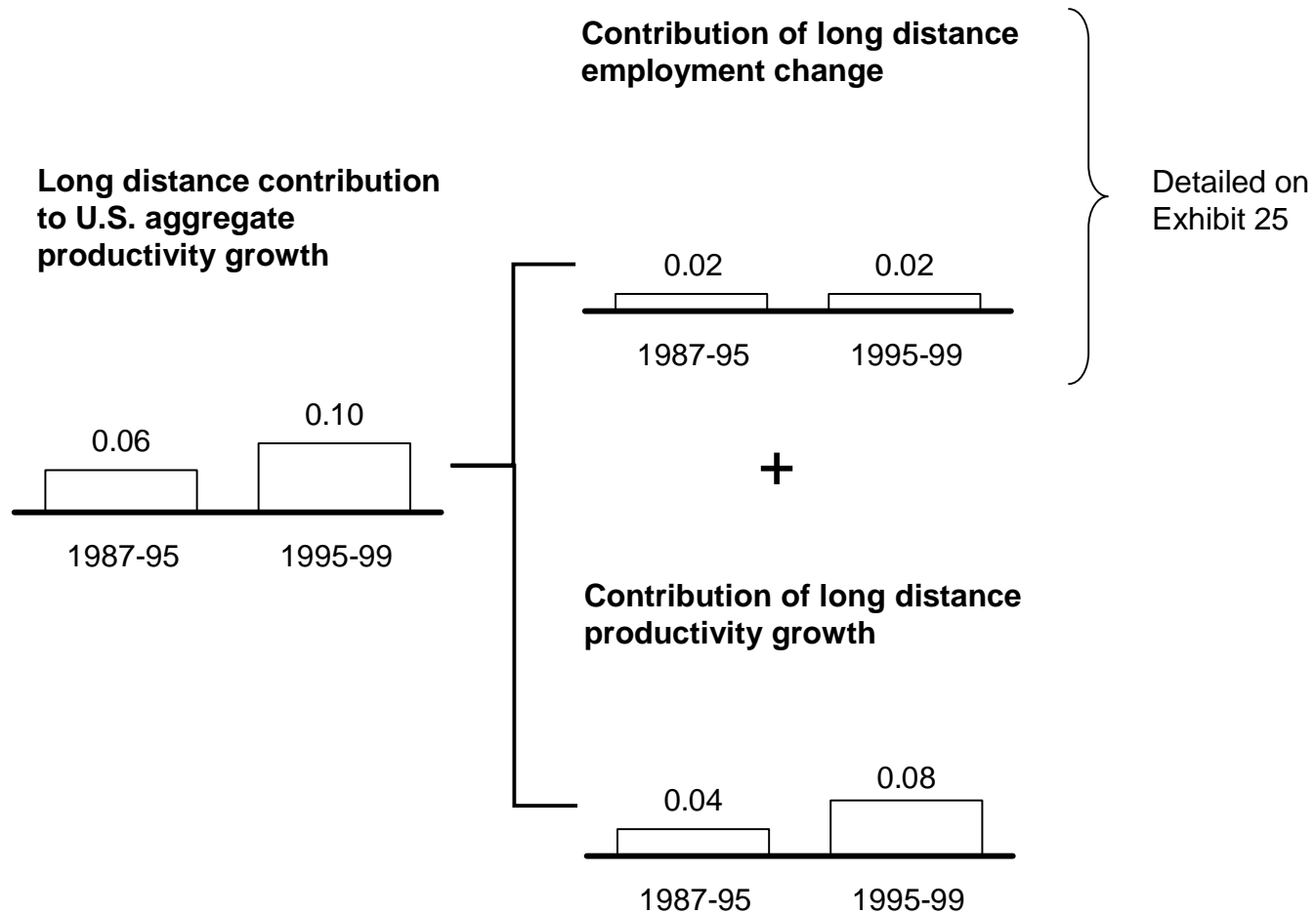
* Note that the long distance contribution is based on MGI analysis (which yields a total telecom sector contribution of 0.11% to the US acceleration) while the aggregate productivity growth jump is measured with BEA data (which yield a total telecom contribution of 0.07%)

** After the other five MGI "jumping sectors", plus mobile communications, farms, health services, and real estate. This ranking does not include the contribution of the "holdings and investment offices" sector because that sector's high contribution is due to statistical irregularities.

Exhibit 24

LONG DISTANCE CONTRIBUTED TO THE US PRODUCTIVITY JUMP BECAUSE ITS OWN PRODUCTIVITY GROWTH ACCELERATED

Compound annual growth rates

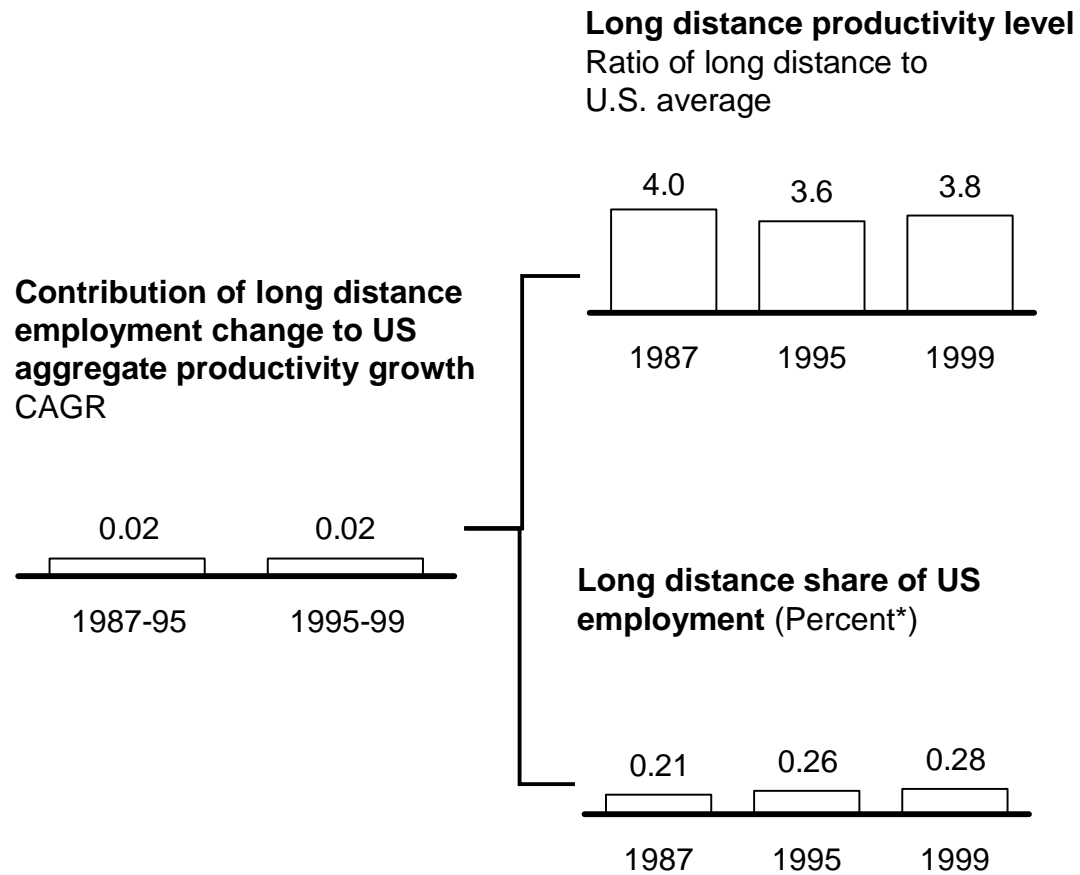


* Share of private sector employment

Source: BEA, MGI analysis

Exhibit 25

CHANGES IN LONG-DISTANCE EMPLOYMENT HAD LITTLE EFFECT ON AGGREGATE PRODUCTIVITY



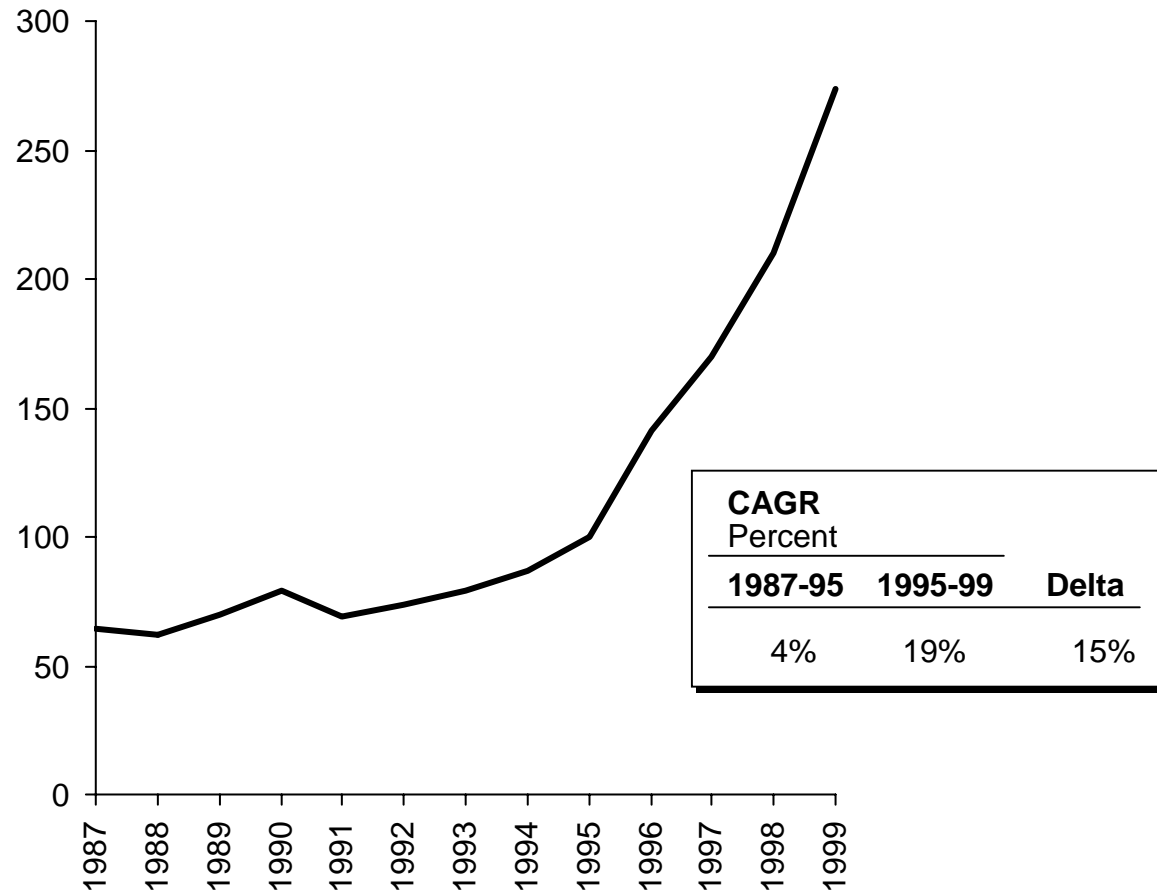
* Share of private sector employment

Source: BEA, MGI analysis

Exhibit 26

IT INTENSITY ACCELERATED DRAMATICALLY

IT capital intensity in long distance, thousands of 1996 dollars per employee*

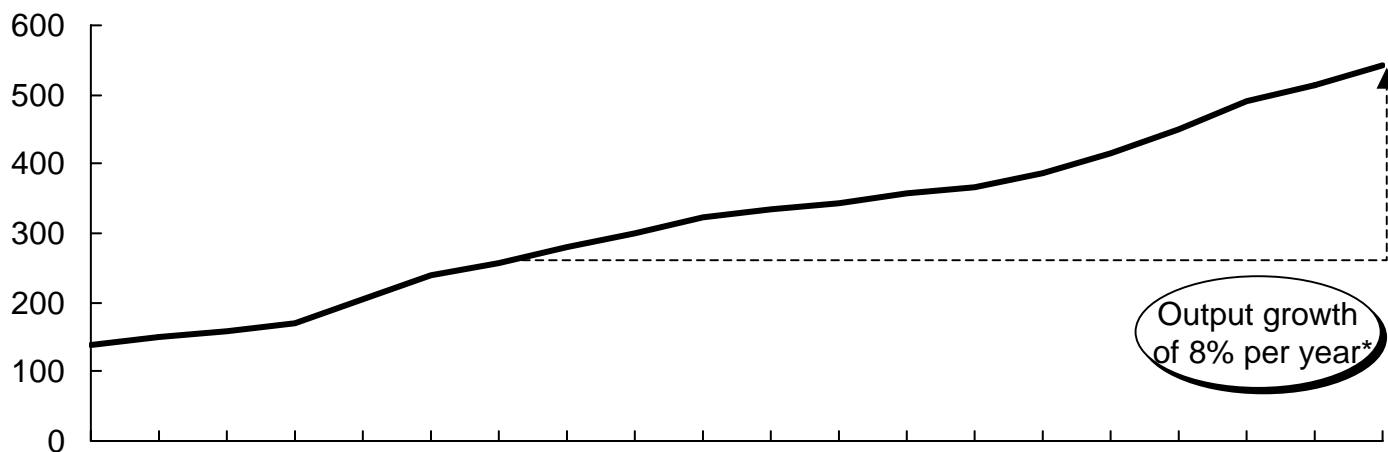


* Communications equipment is included in the MGI definition of IT (and accounts for over 80% of IT investment in the telecommunications sector)

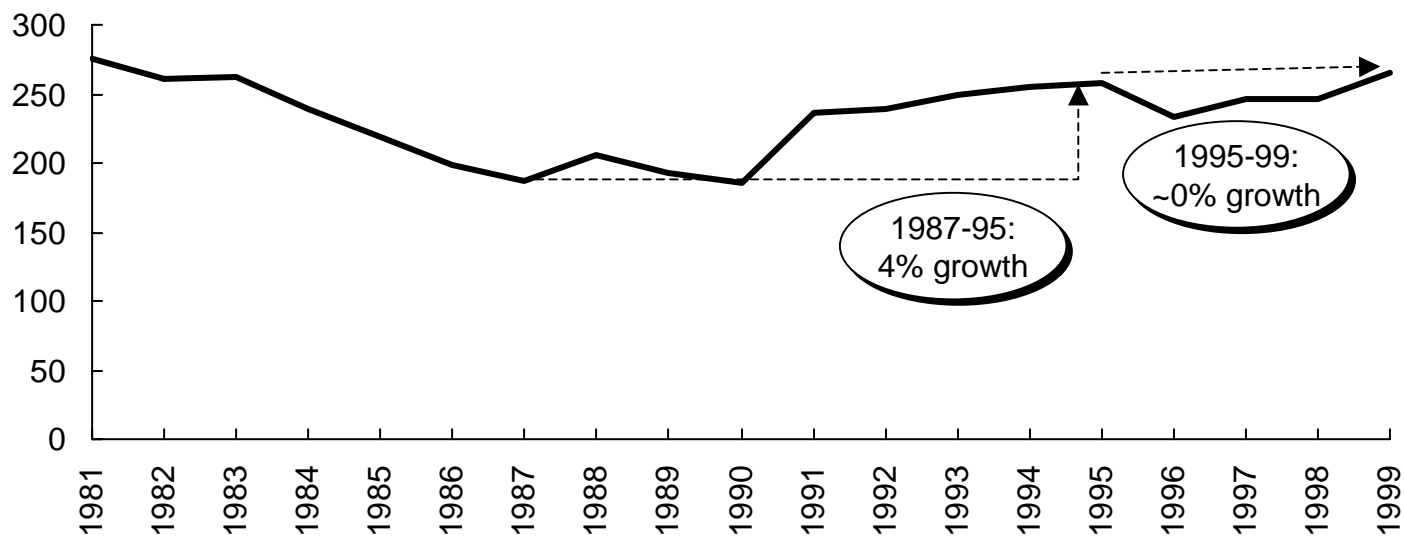
Source: BEA, FCC, Hoovers, Compustat, MGI analysis

A SLOWDOWN IN EMPLOYMENT GROWTH WAS RESPONSIBLE FOR THE 1995-99 PRODUCTIVITY ACCELERATION

Long distance output
Billions of long-distance minutes



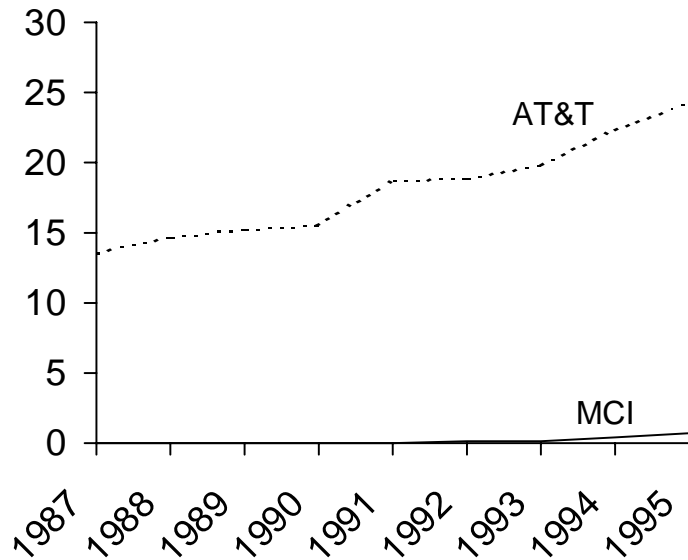
Long distance input
Estimated total long-distance voice employees



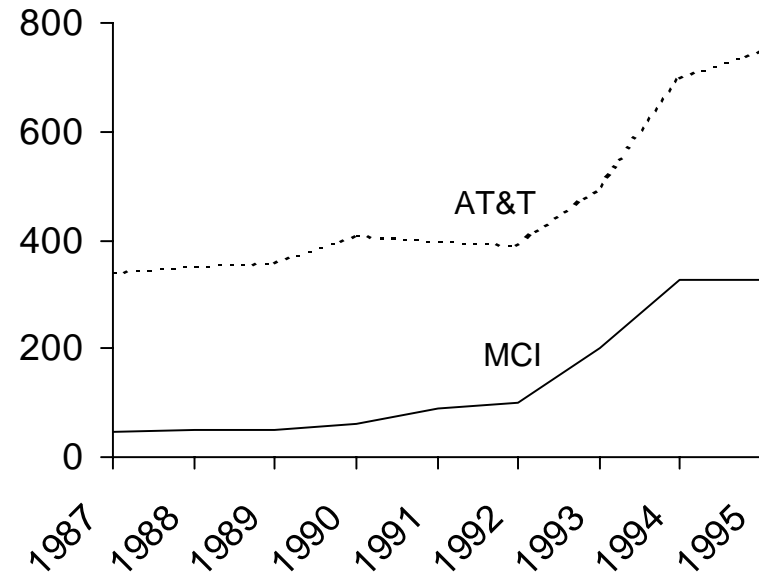
* The actual productivity calculations use a Fisher-weighted index composed of intrastate, interstate, and international minutes

SHARE WARS HELPED DRIVE LABOR INCREASES IN THE EARLY 1990s

Selling, general, and administrative expenses
\$ Billions



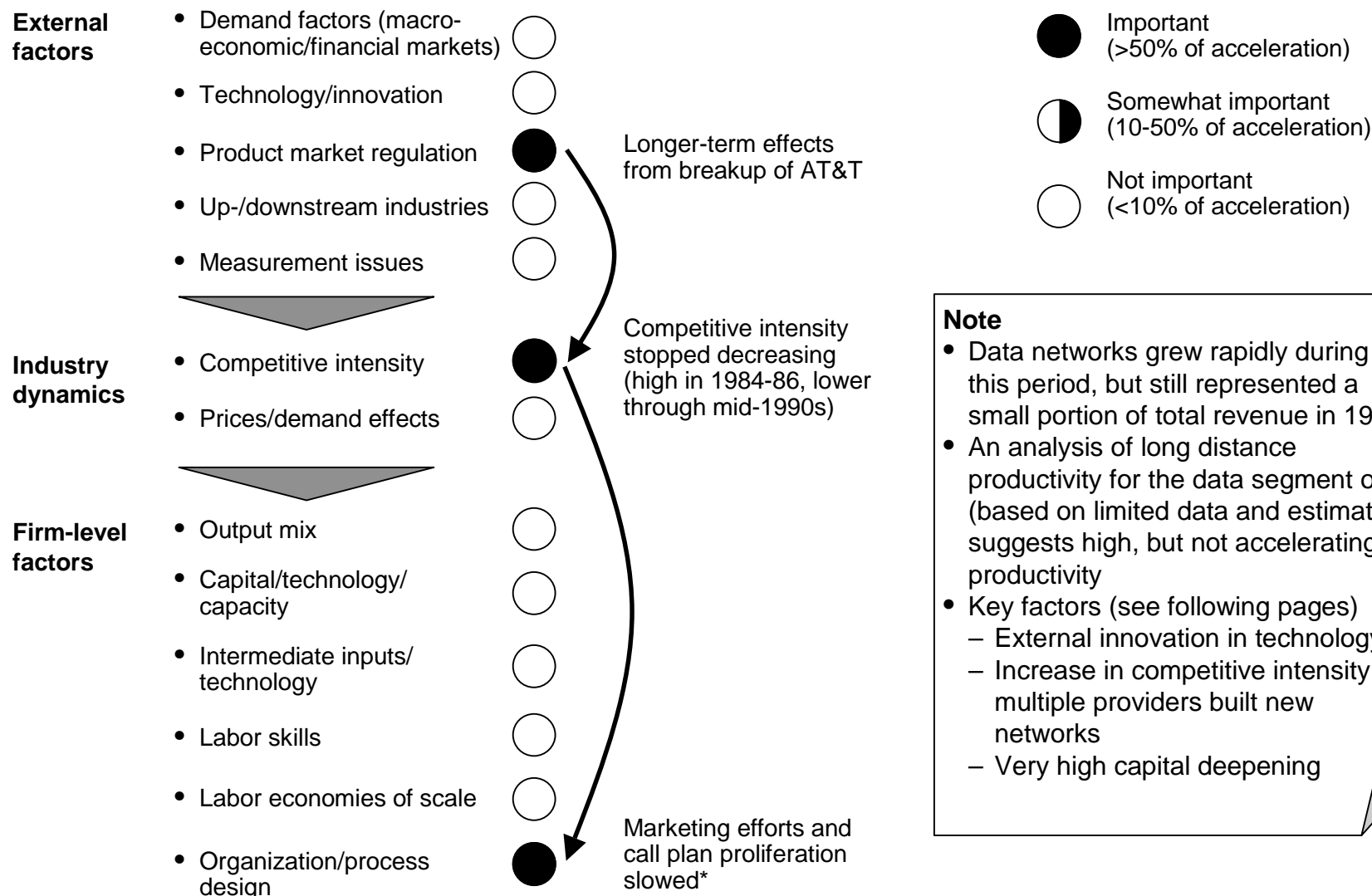
Long-distance advertising expenses
\$ millions



"It's marketing – not technology, which is easily replicated – that's making the biggest difference in the telecommunications business these days"

– Timothy Price, EVP/Group President MCI
(as quoted in *Advertising Age*, Nov. 28, 1994)

THE LEGACY OF REGULATION WAS BEHIND THE EVENTUAL PRODUCTIVITY ACCELERATION IN LONG DISTANCE



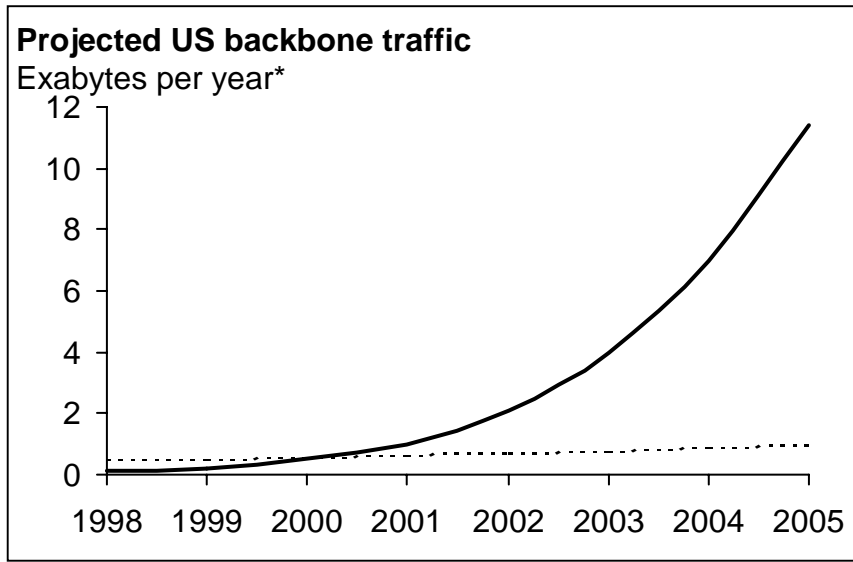
Note

- Data networks grew rapidly during this period, but still represented a small portion of total revenue in 1999
- An analysis of long distance productivity for the data segment only (based on limited data and estimates) suggests high, but not accelerating, productivity
- Key factors (see following pages)
 - External innovation in technology
 - Increase in competitive intensity as multiple providers built new networks
 - Very high capital deepening

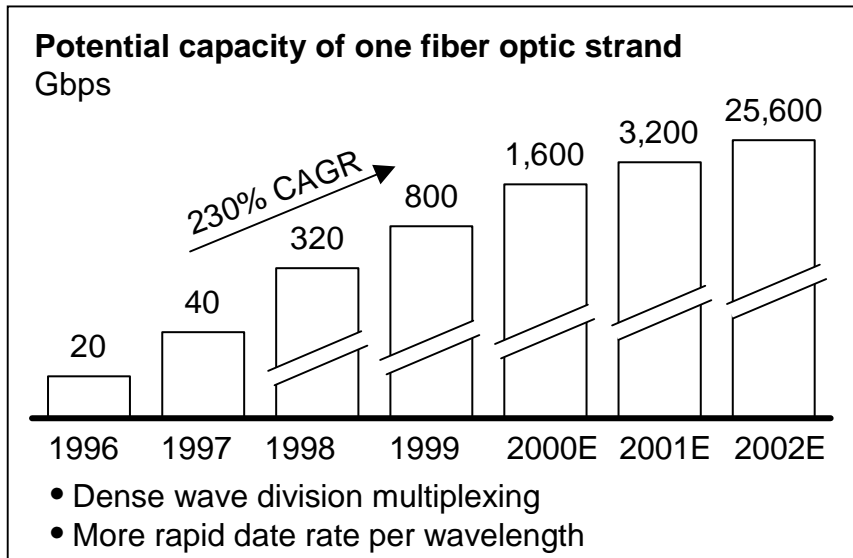
* Some of the observed employment increase in long distance during this period came from the buildup of operations and marketing organizations for data services

TWO FORCES ENCOURAGED NEW ENTRY IN LONG-DISTANCE DATA

Projected surge in demand



Technological discontinuity



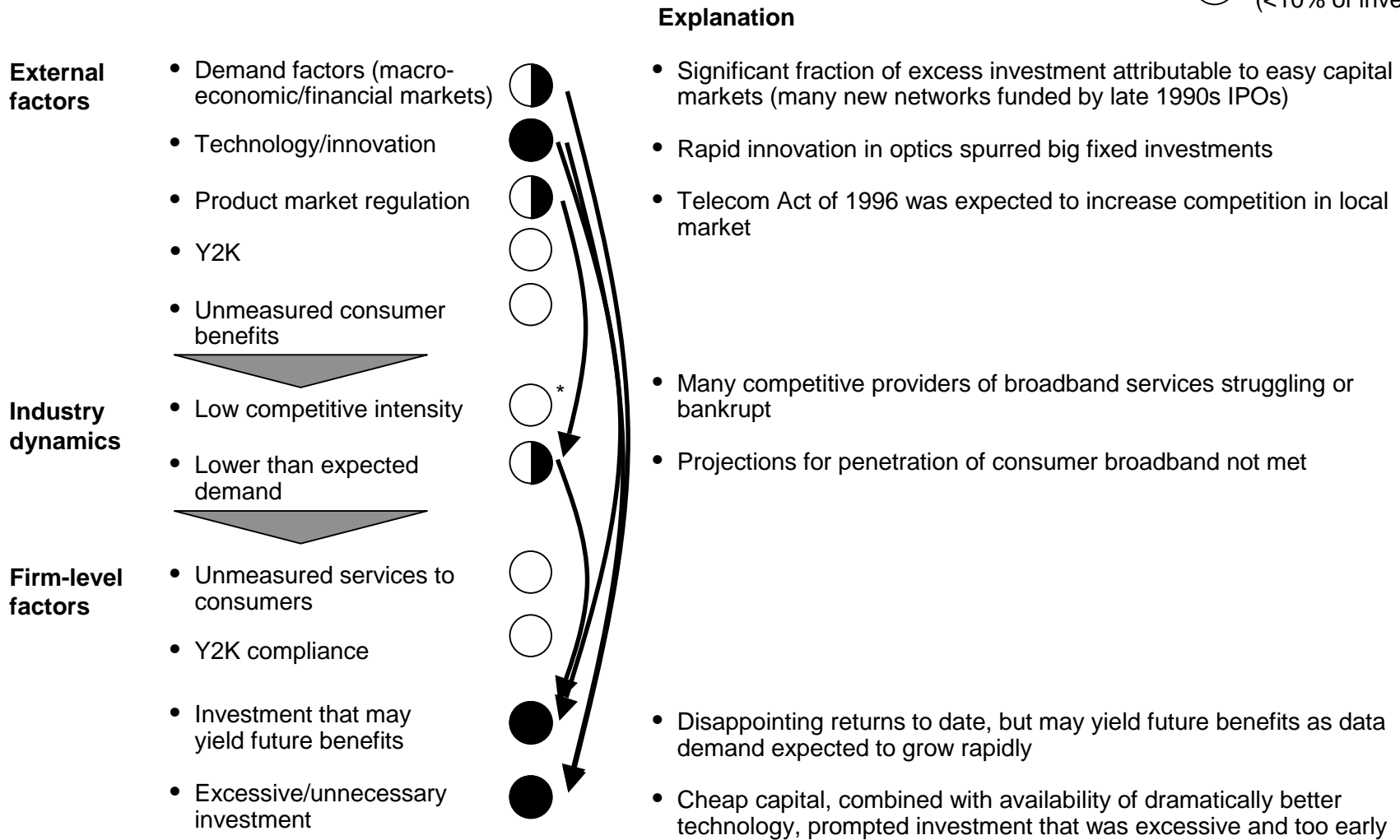
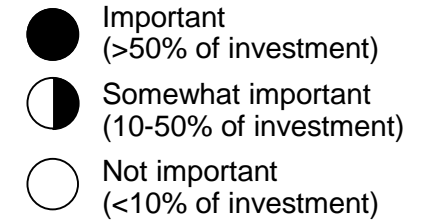
- Multiple new entrants building nationwide backbone networks**
 - Frontier/Global Crossing
 - Qwest
 - Level(3)
 - Digital Teleport
 - IXC/Broadwing
 - Touch America
 - Genuity
 - Enron
- Many other players building regional/metro fiber networks

* One exabyte = 2⁶⁰ bytes

** Easy availability of capital enabled the rapid buildout of multiple networks

Exhibit 31

SEVERAL FACTORS CONTRIBUTED TO OVERINVESTMENT IN LONG HAUL NETWORKS

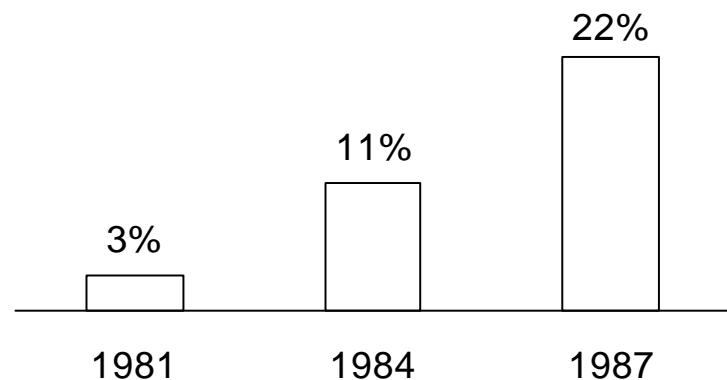


* Long distance industry highly competitive, but lower competitive intensity among local loop providers limited penetration of DSL/broadband

INCREASED COMPETITION LED TO A SURGE IN USAGE

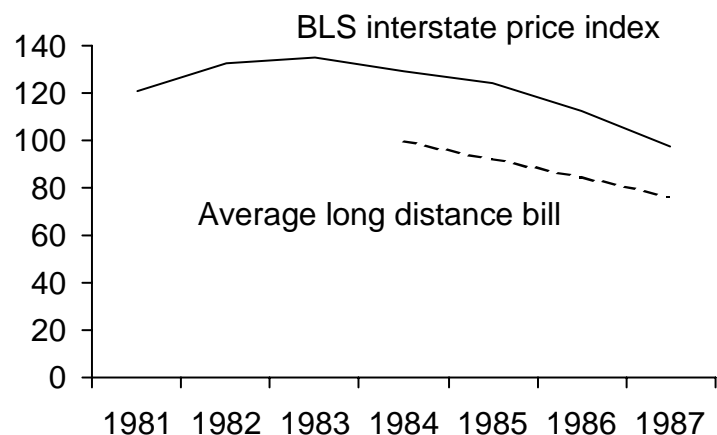
Attacker share of long distance revenue*

Percent



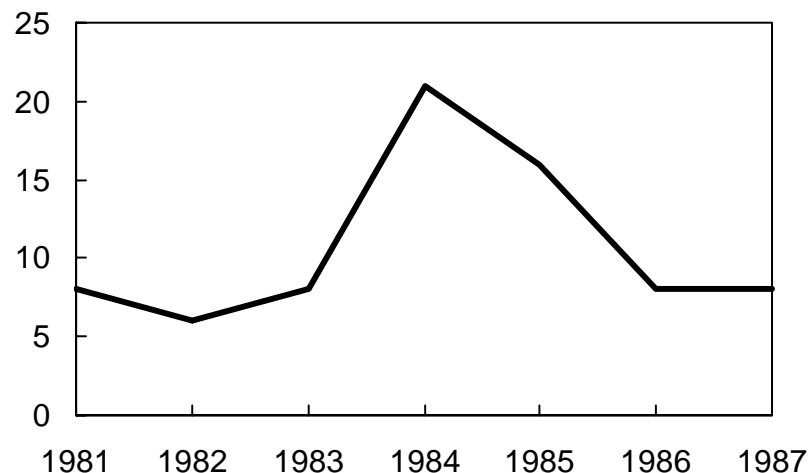
Price per minute of domestic long distance**

Index



Growth in long-distance usage

Annual growth in minutes of usage (percent)



Market stimulated by

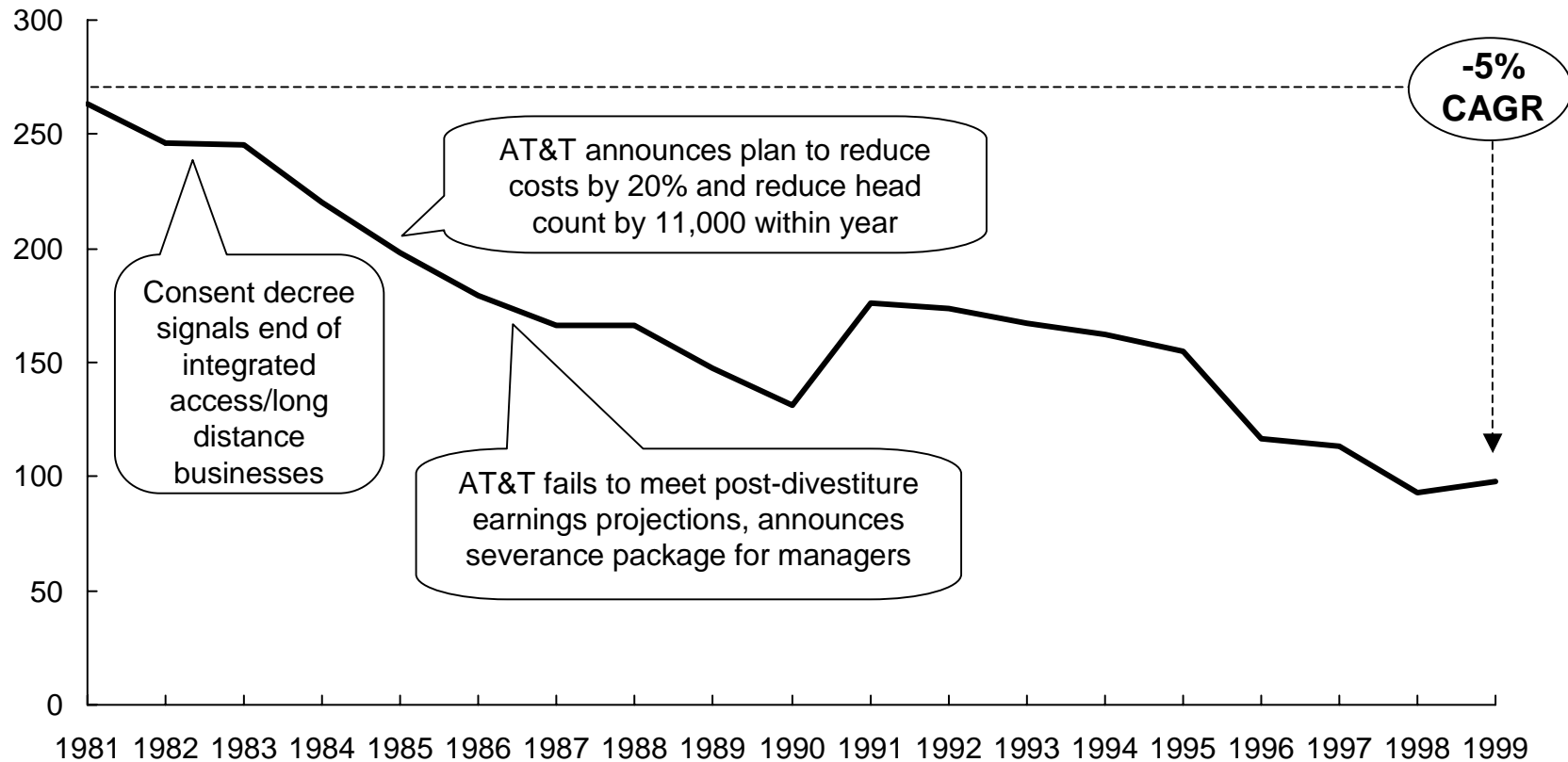
- Aggressive marketing of new competitors
- Increased variety of calling plans, options
- Lower prices

* Includes Sprint, Worldcom (incl. the former MCI), and others

** Measures of average prices understate the drop in the best price available (since not every consumer switched to a lower-cost provider)

NEW COMPETITION AND THE BREAKUP ENCOURAGED AT&T TO BECOME LEANER

Estimated employees in AT&T long distance operations*, 1981-1999 (thousands)



* These figures are an outside-in estimate based on Compustat data for AT&T employment, less estimated employment for Lucent (1981-96), AT&T Wireless, and TCI (1999)

HOW MGI DEFINES OUTPUT

	<u>Industry segments</u>	<u>Specific output measures</u>	<u>BEA</u>	<u>BLS</u>	<u>MGI</u>
MGI output measure	Local service	Access lines	✓	✓	✓
		Minutes of use			✓
		Call services*			
		Data access lines	✓	✓	✓
	Mobile access	Subscribers	✓	✓	✓
		Wireless minutes	✓		✓
	Long distance transport	Intrastate minutes	✓	✓	✓
		Interstate minutes	✓	✓	✓
		International minutes	✓	✓	✓
		Delivered bandwidth			✓

* Call services refers to features such as call waiting, caller ID, and other operator or software-enabled services. Due to a lack of reliable time-series data, these were not included in the MGI output measure