

OPERATIONS

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# Building a flexible supply chain for uncertain times

**The “bullwhip effect” means that distortions in data cascade through a company’s suppliers. Businesses must remain flexible to protect themselves.**

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**The global downturn's speed and severity** have significant implications for the supply chains of global manufacturers. Among steelmakers, chemical players, and some high-tech companies, for instance, order books—and therefore prices—are under tremendous pressure. Output in the steel industry dropped by an unprecedented 30 percent and prices by about 50 percent from June 2008 to December 2008.

That kind of volatility wreaks havoc on traditional supply chain planning: the process for determining production levels, raw-material purchases, transport capacity, and other vital factors, largely by examining historical patterns of demand. “Every month, we produce a rolling three-year plan,” said one metals executive recently, “but right now I can’t see even three weeks ahead.” Indeed, the forecasting challenge is particularly acute because in many upstream industrial settings, as supply partners along the chain anticipate that demand will fall, the supply chain appears to be decoupling from downstream consumption—the focus of most forecasting models.

Against this backdrop, senior executives should reconsider the implications of the “bullwhip effect,” first identified in the 1960s and known to generations of business students as the “beer game.”<sup>†</sup> In this classic phenomenon, distortions in information snowball along the length of a company’s supply chain, propelling relatively small changes in end-consumer demand into much larger and less predictable swings in demand further upstream (Exhibit 1a and Exhibit 1b).

How relevant is the bullwhip effect today? Consider the US inventory-to-sales ratio, which rose sharply from June to December 2008. Exhibit 2, bearing as close a resemblance to a pileup

<sup>†</sup>The beer game simulation, first developed in the 1960s at MIT’s Sloan School of Management, is a laboratory simulation for producing and distributing a single brand of beer. Three main characters play: a retailer, a wholesaler, and a brewery’s marketing director. The game’s point is to show the consequences of decisions that players make when trying to maximize their profits. For more about the bullwhip effect, see Hau L. Lee, V. Padmanabhan, and Seungjin Whang, “The bullwhip effect in supply chains,” *Sloan Management Review*, 1997, Volume 38, Number 3, pp. 93–102.

## Exhibit 1a

### Four causes of the bullwhip effect

In the bullwhip effect, first identified in the 1960s, demand signals are amplified as they move up a supply chain from end consumer to raw-materials supplier.

#### 1 Demand-forecast updating

Planners update their forecasts for future demand by extrapolating from small fluctuations in current demand. When extrapolated over long lead times, these small fluctuations can have large effects (see Exhibit 2).

#### 2 Order batching

Instead of making frequent, small orders, companies batch orders into less frequent, large ones—typically, to reduce product, logistics, or order-processing costs. Periodic batch ordering creates a high degree of variability in demand, amplifying the bullwhip effect.

#### 3 Price fluctuation

At times, companies anticipate that prices will increase (eg, because the manufacturer is running a short-term discount). Managers may then purchase items in advance of when they are needed (forward buy) to take advantage of current low prices. Essentially, the same thing may happen in reverse. The resulting variations in the size and timing of purchases do not reflect the real variations in consumption.

#### 4 Rationing and shortage gaming

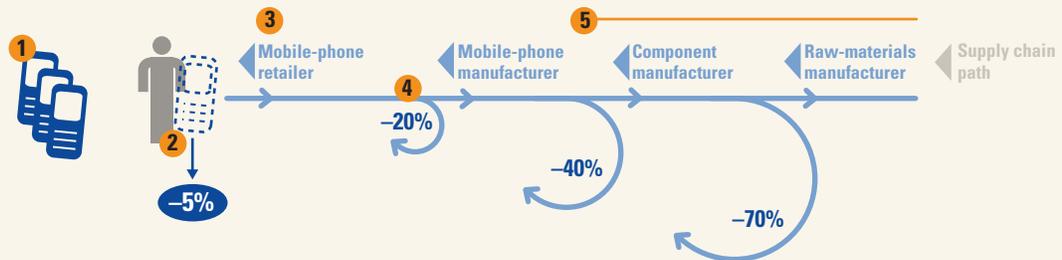
When demand exceeds supply, manufacturers ration their products. Attempting to game the system, customers order more than they need, hoping to achieve the required amount. When the supply returns to normal, customers cancel exaggerated orders, often leaving huge unwanted inventories in the hands of manufacturers.

Exhibit 1b

## The bullwhip effect: Demand-forecast updating

Mobile-phone supply chain example

- 1** Retailer anticipates selling 100,000 handsets a month—requires 100,000 in stock and 300,000 on order from manufacturer.
- 2** Consumer demand drops 5%.
- 3** Retailer has 20,000 excess phones—5,000 unanticipated phones left over in stores at the end of the month, as well as 15,000 too many arriving in the next 3 months.
- 4** Retailer reduces next month's order by 20%.
- 5** The demand signal is further magnified as it moves upstream.



accident as any chart you'll ever see, emphasizes the significant reverberations, up and down the line, of cancelled orders as companies retrench.

Many of the bullwhip effect's classic triggers now operate in full force. Rising commodity prices before the crisis, for example, led to the stockpiling of excess inventory. Now, falling commodity prices give customers an incentive to postpone orders and await better deals. Meanwhile, a new factor—the dash for cash—exacerbates today's difficulties: the evaporation of traditional financing channels leaves companies desperate to shed inventory, reduce working capital, and squirrel away cash. Of course, one company's working-capital reductions are another's cancelled orders.

The good news is that destocking has limits. Over an extended period, upstream orders must equal downstream ones. In the case of steel, for example, unless end-user demand drops by the same 30 percent as did output between June 2008 and December 2008—not impossible, but beyond current demand forecasts of an 8 to 10 percent reduction this year—orders must eventually rise. Yet as the bullwhip metaphor implies, the upswing could be rapid in steel or other industries that have complex, multitier supply chains. Unprepared ones could make companies neglect their customers' needs and lose share to more nimble competitors.

How should manufacturers respond? First, they must make supply chain decisions more quickly: in the face of unprecedented volatile demand, business-as-usual calendars for forecasting, budgeting, and planning won't do. Companies that adhere rigidly to unrealistic plans may find themselves sitting on piles of inventory or fighting price wars.

Some companies are establishing supply chain “war rooms” to make fast decisions across functions. Populated by leaders from production, procurement, logistics, and sales—and furnished with the latest data on purchasing, production, orders, and deliveries—these teams meet weekly or even daily to devise near-term operational plans. A chemical company that created such a team cut inventory levels by 20 percent in just ten weeks, while maintaining high

## Exhibit 2

**The bullwhip  
at work**

**Ratio of total business inventories to sales**, data adjusted for seasonal, holiday, and trading-day differences but not for price changes



Source: US Census Bureau

levels of customer service. What's more, by speeding up decisions, the company increased the frequency but reduced the size of its orders from key suppliers. Greater cross-functional cooperation helped it not only to identify new opportunities for using out-of-spec materials (and thus inventory on hand) but also to make better-informed decisions about where and when to discount overstocked products.

As companies rethink the way they plan, they must also learn how to act on the resulting decisions more quickly and flexibly. When raw-material and transport costs and the use of equipment shift dramatically, for example, companies must be prepared to revisit well-understood trade-offs involving, say, minimum batch sizes or optimal process yields. Things can change quickly, as a plastic goods manufacturer found after working hard to reduce the raw-material content of its products. Its strategy of accepting slightly higher defect rates in return for savings on these inputs has become decidedly less advantageous as their cost plummeted.

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What companies need now is the ability to deal with changing conditions by making production processes more flexible—shifting manufacturing locations quickly as shipping costs change, for example. One source of lessons on flexibility comes from the process industries, like chemicals or cement, which have long adjusted their mix of fuels (such as coal, fuel oils, or biomass) according to changing prices. Manufacturers that can adjust process yields rapidly to suit changing conditions should have a significant advantage over less flexible competitors.

More effective collaboration with key suppliers is important as well—advice that's surely relevant throughout the business cycle, but particularly now that volatility could undermine their survival. Improved collaboration need not depend on expensive integrated IT systems; in our experience, such projects generally have disappointing results. Simple moves, such as establishing direct communication from planner to planner and running forecasting processes jointly with key suppliers, can reduce "signaling" noise and raise service levels. Smaller but more frequent orders are often an easy way to reduce volatility in demand and therefore inventory levels. So is a better understanding of whether reduced demand results from destocking or from the behavior of end consumers.

Manufacturers should view today's environment as an opportunity. Now they can make changes—renegotiating contracts, consolidating manufacturing and distribution networks, launching aggressive productivity programs—that might not have been feasible earlier and may soon be difficult again. Remember, the bullwhip metaphor implies that the future upturn in demand could come rapidly, even if demand doesn't return to its level before the downturn. For many organizations, a return to growth could, paradoxically, close the window of opportunity to improve the supply chain. *Q*

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