

SAP White Paper
mySAP Supply Chain Management



QUANTIFYING THE IMPACT OF SUPPLY CHAIN GLITCHES ON SHAREHOLDER VALUE

THE SIGNIFICANCE OF ADAPTIVE SUPPLY CHAIN NETWORKS

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EXECUTIVE SUMMARY

Most managers intuitively believe that there is a strong link between a company's supply chain performance and its shareholder value. Now this intuition can be backed with hard facts. Results from a research study show that supply chain glitches torpedo shareholder value. After adjusting for industry and market movements, the total shareholder value loss associated with a glitch can be as high as 25 percent. Irrespective of who is responsible for the glitch or what caused the glitch, shareholders of companies that experience glitches pay dearly. Glitches are bad news, regardless of the company's size, industry, and growth prospects. Building adaptive supply chains with the capability to respond to glitches can help reduce the problem and conserve shareholder value.

INTRODUCTION

In the last couple of years, many companies have seen their stock prices tumble. Many stock prices have fallen 90% or more from their highs. Recent disclosures of accounting irregularities have not only significantly undermined investors' confidence in the efficient functioning of the stock market, but have also made investors skeptical of reported corporate earnings. A key lesson from the recent debacle in the stock market is that although a company's promise, potential, and hype can prop up stock prices in the short run, the higher prices are not sustainable in the long run without growth in profitability. To grow profits, companies must renew their focus and commitment to excelling in basic activities such as design, manufacturing and distributing products, and customer service.

A sense of excitement and optimism is growing that effective supply chain management (SCM) can be an important catalyst for enhancing profitability in this tumultuous environment. But SCM faces tough competition for top management's attention and resources. Other widely touted management paradigms such as total quality management (TQM), lean manufacturing, just-in-time (JIT) manufacturing, Six Sigma quality, and knowledge management all have their own strong groups of advocates and promises of improved performance. For SCM to receive the necessary level of attention, objective and conclusive evidence is needed that effective SCM does in fact improve profitability and shareholder value. Such evidence is urgently needed to get CEOs and CFOs excited about and involved in SCM initiatives; to make the business case for investing in technologies that can enhance the performance of supply chains; and to drive the major organizational changes that are needed to improve the effectiveness of supply chains.

Unfortunately, evidence linking supply chain performance to corporate performance is extremely scarce. Most of the evidence offered is anecdotal, and it is often based on non-financial metrics. This paper attempts to overcome this shortcoming by summarizing evidence from a multiyear research project that estimates the economic impact of supply chain glitches – production delays or shipping delays – on shareholder value. This evidence sheds light on two important issues:

- The link between supply chain performance and shareholder value
- The effect of corporate characteristics on the strength of the relationship between supply chain performance and shareholder value

WHY FOCUS ON SUPPLY CHAIN GLITCHES?

Supply chains create value by reliably and responsively matching demand and supply. One approach to determining the value creation potential of supply chains would be to examine the difference in stock price performance between companies that have improved the reliability and responsiveness of their supply chains and companies whose supply chains are unimproved. The difference in performance would yield an estimate of the potential of supply chains to create value. Although intuitively appealing, this type of study is hard to do because of the difficulty of measuring the reliability and responsiveness of supply chains based on publicly available data.

An alternative approach is to estimate the shareholder value lost, if any, when supply chains experience glitches in matching supply and demand. Glitches affect a company's short-term and long-term profitability, which in turn affects shareholder value. By calculating how much shareholder value is lost due to glitches, one can estimate the value creation potential of more reliable and responsive supply chains. The rationale is that if the supply chains had been more reliable and responsive, the companies would not have experienced the glitches and, therefore, would not have experienced the loss in shareholder value. Furthermore, the value loss associated with unanticipated glitches is the value placed by shareholders on glitch-free or smooth operation of the supply chain.

METHODOLOGY AND APPROACH

The evidence presented here is based on estimating the loss in shareholder value from 838 supply chain glitches that were made known publicly by the news media from 1989 through 2001. These news stories appeared in the *Wall Street Journal* or the *Dow Jones News Service* and were about publicly traded companies that experienced production delays or shipping delays.

LOSS IN SHAREHOLDER VALUE DUE TO GLITCHES

Figure 1 depicts the stock market reaction to supply chain glitch announcements, using three different models to adjust for industry and market movements. (See Appendix for a description of the methodology and the models used.) All results presented in this paper are adjusted for industry and market movements.

Supply chain glitches are viewed negatively by investors, as evidenced by the significant shareholder value loss associated with glitches. On average, the initial news report of a glitch is associated with a nearly 11% decrease in stock price. The stock market reaction is negative for 75% of the announcements, providing additional support that glitches have a negative impact on shareholder value. Figure 2 shows that depending on the model used, the average destruction in shareholder value ranges from \$129 million to \$145 million per major glitch. The total loss in shareholder value for companies experiencing the 838 glitches is estimated to be between \$107 billion and \$120 billion – counting only the loss on the day the glitches were made public in the news. By any standards, this represents a significant loss of shareholder wealth.

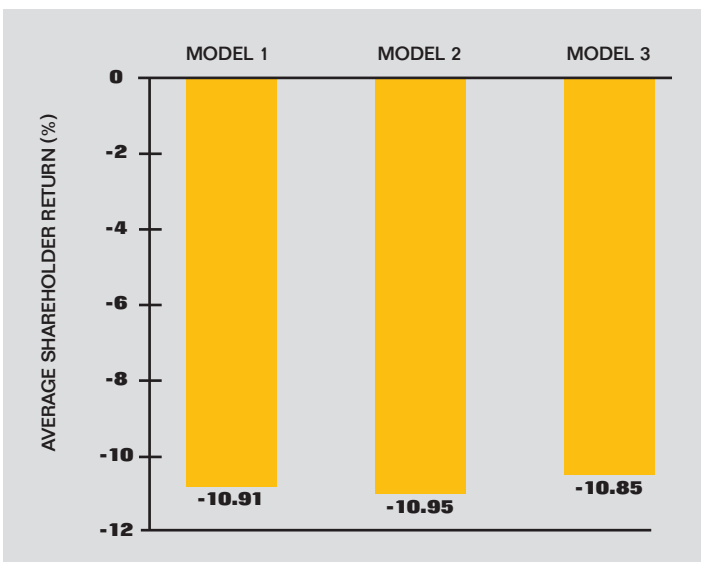


Figure 1: Average Shareholder Return on the Day a Glitch Is Made Public in the News

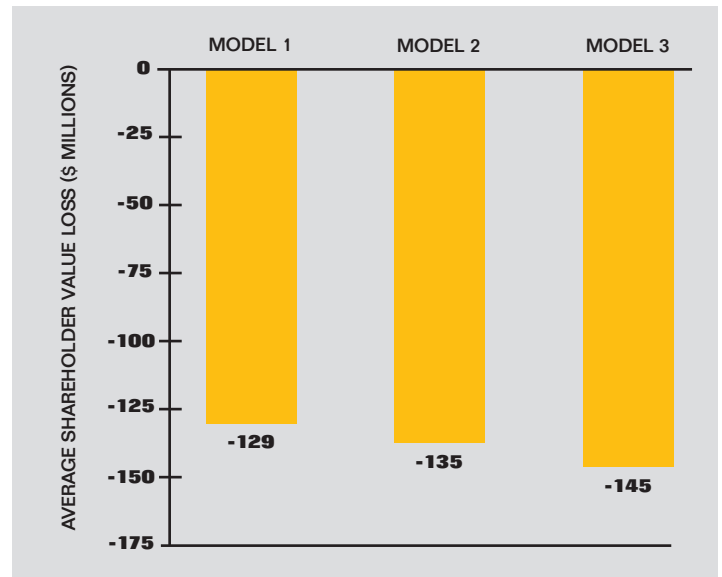


Figure 2: Average Loss in Shareholder Value (\$ Millions) on the Day a Glitch Is Made Public in the News

In addition to causing significant loss in shareholder value, glitches can have other long-term consequences:

- The steep drop in stock price associated with supply chain glitches can easily derail or slow down the long-term growth of companies whose strategy is to use their stock as currency in acquisitions. This is particularly the case in high technology and emerging industries.
- Glitches can adversely impact the long-term reputation of a company and its credibility in the minds of investors. Glitches raise concerns about management's ability to execute fundamental business processes. Investors may view a company's projection of the future with skepticism and may value it at a discount, making it more expensive to raise capital.
- Glitches may lead to loss of revenues from service contracts, add-ons, and related purchases.
- Supply chain glitches can result in negative publicity. Dealing with negative publicity diverts precious time and resources from core business activities.

EFFECTS OF SUPPLY CHAIN GLITCHES IN VARIOUS INDUSTRIES

Figure 3 shows the negative impact of supply chain glitches by broad industry groupings based on standard industrial classification (SIC) codes. The key findings are as follows:

- It does not matter which industry a company is in – supply chain problems have an across-the-board negative impact on shareholder value.
- Companies in high technology, which accounted for nearly 45% of the sample points, experienced an average loss in shareholder value of about \$143 million per glitch. On average, high-tech companies experienced a 12.7% drop in share price on the day the glitch was announced in the news.
- Companies in the automotive industry accounted for 40 of the 838 glitch announcements in the sample. On average, companies in this industry lost about \$123 million of shareholder value – the share price drops on average by 8% – when a supply chain problem occurred.
- Companies operating in the consumer products industry and companies in the wholesale and retailing business lost on average about \$76 million and \$71 million of shareholder value, respectively, when they experienced a supply chain glitch.
- Companies in the aerospace and defense industry, which accounted for 35 glitch announcements, experienced a 2.5% drop in share price and about a \$60 million loss in shareholder value.
- The shareholder value loss due to supply chain glitches in the chemicals industry and the engineering and construction equipment industry averaged about \$55 million.

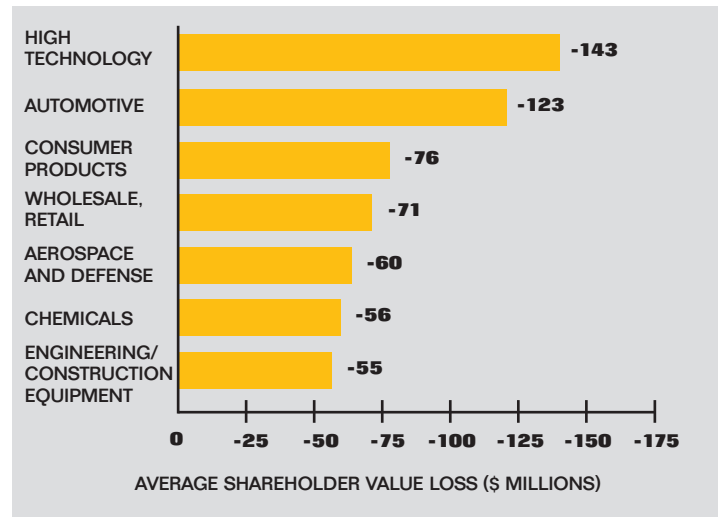


Figure 3: Average Loss in Shareholder Value (\$ Millions) by Industry

THE TREND IN STOCK MARKET REACTION TO GLITCHES

The importance of effective supply chain management to achieving competitive advantage has gained much attention recently in companies as well as in the media. A natural question is whether the negative stock market reaction to glitches is more severe for more recent supply chain glitches. Figure 4 sheds some light on this issue by reporting the stock market reaction over a 12-year period, segmented into six nonoverlapping time periods. The reaction to glitches was negative in all six time periods. During the first two periods (1989-1991 and 1992-1993), market reaction to glitches caused a loss in shareholder value of more than 8%. During the next two periods (1994-1995 and 1996-1997), the reaction became more negative, with the loss averaging around 10%. The more recent glitches (in 1998-1999 and 2000-2001) were penalized even more, with an average loss of about 13%. The higher penalty associated with the more recent supply chain glitches could be due to the fact that effective supply chain management is becoming more crucial to success in the current competitive environment. It is clear from Figure 4 that shareholders' negative reaction is not a new phenomenon. Investors have always recognized the deleterious effect of poor supply chain performance.

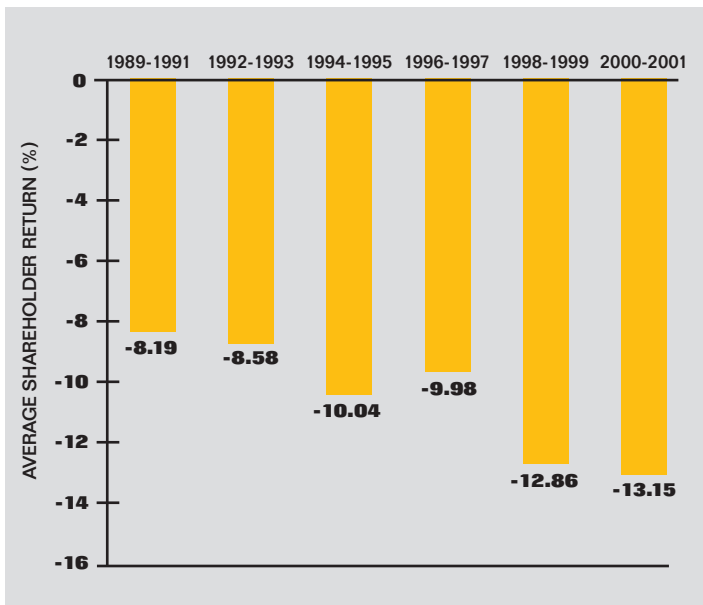


Figure 4: The Trend in Stock Market Reaction to Glitches

Figure 5 depicts the dollar value impact of glitches experienced during the six nonoverlapping time periods. In the same way that Figure 4 shows that the percent drop in share price became larger over time, Figure 5 shows the dollar impact of glitches became larger over time, ranging from an average loss in shareholder value of \$116 million during 1996-1997 to \$130 million during 1998-1999 and \$328 million during 2000-2001.

Figures 4 and 5 together indicate that a 1% decrease in shareholder value resulted in a shareholder value loss of \$11.6 million during 1996-1997, \$10.1 million during 1998-1999, and \$25 million during 2000-2001. The reason the average value loss for every 1% drop in share price was larger during 2000-2001 could be that share prices of many companies skyrocketed during this time period due to increased expectations about future performance – and good supply chain performance was a key factor for meeting those expectations. Thus, when supply chains did not perform as expected, the market penalty in terms of dollar value loss was much more severe than in earlier periods. This was the time period of market hyperactivity and the boom-and-bust period in high technology and dot.com industries. It is worth reiterating that these losses were computed after adjusting for industry and market fluctuations.

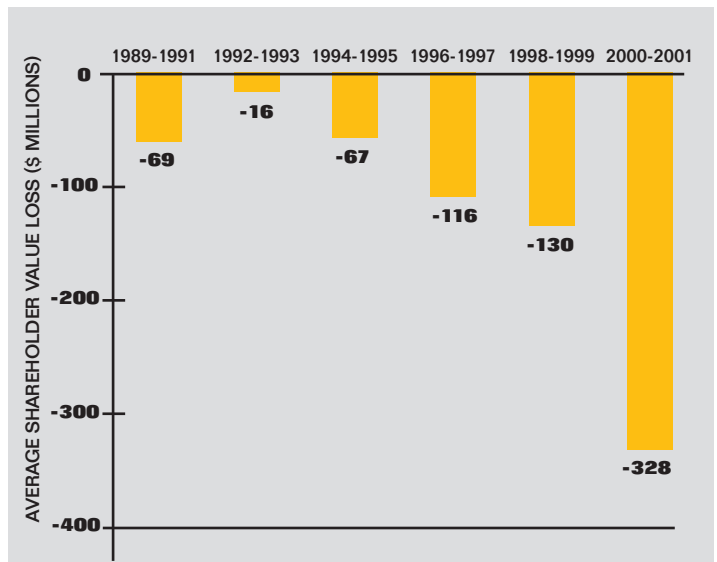


Figure 5: Average Loss in Shareholder Value (\$ Millions) in Different Time Periods

RESPONSIBILITY AND REASONS FOR GLITCHES

A number of sources can be responsible for supply chain glitches. In about 33% of the cases in this study, the primary responsibility was attributed to internal sources – that is, the company took responsibility for the glitches. In nearly 18% of the cases, suppliers were the primary source of the problem. Customers were responsible in 16% of the cases, nature and government were responsible in about 4% of the cases, and various other factors or combinations of responsible parties accounted for 7% of the cases. In about 22% of the cases, the news article did not provide sufficient information to assign the source of responsibility.

Some interesting facts emerge when the stock market’s reaction to glitches is segmented by the source of responsibility (see Figure 6). The market severely penalizes companies that experience glitches, no matter which link in the supply chain is responsible for the glitch. Figure 6 shows that when glitches were attributed to internal problems, the average loss in shareholder value was 10.26%. Glitches caused by customers resulted in a loss of 13.56%, glitches attributed to suppliers were associated with a loss of 10.81%, and glitches due to nature and government-related causes were associated with a loss of 6.62%.

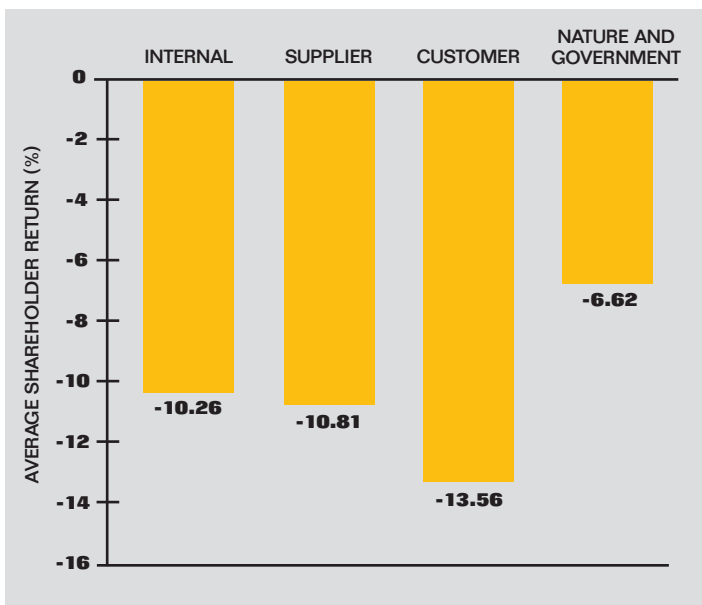


Figure 6: Stock Market Reaction by the Party Primarily Responsible for the Glitch

The results of Figure 6 show the heavy price that a company pays for the poor performance of one link in the supply chain. Such significant losses in shareholder value provide an economic incentive for the company to ensure that all the supply chain links work collaboratively and in an integrated manner to minimize disruptions.

The fact that glitches caused by external sources (suppliers and customers) brought higher penalties than glitches caused internally suggests that these problems are perceived to be more expensive and time-consuming for a company to fix. It also highlights the importance to companies of effective supplier relationship management and customer relationship management to increase the efficiency, reliability, and responsiveness of their supply chains. To develop an effective supplier base, companies need the following:

- A systematic approach for evaluating and formulating a global sourcing strategy
- A fast and responsive supplier qualification system
- A robust and performance-based supplier selection system
- A system for collecting, analyzing, and monitoring information about supplier performance
- A system for creating and managing supplier relationships that allows information sharing, collaboration on plans, and visibility
- The effective use of the Internet and other communications mechanisms to interact and manage the supplier base in real time

To deal effectively with their customers, companies must be able to do the following:

- Interact with customers at each stage of the sales cycle – from initial contact to after-sales support and service
- Capture and analyze information about customers from internal and external sources – and use the information when dealing with the customers to enhance customer satisfaction and loyalty
- Collaborate with customers in real time – to better understand and respond rapidly to their changing needs
- Share information and collaborate on plans – with visibility among customers and suppliers

Additional insight into the nature of supply chain glitches is obtained by analyzing the reasons they occurred. Nearly 20 reasons were identified in the news announcements of the glitches. The top six reasons (and the percent of announcements in which they were mentioned) were parts shortages (22%); order changes requested by customers (13%); various production problems (10%); ramp-up and rollout problems (9%); development problems (5%); and quality problems (5%).

Figure 7 depicts the average loss in shareholder value on the day of the announcement for the six reasons most often cited for the glitches. Parts shortages are associated with a loss of 10.59% in share value. Parts shortages are often caused by poor forecasting, poor planning, dependence on a single supplier, long lead times, low inventory levels, or poor communication of information between supply chain partners. Experts frequently tout the benefits of single sourcing and maintaining low inventory levels. But they often ignore the negative impact that these strategies can have if they result in shortages that disrupt the supply chain.

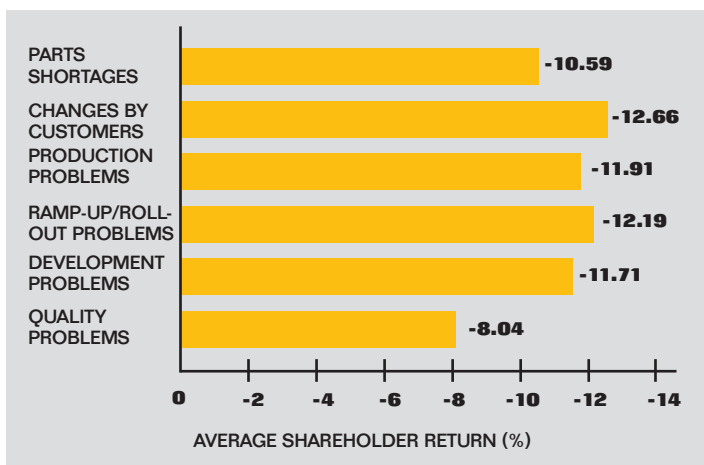


Figure 7: Stock Market Reaction by Primary Reason for the Glitch

Order changes by customers are associated with a loss of more than 12%. Last-minute changes in customer orders are normal occurrences in today's environment, where competition is intense, product life cycles are short, and product and process technologies change rapidly. The cost of a nonresponsive and inflexible supply chain can be extremely high in this environment.

Production problems that cause significant disruptions in supply chain operation are associated with a loss in value of about 12%. The importance of smooth ramp-up and rollout of new technologies and products is underscored by the significant penalties incurred when these activities encounter problems. Specifically, the average loss in shareholder value is about 12%. Quality problems and the corresponding disruptions in supply chain operations are penalized with an 8% drop in market value.

The root causes of the problems listed in Figure 7 could be many and are likely to vary across companies, industries, and actual glitches. Nonetheless, most of the root causes are indicative of a problem in the supply chain. A natural question is how to make the supply chain more reliable, robust, and responsive. While the exact answer varies somewhat depending on the situation, certain general principles are useful in making supply chains more reliable and responsive. These principles are the foundation for the objectives of adaptive supply chain networks:

- Increase flexibility by designing supply chains that are dynamic and able to respond rapidly to changes in market conditions, that integrate all the supply chain partners, and that have slack and buffer capacity at the appropriate points
- Enhance visibility by providing supply chain partners with demand, capacity, and inventory information across the extended supply chain network
- Increase collaboration by jointly planning and executing capacity, production, and inventory plans and by sharing real-time information about execution and the current status of the supply chain
- Focus on optimization by dynamically developing optimal plans and schedules that support the business strategy
- Enhance the capability to react quickly and in a timely manner to exceptions and deviations from plans

Recent advances and development in SCM technology now make it possible for companies to manage their end-to-end supply chain activities using a truly adaptive supply chain network, thus reducing their chances of experiencing supply chain glitches.

RELATIONSHIP BETWEEN CORPORATE CHARACTERISTICS AND THE IMPACT OF GLITCHES

The impact of supply chain glitches on shareholder value is modulated by company size and growth prospects.

COMPANY SIZE

The companies in the study were very diverse in size. Nearly one-fourth of the companies had annual sales of less than \$50 million, while just over 18% had sales exceeding a billion dollars. Figure 8 depicts the stock market reaction for companies of various sizes. The key results are:

- Both small and large companies experience a significant drop in share price when they suffer a glitch.
- A glitch has more devastating impact on smaller companies than on larger companies. Companies with less than \$50 million in annual sales experienced a drop in share price of 13.44%, compared with a drop of 6.61% for companies with more than \$1 billion in annual sales.
- This data indicates that the smaller the company, the more negative the stock market reaction to a glitch.

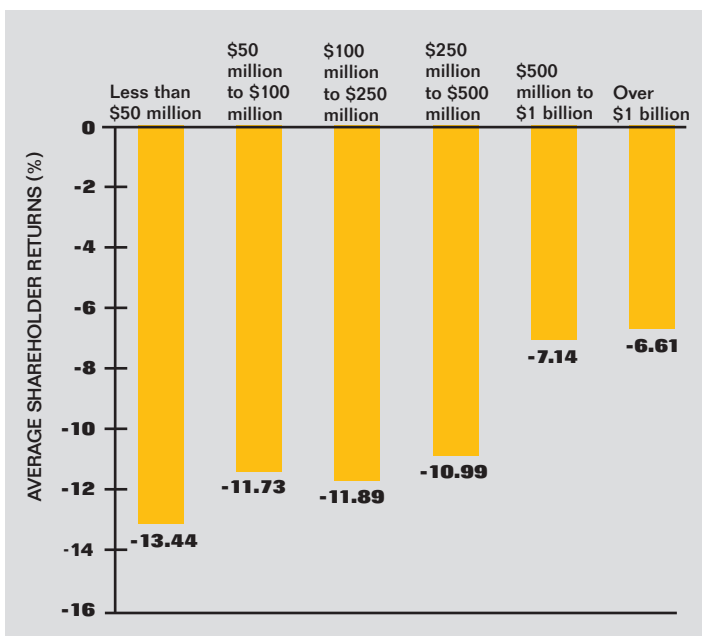


Figure 8: Stock Market Reaction by Size of Company

There could be a number of reasons why smaller companies suffer more from glitches. The economic impact may be more severe for smaller companies because they are more likely to be highly focused on a limited set of products. Typically, their profitability is critically dependent on flawless supply chain management. Smaller companies also may take longer to recover from glitches because they may not have the capital to invest in technologies and solutions that can accelerate recovery. Furthermore, small size can reduce a company's power to influence and change the behavior of supply chain partners in a way that could help it recover from glitches. Finally, analysts and investors are less likely to track smaller companies and, therefore, might be surprised by an unanticipated glitch more often if the company is small.

GROWTH PROSPECTS

Companies with high-growth prospects suffer more from glitches than their low-growth counterparts. Growth prospect is measured by the ratio of the market value of equity to the book value of equity. Higher values of this ratio indicate that the market anticipates higher growth. Figure 9 shows the stock market reaction to glitches when the sample is segmented by growth prospect. Companies in the lowest-growth quartile suffered a 9.74% drop in stock price, compared with the roughly 12% drop suffered by companies in the highest-growth quartile. The more negative economic impact on high-growth companies could be due to the fact their products generally have shorter life cycles, carry higher contribution margins, and require shorter delivery times. Furthermore, high-growth products typically attract a relatively large number of new customers. Since new customers don't have an established loyalty to the company, they may be less likely to wait for the product should shipping delays occur. This could have negative consequences for the company in terms of losing current and future sales. Also, high-growth product companies often face stiff competition. Unreliable and unresponsive supply chains could easily cause customers to migrate to competitors, ultimately leading to permanent loss in market share.

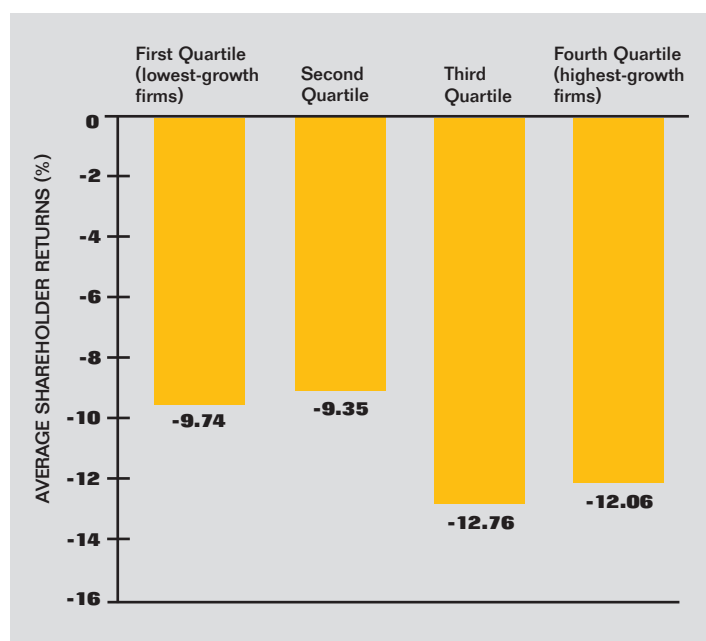


Figure 9: Stock Market Reaction by Growth Prospect

THE LONG-TERM EFFECTS OF GLITCHES

Although news coverage makes a supply chain problem public knowledge, the problem likely occurred before the public announcement. It is possible, then, for the market to obtain advance signals about supply chain problems from other sources, including customers, suppliers, and analysts' reports. Thus some of the valuation impact of glitches could be reflected in stock prices before the news announcement. Also, given the severe negative reaction to glitches, it's important to check whether the stock market overreacts to the news, in which case a correction in stock prices would occur after the announcement. To get an idea of the full economic impact of glitches, it makes sense to examine the stock price behavior in the periods before and after the news is released.

Figure 10 depicts the behavior of the market-adjusted and industry-adjusted stock returns starting six months (125 trading days) before the news announcement and ending six months after the news, where day -125 is the trading day six months before the news and day 125 is the trading day six months after the news. Stock prices show a significant downward trend before the glitch is made public, indicating that the stock market tends to anticipate supply chain problems to some extent. During the six months prior to the glitch announcement, companies lose an additional 14% of their market value, with most of the loss occurring during the three-month period before the problem is announced by the news media.

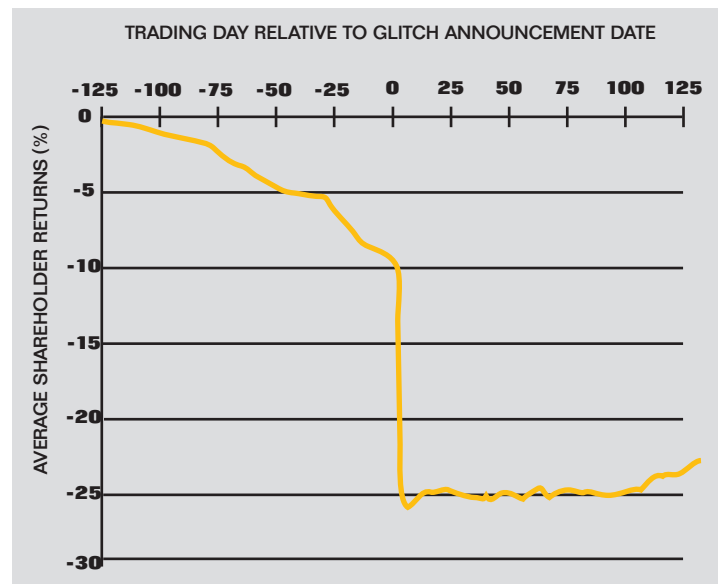


Figure 10: Stock Price Behavior Before and After the News Announcement of a Glitch

In contrast, during the six months after the announcement, no significant trend (up or down) in stock returns is discernable. It appears that after problems are made public, the stock price of a company does not recover in the short term. This suggests that the market does not overreact to the news and then correct itself. Furthermore, the impact of glitches is not temporary. Overall, during the time period that begins six months before the news and ends six months after the news, the average loss in shareholder value is about 25 percent.

DEALING WITH GLITCHES

The historical view of shareholder value destruction due to supply chain glitches is useful because it provides a sense of the economic impact of poor supply chain performance. The evidence clearly indicates that ignoring the possibility of supply chain glitches can have devastating economic consequences. And the chances of experiencing a glitch are higher now than in the past because of recent trends and practices in managing supply chains:

- Supply chains are increasing in complexity due to global sourcing, the large number of supply chain partners, the need to coordinate many tiers of supply chains, and long lead times.
- Increased reliance on outsourcing and partnering has heightened the interdependencies of different nodes of the global supply network. This makes it more likely that a disruption or problem in one link of the supply chain will quickly ripple through the rest of the chain, bringing the whole supply chain to a halt.
- Single-sourcing strategies may have reduced purchase prices and the administrative costs of managing the supplier base but have increased the vulnerability of supply chains, since a single supplier may be unable to deliver on time.
- Focusing on reducing inventory and excess capacity and on taking up the slack in the supply chain has more tightly coupled the various links, leaving little room for errors.
- Market conditions are characterized by intense competition, volatile demand, increased product variety, and short product life cycles, making it very challenging to match demand with supply.

There is no doubt that these trends and practices have led to significant improvements in supply chain performance. Nevertheless, they have also contributed to supply chains becoming more vulnerable and susceptible to disruptions and glitches. The challenge is to devise approaches for avoiding glitches or mitigating their negative effect by dealing with them more effectively. Some approaches are outlined below:

- **Reduce the likelihood of glitches** – Better forecasting and better planning can go a long way to reduce the frequency of demand-and-supply mismatches. Companies can do better forecasting and planning by using the tools, techniques, optimization capabilities, and decision analysis capabilities that are offered in commercially available enterprise resource planning (ERP), supply chain management (SCM), customer relationship management (CRM), and business-to-business (B2B) systems. Investments in such integrated systems – together with appropriate mechanisms and incentives that motivate supply chain partners to communicate, collaborate, share information with each other, and synchronize their plans – can significantly improve the accuracy of forecasts and plans.
- **Develop the ability to predict glitches** – Companies often come to know about problems too late to avoid or minimize the adverse consequences. The solution to this problem is to be able to predict glitches and take preventative action. Developing predictive capabilities involves selecting, defining, and tracking leading predictors of future performance; extracting, integrating, and transforming data from different systems into business performance metrics; delivering business performance data on a real-time or as-needed basis through a user-friendly and interactive interface; and providing visibility into the extended supply chain that includes internal operations, suppliers, and customers. Business performance analytic packages can serve as the foundation for these capabilities.

- **Reduce the lag between the occurrence and detection of glitches** – The negative consequences of glitches are amplified when glitches go undetected. Companies need to develop the capability to learn about glitches sooner rather than later and aim for a lag time of zero between occurrence and detection. Companies must develop real-time visibility within their extended supply chains. A new breed of software applications provides supply chain event management (SCEM) capabilities, which allow companies to find out about and respond to glitches on a timely basis. The SCEM application allows companies to track critical supply chain events and parameters in real time, set thresholds and rules for detecting abnormal performance, generate automatic alerts when performance is outside the preset thresholds, and automatically notify appropriate people when an exception occurs.
- **Reduce the time it takes to resolve glitches** – The longer it takes to resolve a glitch, the more devastating its impact. Companies must be able to resolve the problem quickly and prevent escalation and worsening of the situation. They must respond to crises in ways that are similar to those of emergency-services providers such as 911 or other emergency-response units. This requires developing a systematic process for dealing with and responding to glitches, with clear identification of responsibilities and allocation of resources. It also involves learning from past glitches, identifying the root causes of problems, correcting the various processes to deal with the root causes, and ensuring that problems do not surface again.

The approaches outlined above suggest that companies must invest in developing adaptive supply chain capabilities to deal with glitches. In addition to providing real-time planning and execution capabilities, adaptive supply chain networks can sense exceptions and respond to them continuously and efficiently across the extended supply chain. Key features of adaptive supply chains include:

- Tracking existing hard and soft constraints and making adjustments to planning and execution strategies as unanticipated constraints emerge
- Dynamically optimizing plans and execution strategies across extended supply chains
- Providing real-time visibility of activities, resources, and progress across the supply chain to respond quickly to problems and issues
- Reallocating resources in a dynamic manner to deal with exceptions
- Leveraging the knowledge gained from experience to improve processes and procedures so that similar situations can be handled better in the future

ADAPTIVE SUPPLY CHAIN NETWORK SOLUTIONS FROM SAP

SAP today provides enterprise applications that enable companies to transition their supply chains into adaptive supply chain networks.

The expertise to create the technology links and enable the free and accurate flow of real-time information is crucial in developing successful adaptive supply chain networks. SAP is well-positioned to provide this expertise. SAP has the full suite of solutions that enables the transition to an adaptive supply chain network and backs it up with robust integration technology.

mySAP™ Supply Chain Management (mySAP™ SCM) offers capabilities for demand planning, supply planning, distribution planning, and production planning to help optimize and integrate planning functions across the enterprise. Optimal intraenterprise plans are augmented by collaboration and networking capabilities that facilitate the exchange of real-time transactional data across enterprises. Coordination capabilities further provide visibility and help monitor events across the supply network, and real-time analytics enable intelligent decision making. Execution applications allow order promising and delivery, fulfillment coordination, and transportation execution nearly in real time, which is crucial to flexibly managing the network and reacting quickly to changes in demand. Fulfillment coordination capabilities make procedures visible by linking to the results of event management solutions, thereby providing an up-to-date view of the status of processes across the entire network.

Adaptive supply chain networks rely on effective supplier relationship management and customer relationship management. mySAP™ Supplier Relationship Management (mySAP™ SRM) and mySAP™ Customer Relationship Management (mySAP™ CRM) provide all the necessary capabilities:

- A system for collecting, analyzing, and monitoring supplier performance
- A system for creating and managing supplier relationships that allows information sharing, collaboration on plans, and visibility
- Effective use of the Internet and other communications mechanisms to interact with and manage the supplier base in real time
- The ability to interact with customers at each stage of the sales cycle, from initial contact to after-sales support and service
- The ability to capture and analyze information about customers from internal and external sources and use the information when dealing with the customers
- Real-time collaboration with customers to understand and respond rapidly to their changing needs

mySAP SRM and mySAP CRM enable organizations to better manage their supplier and customer relationships, become more effective in dealing with suppliers and customers, and transition more effectively in building adaptive supply chain networks. In addition, SAP provides the technology to link these applications to the other enterprise solutions, including ERP and product life-cycle management (PLM) solutions. This allows organizations to respond quickly and effectively to events across organizations and across all essential functions.

As businesses continue to demand technological innovations and seek new ways to leverage information, the ability to obtain fast, accurate information, to act on the information, and to continuously monitor the results will be crucial. Success can only be ensured with the right integration technology expertise. SAP can fulfill these needs for companies embarking on the journey to convert their linear supply chains to adaptive supply chain networks.

APPENDIX: METHODOLOGY

The results described in this paper are based on the event study methodology. This methodology estimates the stock market reaction to news of a particular event, such as a glitch in the supply chain, while controlling for industrywide and marketwide fluctuations in stock price. Financial economists developed the methodology to measure the effects of a wide range of events on shareholder value. The basic idea is to study a sample of companies that have experienced similar events and estimate the average stock price changes that can be attributed to that event. The event study is based on the fact that, in an efficient market, the effect of an event is quickly reflected in stock prices. Therefore, examining the change in stock prices over relatively short time periods (such as from one day before the event to one day after) yields an unbiased picture of the stock market's assessment of the event's implications.

Event study methodology has been widely used to study corporate finance and accounting decisions such as stock splits, equity offerings, earnings announcements, tender offers, stock repurchases, and changes in accounting techniques. The results of these studies have significantly influenced financial and accounting decisions. The use of this methodology in other functional areas, such as supply chain management, is now beginning to emerge.

Although the details of executing event studies can appear complex to those unfamiliar with modern finance theory or statistics, the idea behind this methodology is intuitive. Basically, it provides a way to purge a stock's returns of industrywide and marketwide influences over a certain period of time – that is, to control for other factors besides the glitches. By examining a purged series of returns around the time when information about an event becomes public, the percent change in stock price that is associated with the event can be estimated. The methodology controls for other factors by estimating stock price changes for both the company and an appropriate industrywide and marketwide benchmark over the same time period. The change in stock price for the company experiencing the event is then adjusted to account for any industry and market influences. These industry-adjusted and market-adjusted returns provide an estimate that is not contaminated by the influence of factors unrelated to the event. This estimation tool has been refined and developed over time and is now well accepted in academic and business communities.

This paper uses three models to adjust a stock's return over time for industrywide and marketwide influences. The models differ from one another in terms of the benchmark used for adjustment. The first model uses the daily returns of the stock and the overall market for more than 200 trading days before the glitch announcement date to estimate a stock's risk relative to the overall market. This risk factor (commonly referred to as beta) is used to compute the predicted return (the benchmark). Any company's risk partially depends on the overall risk of its specific industry. The model, in this way, accounts for industry-specific influences that might be affecting the company's stock performance. The second model uses the average change in stock price for the S&P 500 as the benchmark. The third model uses the stock's average daily return, estimated from the daily returns for a period of more than 200 trading days before the glitch announcement date. Appropriate statistical tests are done to evaluate whether or not the purged stock prices indicate a statistically significant market reaction to the event.

Other aspects of the study bolster the validity of the results. The large sample size of 838 announcements makes it unlikely that the results are due to a random overreaction by the market. Additionally, the main part of the study looks at the very short time period of one day before the event until one day after the event. This reduces the likelihood that other company-specific factors – such as mergers and acquisitions, new-product introductions, or new-technology implementations – affected the stock price changes.

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