CHAPTER 3

Return on Investment in Technology

T his chapter summarizes the current state of knowledge in connection with returns on investment in technology, particularly information technology. Based on evidence from several seminal studies, it is pointed out here that, up until the early 1990s, information systems and related technology projects had led to almost negligible returns in terms of labor productivity. This finding can be seen as the dirty little secret of the information technology field, since computer hardware and software vendors rarely discuss it. In fact, many vendors who exhibit their products in computer conferences and user-oriented workshops do not seem to be aware of this finding. In academic circles, the finding is often referred to as the *technology productivity paradox.*

It is important to point out that the picture just painted is based on the quantitative summarization of aggregate evidence and thus should be taken with a grain of salt. After all, statistics is the discipline in which one person eats a whole chicken per week over a period of 1 year, another person eats nothing over the same period, and the final conclusion is that each person ate half a chicken per week during that year—a conclusion that, when looked at in isolation, would be incompatible with the latter person dying of hunger.

So, results of statistical analyses of data should be carefully scrutinized and, if possible, triangulated with other types of evidence. There are no doubt exceptions to the productivity paradox. Some individual companies have in the past achieved major productivity increases as a result of investment in information systems and related technologies. Also, from a sectorwide perspective, the manufacturing sector has historically reaped substantially more benefits from technology investments than the service sector.

Moreover, while investment in information technology has not led to significant increases in productivity during most of the 1990s, it is reasonable to argue that such investment has not been completely wasted. That investment has arguably led

to other types of benefits in terms of increases in sales, improved customer satisfaction, and competitive advantages. One does not have to look further than the case of the Semi-Automatic Business Research Environment (SABRE) airline seat reservation system, developed jointly by IBM and American Airlines in the 1960s, which contributed to American Airlines becoming one of the dominant forces in the airline industry.

It is also argued here that increasing (but still modest) productivity returns on investment in information technologies started occurring in the 1990s, particularly the second half of the 1990s, which coincides with the emergence of the business process redesign movement. One of the core messages of that movement is that information technology implementation projects should always be preceded by business process redesign. Consistently with that message, this chapter adds to the arguments presented in previous chapters and provides yet another strong motivation for the adoption of the systems analysis and design orientation proposed in this book.

What Is Productivity?

Robert Solow, the recipient of the Nobel Memorial Prize in Economics in 1987, once remarked that, "We see computers everywhere except in the productivity statistics." Solow's remark is a reminder that the early promise of information technology to completely revolutionize business by making labor productivity sky-rocket may not have turned out exactly as expected. However, before one can reach any further conclusions, it is important to understand what the abstract concepts of productivity and quality really mean and how they relate to the concept of competitive advantage.

Productivity in a business process is usually measured as the ratio between outputs and inputs. This measurement approach may lead to problems, as will be explained below. To illustrate this measurement approach, let's consider the following example. A car assembly process may produce 10 cars per day, with about 10 people working in the assembly line. Thus, the daily productivity of the car assembly process is 1 car per person. If the car assembly process is, say, automated in a particular smart way, it may as a result produce twice as many cars (i.e., 20 cars per day) using only five people as labor. Its daily productivity then would jump to 4 cars per person—a 400 percent increase in productivity.

It should be clear that this approach to productivity measurement is at best myopic. One reason is that it completely disregards the extra costs associated with automation, such as those related to equipment, software, and support personnel. Another reason is that it mistakenly uses actual production numbers to estimate productivity, rather than production capacity numbers, since actual production numbers may be affected by demand patterns that have nothing to do with productivity. If there is no demand for cars, production will go down regardless of how many car units an assembly line can produce.

A better way of measuring productivity in connection with a business process is, arguably, the ratio of production capacity and production costs. Production

capacity is, roughly speaking, how many production units a business process is *capable* of producing, which means that this measure often has to be estimated based on actual output measures. Or, in other words, production capacity is the number of production units being generated by a business process under full demand conditions. The other component of the productivity measurement scheme proposed here, production cost, is the total cost associated with the production capacity of a business process, which would include direct as well as indirect costs.

A production unit of a business process is essentially what the process generates as its output to both internal and external customers, usually measured in a standardized way. For example, in a contract preparation process of a large law firm, the production unit could be one contract, if most contracts had a standard structure and size. In a car assembly process, the production unit would be one car, if the assembly line were dedicated to only one car model.

In idiosyncratic business processes, such as a flexible assembly line that produces a variety of car models, some kind of standardized production unit would have to be used so that productivity could be properly measured—for example, a standard car equivalent unit. Such standardized production units are analogous to the widely used full-time equivalent student (FTES) employed by universities to prepare their budgets; standardization here is necessary because not all university students are actually full-time students. For instance, a student whose paid coursework-related tuition is one third that of a full-time student would contribute approximately 0.33 FTES units to the university in terms of revenues.

Production costs may vary in a business process, without any variation in the number of inputs used in the process. For example, one can reduce the costs associated with a car assembly process by outsourcing the manufacturing of car parts to more efficient suppliers and thus reduce the cost of the parts that go into the final product, the car. Still, the same number of parts may be used. Also, using production costs rather than number of inputs in the calculation of business process productivity allows for the inclusion of support costs into the picture. For example, car assembly automation may reduce assembly labor costs but at the same time add equipment, software, and support labor costs to the process—someone will have to operate and maintain the car assembly automation system. In some cases, production costs are increased to a degree that productivity ends up going down, even though the management's impression is that it is going up, if the proper measures are not in place.

It is hoped that this discussion has been able to make a strong case for measuring productivity through the ratio (production capacity)/(production costs). For the sake of illustration, let us again consider the car assembly process example used earlier in this section. If a car assembly process can generate 10 cars of a particular model per day at a total cost of $100,000, including direct labor costs as well as parts and support costs, then the productivity of that process is 0.1 cars per thousand dollars. If through automation the process can now generate 20 cars per day at a total cost of $150,000, then the productivity is now approximately 0.13 cars per thousand dollars—a 30 percent increase in productivity.

What About Quality?

From a business process perspective, quality is essentially a measure of customer satisfaction with the outcomes of a business process. As such, quality assessment is much more subjective than the assessment of productivity. For example, in a car assembly process, productivity can be estimated directly based on business process attributes such as maximum output, costs of materials and labor, cycle time, and so forth. Quality measurement, on the other hand, often relies on customer perceptions about the car itself. And, if the customers do not like a particular car, they will not buy it, which means that any productivity gains that an automaker may have been able to achieve in connection with its assembly will never be realized. That is, quality and productivity are interrelated, and their relationship is a complex one (see Figure 3.1).

In Figure 3.1, the relationship between productivity and quality is illustrated based on the context created by a help desk operation. Help desk operations usually provide help and support to internal users of information technology in the organizations of which they are a part. In the example, a productivity improvement, that is, a decrease in the number of handoffs in a help desk process, leads to user problems being solved faster and is presented as improving the users' perceptions about the quality of the help desk process. Conversely, an improvement in the quality of the information used by those who solve technology problems sent to the help desk, that is, better categorization and definition of problems by a help desk
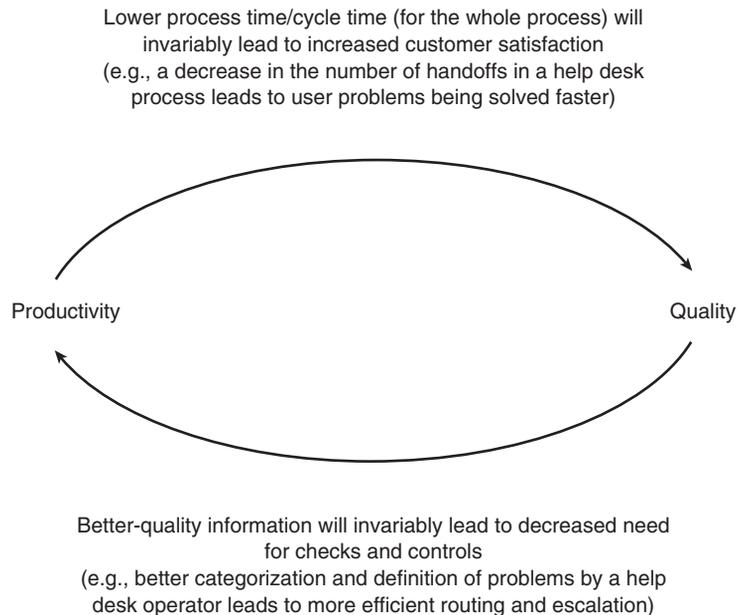
Lower process time/cycle time (for the whole process) will
invariably lead to increased customer satisfaction
(e.g., a decrease in the number of handoffs in a help desk
process leads to user problems being solved faster)

Productivity   Quality

Better-quality information will invariably lead to decreased need
for checks and controls
(e.g., better categorization and definition of problems by a help
desk operator leads to more efficient routing and escalation)

Figure 3.1   The Relationship Between Productivity and Quality

operator, leads to a more efficient routing and escalation of those problems, which is arguably a productivity-related improvement.

Figure 3.1 illustrates the relationship between productivity and quality in a way that also conveys an important idea, namely that quality and productivity matter to both external and internal customers. This is a point that was made quite strongly in the past by William E. Deming, the father of what became known as the total quality management movement. A classic book in which Deming makes this point, as well as other very important ones, is the book titled *Out of the Crisis*, published in 1986 by the Center for Advanced Engineering Study at the Massachusetts Institute of Technology.

While the external customers are the ones who usually pay the company for making and delivering its products (e.g., goods, services, information), the internal customers are usually employees and managers who use the output of certain business processes to produce other outputs. The sequence of business processes that connect several internal customers leading to the delivery of products to external customers is often referred to as the organizational supply chain, when taken as a whole integrated sequence of business processes.

Often, quality is assessed through rather crude percentage-based measures such as the number of defects per N units produced, where N may be a big number (e.g., 1,000). Those measures, whatever they are, ultimately try to assess customer satisfaction in a rather indirect way. Since customers do not like defective products, it is reasonable to assume that there is a correlation between percentage of defects and customer satisfaction. And, quite often, correlation is all that is needed to justify using one measurement in place of another. Sometimes that backfires, though, such as when one single defect leads to catastrophic consequences by causing a death-related accident. An ensuing lawsuit may lead the manufacturer to spend millions of dollars compensating a plaintiff (or class of plaintiffs) and spending even more recalling thousands of defective units already in the hands of other users.

Another, perhaps more sophisticated, way of measuring quality is to calculate the frequency distribution of answers to several question–statements, such as the question–statement "I'm satisfied with the service received from the help desk," using what is normally referred to as a multi-point Likert-type scale for each question–statement. One example of such type of scale would be a 7-point scale with the following answers: disagree very strongly, disagree strongly, disagree somewhat, neither disagree nor agree, agree somewhat, agree strongly, and agree very strongly (each of which would be coded as 1, 2, 3, 4, 5, 6, and 7, respectively). With such a multi-point scale, one could more finely gauge the general perceptions of business process customers regarding quality attributes of a product, be it a good, service, or something else (e.g., a computer program, a news article).

As previously mentioned here, whatever measurement approaches an organization takes, quality will often be more difficult to measure than productivity, and quality's measurement will usually be more subjective as well. In the approach above, the challenge is not only coming up with the right questions, but also convincing customers to answer them, as many hotel managers have found out the hard way. Who wants to fill out questionnaires when they are checking out of a room?

Of course, other approaches for measuring quality exist, such as paying a relatively small group of people to test and provide detailed comments on a product (this is often referred to as a focus group approach), or simply finding ways of closing the gap between the members of an organization and the organization's customers, which is highly advisable anyway. F. Gouillart authored an article published in 1994 by *Harvard Business Review* that became a classic on closing the gap between an organization's members and its customers. The title of the article is "Spend a Day in the Life of Your Customers."

Productivity Goes Down, and We Are Happy!

One of the key topics of this chapter is the apparently meager productivity gains traditionally associated with investment in information technologies. While those meager gains are generally presented as bad news, it must be noted that they are not always the result of mistaken decisions by senior information technology managers and other company executives. Sometimes, senior management intentionally agrees to put up with losses in relative productivity, because those losses are not that bad for their companies when looked at more carefully.

The above may sound a bit strange, so it would be useful to explain it with an example. Let us assume that a life insurance company has $1 billion in revenues, with a net profit margin of 20 percent, or $200 million. It would be reasonable for a company of this size to have an information technology division with a budget of at least $30 million, or 3 percent of its revenues. Now, let us also assume that the company is considering an information technology–related decision in connection with the deployment of a new computer program to its main outside partners, the insurance brokers. The deployment will cost the company $2 million.

The aforementioned deployment is likely to double the company's revenues, but the downside is that it will probably have a negative impact on productivity, which in turn is expected to reduce the company's net profit margin to 15 percent. The resulting picture will be a company making $2 billion in revenues, with a net profit margin of 15 percent, or $300 million; this reduction also takes into account the $2 million cost of the computer program deployment. Will the life insurance company's senior management agree to the deployment of the new computer program to its insurance brokers? Yes, it will, because having $300 million in cash is better than having $200 million. The conclusion is that the relative productivity of the company will go down, and this reduction will be a direct result of an investment in information technology.

This scenario is obviously a fairly simplified version of what would likely happen in reality, where many other factors would be at play, including political infighting, economic forecast uncertainties, and potential threats by competitors, just to name a few. Nevertheless, it illustrates an organizational reality that often biases results in connection with productivity gains resulting from information technology investments. Companies will often reduce their own productivity and profit margins to increase their revenues, as long as their cash flow situation improves, even if in the long run.

The above is accomplished sometimes by the company's increasing the size of the market as a whole and sometimes by the company's getting a greater market share without affecting the size of a stable market. An extreme example (usually of the latter) is the competitive strategy called "dumping," where a company will offer a product at a very low cost (sometimes for free) to become the dominant player in a certain market. It seems that this is what one of the most visible and valuable companies in the world, Microsoft, did in the 1990s when it gave away its Internet Explorer product to dominate the Web browser market, whose leader then was a company that had helped usher in the Internet revolution, Netscape.

The scenario that was laid out above is not aimed at setting the stage for the argument that there is no point in worrying about productivity gains resulting from information technology investments. We should indeed worry about those productivity gains and certainly try to increase them if we can. Nevertheless, the scenario laid out above sets the stage for the argument, which the author would like not only to make but also to stress here, that conclusions derived from the analysis of aggregate evidence regarding organizations' productivity measures and investments on information technology should be made very carefully. Simply put, sometimes the aggregate evidence does not tell us the whole story.

The Technology Productivity Paradox

The technology productivity paradox (a.k.a. the information technology productivity paradox) is a term apparently coined by Steven Roach sometime between the late 1980s and early 1990s; it is a term that has gained a lot of attention and been repeated many times since. Roach was then Morgan Stanley's chief economist and author of a widely cited study on service sector productivity and its relationship with investment in information technology. The term refers to the poor gains in productivity in the service sector in spite of heavy information technology investments by service companies such as banks, insurers, airlines, retailers, and telecommunications providers.

A senior manager at the consulting firm Booz, Allen and Hamilton discussed the technology productivity paradox regarding particular industries in the service sector in an article published in 1990 in the journal *Sloan Management Review*. The author, Gregory Hackett, aptly titled the article "Investment in Technology: The Service Sector Sinkhole?" He presented evidence suggesting that banks and insurance companies, in particular, have been ineffective at reaping productivity gains from information technology investment.

This scenario, interestingly, does not extend to manufacturing companies in general, which have generally been more effective than service companies in turning technology investments into productivity gains. This is illustrated in Figure 3.2, which provides a general and schematic view of productivity increases in the period that goes from the 1950s to the 1990s. Figure 3.2 provides a general idea of how productivity varied over time in the manufacturing and service sectors, as well as in the banking and insurance areas; the latter are a part of the service sector.
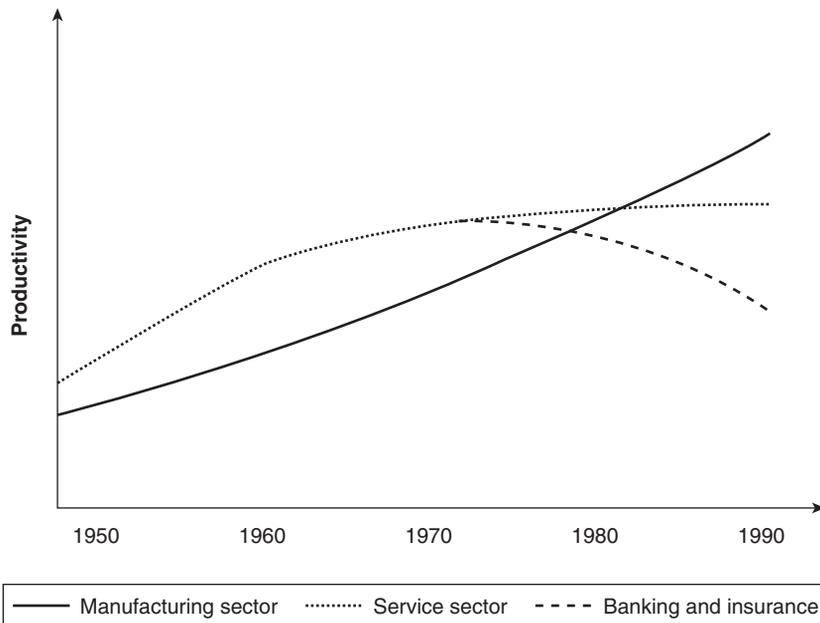
Figure 3.2   Productivity Growth From the 1950s to the 1990s

At this point, the reader may be thinking: "Well, the situation is not so bad. At least the manufacturing sector is doing well." The bad news, of course, is that the lion's share of the economic output of most developed and developing countries comes from the service sector, which usually accounts for 60 percent or more of those countries' employed workforce and gross national products. This means that, in the United States, for example, for every $10 spent, at least $6 goes to pay for service-related activities.

The period that goes from the 1950s until the 1990s saw a truly massive investment in information technology, a type of investment that has also steadily grown over the years, in spite of the fact that computer processing and memory capacity have been steadily growing over the years without a corresponding increase in the cost of computing technology. Given the high stakes of the technology spending game, the technology paradox attracted a tremendous amount of interest from the information systems research community and also much speculation about its reasons.

In a seminal article titled "Beyond the Productivity Paradox," published in the journal *Communications of the ACM*, MIT professor Erik Brynjolfsson and University of Pennsylvania's Wharton School professor Lorin Hitt argue that computer-based automation does not increase productivity per se. Computer-based automation provides, according to Brynjolfsson and Hitt, a basic ingredient that enables changes in organizational practices. Those changes in organizational practices do, in turn, have an effect on productivity. Because of this indirect relationship between investments in computing technologies and productivity gains, it seems that the time lag between investments and observable gains in productivity

is longer than initially predicted, often exceeding 2 years, after which productivity gains are reaped for several additional years.

The argument that computer automation provides a basic ingredient that enables changes in organizational practices is similar to another idea proposed in the early 1990s by information technology and management consultant Michael Hammer and others, called business process reengineering. The original business process reengineering idea was simple and direct enough to capture vast interest in the business community, which led to what many would call a management revolution. While the original premises of business process reengineering lost some of their appeal, particularly due to some highly publicized failures, the notion that organizations should redesign their business processes before automating them has slowly taken hold in the business community. This is a topic that will be picked up later in this book, since it is at the core of the message that this book tries to convey.

Why Technology Investment Kept Going Up and Up

Given the poor returns in terms of productivity gains from technology investment, should not managers have pulled the plug on information technology spending early on? Why have they done the opposite and in fact increased spending in information technology during the period that goes from the 1950s to the early 1990s? The answers to these questions can be summarized in one simple statement: Productivity is not everything.

In other words, while productivity is very important in the long run, other factors, such as the need for and opportunity to achieve cash flow improvement, production flexibility, on-the-fly product customization, quick identification of new production trends, market share increases, and other related needs, also play an important role in information technology spending decisions. The common thread among those factors is that they all have the potential to affect the competitive advantage of an organization, some more than others, depending on the economic context in which the organization finds itself.

As we have seen earlier in this chapter, it may make sense for a company to put up with a reduction in productivity, as well as relative profits, as long as its cash flow situation improves from an absolute perspective. For instance, a 15 percent profit margin on $2 billion in revenues may be preferable to a 20 percent profit margin on $1 billion in revenues, if we assume that information technology spending can have that kind of positive effect on revenues. Why? Simply because $300 million in absolute profits (15 percent of $2 billion) is generally preferable to $200 million (20 percent of $1 billion). Many companies prefer to operate on a lower profit margin as long as they can dominate a market. Some retail chains are particularly good at alternating between periods of very low profit margins on certain retail items, undergone as a way of attracting new customers to their stores, and periods of above-average profit margins, implemented as a way of reaping the benefits of the previously gained extra market share.

There has been a great deal of research on the relationship between information technology spending and revenues and competitive advantage. In an article titled "Technology Investment and Business Performance," published in the journal *Communications of the ACM*, Georgia State University professor Arun Rai and colleagues show that technology spending quite often affects revenues in a positive way. At the same time, Rai and colleagues warned readers about the need for business process redesign, as illustrated by the following quote from their article.

> IT investments for improving the effectiveness of an organization's management require a simplification and redesign of management processes. In the absence of such redesign, IT investments may increase management expenses without concomitant increases in management productivity.

Being an early adopter of a technology has been presented by many as a risky thing to do and likely to have a negative impact on productivity, since the costs associated with being an early adopter are generally higher than those for late adopters—which is probably correct, for most organizations. This is a point made by a controversial article authored by Nicholas Carr titled "IT Doesn't Matter," published in *Harvard Business Review*. Carr has been one of the many technology pundits who have strongly criticized overspending in information technology by U.S. organizations. In his *Harvard Business Review* article, Carr also argued that it is unadvisable for companies to be early technology adopters.

Prior research, however, contradicts Carr's latter argument. One of the first studies addressing the business advantages of being a "first mover," or leader, in the adoption of a particular technology was conducted by Brian Dos Santos and Ken Peffers and published under the title "Rewards to Investors in Innovative Information Technology Applications: First Movers and Early Followers in ATMs" in the journal *Organization Science*. Their study spanned the period from 1971 to 1983 and included 2,534 banks from across the United States. The results of the study strongly suggested that the earliest adopters of automatic teller machine (ATM) technologies, the banks that adopted the technology between 1971 and 1973, gained market share and sustained those gains for a long time. On the other hand, the study shows that late adopters of the technology, banks that adopted ATMs between 1974 and 1979, generally did not gain any market share as a result of adopting the technology. These findings provide support for the notion that early adoption of new technologies has the potential to lead to long-term competitive advantages for the early adopters, even though the costs associated with being an early adopter may lead to short-term losses in productivity.

There are many other examples of companies that derived significant benefits from being early technology adopters. And, as mentioned before in this chapter, being an early technology adopter does not necessarily lead to gains in productivity, since leading the way in the adoption of a technology is usually more costly than adopting the technology after it has been tested by others. Classic examples of companies that gained significant competitive advantages from the early adoption of key information technologies are that of United Parcel Service and American Airlines.

United Parcel Service, a high-profile parcel delivery company, invested heavily in information technology during the early 1990s. Among other technology innovations, United Parcel Service led the way in its industry with the implementation of a parcel delivery-tracking system called TotalTrack, which is constantly updated with information about deliveries by truck drivers using a piece of equipment called the Delivery Information Acquisition Device (DIAD). By the late 1990s, United Parcel Service was by far the leader in its industry, a position that has been maintained over the years. United Parcel Service's leadership position has been often challenged by its main competitor, which coincidentally is also a leading new technology adopter, Federal Express.

American Airlines, an airline carrier, invested heavily in information technology in the 1960s and 1970s, particularly in connection with its airplane seat reservation system, called SABRE, one of the first air travel reservation systems to be widely used by travel agents in the world. SABRE is widely credited to contributing to American Airlines' dominance in the airline carrier industry in the 1970s and 1980s, together with United Airlines (which also developed its own reservation system, called APOLLO).

So, as can be inferred from the discussion above, there are many factors, other than productivity improvement, that may lead organizations to invest in information technologies. Among these are potential increases in revenues and improved competitive positioning, which may be achieved at the expense of productivity decreases, at least at first. But don't get the wrong idea; productivity does matter! The argument that is being put forth here is that technology investments do not necessarily go down because they do not lead to productivity gains, since those investments often lead to other benefits that may easily be seen as offsetting the lack of returns in terms of either production capacity increases or cost decreases.

Productivity Gains in the 1990s

The technology productivity paradox led many management and technology consultants and researchers to call for alternative approaches that would increase the chances that technology investment would lead to productivity gains. Particularly noticeable were the calls for organizational change approaches associated with the adoption of information technologies, which have apparently built on the general notion that the business processes that make up organizations should be redesigned with an eye on productivity and quality improvement *before* information technologies are used to automate them.

Perhaps because of the organizational responses to these calls for business process redesign, the productivity gains associated with information technology investments seem to have shown some improvement in the late 1990s, when compared with the previous 25 years. For example, a study conducted by the Center for Research on Information Technology and Organizations (CRITO) at the University of California at Irvine shows that, in the 1995–1999 period, annual labor productivity growth has been 4.3 percent in the manufacturing sector, which is higher than the labor productivity growth in several industries in the service sector for the same

period. The same study shows, also for the 1995–1999 period, annual labor productivity growth rates of 1.7 percent for transportation services and 2.7 percent for finance, insurance, and real estate services.

While these numbers show a trend similar to that observed in the technology productivity paradox period, notably of better returns in the manufacturing than the service sector, the picture looks a little better for the service sector. Moreover, and perhaps more telling, the same study by CRITO shows that annual labor productivity growth during the 1995–1999 period has been 4.2 percent for industries where information technology was intensely used (most of which were from the service sector), as opposed to 1 percent for industries where information technology was not used very intensely.

These results suggest that productivity gains due to investment in information technologies have been improving since the mid-1990s, particularly in the service sector, since it is into that sector that historically most of the technology investments have been poured. It would of course have been interesting to analyze data in the early 2000s to see if that trend continued, but a major technology-related economic phenomenon happened, which is most likely to pose serious challenges for the interpretation of technology investment data collected in the early 2000s. The phenomenon was called the great technology bubble burst.

The Technology Bubble Burst

The technology bubble burst phenomenon was characterized by an unusual euphoria about technology companies, particularly companies whose products or services had anything to do with the Internet. Those technology companies that were publicly traded, with shares made available to the public in stock markets, saw their share prices (and thus market values) skyrocket. Many privately owned technology companies, trying to cash in, quickly became publicly traded through initial public offerings (a.k.a. IPOs) that often turned not very wealthy company founders into instant millionaires.

The technology bubble burst period occurred between approximately 1999 and 2001 and is illustrated by the variation in stock prices of publicly traded companies during that period (see Figure 3.3). During that period, technology companies attracted vast amounts of capital investment and also sold many products and services to technology users, which included other companies. As can be seen in Figure 3.3, investments in technology company stocks made around 1999 yielded huge returns by around 2000. However, those returns fell precipitously (to 1999 levels) around 2001. Unfortunately, a lot of individual investors purchased stocks when their prices were going up and then lost almost all of what they had invested about a year after.

The technology bubble burst poses a big hurdle to those interested in assessing returns on investment in technology in the 2000s. The reason is that a disproportioned amount of investment in technology was made during that period, and much of that investment was, in a sense, lost. That is most likely to have created a
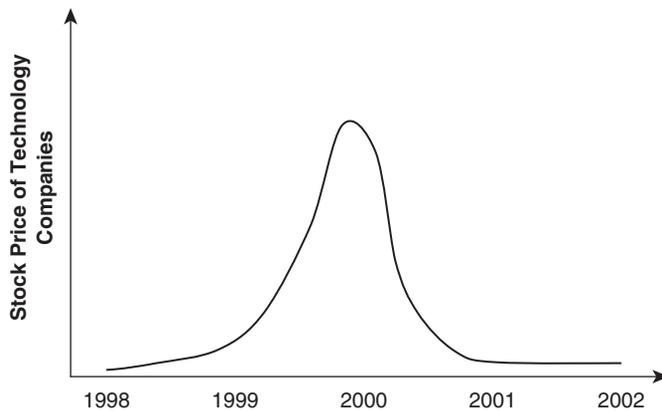
Figure 3.3   Stock Prices of Technology Companies During the Technology
Bubble Burst

great deal of unused technology resources in organizations, which may or may not
have contributed to increases in productivity, depending on how those organiza-
tions faced the situation.

Complicating this picture further is the fact that a great deal of investment in
and before the year 2000 was aimed at addressing the so-called millennium bug
problem. That is, many computer programs and databases stored dates with only
two digits. This was seen as likely to lead to potentially catastrophic consequences
if those programs and databases were not modified and replaced before the turn of
the year. For example, a computer program that used the current date to make sales
projections would be reset to the year "00" and would possibly make useless pro-
jections. Other computer programs were seen as more critical, such as those con-
trolling crucial operations such as nuclear reactor plants and airline flight paths,
since their malfunction could lead to serious accidents and much death and
destruction.

Some have argued that the massive technology investments in the early 2000s
have led to the creation of something called organization "slack" throughout the
economy, or the ability to use idle resources to restructure one's operations. Since
the early 2000s has been a period of economic recession, organizations have been
pushed into resorting to worker layoffs and business process redesign to control
costs. Given the aforementioned slack, the resulting picture may have been one of
increased productivity, at least from a statistical standpoint. Some results suggest
that this is the case, but the jury is still out as to the nature of productivity gains in
connection with technology investment in the 2000s. One of the big problems with
productivity gains obtained in periods of massive layoffs is that those gains may be
short-lived, because massive layoffs are bound to eventually lead to a tightening of
consumer demand (employees are consumers too), and thus losses of revenues.
Without revenues, productivity gains simply cannot be realized.

Summary and Concluding Remarks

Many studies suggest that productivity gains associated with information technology investments have been okay in the period going from the 1950s to the 1960s and somewhat dismal in the period going from the 1970s to the 1990s. The irony here is that information technology investments have gone up substantially in the latter period, a situation that has been labeled the technology productivity paradox and that begs the question: Why do organizations keep investing in information technology?

The answer provided in this chapter is that information technology investments are made not only so that productivity gains can be achieved. Those investments may have other goals, such as increased customer satisfaction, increased production flexibility (which allows organizations to respond quickly to changes in market demand), and better competitive positioning. In some cases, productivity losses will be taken in return for increases in revenues—a situation that will often lead to a reduction in relative profits (e.g., 30 percent to 20 percent) but sometimes an increase in absolute profits (e.g., $100 million to $150 million).

Moreover, products, whether they are tangible (e.g., cars) or intangible (e.g., software), have become increasingly more complex over the years. That increase in complexity was not accompanied by an increase in the cognitive capacity of human beings. Our cognitive capacity today is functionally identical to the cognitive capacity possessed by our early *Homo sapiens* ancestors who emerged in Africa over 100,000 years ago. Therefore, we have had to rely increasingly on information technologies over the years to cope with complexity. Without technology investment, or rather, without *massive* technology investment, we would not have many of the goods and services we take for granted today.

But still, we have to face the challenge of increasing productivity gains resulting from information technology investment. As has been shown in this chapter, a great deal of the literature on the technology productivity paradox converges on one generic recommendation to address the poor investment returns underlying the paradox. The recommendation is that information technology should not be used simply to automate organizations, but instead should be used as an enabler of innovations implemented through organizational change. This book is closely aligned with that generic recommendation and is aimed at providing people with the concepts and methodological tools to implement that recommendation.

Review Questions

1. Measuring productivity as the ratio between outputs and inputs:
   (a) Is one of the best measurement approaches around.
   (b) Isn't actually used by anyone.
   (c) Is not a very good approach, except for factories, where it leads to excellent results.
   (d) Often disregards some legitimate productivity gains.

2. Which of the following statements is incorrect?
   (a) Productivity can be measured through the ratio of production capacity and production costs.
   (b) Productivity can never be objectively measured.
   (c) Productivity is one of the attributes of a business process.
   (d) Productivity may affect quality.

3. Which of the following statements in connection with quality is correct?
   (a) Quality assessment is much more subjective than the assessment of productivity.
   (b) Quality and productivity are completely unrelated.
   (c) Quality refers only to perceptions by external customers.
   (d) A seminal work on quality is *Out of the Crisis*, by Michael Hammer.

4. Which of the following statements is incorrect?
   (a) Investments in IT may lead to labor productivity improvements.
   (b) In some cases, it may make sense to invest in IT when profitability is expected to go down.
   (c) Technology investment may lead to increases in a company's revenues.
   (d) Investments in IT have historically led to significant increases in productivity.

5. It is correct to say, in connection with the technology productivity paradox, that:
   (a) It refers to poor gains in productivity in spite of heavy investments in IT, particularly in the service sector.
   (b) William Deming was the first to propose it as a theoretical idea.
   (c) The Internet bubble caused it.
   (d) The manufacturing sector has been the most affected by it.

6. The technology productivity paradox is:
   (a) A problem that affects only the manufacturing sector.
   (b) Probably bad for the U.S. economy.
   (c) A new management idea created by IBM.
   (d) A direct result of computer technology's reliance on electricity.

7. It is correct to say that:
   (a) Banking and insurance industries are particularly good examples of industries affected by the technology productivity paradox in the 1980s.
   (b) Banks and insurance companies did not benefit at all from IT investment in the 1980s.
   (c) If there were no IT investment in the banking and insurance industries during the 1980s, certainly the services delivered by them to customers would be much better now.
   (d) Banking and insurance industries are bad examples of industries affected by the technology productivity paradox in the 1980s, since their investments in IT usually led to formidable productivity gains.

8. Technology investment kept growing in the 1980s because:
    (a) It consistently led to gains in productivity, as well as in areas not necessarily related to productivity, such as revenues and competitive advantage.
    (b) It always increased the competitive advantage of any company that made a technology investment, especially in non–cutting-edge information technologies.
    (c) It led to gains in areas not necessarily related to productivity, such as revenues and competitive advantage.
    (d) All senior managers at the time were uneducated, had a poor understanding of their businesses, and knew very little about likely IT effects on organizations.

9. It is correct to say that:
    (a) The productivity gains associated with information technology investments seem to have shown some improvement in the 1980s, when compared with the previous 30 years.
    (b) The productivity gains associated with information technology investments have been quite spectacular in the 1990s, when they have grown more than 10 times higher than those of the previous 40 years.
    (c) The productivity gains associated with information technology investments have been horrible in the 1990s and much worse than in any of the previous 40 years.
    (d) The productivity gains associated with information technology investments seem to have shown some improvement in the late 1990s, when compared with the previous 10 years.

10. Which of the statements below, in connection with the technology bubble burst, is wrong?
    (a) It was caused by an unusual euphoria about technology company stocks.
    (b) It was largely a stock market–driven phenomenon.
    (c) It was based on speculation and probably on wrong ideas about the likely future demand for information technology products.
    (d) The explosion of what was then referred to as a virtual electronic bubble caused it.

Discussion Questions

1. What would have happened if there had been no investments in information technology in the banking industry in the 1970s and 1980s? Illustrate your answer through the development of a business scenario involving two fictitious banks, one that invested in technology and another that did not. The scenario developed by you should be as realistic as possible.

2. Try to reconcile your answer to Discussion Question 1, as well as the related scenario you created and conclusions you reached, with the technology productivity paradox notion. Are they compatible? Explain your answer.

3. Let's assume that you have just been asked to develop a forecast of productivity gains in connection with a large information technology project. Develop a business scenario of such a project in an organization in the service sector. The business scenario should illustrate how you would demonstrate, through some careful number crunching, that the information technology project would or would not lead to productivity gains. The scenario developed by you should be as realistic as possible.

4. Develop a well-crafted business scenario involving an information technology project, in an organization in the service sector, which clearly illustrates the relationship between quality and productivity. The scenario developed by you should be as realistic as possible.

5. Develop a well-crafted business scenario involving an information technology project at an organization that clearly illustrates that, in some situations, even though productivity and profitability may go down as a result of investment in technology, senior management may still end up happy with the overall results of the technology investment for the organization. The scenario developed by you should be as realistic as possible.