Where IT's @: Technology and the Economy

Since 1995, productivity in the United States has surged, with output per hour rising an average of more than 3 percent annually. Information technology (IT) is getting credit for much of this increase. But should it?

IT has brought significant enhancements. It has streamlined supply chains, automated routine workflows and given firms greater insight into customers. Companies taking advantage of these productivity enhancements have gotten a leg up on the competition. But now, with the dust beginning to settle, some see IT as just another commodity, another input necessary to compete but insufficient to ensure competitive advantage.

On September 10, 2004, the Federal Reserve Bank of Dallas hosted a conference on technology and the economy, cosponsored by the Technology Roundtable of the National Association for Business Economics (NABE). This article summarizes the ideas presented at the conference on how to assess technology and its potential impact on economic growth and productivity.

Productivity and IT

U.S. productivity growth has taken off in recent years to more than double the growth rate experienced from 1973 to 1995 (*Chart 1*). Michael Cox, senior vice president and chief economist of the Dallas Fed, argued that technology and globalization are providing the nation with unusually strong productivity growth.[1] The era of Solow's paradox—the observation that computers are everywhere except in the productivity statistics—appears to have ended.[2] The United States has a dynamic, flexible and open economy that continues to reorganize work and expand markets through technological innovation and change. Cox emphasized the importance of upgrading one's skills and knowledge to take advantage of the new and better jobs created by these changes. He noted that occupations using people skills, emotional intelligence, creativity and imagination point the way to the jobs of the future.

Hal Varian, professor in the School of Information Management and Systems at the University of California at Berkeley, brought the issue of productivity to a more micro level. Varian described *combinatorial innovation* as one of the building blocks of productivity. Combinatorial innovation is where a set of component technologies can be combined and recombined to create new products. Eli Whitney's use of standardized interchangeable parts in the early 1800s was one such example; the development of the gasoline engine in the early 1900s was another.

Today, combinatorial innovation is taking place with the Internet and associated information technologies. The component parts are bits of information—digital strings of zeros and ones—that have many productivity-enhancing characteristics. With bits, there are no time-to-manufacture, inventory or delivery problems. Varian noted that bits can be shipped in seconds to many places in the world, where innovators can work in parallel.

Lacking physical constraints, the Internet has provided a platform for rapid innovation and change. Moreover, relatively open technologies and low barriers to entry have created an intensely competitive environment, which has led to overcapacity in some instances. While this is good news for consumers, it can be difficult for companies to manage.

Another caveat is that new ideas and technologies created through combinatorial innovation can capture the public's imagination, leading to potential financial speculation and overinvestment. This happened in the past with railroads and automobiles and recently with the high-tech boom in information technology companies. Although it will take some time to work through the excess capacity created during the dot-com investment boom of the late 1990s, Varian is optimistic about the future.

Varian said that businesses—particularly small and medium-sized enterprises—are learning how to use IT cap-

Chart 1

Productivity Growth Surges

(Output per hour, nonfarm business)

SOURCE: Bureau of Labor Statistics.

Productivity growth results not only from new technology, but also from new business organization around that technology.

ital effectively. The resulting effects on aggregate productivity are clear, but the impact on profitability is trickier due to lack of entry barriers. The focus today is on information management, that is, how information flows through an organization and how it can be changed to improve decisionmaking. Finally, business survival depends on understanding how the new network (or information) economy differs from the past. Technology changes, but economic laws do not.[3]

Productivity growth results not only from new technology, but also from new business organization around that technology. Erik Brynjolfsson, professor of management at Massachusetts Institute of Technology, acknowledged that computers are associated with greater productivity and that IT is the catalyst behind the recent productivity surge. However, he suggested that modern businesses need to be reorganized to take advantage of IT and rethink the way their work is done. On average, productivity improves as IT capital stock increases.

Not all firms with similar new technologies are equally productive, though. In trying to understand the variation across firms, Brynjolfsson analyzed whether business productivity was related to a firm's corporate culture and organizational practices or related more to a firm's investment in IT. His conclusion was that business performance depends on both IT and organizational capital. Direct IT capital costs are often only 10 to 20 percent of total IT project costs. Far more important in the information economy are intangible assets: how the organization structures its people and processes, how it manages risk and how it integrates knowledge and ideas.

Digital organizations, as termed by Brynjolfsson, are heavy users of information technology, with distinctly different corporate cultures and organizational practices formed into a coherent system. He identified some key practices of digital organizations: moving from analog to digital business processes, distributing decision rights, fostering open information access, linking incentives to performance, maintaining focus, communicating goals, hiring the best people and investing in human capital.

Brynjolfsson illustrated that digital organizations perform better and have higher productivity and higher market valuation than traditional organizations.[4] He stressed that market values rise disproportionately for firms that follow the digital organization practices *and* invest heavily in IT capital.

Industry Applications

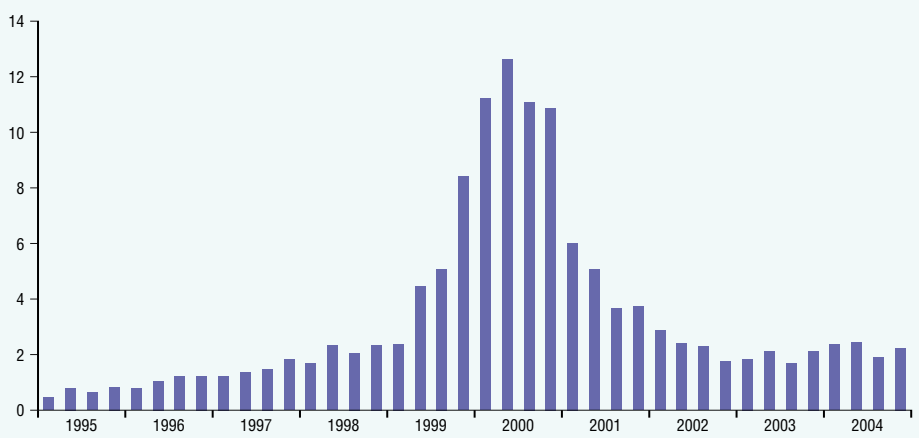
Entertainment is one example of an industry in which new technology has immeasurably increased productivity and greatly lowered costs. Chris Anderson, editor in chief of *Wired* magazine, focused on the nearly unlimited supply of music, books and films available through online retailers.[5] Before the digital age, the entertainment industry was limited by broadcasting technology. It needed local audiences for movies and was physically limited by the 24 hours in a day and the radio and TV spectra. Suddenly, we are no longer as bound by the shelf space, seating capacities and distribution constraints of the physical world. In the new digital economy, scarcity can be replaced by abundance.

Anderson argued that the emerging digital entertainment economy is going to be radically different from today's mass market. The 20th century entertainment industry was about hits; the 21st century will be equally about misses. Misses (80 percent of the market) are just as profitable as hits (the other 20 percent). That is, with no physical constraints to limit availability, profit margins on hits and misses are roughly equal, and the greatest profits will likely come from the less familiar titles that fall in the long tail of the demand distribution. "Long-tail" businesses can treat customers as individuals and offer mass customization rather than mass-market fare. Anderson pointed to the success of online movie retailer Netflix and online music retailers such as Rhapsody.

The power of the long tail is that the market is so much larger but just as profitable on the margin. As a result, Anderson said, three new rules apply for the new entertainment economy. First, because offering misses increases the market's potential size, online retailers should not be selective in what they offer, but should instead make everything available. Second, online retailers

Chart 2

U.S. Venture Capital Investment in Information Technology



NOTE: IT includes semiconductors, telecommunications, software, and computer and peripherals sectors.
SOURCE: MoneyTree Survey, PricewaterhouseCoopers.

should price items according to digital costs, not physical ones. And finally, online retailers should make recommendations to customers and drive demand down the long tail.

Many other industries have also benefited from the effective implementation of information technology. Jeff Donnellan, chief information officer of Landmark Graphics, presented evidence that new information technologies are being used to help find drilling locations for oil and gas exploration firms, thereby reducing planning and production cycle times. Rik Heller, president of FreshLoc Technologies, noted the productivity achievements gained in food distribution and storage through the use of radio frequency identification devices, or RFIDs. In addition to providing real-time information on inventory levels, these devices can monitor temperatures to increase shelf life and improve the safety of foods being transported in truck trailers to restaurants and grocery stores.

Does IT Matter?

In a seemingly divergent vein, Nicholas G. Carr, former editor of the *Harvard Business Review*, argued that IT's strategic importance has dissipated as its core functions have become available and affordable to all.[6] Carr views IT as an infrastructural technology, like railroads and electric power, shared broadly by all firms in an industry. He argued that IT has moved from being a proprietary resource that helps firms generate profits to being a commodity with vanishing advantages.

As such, Carr sees IT's strategic importance diminishing even as it has become more powerful, more affordable and more commoditized. While this position at first seems contradictory, the argument is that IT is necessary to compete but is insufficient to ensure competitive advantage. Thus, as IT becomes less expensive, more accessible and better understood, its beneficial and valuable uses can be easily replicated by competing firms. The managerial implications of this shift in thinking can be important.

Carr concluded by offering the following, somewhat controversial, guidelines for IT investment and management: Spend less; follow, don't lead; innovate when risks are low; and focus more on vulnerabilities than opportunities.

IT and Financial and Human Capital

All new technologies require investments in venture and human capital. Ron Harris, founder and general partner of the venture capital firm Southwest Capital Partners, and Robert Helms, professor and dean of the School of Engineering and Computer Science at the University of Texas at Dallas, provided perspectives on the role of financial and human capital in today's IT-enabled economy.

Harris chronicled venture capital investments in IT beginning with the early 1980s, around the time the first personal computers were introduced. He explained that the Internet emerged as a viable business platform with the creation of the World Wide Web in the early 1990s, and an IT renaissance began as capital spending on IT equipment and software soared.

This incredible boom, however, was followed by an almost equally incredible bust and an IT recession that began in early 2000 (*Chart 2*). IT investments came to a halt as the century date change (Y2K) passed almost without notice and as business valuations of Internet firms were scrutinized and reevaluated. As global growth slowed, firms realized the harsh realities of maintaining a competitive web presence and implementing and integrating business process technologies into an efficient and effective system.

In the aftermath, it became clear that a different IT strategy was required: one that made information available to those who need it in real time. Harris concluded by describing the "intelligent real-time enterprise" as one that focuses its IT efforts on security, business integration, real-time monitoring, wireless connectivity, systems management and disaster recovery. In his view, the winners will be those firms that recognize and adapt to the new realities created by information technology.

Helms acknowledged the key role IT has played in boosting productivity, mainly by improving cycle times. New technologies allow large quantities of information to be moved rapidly to those who need it anywhere in the world. This, in turn, requires deeper and broader strategic partnerships between educational institutions and technology firms to accelerate learning and speed the flow of information.

Looking ahead, Helms is concerned about how the United States' competitive advantages—knowledge, relationship management and innovation—can be maintained and nurtured. He asserted that academic-engineering power drives regional excellence and economic development. Other nations are already outpacing the United States in graduating engineers. In the United States only 1.8

percent of 24-year-old graduating seniors have engineering degrees, while the share is 2.7 percent in Europe and 5.8 percent in Japan. Moreover, federally funded research and development initiatives have been on the decline since the mid-1960s. Helms stressed that a commitment to education and the development of human capital is required for the United States to be able to keep its competitive edge over the rest of the world.

Future Trends

The final panel of the conference engaged in a lively discussion of future trends in technology. What new technologies (or industries) might be on the horizon that could impact business productivity? What pitfalls and dangers lurk in the shadows? What kinds of disruptions to accepted societal norms might result?

Douglas S. Rasor, vice president and manager of worldwide strategic marketing at Texas Instruments, opened the discussion by sharing technology ideas for the future. In a world that requires more real-time monitoring and sharing of information, Rasor stressed the importance of bandwidth for high-speed digital communications.

Dennis Wilson, chief technology officer, chairman and founder of Nanotechnologies, explained the future importance of nanotechnology to business. Wilson defined nanotechnology as the commercial development of materials, tools, processes and devices that exploit new properties occurring at dimensions of only a few nanometers. Wilson argued that nanotech is a disruptive technology with the potential to significantly enhance business productivity by creating powerful new materials with great strength and less weight and size.

But the benefits of new technologies are not without potential problems and concerns. John South, director of information security at Alcatel North America, warned that economic espionage is alive and well—and thriving. South stressed that security of information flows and communication networks cannot be overlooked or underestimated. In today's increasingly global economy, hackers and computer viruses present a real and present danger.

Similarly, G. Anthony Gorry, professor of management and computer science at Rice University, warned of technology's impact on societal norms. For example, technology has made intellectual property theft easier and may be changing the moral attitudes of the public about such theft. The students he has observed are more cavalier about downloading copyrighted material from the Internet than they would be about stealing a book or record from a retailer.

Conclusion

Information technology is everywhere in today's global economy. In the past, IT helped firms become more productive and competitive. However, future gains will likely come through improved information management and distinctly different corporate cultures that focus on improving organizational capital. IT remains important, but the effective integration of IT into an organization's culture and the reorganization of work are what create competitive advantages.

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Notes

1 See "A Better Way: Productivity and Reorganization in the American Economy," by W. Michael Cox and Richard Alm, Federal Reserve Bank of Dallas 2003 Annual Report, pp. 3–24.

2 See "We'd Better Watch Out," by Robert M. Solow, *New York Times*, July 12, 1987, p. BR36.

3 See *Information Rules: A Strategic Guide to the Network Economy*, by Carl Shapiro and Hal R. Varian, Boston: Harvard Business School Press, 1999.

4 See "Beyond Computation: Information Technology, Organizational Transformation and Business Performance," by Erik Brynjolfsson and Lorin Hitt, *Journal of Economic Perspectives*, vol. 14, Fall 2000, pp. 23–48.

5 See "The Long Tail," by Chris Anderson, *Wired*, vol. 12, October 2004, pp. 170–77.

6 See *Does IT Matter? Information Technology and the Corrosion of Competitive Advantage*, by Nicholas G. Carr, Boston: Harvard Business School Press, 2004.

Information about the conference and speakers and copies of most presentations are available on the Dallas Fed web site, www.dallasfed.org, in the News & Events section.