BOOKS: ECONOMICS AND TECHNOLOGY

The Productivity Payoff of Computers

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In the last decade, American firms have made unprecedented investments in information technology, which by some estimates now accounts for 30% of new capital investment. It is easy to find anecdotal evidence of the benefits of information technology, as companies respond to the "Internet Age" by transforming their operations, their marketing, and their relationships with customers and suppliers. Amidst the phenomenal revolution in information technology (IT) however, several economists have been puzzled to find only modest growth in productivity reflected in the official statistics of the United States economy. The recognition of this "productivity paradox" is often attributed to Nobel-winning economist Robert Solow, who in 1987 famously quipped that computers can be seen everywhere "except in the productivity statistics."

The Computer Revolution
An Economic Perspective
by Daniel E. Sichel

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To address this paradox, some researchers have studied the effects of information technology on productivity in individual companies. The coefficients of a "production function" are estimated from inputs (typically computer and non-computer capital stock, information systems labor, other labor, and research and development) and outputs (typically sales or value-added); these coefficients indicate the contributions of the included input factors. Brynjolfsson and Hitt analyzed data from 367 firms over the period 1988 to 1992, and found no evidence of a shortfall in productivity, and if anything, found evidence of excess returns for IT capital and information systems labor (*1*). Their results were robust to different specifications of their production function, and have been replicated with data from different sources (*2*).

Although these studies seem to debunk the productivity paradox at the level of individual firms, macro-level data still show that, for the total economy, measured productivity gains have not substantially accelerated since 1960 despite rapidly increasing investments in computers and other types of IT (*3*). Four prominent hypotheses have been proposed to explain this fact: mismeasurement, mismanagement, diffusion delay, and the capital stock theory. Mismeasurement suggests that a large proportion of the benefits from IT will not appear in productivity statistics because they take the form of greater convenience, product variety, quality or timeliness—contributions that are largely missed in traditional gross domestic product (GDP) accounting (*4*). Mismanagement might lead to wasteful or unproductive information technology investments, ones that would not increase productivity. The diffusion hypothesis suggests that many years may pass before the productive potential of an innovation is fully realized. Paul David offers the example of the electric dynamo, where the productivity benefits followed the required technical developments (largely complete by 1880) by several decades (*5*).

In his book, Daniel Sichel, a senior economist at the Federal Reserve Board, makes the case for the fourth explanation of the productivity paradox, the capital stock theory, which he developed in collaboration with Stephen Oliner (*6*). Providing a rigorous discussion of growth accounting for the U.S. economy that is accessible to the non-economist, Sichel describes how economists derive the output and contribution to economic growth for the hardware and software sectors. He then shows that despite the large current spending in information technology, computers are still only a small fraction of the existing capital stock. One reason for this is that only recently have firms been making substantial investments in computers, but they have accumulated large amounts of other productive capital from many decades of investment. Another reason is that computers rapidly become obsolete, and as a result large spending does not imply a large accumulation of capital stock.

In 1993, broadly defined "information processing equipment" was estimated to be 11.7% of the stock of nonresidential equipment and structures, and computers themselves accounted for a mere 2% of this capital stock (in nominal dollars). Sichel argues that since computers represent such a small fraction of capital stock, their contribution to economic growth should be correspondingly small. For example, he estimates that for the period 1980 to 1992, computer hardware contributed only 0.20% of the total 2.3% average annual growth in gross nonfarm output. Sichel estimates the contribution of computers to economic growth through 2003 under different assumptions, projecting a contribution to net growth (that is, after depreciation) ranging from 0.11 to 0.38% at the end of that period.

Sichel's analysis is important, because we must set realistic expectations for the ability of information technology to foster productivity and economic growth. It is equally important, however, to remember that even if Sichel's estimates are accurate, the glass is not empty. With recent GDP growth in the United States around 2% and labor productivity growth just about 1%, a 0.20% contribution of IT to economic growth is nothing to sneeze at. The continuing improvement in the cost/performance ratio of IT is unprecedented, and as a result it is hard to point at any other single technology that has a comparable impact on productivity growth.

The real picture, however, is likely to be brighter than that painted in the book. For example, Sichel does not measure directly the contribution of IT to growth, but he infers it by assuming that the net return of computers is similar to that for other capital, around 12% annually. Econometric studies of data from individual firms suggest that marginal net returns to IT capital investments may be twice as high as this, and—since the ability of firms to deploy IT is limited by the availability of complementary factors such as information systems labor—their average returns may be even higher.

Finally, Sichel's approach may be too narrow. What is exciting about information technology is not its ability to substitute for other capital, but its ability to restructure every aspect of business—in the process creating new types of markets and organizations. Unfortunately Sichel's analysis is not capable of capturing these higher-order impacts. Nevertheless, as long as his findings are kept in perspective, the author deserves credit for contributing an interesting argument and a rigorous methodology to our understanding of how information technology affects productivity and economic growth.

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