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Productivity

Remarks

by

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One of the most important economic developments in the United States in the past decade or so has been a sustained increase in the growth rate of labor productivity, or output per hour of work. From the early 1970s until about 1995, productivity growth in the U.S. nonfarm business sector averaged about 1-1/2 percent per year--a disappointingly low figure relative both to U.S. historical experience and to the performance of other industrial economies over the same period.[1] Between 1995 and 2000, however, the rate of productivity growth picked up significantly, to about 2-1/2 percent per year--a figure that contributed to the view, held by many at the time, that the United States might be entering a new economic era.

Talk of the "new economy" faded with the sharp declines in the stock valuations of high-tech firms at the turn of the millennium. Yet, remarkably, productivity accelerated further in the early part of this decade. From the end of 2000 to the end of 2003, productivity rose at a 3-1/2 percent annual rate and, even after recent downward revisions to the data, it is estimated to have increased at an average annual rate of 2-1/4 percent since the end of 2003. These advances were achieved despite adverse developments that included the 2001 recession, the terrorist attacks of September 11, corporate governance scandals, and in the past few years, devastating hurricanes and very substantial increases in the cost of energy.

Why is the rate of productivity growth so important? Economists agree that, in the long run, productivity growth is the principal source of improvements in living standards. The logic is simple: In the long run, what we can consume as a nation is closely tied to how much we can produce. The link between the growth of productivity and the standard of living of the average person is somewhat looser in the short-to-

medium run, because variation in factors such as the share of the population that is employed, the division of income between capital and labor, and the distribution of each type of income across households also matters. Nevertheless, the rate of productivity growth influences the economy in important ways even in the short run, affecting key variables such as the growth rate of output, employment gains, and the rate of inflation.

Today I will discuss the acceleration of productivity that has occurred over the past decade and our current understanding of its causes. In the discussion I will comment on two puzzles raised by this improved performance and then conclude by briefly addressing the longer-term prospects for productivity growth in the United States.

The U.S. Productivity Resurgence and Its Causes

What underlies the resurgence in U.S. productivity growth? Explanations of the rise in productivity growth since about 1995 have evolved somewhat over time. By 2000 or so, an emerging consensus held that the pickup in productivity growth was, for the most part, the product of both rapid technological progress and increased investment in new information and communication technologies (IT) during the 1990s (see Jorgenson and Stiroh, 2000, and Oliner and Sichel, 2000). According to this view, developments in IT promoted U.S. productivity growth in two ways. First, technological advances allowed the IT-producing sectors themselves to exhibit rapid productivity growth. For example, the development of more-reliable semiconductor manufacturing equipment and faster wafer-inspection technologies increased the rate at which companies such as Intel were able to produce microprocessors. Intel was also able to shorten its product cycle and increase the frequency of new chip releases, shifting its product mix toward more-powerful and, consequently, higher-value chips. Both the more-rapid pace of production

and the higher average quality of output raised productivity at Intel as well as at competing firms that were forced to keep pace.

Second, advances in information technology also promoted productivity growth outside the IT-producing sector, as firms in a wide range of industries expanded their investments in high-tech equipment and software and used the new technologies to reduce costs and increase quality. Some large retailers, for example, developed IT-based tools to improve the management of their supply chains and to increase their responsiveness to changes in the level and mix of customer demands. Securities brokers and dealers achieved substantial productivity gains by automating their trading processes and their back-office operations. In the durable goods sector, automobile producers developed programmable tooling systems to increase the flexibility of their manufacturing processes--for example, to permit vehicles based on different platforms to be produced on the same assembly line. One study (Stiroh, 2002) found that a majority of U.S. industries experienced an acceleration of productivity in the latter part of the 1990s. Significantly, the study also found the gains to be the greatest in industries that use IT capital most intensively.

Undoubtedly, the IT revolution and the resurgence of productivity in the United States after 1995 were closely connected. However, the technology-based explanation of increased productivity growth does raise a couple of puzzles (see, for example, McKinsey and Company, 2001 and 2005, and Basu and others, 2003). First, the United States was not the only country to have access to the new technologies or to have experienced a rapid expansion in IT investment; other industrial countries also invested heavily in these technologies in the 1980s and 1990s. Yet, with a few exceptions, the available data show

that productivity growth in other advanced countries has not increased to the extent seen in the United States. Second, as I have noted, productivity growth increased very rapidly earlier this decade and has continued to rise at a solid pace, even though IT investment declined sharply after the stock prices of high-tech firms plummeted in 2000. More generally, as a historical matter, increases in IT investment have not always been followed in short order by increases in productivity growth. This observation raises the question of why, in some cases, the putative productivity benefits of investments in new technologies do not occur until years after those investments are made.

In regard to the first puzzle--the fact that the United States has enjoyed greater productivity growth in recent years than other advanced countries--the comparison with Europe is particularly interesting. Throughout most of the post-World War II period, productivity growth in Europe exceeded that in the United States, at first because of the rapid gains during the postwar reconstruction and then later because of a gradual convergence of European technology and business practices to American standards. By one estimate, European productivity increased from 44 percent of the U.S. level in 1950 to near-equality with the United States by 1995 (Gordon, 2004 and 2006). However, the available data suggest that, since about 1995, productivity growth in European nations has slowed, on average, in contrast to the pickup experienced in the United States. These trends have led to an increasing divergence in productivity levels in the United States and Europe (see van Ark and Inklaar, 2005).

Researchers have made the important point that differences in productivity growth between the United States and Europe appear not to have been particularly large in the IT-*producing* sectors, where U.S. strengths in the development of computers and

semiconductors have been partly offset by European leadership in communications. Rather, the U.S. advantage has been most evident in the IT-*using* sectors, which have performed better in the United States than elsewhere. What accounts for this apparent U.S. advantage?

Differences in economic policies and systems likely have accounted for some of the differences in the performance of productivity. One leading explanation for the strong U.S. productivity growth is that labor markets in the United States tend to be more flexible and competitive, market characteristics that have allowed the United States to realize greater economic benefits from new technologies. For example, taking full advantage of new information and communication technologies may require extensive reorganization of work practices, the reassignment and retraining of workers, and ultimately some reallocation of labor among firms and industries. Regulations that raise the costs of hiring and firing workers and that reduce employers' ability to change work assignments--like those that exist in a number of European countries--may make such changes more difficult to achieve.

Likewise, in product markets, a high degree of competition and low barriers to the entry of new firms in most industries in the United States provide strong incentives for firms to find ways to cut costs and to improve their products. In some other countries, in contrast, the prominence of government-owned firms with a degree of monopoly power, together with a regulatory environment that protects incumbent firms and makes the entry of new firms difficult, reduces the competitive pressure for innovation and the application of new ideas. For example, some economists have argued that restrictions on land use and on shopping hours in Europe have impeded the development of "big box" retail

outlets, reducing competition and denying European firms the economies of scale that have been important for productivity growth in the retail sector in the United States (Gordon, 2004). More generally, recent empirical research has typically found that economies with highly regulated labor and product markets are indeed less able to make productive use of new technologies (Gust and Marquez, 2004). Also, although it is not a feature unique to the United States, the increasing degree of openness of our economy to trade and foreign investment and the consequent exposure of U.S. companies to the rigors of international as well as domestic competition, may have promoted productivity growth.[2] As a leading example, productivity gains in U.S. manufacturing--which is particularly subject to international competition--have been especially impressive in recent years, averaging, by one measure, about 6 percent per year over the past decade.[3]

A number of other explanations have been advanced for the relatively stronger performance of productivity in the United States in recent years, including international differences in management practices, the depth and sophistication of U.S. capital markets, more favorable attitudes toward competition and entrepreneurship in the United States, and the role of U.S. research universities in fostering innovation.[4] Further study of national productivity differentials clearly is warranted.

The second productivity puzzle relates to the further acceleration in productivity that occurred earlier in this decade despite the decline in IT investment after 2000 and the rather modest recovery in recent years.[5] Again, a number of explanations have been proposed, including business restructuring and an even more rapid pace of technical change and of the diffusion of technological advances. It is interesting, however, that the recent episode is not the first time that we have seen productivity improvements lagging

well behind investments in new technology. Notably, computers were first commercialized in the 1950s, and personal computers began to come into widespread use in the early 1980s; but until the mid-1990s, these developments had little evident effect on measures of productivity. Indeed, an oft-quoted quip by economist Robert Solow held that, as of the late 1980s, "computers are everywhere except in the productivity statistics."

In attempting to explain the tendency of productivity growth to lag behind investments in new technologies, economists have emphasized that much more than the purchase of new high-tech equipment is needed to achieve significant gains in productivity. In particular, to be successful, managers must have a carefully thought-out plan for using new technologies before they acquire them. Case studies of individual industries show that the planning for technological modernization has not always been adequate, with the result that some purchases of high-tech equipment and software have not added much to productivity or profits. The idea that managers can buy the hardware first and then decide what to do with it does not square with the evidence.

Some observers have characterized the new information and communication technologies as *general-purpose technologies*, which means that--like earlier major innovations such as electrification and the internal combustion engine--they have the potential to revolutionize production and make many new goods and services available to consumers (see Bresnahan and Trajtenberg, 1995). To make effective use of such a technology within a specific firm or industry, however, managers must supplement their purchases of new equipment with investments in firm- or industry-specific research and development, worker training, and organizational redesign--all examples of what

economists call *intangible capital*. Although investments in intangible capital are, for the most part, not counted as capital investment in the national income and product accounts, they appear to be quantitatively important.[6] One recent study estimated that, by the late 1990s, investments in intangible capital by U.S. businesses were as large as investments in traditional tangible capital such as buildings and machines (Corrado, Hulten, and Sichel, 2006).

Recognizing the importance of intangible capital has several interesting implications. First, because investment in intangible capital is typically treated as a current expense rather than as an investment, aggregate saving and investment may be significantly understated in the U.S. official statistics. Second, firms' need to invest in intangible capital--and thus to divert resources from the production of market goods or services--helps to explain why measured output and productivity may decline or grow slowly during the period after firms adopt new technologies. Finally, the concept of intangible capital may shed light on the puzzle of why productivity growth has remained strong despite the deceleration in IT investment. Because investments in high-tech capital typically require complementary investments in intangible capital for productivity gains to be realized, the benefits of high-tech investment may become visible only after an extended period during which firms are making the necessary investments in intangibles.

Longer-Term Prospects for Productivity Growth

Historical analyses of the sources of fluctuations in productivity growth are challenging, but not nearly so challenging as trying to predict how productivity will evolve in the future. However, because the rate of productivity growth is a primary

determinant of economic performance, policymakers have few options other than to try to forecast future gains in productivity. For example, estimates of long-term productivity growth are needed to determine the rate of output growth that the economy can sustain in the long run without generating inflationary pressures.

The task of trying to predict the behavior of productivity in the medium-to-long run is complicated by the fact that productivity growth generally varies with the business cycle, tending to be below its longer-term trend when the economy is contracting and above that trend when the economy is in the early stages of an expansion (see Basu and Fernald, 2001, for a discussion). (This well-documented pattern makes the strong growth of productivity during the early part of this decade, a period that featured a recession and generally slow growth, all the more remarkable.) Economists use statistical methods to try to abstract from cyclical influences to determine the longer-term trend in productivity. What do they find?

As of a couple of years ago, the consensus among leading researchers was that productivity in the nonfarm business sector was likely to grow at about 2-1/2 percent per year in the longer term, close to the rate of productivity growth achieved during the 1995 to 2000 period (see, for example, Baily, 2003; Gordon, 2003; and Jorgenson, Ho, and Stiroh, 2004). On the one hand, recent data revisions to the national income and product accounts have shown that productivity growth over the past few years was slightly weaker than we thought, leading some analysts to revise down their estimates of trend productivity growth about 1/4 percentage point or so per year. On the other hand, the fact that productivity growth has remained solid in recent years increases confidence that a larger fraction of those productivity gains reflects longer-term developments and a

smaller fraction reflects cyclical factors. On net, the recent experience does not appear to require a significant rethinking of long-term productivity trends. Indeed, recent estimates by leading economists continue to peg the expected longer-term rate of productivity growth at roughly 2-1/2 percent per year.[7]

Of course, as the saying goes, past returns do not guarantee future results, and not all the evidence supports this optimistic view of productivity trends. For example, although spending on high-tech equipment and software has recovered noticeably from its recent lows, growth in IT spending remains well below the rates observed before the 2001 recession. Some industry participants have suggested that less-rapid growth in IT spending may reflect the absence of major new business applications for IT--"killer apps," as they are called. Moreover, until we have a more complete understanding of the factors behind productivity growth in the past five years, we should be cautious in drawing any strong conclusions about the future.

These caveats notwithstanding, a case can be made that the strong productivity growth of the post-1995 era is likely to continue for some time. Notably, the price of computing power continues to fall sharply, having declined by nearly half in the five years between 2000 and 2005. Increased computing power has in turn contributed to advances in other fields, such as biotechnology, and has helped to increase the range of goods and services available to businesses and consumers. Moreover, whatever the pace of future technological progress, further diffusion of already-existing technologies and applications to more firms and industries should continue to increase aggregate productivity for a time.

I have focused today on how technological change and investment, both tangible and intangible, promote productivity growth. I will close by noting that, from the perspective of society as a whole, a particularly important form of intangible investment in future years will be investment in the skills of the U.S. labor force. As we know from everyday experience, few jobs or occupations have not been affected in some way by the technological changes of recent years, a trend that will certainly continue. Not only scientists and engineers but also nurses, auto mechanics, and factory workers now use advanced technologies every day. But new technologies will translate into higher productivity only to the extent that workers have the skills needed to apply them effectively. Moreover, because technology is always changing, the acquisition of those skills has become a lifelong challenge, one that continues well after formal education is completed. If the recent gains in productivity growth are to be sustained, ensuring that we have a workforce that is comfortable with and adaptable to new technologies will be essential.

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[1] I will use "labor productivity" and "productivity" interchangeably in my remarks today. An alternative productivity concept, multifactor productivity, measures the quantity of output that can be produced by a given combination of capital and labor. Changes in labor productivity reflect changes in both multifactor productivity and the amount of capital per worker.

[2] Lewis (2004) discusses the link between competition and productivity.

[3] The figure for growth in output per hour in the text uses the Federal Reserve's industrial production index for the manufacturing sector as the measure of output.

[4] Regarding differences in management practices, Bloom, Sadun, and Van Reenen (2006) found that business establishments in the United Kingdom that are owned by U.S. multinationals get higher productivity from information technology than do other establishments in that country. Their study tied the differential to the management and organizational practices employed by U.S. firms.

[5] Indeed, productivity accelerated in a wide range of industries that had not experienced much improvement in productivity growth in the 1990s. For discussions of more recent developments at the industry level, see Corrado, Lengermann, Bartelsman, and Beaulieu (2006), Bosworth and Triplett (2006), and Stiroh (2006).

[6] Software is one intangible investment that is treated as part of business fixed investment in the U.S. national accounts.

[7] Martin Baily puts the trend for the nonfarm business sector a little above 2-1/2 percent (conversation with Board staff in August 2006). Robert Gordon reports a current trend of 2.6 percent but predicts that it will move lower in the next couple of years (conversation with Board staff in August 2006). Jorgenson, Ho, and Stiroh (2006) put the trend at 2.6 percent for the private economy (a sector quite close to nonfarm business), but that figure was generated before the recent NIPA revisions.