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Changing Productivity Trends

As important as productivity growth is to the health of the economy, much remains to be understood about how and why its trend growth rate changes. This *Economic Letter* discusses some of the points of debate in the research on these issues.

The data and some early explanations

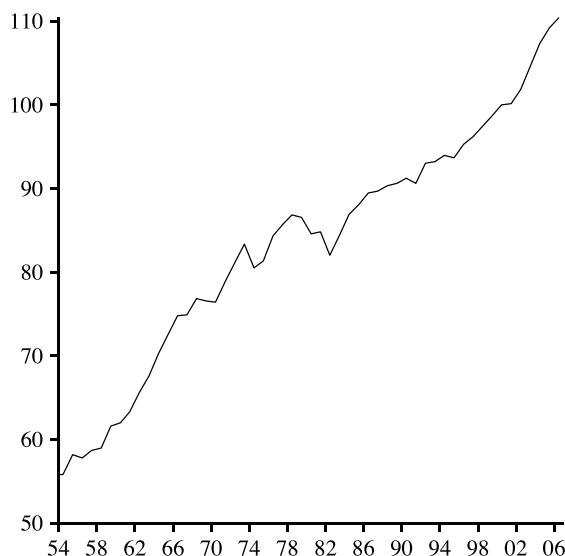
Figure 1 plots productivity growth over the last 50 years based on calculations by the Bureau of Labor Statistics of multifactor productivity (MFP) for the nonfarm business sector, which "... measures the changes in output per unit of combined inputs." Like most other such constructs, this measure illustrates that productivity grew rapidly in the 1960s, then slowed from the 1970s to the mid-1990s, and then grew rapidly again.

Much ink has been spilt trying to explain the period of slow productivity growth. A favorite early candidate was the dramatic rise in the price of oil during this period. Nordhaus (2004) provides a recent restatement, arguing that the slowdown was concentrated in industries that are related to oil, such as pipelines and auto repair. Yet, the sharp decline in oil prices in 1986, for example, did not lead to faster productivity growth. Others suggest that the slowdown was due to diminishing returns to science and technology in general (see the references in Griliches (1993)).

An explanation related to information technology

Greenwood and Yorukoglu (1997) turn the argument about diminishing returns on its head, arguing that the slowdown resulted not from an exhaustion of technical possibilities but from the opening up of new ones, specifically, the introduction of information technologies (IT). The authors argue that firms and workers will take a while to learn how to use the new technology. For example, they point to David's (1991) analysis of electrification in America. Before electricity, factories used a single source of energy—typically steam or water—to power all the machines at once, using a system of belts and drives. They continued to use this single-power-source structure even after the advent of electric power, using motors to drive groups of machines.

Figure 1
Multifactor productivity, nonfarm business sector
2000 = 100



Over time, however, firms figured out that machines could be powered individually, leading to more efficient production processes; for instance, the production plans for one machine no longer had to take account of when the other machines were running.

Critically, during this period, when both firms and workers are learning what to do with the new technology, worker productivity is likely to fall below what it was otherwise. Thus, Greenwood and Yorukoglu (GY) argue that while new technology ultimately leads to higher productivity, the immediate response to the new technology is likely to be a decrease in productivity.

The GY explanation elegantly links the 1970s and the 1990s. Productivity slowed down in the 1970s as workers and firms struggled to learn and implement the new information technologies; as this process moved ahead, productivity surged in the 1990s. And the idea that learning is costly and may be accompanied by temporarily lower output growth is plausible as well.



CSIP NOTES

CSIP Notes appears on an occasional basis. It is prepared under the auspices of the Center for the Study of Innovation and Productivity within the FRBSF's Economic Research Department.

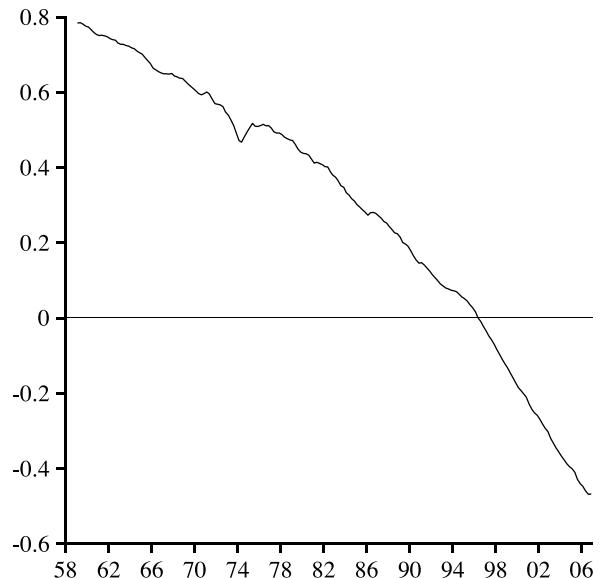
What is implausible is the speed of learning required for this story. The productivity slowdown that began in the early 1970s lasted more than two decades. Could it really take that long to learn about each of the new information technologies that have emerged over this period? Most importantly, would the productivity growth rate remain depressed for 25 years? A recent counterexample is the creation of the world wide web in the mid-1990s, which was followed almost immediately by waves of new uses that are still ongoing as firms have continued to figure out ways to capitalize on it. Note that productivity growth accelerated at about the same time. This suggests that the IT revolution (and, by implication, any other significant shift in technology) should be viewed not as a single drawn-out process requiring a long period of learning during which one must live with below normal productivity growth, but rather as a series of related breakthroughs and inventions, each of which is figured out and mastered (and the productivity gains enjoyed) as it emerges.

Also suspect in the GY analysis is their approach to measuring technical progress. They recommend using the price of capital goods (defined here to include equipment as well as consumer durables) relative to the price of consumer goods (defined to equal nondurable consumer goods and services). This recommendation not only can be justified by a formal model, but its underlying intuition also is straightforward: think of how much the price of computers has fallen (relative to the price of shirts, say) over the last two decades and how much more productive computers have become over the same time. Figure 2 shows that the decline in the relative price of capital goods is not a recent phenomenon, but has been going on for some time. However, as Marquis and Trehan (2007) point out, this price also depends upon what is happening to the price of consumer goods. When the founder of Wal-Mart figured out how to create a more efficient retail chain, for example, he caused the price of shirts to fall relative to the price of numerically controlled machines. But GY would see the resulting rise in the relative price of capital goods as a negative shock to capital sector technology. More generally, the point is that the change in the behavior of the relative price of capital goods in the 1970s could have been caused by changes in productivity outside that sector.

An alternative that emphasizes the service sector

Griliches (1993) provides one set of arguments along these lines, arguing that the productivity slowdown that began in the late 1960s tended to be concentrated in the service sectors, where it was hard to measure (for example, health services) and not in sectors where measurement was relatively easy (such as manufacturing).

Figure 2
The relative price of capital goods



How large a role measurement issues may have played has been a matter of dispute, but others—such as Triplett and Bosworth (2000)—have confirmed that productivity did slow down by more in the service sector. In subsequent research (2007), these authors argue that the service sector productivity deceleration that took place in the early 1970s has been reversed since the mid-1990s. Using a data set that covers 34 service sector industries and spans the 1987–2005 period, they calculate that annual MFP growth in the service sectors accelerated from 0.5% over the 1987–1995 period to 1.3% over 1995–2000 and to 1.5% over the 2000–2005 period; the corresponding numbers for the goods sectors are 1.8%, 2.3% and 1.9%. According to the authors: “The services sector contributed three-quarters of the economy-wide acceleration in MFP after 1995, a contribution that is without historical precedent” (p. 4).

Based on this evidence, they conclude that “Baumol’s disease” has been cured. This refers to Baumol (1967), who pointed out that in an economy where productivity was growing in some but not all sectors (with teaching and hospitals among many examples of the latter), economic growth would slow down over time, unless consumers were willing to reduce the share of income they spent on goods with little or no productivity growth. His account provided an explanation for what happened in the U.S. during the 1970s, when productivity growth slowed down and employment in the service sector grew much faster than in manufacturing.

While Bosworth and Triplett's careful measurement and analysis highlight the role of MFP changes in the service sector both in the productivity slowdown of the 1970s and the acceleration of the 1990s, we do not know if these changes are statistically significant. For example, it has been argued that the only clear evidence of productivity change in services lies in the wholesale and retail trade sectors. Nor do the authors provide any explanation of what caused the changes in service sector productivity growth. It is difficult to know, for instance, what to make of the "measurement explanation" of the 1970s productivity slowdown in light of the recent acceleration in service sector productivity.

Another aspect of the Bosworth and Triplett argument is that the acceleration in MFP growth in the service sector is not related to either previous or contemporaneous IT investment. Note that this is not the same thing as saying that increasing amounts of IT investment do not affect output per worker or labor productivity.

But others have emphasized the role of IT (and the capital goods sector more generally) in the recent productivity acceleration. Basu and Fernald (2006) argue that the recent productivity surge represents the effects of earlier IT investment. In particular, they argue that cheaper IT allows firms to reorganize production in radically different and more productive ways and also fosters complementary innovations. Further, it takes some time for these productivity enhancing effects of IT investment to manifest themselves. In their empirical analysis, they find that, during the 2000s, productivity growth accelerated by more in industries that had high IT investment growth rates over 1987–2000. Using a different data set and techniques, Marquis and Trehan (2007) argue that the productivity deceleration of the 1970s resulted from a common shock that had dissimilar effects on different sectors of the economy (which is consistent with a deceleration in service sector productivity), but that the acceleration of the 1990s is located in the capital goods sector alone.

Conclusions

It is tempting to look for a common explanation for the productivity deceleration of the 1970s and the acceleration of the 1990s. But this turns out to be a difficult task. An alternative view is that periods of rapid productivity growth represent changes in the level of productivity due to unrelated innovations that come along every so often. For example, one might see rapid productivity growth as the economy moved from a pre-IT environment to an IT-based environment, but the

faster growth would dissipate once the new technology was fully incorporated into the economy. This view still leaves us without an explanation of the 1970s most people can agree with. While analyses suggest that some sectors slowed down by more than others, the reasons for that are far from obvious and do not appear to be related to the IT sector. There is greater agreement that the productivity acceleration of the 1990s was related to IT, though here again not everyone agrees about what—if any—other factors may have been involved.

Bharat Trehan
Research Advisor

References

- Basu, Susanto, and John Fernald. 2006. "Information and Communications Technology as a General Purpose Technology: Evidence from U.S. Industry Data." Federal Reserve Bank of San Francisco Working Paper 2006-29. <http://www.frbsf.org/publications/economics/papers/2006/wp06-29bk.pdf>
- Baumol, William J. 1967. "Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis." *American Economic Review* 57, pp. 415–426.
- Bosworth, Barry, and Jack Triplett. 2007. "The Early 21st Century Productivity Expansion Is Still in Services." *International Productivity Monitor* 14 (Spring) pp. 3–19.
- Bureau of Labor Statistics. <http://www.bls.gov/mfp/home.htm#data> (BLS measure of MFP and discussion).
- David, Paul. 1991. "Computer and Dynamo: The Modern Productivity Paradox in a Not-too-Distant Mirror." *Technology and Productivity: The Challenge for Economic Policy*. Paris: Organization for Economic Cooperation and Development, pp. 315–348.
- Greenwood, Jeremy, and Mehmet Yorukoglu. 1997. "1974." *Carnegie-Rochester Conference Series on Public Policy* 46, pp. 49–95.
- Griliches, Zvi. 1993. "Productivity, R&D, and the Data Constraint." *American Economic Review* 83, pp. 1–23.
- Marquis, Milton, and Bharat Trehan. 2007. "On Using Relative Prices to Measure Capital-Specific Technological Progress." Mimeo, Federal Reserve Bank of San Francisco.
- Nordhaus, William. 2004. "Retrospective on the 1970s Productivity Slowdown." NBER Working Paper 10950.
- Triplett, Jack, and Barry Bosworth. 2000. "Productivity in the Services Sector." Brookings Economic Papers, January.

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