PAGE ONE Economics®

The Productivity Puzzle

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GLOSSARY

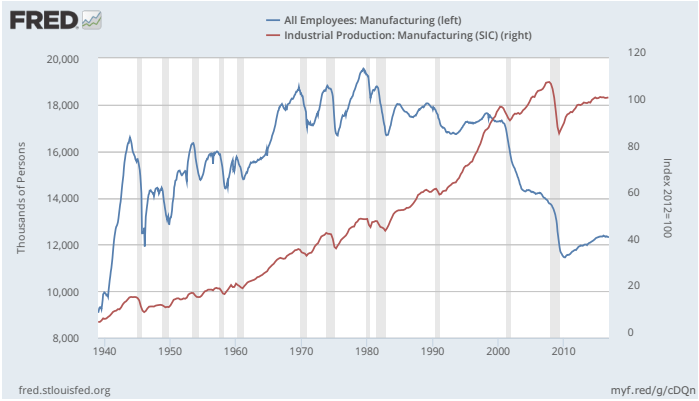
Investment: The purchase of physical capital goods (e.g., buildings, tools and equipment) that are used to produce goods and services.

Standard of living: A measure of the goods and services available to each person in a country; a measure of economic well-being. Also known as per capita real GDP (gross domestic product).

"Human history teaches us that economic growth springs from better recipes, not just from more cooking."
—Paul Romer

Have you ever walked through a store and looked closely at where the products are made? If so, you might find yourself wondering if anything is manufactured in the United States anymore. As it turns out, manufacturing output in the United States is near its highest levels ever. In fact, the United States produces twice as much as it did in 1982, with one-third fewer workers (Figure 1).[1]

Figure 1
Manufacturing Output and Employment



NOTE: The red line shows manufacturing output; the blue line shows employment in manufacturing. Starting in the 1980s, manufacturing employment started to fall, while output continued to rise.

SOURCE: U.S. Bureau of Labor Statistics and Board of Governors of the Federal Reserve System, retrieved from FRED®, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/graph/?g=cexg, accessed January 20, 2017.

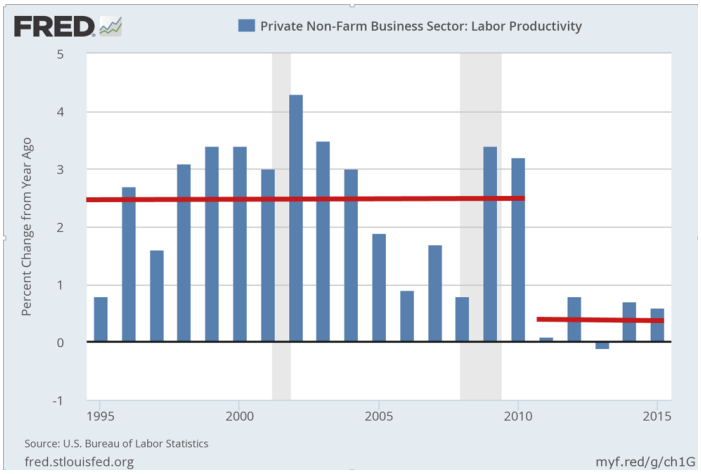
Where Does Productivity Come From?

Here's our riddle: How does an economy manufacture more goods with fewer workers? The answer lies in the economic concept of productivity. Productivity is the ratio of output per worker per unit of time. Increasing

productivity enables an economy to produce the same amount of output (or more) with fewer workers. In fact, productivity is key to raising the **standard of living**. Basically, a country can consume (buy) more goods and services per person if they produce more goods and services per person. But how does this happen? Economists say that changes in productivity are usually due to some combination of these factors:

1. **Increases in physical capital (both quantity and quality) per worker.** Physical capital (also known as capital resources and capital goods) are goods that have been produced and are used to produce other goods and services. They are used over and over again in the production process. For example, imagine an accountant keeping track of a corporation's finances with an old-fashioned adding machine. Now, imagine the same accountant equipped with a computer and sophisticated software. In each case, one accountant is doing the work, but the output (and therefore productivity) will likely be higher with the computer and software.
2. **Increases in human capital per worker.** Human capital is the knowledge and skills that people obtain through education, experience, and training. Consider the accountant with her computer and software, but imagine she gets new software. Chances are she would benefit from training on the software, and her skills will grow further with experience. In a similar way, the education that students receive in school and college (and further training and work experience) is an important part of the productivity growth story.
3. **Technological change.** Technological change (also known as technological advancement) is an advance in overall knowledge in a specific area. For example, it could be the introduction of new production techniques or methods that allow firms to produce more output with the same amount of labor and physical capital. Technological change is the largest contributor to productivity.[2] Think about farming. One hundred years ago, a large portion of the American labor force worked on farms because food production was very labor intensive. But, due to large increases in productivity (because of new farming technology), more food is produced, while less than 2 percent of the labor force is now working in the agriculture sector of the economy.[3]

Figure 2
Productivity Growth



NOTE: From 1995 to 2010 productivity growth averaged 2.5 percent (top red line), since that time (2011-2015) it has been 0.4 percent (bottom red line).

SOURCE: Author's calculation and U.S. Bureau of Labor Statistics, retrieved from FRED®, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/graph/?g=c4cP, accessed January 20, 2017.

Changing Productivity Over Time

Because productivity determines output, productivity is a major influence on a country's rate of economic growth and standard of living. As such, it is very important economic data. From 1995 to 2010, U.S. productivity growth averaged 2.5 percent (Figure 2). Recently, however, productivity has declined—it averaged only 0.4 percent from 2011 to 2015.[4] Lower productivity growth constrains a country's economic growth and results in a slower increase in the standard of living.

Economists have suggested several theories for the productivity slowdown,[5] and most of the analysis centers on changes in the three factors discussed above.

First, economists point to weak investment in capital stock. The capital stock is the total available physical capital in a nation. A nation can increase its capital stock through **investment**. The capital stock decreases due to capital depreciation, which is the amount of capital worn out or used up in producing a nation's economic output. Currently, the capital stock has been growing at a slower rate. This means that the increase in capital per worker has been smaller than in previous periods and

that productivity will improve more slowly.[6] Economists disagree about how much this piece explains the larger puzzle, with estimates ranging from 25 to 70 percent of the current slowdown in productivity.[7]

Second, economists suggest that changes in human capital in the workforce are contributing to the change in productivity. Research suggests that rising levels of human capital explain about 20 percent of U.S. productivity growth from 1950 to 2007. Average educational attainment, which is the highest level of education that an individual has completed, has been growing at about one year per decade and has contributed about 0.6 percentage points to productivity growth per year.[8] Most recently, educational attainment has slowed, which will (other things equal) likely contribute to slower productivity growth in the future.

Finally, some of the slowdown in productivity growth is likely due to a slowdown in technological change. Some economists speculate that even with advances in technology, some of the newer advances might impact productivity only slightly. For example, Twitter and Snapchat have great social value (and the companies themselves have a high market value), but they likely have little impact on labor productivity. In fact, some speculate that they might even reduce labor productivity because they distract workers from their jobs.[9] A reality of technological change is that there is very often a long lag before it impacts productivity. For example, consider the series of inventions between 1860 and 1900, which included the electric light, electric motor, and internal combustion engine; telegraph and telephone; and indoor plumbing and sanitation. This burst of technological change has been called the Second Industrial Revolution. These inventions had an immediate effect, but they continued to dramatically increase productivity for six decades—from 1913 to 1972—as people found new ways to apply them.[10] It has been proposed that the invention of the computer and internet might embody a Third Industrial Revolution in that the impact of these technologies will take years to play out as people find new ways to use them.[11]

What's Next?

If productivity stays at its current pace, slow growth in the standard of living and wages for workers is likely. Innovations are, however, by their very nature unpredictable. Some suggest that we could be one innovation away from a burst in productivity growth similar to the one from 1995 to 2004.[12] Possible sources are the fields of robotics and artificial intelligence.[13] Or the case could be, as proposed by some, that the age of large innovations (e.g., electrification and computers) is behind us and that productivity growth (and living standards) will likely increase little for the foreseeable future.[14]

Can the Government Boost Productivity?

Economists concerned about the decrease in productivity suggest that government policy can play a role. Government spending on infrastructure (e.g., airports, highways, and bridges) could increase productivity because it reduces the cost (in time and money) of transporting goods and people from one place to another.[15] Government could also increase productivity by increasing education spending,[16] which increases the human capital of the workforce. In addition, tax reform that creates incentives for capital investment by private firms and more effective regulations could also increase productivity.[17] Spending on R&D (research and development) could promote technological change, but more R&D does not always result in new technologies. And, because government intervention has costs, paying for these policies will result in higher taxes, larger budget deficits, or the loss of services currently enjoyed. The key piece of the productivity puzzle—technological change—is the most difficult to achieve because it is unpredictable.

Conclusion

U.S. productivity experienced rapid growth from 1995 to 2010, but it has slowed recently. Because productivity growth directly affects living standards and workers' wages, economists have discussed many potential reasons for the slowdown. They have identified weak capital investment and a slowdown in educational attainment as causes but also a slowdown in technological change. Historically, the largest contributor to productivity growth has been technological change. Capital investment and educational attainment are easier to improve through investment and spending on education; however, technological change is more difficult to fix because it is inherently unpredictable. ■

Notes

[1] U.S. Bureau of Labor Statistics and Board of Governors of the Federal Reserve System, retrieved from FRED®; https://fred.stlouisfed.org/graph/?g=cexg, accessed January 20, 2017.

[2] McConnell, Campbell R.; Brue, Stanley L. and Flynn, Sean M. *Economics: Principles, Problems, and Policies*. 19th Edition. McGraw-Hill Irwin, 2013, p. 515.

[3] Bureau of Labor Statistics. "Employment by Major Industry Sector"; https://www.bls.gov/emp/ep_table_201.htm, accessed January 20, 2017.

[4] U.S. Bureau of Labor Statistics, retrieved from FRED®; https://fred.stlouisfed.org/graph/?g=chrH, accessed January 20, 2017.

[5] Some economists suggest that productivity is not being properly measured in that traditional measurement strategies do not capture gains from newer technologies, while others suggest that if mismeasurement is a factor, it is tiny (See Fischer, Stanley. "Remarks on the U.S. Economy." Federal Reserve Board of Governors. August 21, 2016; https://www.federalreserve.gov/newsevents/speech/fischer20160821a.pdf). Other economists suggest that the recent decrease in productivity is a return to normal productivity growth. Specifically, they say the acceleration of productivity from the mid-1990s to the early 2000s was an anomaly that should not be expected to continue.

[6] Fischer (2016; see footnote 5).

[7] Blinder, Alan S. "The Mystery of Declining Productivity Growth." *Wall Street Journal*, May 14, 2015; http://www.wsj.com/articles/the-mystery-of-declining-productivity-growth-1431645038.

[8] Fernald, John G. and Jones, Charles I. "The Future of U.S. Economic Growth." *American Economic Review*, May 2014, *104*(5) pp. 44-49.

[9] See, for example, Blinder (2015; see footnote 7).

[10] Gordon, Robert J. "Does the 'New Economy' Measure Up to the Great Inventions of the Past?" *Journal of Economic Perspectives*, 2000, *14*(4), pp. 49-74; www.jstor.org/stable/2647075.

[11] Fernald, John and Ramnath, Shanthi. "Information Technology and the U.S. Productivity Acceleration." *Chicago Fed Letter*, September 2003, *193*(1).

[12] Fernald, John G. "Reassessing Longer-Run U.S. Growth: How Low?" Working Paper 2016-18, Federal Reserve Bank of San Francisco, August 2016; http://www.frbsf.org/economic-research/files/wp2016-18.pdf.

[13] Powell, Jerome. "Recent Developments and Longer-Run Challenges." November 29, 2016; https://www.federalreserve.gov/newsevents/speech/powell20161129a.htm.

[14] Powell (2016; see footnote 13).

[15] Miller, Matt and Bullard, James. "Bullard: Infrastructure Plan Could Boost Productivity" (video). Bloomberg.com, November 18, 2016; http://www.bloomberg.com/news/videos/2016-11-18/bullard-infrastructure-plan-could-boost-productivity.

[16] Fischer (2016; see footnote 5).

[17] Fischer (2016; see footnote 5).

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Federal Reserve Bank of St. Louis *Page One Economics®*:

"The Productivity Puzzle"

After reading the article, complete the following:

1. Define productivity:

2. The *Page One Economics* essay identifies three factors that contribute to productivity. Describe the key aspects of each by completing the table below.

Factor	Definition	How does it contribute to the productivity slowdown?	How could government play a role?
Physical capital			
Human capital			
Technological change			

3. How is productivity related to a country's standard of living?

4. What are the potential risks of using government policy to try to increase productivity?