PIIE PETERSON INSTITUTE FOR INTERNATIONAL ECONOMICS

POLICY BRIEF

17-26 The Case for an American Productivity Revival

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June 2017

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Labor productivity performance in the United States has been dismal for more than a decade. But productivity slowdowns—even lengthy ones—are nothing new in US economic history. This Policy Brief makes the case that the current slowdown will come to an end as a new productivity revival takes hold.

Why the optimism? Official price indexes indicate that innovation in the technology sector has slowed to a crawl, but better data indicate rapid progress. Standard measures, focused on physical capital, suggest that business investment is weak, but broader measures of investment that incorporate intellectual and organizational capital report much more robust investment. New technological opportunities in healthcare, robotics, education, and the technology of invention itself provide additional reasons for optimism.

This Policy Brief gauges the potential productivity impact of these developments. The evidence points to a likely revival of US labor productivity growth from the 0.5 percent average rate registered since 2010 to a pace of 2 percent or more. A productivity revival of this magnitude would provide a solid foundation for steady increases in wages and imply that the long-run growth rate of real GDP could exceed 2.5 percent, a significant pickup from current rates.[1]

This outcome is more likely in the context of a supportive policy environment. To foster such an environment, the federal government should expand its support for basic scientific research; allow more immigration by highly skilled scientists, engineers, and entrepreneurs; and preserve America's longstanding commitment to open trade and investment policies. It should also strengthen the safety net rather than pare back support for workers displaced by the innovations that will drive future productivity growth. Additional policy interventions (described in this Policy Brief) are required to take full advantage of new educational technologies. If they avoid policy errors, President Trump or his successor could have the good fortune of presiding over a productivity revival.

HISTORICAL UPS AND DOWNS OF PRODUCTIVITY GROWTH

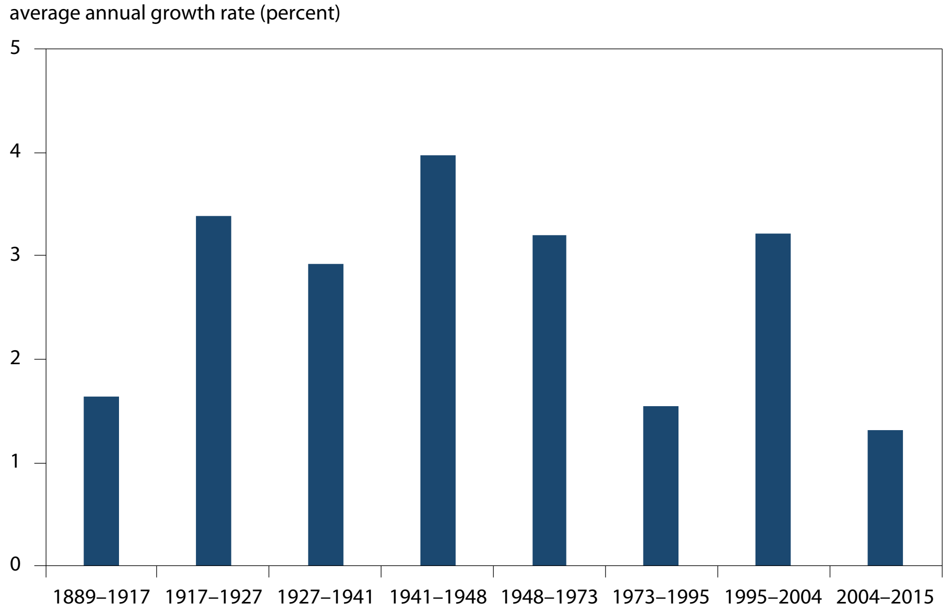
Recent weak performance of productivity has persuaded many observers that the economy faces a bleak "new normal."[2] According to Robert Gordon (a leading productivity expert and professor of economics at Northwestern University), the impact of today's digital innovations cannot compare with the fundamental technological developments (such as electrification and motorization) that boosted US growth and raised living standards between 1870 and 1970.[3] In his 2016 book *The Rise and Fall of American Growth: The US Standard of Living since the Civil War,* Gordon contends

1. Although considerably more optimistic than the current consensus view of productivity prospects, the revival described in this Policy Brief falls well short of President Trump's stated goal of 3.5–4 percent real annual GDP growth, which most economists consider unrealistic (see Daniel E. Sichel, "Can the US Economy Sustain 3½ to 4 Percent Economic Growth?" *Econofact*, January 25, 2017, http://econofact.org/can-the-u-s-economy-sustain-3%C2%BD-to-4-percent-economic-growth).

2. Some observers claim that the current productivity slowdown is a mere artifact of measurement error (because the economy grows in ways that traditional statistics fail to capture). The evidence, however, strongly supports the view that labor productivity growth has slowed sharply (see Syverson 2016 and Byrne, Fernald, and Reinsdorf 2016).

3. In addition to Gordon (2016), see Fernald (2014) and Fernald and Wang (2015).

Figure 1 Average annual growth of labor productivity in the US business sector, 1889–2015



Sources: Data for 1947–2015 are from the Bureau of Labor Statistics. Data on real output for 1929–47 are from the Bureau of Economic Analysis. All other data for 1889–1946 are from Kendrick (1961).

that slower growth of the labor force, fiscal challenges, and lagging educational attainment are also constraining growth. Former Treasury Secretary Lawrence Summers recently resurrected the term *secular stagnation* to describe the nation's economic funk.[4]

Productivity slowdowns are not unusual in the United States; its economy has long featured alternating periods of faster and slower productivity growth. Labor productivity growth in the business sector since 1889 fluctuated between periods of more and less rapid growth, with modest declines after 1927 and 1948 and more dramatic slowdowns after 1973 and 2004 (figure 1).[5] Throughout these periods of faster and slower growth, expectations for the economy's long-run prospects often turned pessimistic not long before a resurgence. Harvard professor Alvin Hansen famously predicted in 1938 that the US economy was floundering in an era of "secular stagnation" that was likely to continue for an extended period;[6] a growth surge during the 1940s, 1950s, and 1960s proved him wrong.

In the early 1970s, a significant slowdown in productivity began that persisted into the 1990s. Shortly before the end of that episode, Paul Krugman (1990) concluded that productivity growth would likely remain weak and that Americans should just get used to it. By the mid-1990s, official forecasts of long-run productivity growth reflected this pessimism. In 1997, for example, the Congressional Budget Office's estimate of the average annual growth rate of labor productivity in the long run was just over 1 percent. These downbeat assessments were confounded in the mid-1990s, as productivity growth revived to a pace of more than 3 percent from 1995 to 2004, driven by information and communication technologies.[7]

With this dramatic improvement, the pessimistic outlook of the late 1980s and early 1990s brightened.

4. Summers has written and spoken extensively on this topic (see, for example, Summers 2014). He emphasizes inadequate demand as the source of sluggish growth.

5. Before the benchmark revision of the national accounts in 1996 (which significantly boosted real GDP growth in the 1940s), the data showed a much slower growth rate of productivity for 1941–48. For example, real GDP growth for 1942 reported in Kendrick (1961) is about 6 percentage points less than that reported in the latest vintage of GDP data. Apparently, the chain-weighting introduced in the 1996 revision had a large effect on growth rates during the period when the US economy was transforming to a wartime basis. If the slower growth rate during 1941–48 in the earlier vintage of data had been used, figure 1 would have a more apparent up and down pattern of productivity growth.

6. Hansen was president of the American Economic Association; he raised the possibility of "secular stagnation" in his presidential address at the end of 1938. He described secular stagnation as "sick recoveries, which die in their infancy and depressions which feed on themselves and leave a hard and seemingly immovable core of unemployment" (see Hansen 1939).

7. For a discussion of the role of information technology in the 1990s productivity resurgence, see Oliner and Sichel (2000) and Jorgenson and Stiroh (2000).

Indeed, economists swung too far in the optimistic direction: By 2001 the Congressional Budget Office was projecting potential labor productivity growth in the nonfarm business sector of 2.7 percent a year for the foreseeable future. By the 2010s labor productivity growth had dropped to less than one-fifth that level.

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WHY THE PESSIMISTS MAY BE WRONG

Pessimists often claim that the pace of innovation has slowed and that businesses are not investing aggressively, concluding that prospects for productivity growth remain bleak. For several reasons, their pessimism may be misplaced.

Official Data Significantly Underestimate the Rate of Innovation in Information Technology

Advances in information technology (IT) drove the most recent productivity surge, which took off in the mid-1990s. During the second half of the decade, semiconductor producers improved designs and manufacturing processes, causing IT prices to fall rapidly.

Has that engine of progress ground to a halt? Robert Gordon and many other economists have noted that the prices of high-tech equipment have fallen at a much slower pace in recent years than in earlier decades. Indeed, official published measures of prices for many high-tech products are barely falling at all. Gordon and others focus on prices because economists often use trends in relative prices in a sector to infer rates of innovation.[8]

However, a growing body of literature suggests that significant biases exist in these official price measures. Byrne, Oliner, and Sichel (forthcoming) developed a new index for microprocessors used in desktop personal computers. Their preferred index fell at an average rate of 42 percent a year between 2009 and 2013, while the most comparable official price measure (the producer price index for microprocessor units [MPUs]) declines by an average rate of only 6 percent a year. This measurement gap arose in the mid-2000s because of a major change in the life-cycle pattern of Intel's posted prices for MPUs. Before the mid-2000s, the posted prices of MPUs tended to fall as newer models were introduced. This price trajectory allowed a standard methodology used for semiconductors in the producer price index (matched-model indexes) to capture quality change through the rapid price declines of older models. Since the mid-2000s, posted prices of Intel MPUs have tended to remain stable, even after the introduction of newer, more powerful models. Reflecting these relatively flat price profiles, a matched-model index will indicate little change in quality-adjusted prices even if the quality of each newly introduced model is much greater than its predecessor. The new price measure Byrne, Oliner, and Sichel developed (an hedonic index) more fully captures ongoing quality change and reveals rapid price declines after this quality change is taken into account.

This evidence on faster price declines indicates that innovation and multifactor productivity growth in semiconductors—the general-purpose technology behind much of the digital revolution—has been far more rapid than official indexes suggest. Byrne and Corrado (2016) document rapid price declines for a range of other high-tech products, pointing to ongoing brisk technical advances in a wide range of high-tech sectors. This evidence suggests that the IT revolution is still going strong.

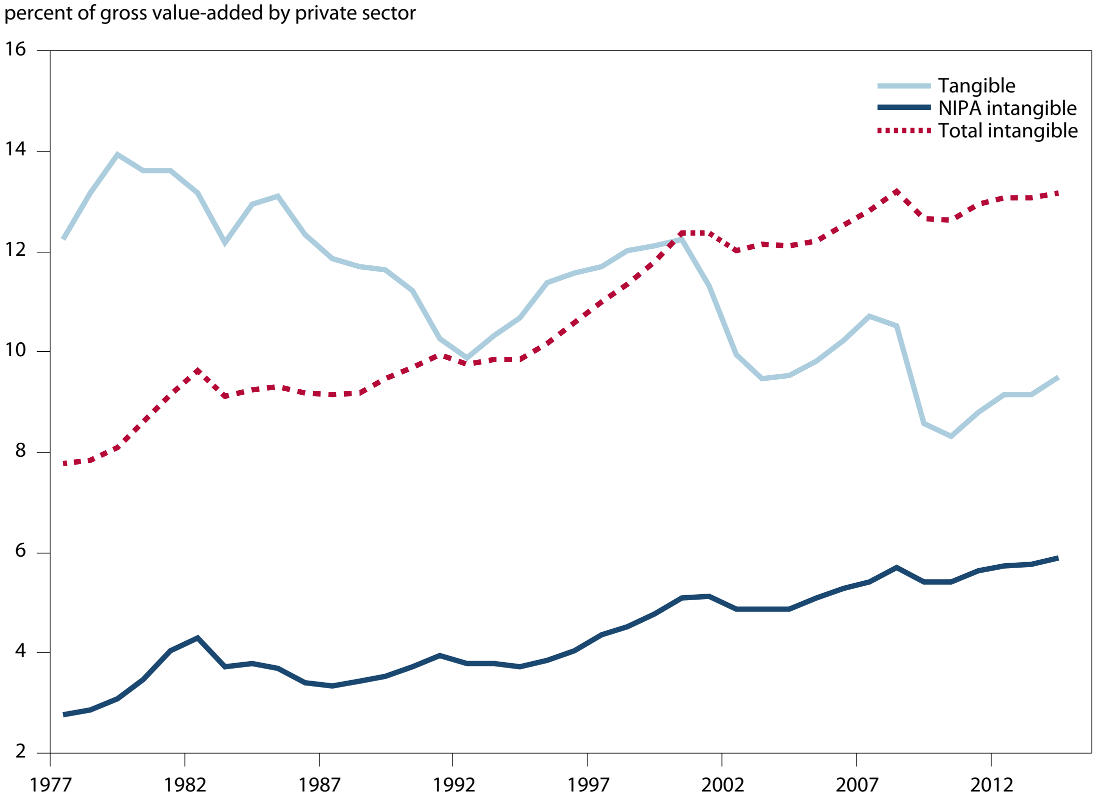
Standard Measures Underestimate the Strength of Business Investment

The share of the private sector's traditional tangible investment in GDP has recovered in recent years, but it remains below its peak in the mid-2000s and well below its value in 2000 (figure 2). For productivity pessimists, this persistent weakness in investment reflects the dispiriting view that there is little new exciting, productivity-enhancing technology in which firms can invest.

Measures of investment in physical capital tell only part of the story, however. In recent years businesses have invested aggressively in intangible capital (a concept that includes intellectual property but is broader than conventional definitions of intellectual property). The US GDP accounts only partially capture this investment. Corrado, Hulten, and Sichel (2009) argue for a broader approach. They define business investment as "any use of resources that reduces current consumption in order to increase it in

8. More formally, the link between prices and multifactor productivity relies on the "dual" representation of a production function. See Oliner and Sichel (2002) and Byrne, Oliner, and Sichel (2013, 2017) for applications of this approach. For a cautionary note, see Aizcorbe, Oliner, and Sichel (2008).

Figure 2 Tangible and intangible investment as share of total value added by the private sector in United States, 1977–2014



NIPA = National Income and Product Accounts

Note: Tangible investment excludes intangible assets included in the GDP accounts, such as software and research and development. The total intangible share is adjusted by adding the additional intangible output to the denominator as well the numerator.

Source: Update to Corrado et al. (2012) provided by Carol Corrado. Total intangible share is adjusted for additional intangible output in denominator of share.

the future." Based on this standard, business investment in software, research and development (R&D), and other types of intangible capital should be counted as business investment in the national accounts. The US GDP accounts count only some types of intangible capital as business investment (software, scientific R&D, mineral exploration, and the development of entertainment products). The investment share of these categories has continued to rise, dipping only modestly in the Great Recession.

If one adds the categories of intangibles identified by Corrado, Hulten, and Sichel that are not currently included in the GDP accounts—including nonscientific product development, brand equity, training, and organizational capital—the investment share of intangible capital (the dashed red line in figure 2) has held up.[9] In fact, the overall investment share of both tangible and all intangible capital has been relatively stable since the late 1970s. This conclusion is not surprising in an economy in which the newest technical capabilities and products rely at least as much on intangible capital as on tangible capital. This feature surely characterizes leading companies such as Google, Amazon, Facebook, and Microsoft (see Hulten 2010 for an analysis of the role of intangible capital at Microsoft). Even industrial companies like GE are increasingly investing in big data, predictive analytics, and machine learning. Moreover, some of the softness in investment in tangible IT equipment could actually reflect rapid advances in digital technologies. The rise of cloud computing, for example, has led many businesses to shift from purchasing and operating their own computers, servers, and expensive in-house software systems to renting computing services from companies like Amazon and Microsoft. These developments could cause measured investment in computer hardware to be weak even as the consumption of computer capital services rises (see Byrne and Corrado 2016 and Byrne, Corrado, and Sichel 2017).

9. The figures for brand equity include only expenditures intended to have long-lasting effects, not expenditures that are for, say, "this week's sale."

Effects of Innovation and Investment in New Technology Take Time to Emerge

If the pace of IT innovation is much faster than official indexes suggest and business investment is much stronger than traditional measures indicate, why has productivity growth remained sluggish? History suggests that the macro-level productivity effects of innovation and investment in new technology often take time to emerge. The basic technologies needed to electrify the manufacturing sector in the United States were in place by 1890, for example, but it took decades before they diffused through the economy as firms learned to use them effectively (David 1990). When the measurable impact of all this investment on productivity finally arrived, it appears to have come in waves rather than in one period of uniformly rapid productivity growth, according to Syverson (2013).

A similar pattern emerged for the digital revolution. In 1987, Robert Solow famously quipped, "We can see computers everywhere but in the productivity statistics." Just a few years later, this "Solow paradox" had been resolved by a pronounced productivity acceleration—but that acceleration arrived long after computers had become commonplace. Brynjolfsson, Hitt, and Yang (2002) document significant coinvestments in software and skill building that were necessary to realize the benefits of investments in computer hardware. Indeed, they find that firms spent significantly more on these associated coinvestments than on computer hardware itself and argue that it took considerable time for these coinvestments to be made. It was therefore not surprising that the productivity benefits of the IT revolution arrived long after the fundamental underlying technologies were developed and initially commercialized.[10] In the same way, the rapid innovation and robust investment of recent years will eventually have an impact, but it could take some time for the next wave of productivity growth to become visible at the aggregate level.

BASIC ARITHMETIC OF A PRODUCTIVITY REVIVAL

For a new wave of digital-related productivity growth to appear, ongoing technological advances need to spread across multiple sectors, spur additional business investment, and translate into growth in labor productivity. Byrne, Oliner, and Sichel (2013, 2017) rely on a standard model of economic growth to illustrate the possible magnitude of such gains. Using a multisector elaboration of the Solow growth model, they estimate long-run labor productivity growth based on assumptions about rates of technical advancement in key technologies. Using official measures of high-tech prices, they generate a baseline estimate for trend labor productivity growth of 1.5 percent a year. They also present an alternative projection, in which digital technologies improve at a rate that takes account of the mismeasurement of high-tech prices described above. Steady-state labor productivity growth in this scenario is about 2¼ percent a year. This estimate suggests that the recent pace of labor productivity growth has been well below the rate implied by a plausible reading of technology trends and provides support for a productivity revival.

The analysis in Byrne, Oliner, and Sichel is aggregate rather than granular. To more clearly illustrate what a productivity revival could look like, the next section examines four ongoing developments in nonmanufacturing sectors that undergird the case for optimism. The focus is on nonmanufacturing sectors in order to confront Gordon's argument that technical advance in manufacturing may well continue to proceed at a solid rate but that manufacturing represents too small a share of the economy for those advances to have an important effect on aggregate labor productivity. Each of the factors examined includes a back-of-the-envelope calculation that provides a plausible range of future gains related to digital technologies. The estimates are then incorporated within the Byrne, Oliner, and Sichel framework to assess the degree to which productivity growth might rise above its recent lackluster trend.

This accounting exercise is undertaken using the same basic productivity accounting approach as Byrne, Oliner, and Sichel, which can be described by their main equation:

$$\dot{Y} - \dot{H} = \sum_j^J \alpha_j^k \left(\dot{K}_j - \dot{H}\right) + \propto^L \dot{q} + \dot{MFP}.$$

Labor productivity growth $(\dot{Y} - \dot{H})$ is measured as the growth in output $(\dot{Y})$ minus the growth in hours $(\dot{H})$. Productivity growth is decomposed into contributions from J types of capital, including both tangible and intangible capital; aggregate growth in labor quality $(\propto^L \dot{q})$; and multifactor productivity growth $(\dot{MFP})$. The $\propto_j^k$ terms in the equation are income shares for each type of capital.[11]

10. See Brynjolfsson and Hitt (2003) for evidence on the lagged productivity effects of IT investments.

11. For the formal derivation of this approach, see Oliner, Sichel, and Stiroh (2007).

NEW OPPORTUNITIES

Four developments have the potential to contribute to faster productivity growth in the United States: improvements in the healthcare system, increasing use of robots, a revolution in e-learning, and globalization of invention.[12]

New Cures for a Sick Healthcare System

Critics of the American healthcare system have long decried its poor productivity. According to the Institute of Medicine, $765 billion—roughly 20–30 percent of annual US healthcare expenditure—was wasted in 2010 (Yong, Saunders, and Olsen 2010). Other studies cite large differences in the cost of treatment of the same diseases in similar patients across different providers and regions, with no corresponding difference in health outcomes (see Skinner 2012). Lack of data, lack of expertise within the healthcare community concerning large-scale data analytics, and limitations in computing power have hampered efforts to root out waste and identify best practices. But emerging technologies offer three new pathways to faster productivity growth.

Four developments have the potential to contribute to faster productivity growth in the United States: improvements in the healthcare system, the increasing use of robots, a revolution in e-learning, and the globalization of invention.

First, the healthcare community is increasingly combining its growing data analytics capabilities with large-scale data sharing among regional healthcare systems.[13] These developments hold out the promise of raising the labor productivity of the sector by identifying cost-effective best practices and speeding their diffusion throughout the country. Second, physicians are increasingly using clinical decision support systems that use artificial intelligence to catch and prevent costly medical errors arising from fatigue or inattention (Neill 2013, Somanchi and Neill 2013). Third, telemedicine is relaxing the traditional need for patients to be in the physical presence of their healthcare providers. Thanks to smartphones and the declining cost of systems of sensors, medical experts can monitor key biophysical characteristics, evaluate uncertain medical situations, assist in emergencies, and even manage chronic diseases from a distance, saving time and transportation costs while avoiding expensive hospitalizations.

Could these developments have an impact on aggregate productivity? A study by McKinsey (Manyika et al. 2011) concludes that deploying these kinds of technologies could raise the annual productivity growth of the healthcare sector by 0.7 percentage point for years, perhaps even a decade or two. Given the massive size of the sector—roughly one-fifth of US GDP—the McKinsey estimates imply a boost to aggregate productivity growth of 0.14 percentage point a year. A more conservative scenario that cuts the McKinsey productivity growth forecast in half could still generate 7 basis points of additional aggregate productivity growth.

Rise of Robots

The ability of robots to navigate complex environments has increased significantly, thanks to the diffusion of GPS, better (and less expensive) sensors, and software that allows robots to create and instantaneously update internal maps of their surroundings.[14] Roboticization of parts of the workflow in the manufacturing and service sectors no longer requires the complete and often expensive redesign of the workspace that would have been necessary years ago. Reflecting these new opportunities, leading service companies like Google and Amazon have invested aggressively in robot technology. Market statistics point to an unprecedented surge in purchases of robots in a growing range of sectors (see Thomas, Kass, and Davarzani 2014, and Robotic Industries Association 2016).

Sizing up the ultimate impact of roboticization on productivity is difficult, in part because the range of sectors that could effectively exploit this technology is still unknown. This analysis assumes a lower bound of just 7 basis points of additional productivity growth per year from widespread deployment of new robotics technologies throughout the economy. One could imagine a productivity boost more than three times as large (25 basis points) as robots become a significant complement to labor in both services and manufacturing.

12. This section draws on a study conducted for the White House Office of Science and Technology Policy by Carnegie Mellon students Marwa Al-Fakhri, Jonathan Lakey, Dini Maghfirra, Tara O'Neill, Dennis Sawyers, and Lara Tengelsen, supervised by Lee Branstetter. The study (Al-Fakhri et al. 2014) is available upon request.

13. One of the most compelling research projects under way in this domain is PCORnet, the national patient-centered clinical research network, described at www.pcornet.org.

14. These observations reflect conversations with leading experts on robotics at Carnegie Mellon, including William "Red" Whittaker.

E-Learning Revolution

One of the most powerful drivers of US productivity growth over the past century was the steady rise in the level of formal education of successive cohorts of American workers. This growth slowed dramatically in recent decades, as Goldin and Katz (2008) note. Modern digital technology may be able to boost its growth.

One of the most exciting advances in educational technology is the growing use of "cognitive tutors" to enhance classroom learning. Using models of human learning based on advances in cognitive science, these computer programs analyze student errors, identify what the student does not understand, and give the student personalized practice problems and instruction to remedy the lack of understanding.

In a two-year randomized control trial by the RAND Corporation in 147 schools in seven states, the use of a cognitive tutor for Algebra I developed by Carnegie Learning (a Carnegie Mellon University spinoff) roughly doubled student learning over the course of a year. These effects were uniform over every part of the mathematics ability distribution (see Pane et al. 2014). The direct cost of this technology was tiny: The software cost less than $70 per student per year.[15]

Could intelligent tutors in other subjects achieve the same degree of learning acceleration documented in Algebra I? If so, this technology could transform the skill levels of the American workforce.

The baseline projections of Byrne, Oliner, and Sichel assume a minimal increase in educational attainment and labor quality that contributes only 7 basis points a year to aggregate labor productivity growth. The possibilities opened up by new educational technology suggest a potential contribution of at least 15 basis points a year. Even faster growth in the human capital stock could boost labor productivity by as much as 30 basis points a year. Although well above what can be expected with current educational procedures, technologies, and policies, this higher increment to labor productivity growth would still be well below that achieved in the 1980–2005 period. Over this 25-year period, US human capital growth tapered off sharply; the educational attainment of the average worker at the end of this period was only slightly more than a year greater than it had been at the beginning.

15. Muralidharan, Singh, and Gamanian (2016) find evidence of even larger gains from the deployment of similar technologies in India.

Globalization of Invention

This Policy Brief paints an optimistic picture of vigorous American innovation. However, modern theories of economic growth warn that inventors will be increasingly unable to shoulder the growing "burden of knowledge" (Jones 2009). According to these theories, innovation has become harder because would-be innovators must now acquire a larger stock of knowledge before they can contribute to it. Because it takes more and more effort to expand the knowledge stock, the innovation rate must decline in the long run. The advanced economies have only so many good minds to devote to innovation, and they can be procured in ever-larger numbers only at an ever-increasing cost.

An impressive body of evidence supports these theories (see Jones 1995a, 1995b; Bloom et al. 2017)—and their implications are sobering. Even if every argument that has been advanced in this Policy Brief is correct, the reprieve from a long-run slowdown in innovation itself may be only temporary.

There is a silver lining in this pessimistic model of innovation, however: The scale of investment in innovation matters, and the globalization of knowledge creation is likely to be a powerful force boosting productivity growth. A small number of mostly British engineers, tinkerers, and entrepreneurs produced the great breakthroughs of the first Industrial Revolution. The second Industrial Revolution went farther, and it achieved more, because it rested on a much broader foundation of inventors that extended well beyond Great Britain. This broader mobilization of Western inventive talent had its limits: The research technology of the era required collaborators to be in the same place at the same time. Innovation labor markets were, at best, national in scope, limiting the array of research teams that could be created. Human industrial advance still rested on a narrow foundation, with most of the human race effectively excluded from participation.

Today, this situation is changing in a way that has important implications for future productivity growth. Higher education is spreading rapidly in emerging markets like China and India (see Freeman 2009 and Freeman and Huang 2015). In just the past dozen years, China expanded the number of bachelor's degrees it grants in science and engineering by about 300,000, to more than 1.3 million per year (NSF 2016). By contrast, the United States awards only about 250,000 bachelor's degrees in science and engineering per year. The average quality of an engineering education in China or India remains well below that of Western countries, and the ability of either China or India to innovate at the global technology frontier through the efforts of its indigenous firms is still limited (Freeman and Huang 2015).

Table 1 Conservative and optimistic projections of productivity growth

Item	Conservative scenario	Optimistic scenario
Annual percentage growth in labor productivity (baseline from Byrne, Oliner, and Sichel 2017)	1.50	1.50
Source of additional productivity growth (percentage points)		
Big data in healthcare	0.07	0.14
Robotics	0.07	0.25
E-learning	0.15	0.30
Higher research intensity in non-Western economies	0.10	0.25
Total augmented labor productivity growth (percent)	1.89	2.44
Memorandum:		
Second wave scenario from Byrne, Oliner, and Sichel (2017) (percent)	2.20	2.20

Source: Authors' calculations.

But multinationals have responded to this growing talent pool by ramping up the amount of R&D they undertake in emerging-market countries. With computer-assisted design software, internet videoconferencing, and the ability to quickly access terabytes of test data, it is now increasingly possible for Chinese and Indian engineers to collaborate closely, in almost real time, with seasoned technology experts in the United States, Western Europe, and Japan.

This combination of Western savvy and Asian talent appears to produce impressive results. In a comprehensive study of US patents granted to teams that included at least one Indian or Chinese inventor, Branstetter, Li, and Veloso (2015) find that Chinese engineers working for foreign-based multinationals produced inventions in China that appear to be at least as good as the inventions produced by the same multinationals in their home countries. IBM or Intel engineers in China can be as productive as IBM or Intel engineers in Silicon Valley—and the number of good engineers in China is rapidly growing.

Those engineers could power an acceleration in the rate of multifactor productivity growth around the world. Fernald and Jones (2014) estimate that about 1.3 percentage points of the average 2 percent annual increase in US labor productivity from 1950 to 2007 stemmed from higher research intensity (that is, the rising fraction of the population engaged in invention) in the advanced countries. A massive rise in research intensity outside the postindustrial West is already underway, and it appears to have many decades of rapid growth left in it. As investment in higher education spreads through the developing world, it is easy to imagine global research intensity doubling or more than doubling in coming decades.

To be conservative, the calculations presented in the next section do not presume that the massive brain mobilization underway in Asia will generate the same kind of productivity boost that the postwar rise in research intensity in the Western economies did. The analysis presumes that the rise in research intensity in Asia generates only 10 basis points of additional productivity growth in the United States in the low-growth scenario and 25 basis points of growth in the higher-growth scenario. Regardless of the exact magnitude of the productivity boost, the long-run nature of human capital accumulation ensures that these forces will be operative for decades, providing crucial support for faster productivity growth even in the longer run.

Putting the Pieces Together

Even the conservative estimate of the additional boosts to productivity that could arise from the various new sources indicate a sizable boost to productivity growth, effectively lifting the growth rate to nearly 2 percent (table 1). In a more optimistic scenario (based on an increase in productivity through the use of big data in healthcare, the deployment of robots, e-learning, and rising research intensity outside Western economies), expected productivity growth rises to almost 2½ percent. Even the optimistic scenario hardly represents unconstrained techno-enthusiasm. The analysis thus strongly supports the view that a 2¼ percent growth rate for labor productivity—roughly the midpoint of the modest and optimistic scenarios—is a highly plausible outcome in coming years.

POLICIES TO PROMOTE A PRODUCTIVITY REVIVAL

The best way government could hasten this productivity revival is through continued adherence to a set of growth-supporting policies that have received bipartisan support for decades. The first is robust federal investment in basic science. Although science is the foundation on which technological progress depends, markets will not invest in it to a sufficient degree; the argument for government support is clear and compelling (Stephan 2012).

Evidence also shows that immigrant scientists and entrepreneurs play a disproportionate role in driving the technological advances that power productivity growth in the United States (Kerr et al. 2016). Rather than dissuading highly skilled immigrants from seeking educational and employment opportunities in the United States, as the Trump administration seems to be doing, the federal government should make it easier for inventors, scientists, and entrepreneurs from around the world to secure the right to work in the United States. The globalization of invention could undergird productivity growth in the United States—but globalization of invention presupposes the continuation of an open global trading and investment system supported by the United States. Recent statements and policy steps by the new administration backing away from that longstanding bipartisan embrace of open trade and investment are likely to undermine, rather than support, future economic growth.

The best way government could hasten this productivity revival is through continued adherence to a set of growth-supporting policies that have received bipartisan support for decades.

That said, openness to international trade, investment, and new technology often brings disruption. The safety net has not done nearly enough to limit the disruptive impact of trade and technology shocks in the United States. Many economists have long advocated "wage insurance," which would compensate workers forced to move to jobs that paid less than they had been earning, as a useful addition to the safety net (Lalonde 2007). Such a system merits close consideration. Current proposals to curtail or weaken the safety net represent a significant step in the wrong direction.

New educational technologies are potentially transformative, but the fragmented and imperfect nature of the market for them could drastically limit their adoption and slow their diffusion. As Chatterji and Jones (2012) note, the officials making curricular decisions for the more than 13,000 school districts in the United States are constantly bombarded by (mostly false) claims regarding the efficacy of new educational products and curricular fads—claims they generally lack the expertise to verify. They also face distorted incentives: If they adopt a new technology that fails, their careers are in jeopardy, whereas if they continue to underperform as badly as peer institutions, their jobs are secure. Given these market imperfections, Chatterji and Jones make the case for a public agency or public-private partnership that could certify the efficacy of new educational technologies in the same way the Food and Drug Administration (FDA) certifies the safety and efficacy of new drugs, by supervising rigorous, randomized control trials.[16] Modest policy effort in this direction could yield rich dividends in the form of much faster, more cost-effective human capital formation.

CONCLUSION

Prominent researchers have raised troubling questions about future prospects for productivity gains and advances in living standards. Even before the financial crisis, US productivity growth had slowed sharply, and it remains stuck in low gear more than a decade later. This persistent slowdown strengthens techno-pessimists, who argue that slow productivity growth is likely to continue.

This Policy Brief makes the case for a far more optimistic view. Productivity slowdowns are nothing new in the United States, and there are strong reasons to believe that this one, like all its predecessors, will come to an end.

This optimism is based on several factors. The pace of innovation in IT and the strength of business investment are far greater than official statistics suggest. Prospects for significant innovation in healthcare and education are strong, and robots are likely to become increasingly important throughout the economy. The ongoing globalization of R&D could provide essential underpinnings for an acceleration of productivity growth, even in the longer run.

A standard productivity growth accounting framework captures these factors to highlight how a significant revival of productivity growth could emerge, especially in the medium to long run. A pace of 2¼ percent a year is eminently plausible—and there are solid reasons to hope for even more rapid productivity growth.

16. The Department of Education already conducts randomized control trials through the Institute of Education Sciences (https:/ies.ed.gov), but it does not certify interventions that work. Chatterji and Jones make the case for an agency or public-private partnership to undertake this certification function.

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