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The U.S. productivity slowdown: an economy-wide and industry-level analysis

Labor productivity—defined as output per labor hour—has grown at a below-average rate since 2005, representing a dramatic reversal of the above-average growth of the late 1990s and early 2000s. The productivity slowdown during these years has left many economic observers wondering why this situation has occurred and what factors may have contributed. To clarify potential sources of the productivity slowdown, this article presents an analysis of labor productivity and its component series—multifactor productivity, contribution of capital intensity, and contribution of labor composition—at both the economy-wide and industry levels, complemented with a survey of the contemporary productivity literature.

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The figure—$10.9 trillion—represents the cumulative loss in output in the U.S. nonfarm business sector due to the labor productivity slowdown since 2005, also corresponding to a loss of $95,000 in output per worker.[1]

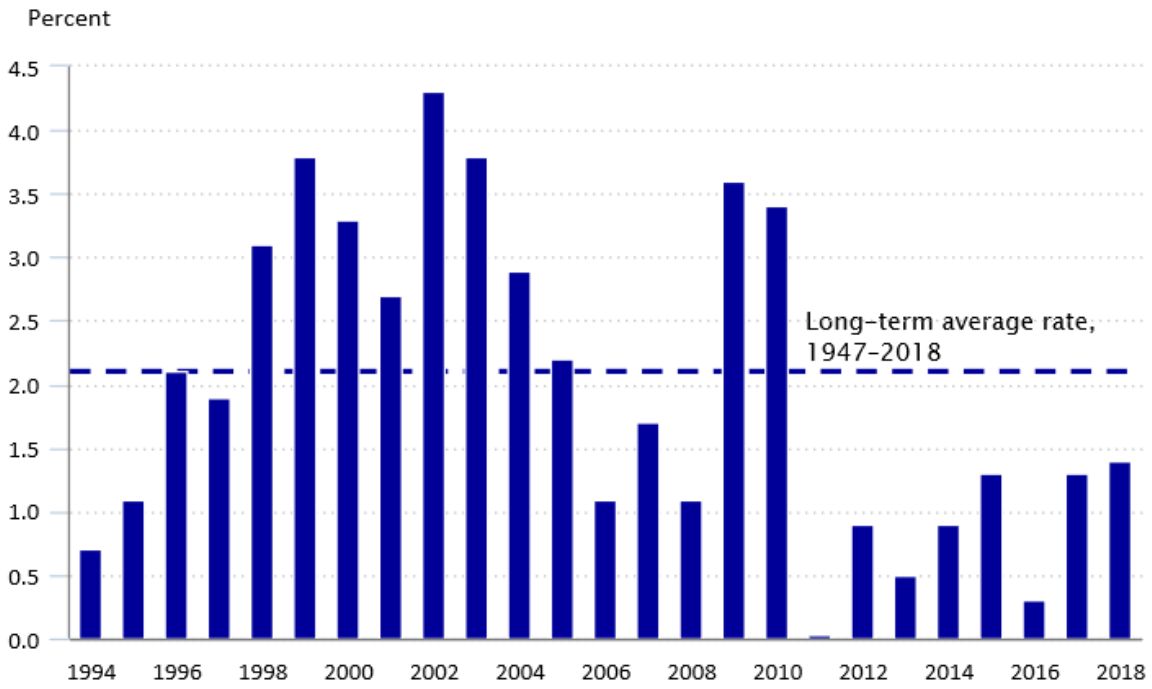
These figures show that, when there is consistently below-average productivity growth, year after year, a substantial effect can result over an extended period. How could this situation have occurred, in a modern and technically advanced economy such as in the United States? Well, not only has the productivity slowdown been one of the most consequential economic phenomena of the last two decades, but it also represents the most profound economic mystery during this time, and though many economists have grappled with the issue for over a decade and even created some innovative research approaches to address the question, we still cannot fully explain what brought on this situation.

One of the more perplexing aspects of the current slowdown is its genesis: that it came immediately following a historic productivity boom in the United States, and represented a swift rebuke of the popular idea of that time that we had entered a new era of heightened technological progress. The suddenness and size of the reversal were difficult to comprehend. For some background, in the late 1990s, when that much-cited productivity boom had begun, U.S. labor productivity growth had accelerated to rates of change that had not been seen since the late 1960s and early 1970s. This late 1990s surge surprised many economic observers, who had become accustomed to the below-average productivity growth rates of the mid-to-late 1970s through the early 1990s. In addition, the

situation in the United States was even more startling due to the fact that the rest of the more-developed economies of the world were not similarly experiencing a speedup in growth rates.[2]

A debate ensued among economists: Was the tremendous productivity growth of the late 1990s here to stay—a fundamental change generated by the computing and internet-related innovations that were all around us—or was it a temporary phenomenon that would pass? The fact that the productivity speedup persisted through the recession of 2001, and then became even more pronounced in 2002, convinced many observers that perhaps something had changed.[3] The acceleration of U.S. productivity growth is shown in figure 1, illustrated by the growth rates during 1998 through 2005, which rise above the long-term average rate since 1947, denoted by the dashed blue line. Over these high-growth years, U.S. labor productivity grew at an average rate of 3.3 percent,[4] which is markedly higher than the cumulative 2.1-percent average rate from 1947 to 2018.

Figure 1. Labor productivity growth: annual percent changes, nonfarm business sector, 1994–2018



Hover over chart to view data.
Source: U.S. Bureau of Labor Statistics.

This high-growth period came to an end during the mid-2000s, when U.S. labor productivity growth rates began to stumble, and in 2006 receded below the long-term average trend line for the first time in a decade. And, notwithstanding 2 years of high growth in 2009 and 2010 following the Great Recession, productivity growth rates have remained stubbornly low in subsequent years. Many economic observers were yet again surprised, in this case at just how drastically growth rates slowed, given the recently observed high rates of growth and the continued technological innovations that were proliferating throughout the economy. In the years since 2005, labor productivity has grown at an average annual rate of just 1.3 percent, which is lower than the 2.1-percent long-term

average rate from 1947 to 2018. The slow growth observed since 2010 has been even more striking: labor productivity grew just 0.8 percent from 2010 to 2018.

As the slowdown in labor productivity growth has steadily held on throughout the past decade, economic observers have been trying to understand this phenomenon, which has the effect of placing downward pressure on economic growth, worker compensation gains, profits growth, and gains in living standards of Americans. Many observers began to wonder: Why has U.S. labor productivity growth been so consistently low in recent years, and why is it so markedly different from the strong growth observed relatively recently? This article presents two approaches to address these questions, with each approach including an analysis of the U.S. Bureau of Labor Statistics (BLS) productivity data and a review of the contemporary productivity literature. First, the economy-wide slowdown in labor productivity growth is analyzed by breaking out the series into its three component series: multifactor productivity (MFP) growth, the contribution of capital intensity, and the contribution of labor composition. Second, industry-level productivity data are used to identify the industries that made notable contributions to the economy-wide labor productivity slowdown.

Economy-wide analysis of the U.S. labor productivity slowdown

This section presents an analysis of the economy-wide slowdown in labor productivity growth that decomposes the series into its three component series: multifactor productivity growth, the contribution of capital intensity, and the contribution of labor composition. This section also presents a dollar and time cost analysis of the slowdown, and an analysis of how U.S. regions impacted the economy-wide slowdown.

Decomposition of labor productivity growth

Labor productivity is a measure of economic performance that compares the amount of goods and services produced (output) with the number of labor hours used in producing those goods and services. It is defined mathematically as output per hour of work, and growth occurs when output increases faster than labor hours. For example, if output is rising by 3 percent and hours are rising by 2 percent, then labor productivity is growing by 1 percent.

Labor productivity growth is vitally important to present and future prospects for economic growth, because it represents the only path by which economic growth can rise above what would be possible by simply increasing labor hours (as, by definition, economic growth can only come from either hours growth or labor productivity growth). The economic gains brought about by labor productivity growth make it possible for an economy to achieve higher growth in labor income,[5] profits and capital gains of businesses, and public sector revenue; these economic gains also hold the potential to lead to improved living standards for those participating in an economy, in the form of higher income, greater leisure time, or a mixture of both. In addition, as labor productivity rises, all of these factors may increase simultaneously, without gains in one coming at the cost of one of the others.

Given the importance of labor productivity growth, it is worth delving into the measure in more detail to see what underlying factors are making this growth possible. As such, in addition to labor productivity growth being defined as a residual—the difference between output growth and hours growth—we can also analyze it as a sum, built up from the contributions of its three component series.

Components of labor productivity growth

The following equation allows us to quantify the sources of labor productivity growth and helps us better understand the measure by looking into its three component series:

labor productivity growth = multifactor productivity growth + contribution of capital intensity + contribution of labor composition

Multifactor productivity (MFP) growth represents the portion of output growth that is not accounted for by the growth of capital and labor inputs and is due to contributions of other inputs, such as technological advances in production, the introduction of a more streamlined industrial organization, relative shifts of inputs from low to high productivity industries, increased efforts of the workforce, and improvements in managerial efficiency. Similar to labor productivity growth, MFP growth can also be defined as a residual—output growth minus the growth of the combined inputs of labor and capital.

The **contribution of capital intensity** is defined as the capital-weighted change in the capital-labor ratio. The measure is computed as capital's share of current dollar costs multiplied by the growth in capital services per labor hour. The contribution of capital intensity—also called capital deepening—reflects businesses' decision-making process between hiring more workers and purchasing more or higher-quality equipment, or of substituting equipment for workers or vice versa.* In cases in which firms increase their usage of capital relative to labor, or where capital costs rise relative to labor costs, there will be an increase in the contribution of capital intensity to labor productivity growth.

The **contribution of labor composition** is defined as the labor-weighted change in a measure—labor composition—which reflects shifts in the level of skills and experience of the workforce. It is computed as labor's share of current dollar costs multiplied by labor composition.** The contribution of labor composition helps us gauge the productive capacity of the workforce at a given point in time. When firms hire more workers with higher skills and more experience or lay off workers with lower skills or less experience, or when labor costs rise relative to capital costs, the contribution of labor composition to labor productivity growth increases.

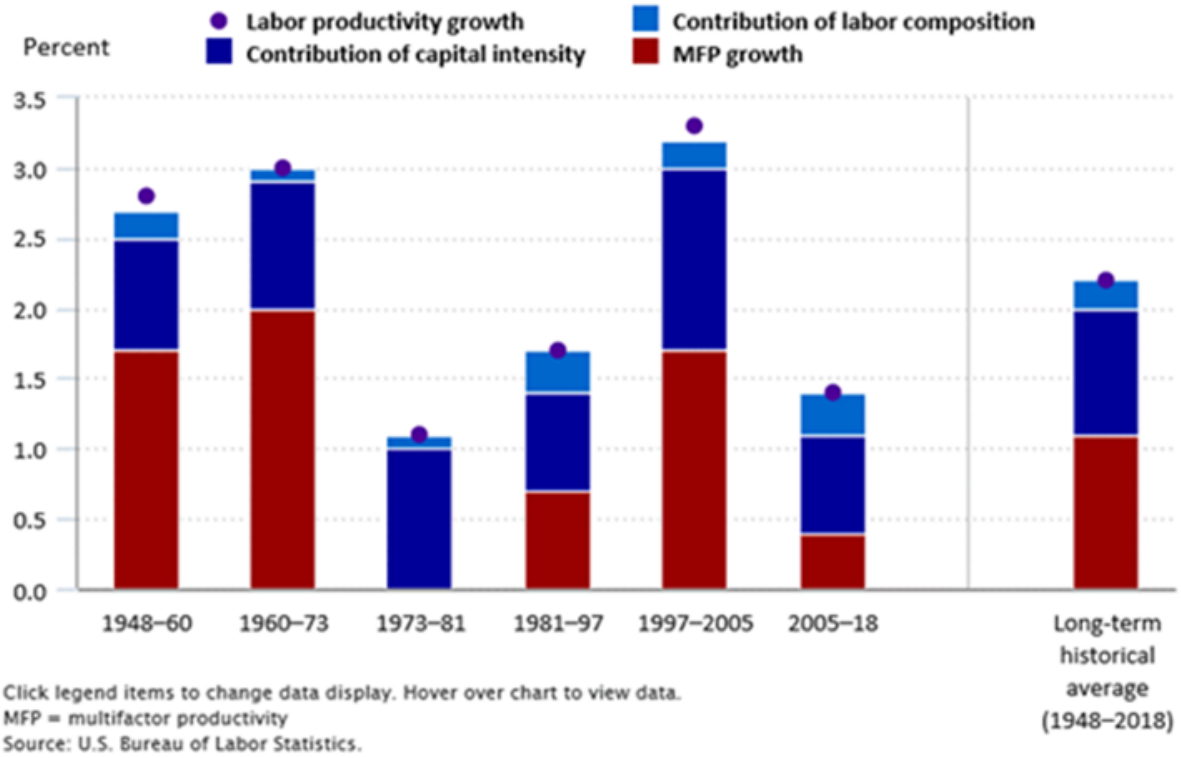
* Specifically, the contribution of capital intensity is defined as $w_k \left[\left(\ln\frac{K_t}{K_{t-1}}\right) - \left(\ln\frac{L_t}{L_{t-1}}\right)\right]$, where w_k is the 2-year average cost share of capital and K_t and L_t are capital services and labor hours at a given time t.

** The BLS labor composition methodology can be found at https://www.bls.gov/mfp/mprlabor.htm.

The three components of labor productivity growth are displayed in figure 2 for the slowdown period (2005–18), the speedup period (1997–2005), as well as other selected post-World War II (WWII) periods and the long-term historical average.[6] Labor productivity growth, corresponding to the purple dots, represents the sum of the three stacked bars of MFP growth,[7] contribution of capital intensity, and contribution of labor composition. It is apparent that the labor productivity growth rate (1.4 percent) of the slowdown period has slackened relative to the rate of the

speedup period and is also below the long-term historical average. Furthermore, we can see from the diminished red and dark-blue stacked bars of the slowdown period relative to the bars of the speedup period that MFP growth and the contribution of capital intensity are the sources of the U.S. labor productivity slowdown. (The contribution of labor composition was approximately the same as that of the speedup period and did not contribute to the slowdown.[8]) MFP grew 0.4 percent during the slowdown period, which is *less than one-fourth* the growth of the speedup period and is also well below the long-term historical average. In addition, the contribution of capital intensity in the slowdown period, 0.7 percent, is around half that of the speedup period and is also below the long-term historical average.

Figure 2. Contributions to labor productivity growth: MFP growth, contribution of capital intensity, contribution of labor composition, average annual growth rates for selected periods, private nonfarm business sector, 1948–2018



Click legend items to change data display. Hover over chart to view data.
MFP = multifactor productivity
Source: U.S. Bureau of Labor Statistics.

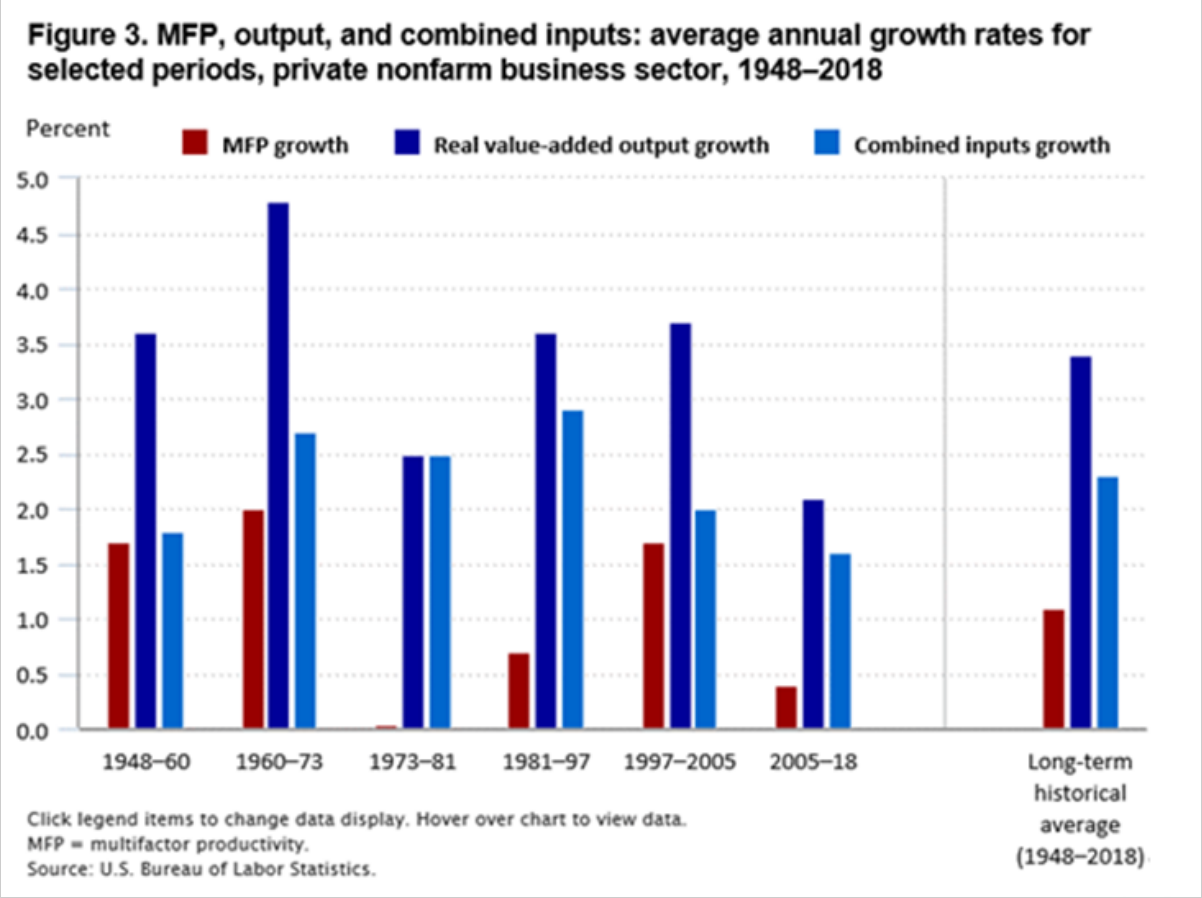
The deceleration in MFP growth—the largest contributor to the slowdown—explains 65 percent of the slowdown relative to the speedup period; it also explains 79 percent of the sluggishness relative to the long-term historical average rate. The massive deceleration in MFP growth is also emblematic of a broader phenomenon shown in figure 2. We can see that throughout the historical period since WWII, the majority of the variation in labor productivity growth from one period to the next was from underlying variation in MFP growth, rather than from the other two components. While the contribution of labor composition varied only between a range of 0.1 percent to 0.3 percent during the entire post-WWII era and the contribution of capital intensity varied between 0.7 percent and 1.3 percent, MFP growth varied within a wider range, between 0.0 percent and 2.0 percent.[9]

At the same time, in addition to the notable variation in MFP growth during the recent periods, something unprecedented about these recent periods was the additional contribution from variation in the contribution of capital intensity. The contribution of capital intensity had previously remained within a relatively small range (0.7 percent to 1.0 percent) during the first five decades of post-WWII periods, but then in the 1997–2005 period, the measure nearly doubled, from 0.7 percent up to 1.3 percent, followed by nearly halving to 0.7 percent in the 2005–18 period. This unprecedented variation in the contribution of capital intensity was the factor that combined with the variation in MFP growth to bring about such historic speedup and slowdown periods in recent years, increasing the size of the overall labor productivity slowdown to rival the widely noted 1970s slowdown. The contribution of capital intensity accounts for 34 percent of the labor productivity slowdown relative to the speedup period and explains 25 percent of the sluggishness relative to the long-term historical average rate.

The slowdown in MFP growth

Now let us take a deeper look into the two contributors to the labor productivity slowdown. For MFP growth, let us start out by noting the inherent difficulty in attempting to quantify the sources, components, or causes of MFP growth or lack thereof. This difficulty arises because MFP growth itself cannot be measured or identified on its own but can only be ascertained as the leftover output growth that remains after all measurable inputs to production—in this case, labor and capital[10]—have already been taken into account. With MFP growth, we are actually measuring something that is unidentifiable, similar to how cosmologists can measure the extent of dark matter and its influence on the universe even as they do not know what this matter comprises.[11] This is the reason that the question of what is driving the slowdown in MFP growth has puzzled so many economic observers in recent years and still remains incompletely explained following more than a decade of work on the issue.

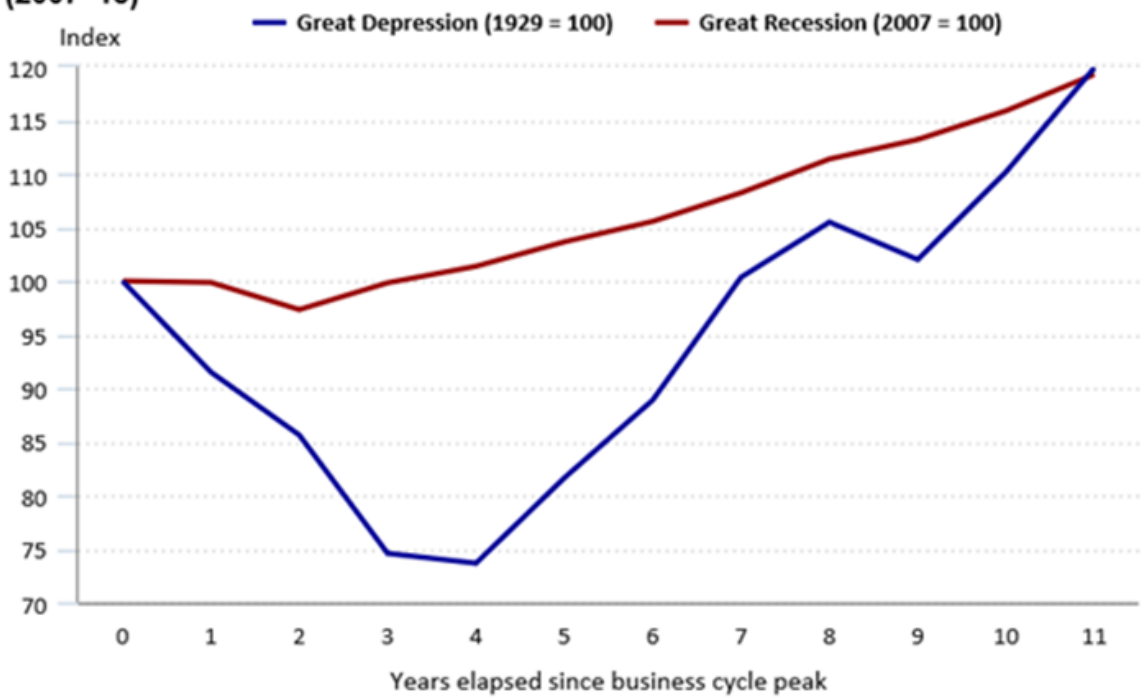
However, there are a few approaches that can be taken to help us gain a foothold on what might be happening to MFP growth, both by using BLS data as well as by looking at some clever approaches of the numerous researchers working on this issue. As a first step in our analysis, let us look at the BLS series used in calculating MFP growth, in order to provide some background and context on the economy in which the MFP slowdown took place. As just noted, MFP growth is a residual: output growth minus the growth of the combined inputs of capital and labor. Figure 3 reveals that, although both output growth and combined input growth atrophied in the slowdown period relative to their higher rates of the speedup period, output growth succumbed to a much more serious retrenchment. Namely, while combined input growth slowed by 0.4 percentage point, output growth slowed 4 times as much, by 1.6 percentage points. The fact that output growth retreated so much further than combined inputs during the slowdown period is reflected in the notably low MFP growth rate of 0.4 percent during this period, and is a key fact connected with the productivity slowdown. For this reason, as we begin our investigation of the MFP slowdown, we will first be looking closely at the historically weak output growth and getting a sense of the state of the economy during this period.



Historically weak output growth of the post-2005 slowdown period

The rate of output growth during the 2005–18 slowdown period (2.1 percent) is a historically weak growth rate. Not only does this rate pale in comparison to the 3.7-percent growth of the speedup period, but it also represents a historically slow rate for the entire post-WWII period, well below the historical average growth rate of 3.4 percent (see figure 3). Of course, a large portion of the below-average output growth in the slowdown period reflects the fact that this period encompasses the global financial crisis and Great Recession of 2007–09 and the subsequent recovery. It might surprise some to discover that the post-2007 business cycle, which contains this historic downturn, not only had slower cyclical growth than all previous business cycles since WWII, but it even recorded a slower overall growth rate than the Great Depression of the 1930s (see figure 4). In the case of the Great Depression, output plummeted by 26 percent—a much more severe decline than the 3-percent decline during the Great Recession.[12] However, the recent cycle exhibited a much weaker recovery than that of the Great Depression, with output growth from 2009 to 2018 being less than *one-third* of the 7.2-percent rate posted during the peacetime recovery from 1933 to 1940.[13] Because of this extended weak recovery, as of 2018, the post-2007 cycle's growth rate came in slightly below what had occurred during the 1930s—even more striking when one considers that the population growth rate was the same in these two periods.[14]

Figure 4. Output during declines and recoveries, relative to business cycle peak: real GDP index of Great Depression (1929–40) and Great Recession (2007–18)



Click legend items to change data display. Hover over chart to view data.
GDP = gross domestic product.
Source: U.S. Bureau of Labor Statistics.

The historically low output growth of the post-2007 business cycle—and particularly the anemic recovery—was not wholly unexpected. Valerie Cerra and Sweta Chaman Saxena, Carmen M. Reinhart and Kenneth S. Rogoff, and Carmen M. Reinhart and Vincent R. Reinhart show that a permanent loss of output and a lack of rebound to the long-term growth trend often follow financial crises such as the one the United States experienced in 2008.[15] Similarly, the International Monetary Fund (IMF) asserts that output losses arising from banking crises are usually substantial, stating that "typically, output does not recover to its precrisis trend. On average, output falls steadily below its precrisis trend until the third year after the crisis and does not rebound thereafter," although the IMF also clarifies that following this permanent output loss, "medium-term growth rates tend to eventually return to the precrisis rate."[16] Daisuke Ikeda and Takushi Kurozumi offer a story that may underlie this phenomenon, suggesting that an "adverse financial shock tightens firms' financing and thereby dampens their activities, which in turn has a significant negative impact on the economy as a whole by decreasing activities not only on the demand side but also on the supply side of the economy. The effect on the supply side, such as the sectors of research and development (R&D) and technology adoption, induces a persistent decline in [MFP] and thus can cause a permanent decline in output relative to a pre-shock balanced growth path."[17]

James H. Stock and Mark W. Watson look even further back in time, to before the financial crisis, claiming that more than half of the weakness of the recovery is from slower long-term trend growth—due to changing demographics—that was already apparent before the Great Recession.[18] However, they also note that particularly slow government spending (specifically from the phaseout of the American Recovery and

Reinvestment Act and the budget sequestration of 2013, as well as from slow state and local government hiring during the entire recovery) and faltering international demand following the recession also played a role. Ray C. Fair also cites sluggish government spending following the Great Recession, asserting that it was the central factor underlying the weak recovery.[19]

In addition to researchers citing weak fiscal stimulus, other researchers have pointed to limitations on monetary stimulus. Robert E. Hall offers that the zero lower bound on interest rates following the financial crisis presented a limiting factor that had not been operative in prior U.S. recessions.[20] Robert J. Barro also claims that monetary stimulus was insufficient to spur a vigorous recovery.[21]

The drag on MFP growth from the Great Recession

Now that we have an understanding of the recent trends in the measures used to compute MFP growth (in particular the unusually slow output growth of recent years), our first task is to attempt to use this basic information to help us better understand the slowdown in MFP growth. Specifically, we may ask: Could the state of the economy during the slowdown period, as indicated by the atypically low output growth, especially with it running below its potential and capacity during and following the Great Recession, have helped to cause the low MFP growth?

Yes, according to several authors, the weakened state of the economy during much of the 2005–18 slowdown period could be one factor underlying the low MFP growth. As noted earlier, Ikeda and Kurozumi argue that when an economy is operating below its potential, firms may pull back on investment in R&D and new technology.[22] David M. Byrne, Stephen D. Oliner, and Daniel E. Sichel concur, noting that one possible explanation for the productivity slowdown is that "the economy has taken a long time to recover from the financial crisis and Great Recession, as the repair of balance sheets has proceeded slowly and as uncertainty about the pace of the recovery has held back investment."[23] Romain Duval, Gee Hee Hong, and Yannick Timmer agree, postulating that "the combination of pre-existing firm-level financial fragilities and tightening credit conditions made an important contribution to the post-crisis productivity slowdown,"[24] and also that "while most forms of physical capital can be pledged as collateral to get a loan, intangible assets such as R&D or workforce training cannot. Furthermore, investments in intangible assets tend to translate more slowly into sales and to be riskier. Therefore, [their] hypothesis is that credit-constrained firms cut their investment in intangible assets, contributing in part to a sharper productivity slowdown after the crisis."[25]

Waning dynamism: reduced responsiveness to productivity gains at the firm level

At the same time, although the Great Recession and its aftermath have substantially affected recent economic trends, the data clearly show that the productivity slowdown started *before* the global financial crisis and Great Recession.[26] Looking back at figure 1, we can see that labor productivity grew at a successively lower rate in each consecutive year from 2002 through 2006, descending to well below the long-term average trend by 2006. So, a second question emerges: What might have led to this initial slowing and commencement of the slowdown period, or, more broadly, what factors might have contributed to the productivity slowdown of the entire 2005–18 period, other than the Great Recession and its deficient recovery?

One major finding is that the businesses that have been spurring recent innovations are having difficulty expanding, and thus, their innovations are failing to make a bigger impact on the economy as a whole than would otherwise be the case. Ryan A. Decker, John C. Haltiwanger, Ron S. Jarmin, and Javier Miranda show that, despite the broad slowdown in productivity growth, many firms are actually still seeing strong productivity gains, with innovation having continued to occur at the "productivity frontier" during the slowdown period since the early 2000s, among the firms that are the productivity leaders in their respective industries.[27] The authors reveal this indirectly, by observing that productivity dispersion in the United States has expanded in recent years, which means that a wider gap exists between these leading firms and the laggards. The authors claim that, within the framework of Michael Gort and Steven Klepper, this increased productivity dispersion implies that there has *not* been a declining pace of innovation.[28]

So then, why are the innovations that have been sparking at these higher-productivity firms not translating into solid economy-wide productivity gains? The answer has to do with how these firms have responded to their productivity windfall. Namely, Decker et al. observe decreased responsiveness to these firm-level productivity bursts as a potential source of the aggregate productivity slowdown, as evidenced by falling rates of job reallocation among these firms.[29] In other words, many of the firms that have been innovating have not similarly been able to scale up and hire more employees commensurate with their improved productivity.

This slump in firm-level reallocation coincides with the timeline of the aggregate productivity slowdown, with Decker et al. finding that "reallocation has declined in all sectors—particularly the high-tech sector—since the early 2000s."[30] In terms of quantifying the impact of this phenomenon, the authors observe that "counterfactual exercises imply that the decline in responsiveness yields a significant drag on aggregate (industry-level) productivity, as much as 2 log points in high-tech manufacturing and more than 5 log points economy-wide in recent years."[31] (Note that we will further explore in depth the slowdown in high-tech manufacturing in the "Industry-level analysis of the U.S. labor productivity slowdown" section of this article, particularly the dramatic slowdown in the computer and electronic products industry.) As for the underlying sources, which may be resulting in these lower rates of reallocation, Decker et al. cite several potential factors: rising adjustment costs, globalization, increased regulation, and declining competition.

The factor of declining competition—as potentially having a stultifying effect upon productivity-enhancing job reallocation—has been of particular interest in the literature, with Jan De Loecker, Jan Eeckhout, and Gabriel Unger outlining this phenomenon in the United States, offering as evidence that average markup costs have nearly tripled—from 21 percent as of 1980 to a level of 61 percent in 2016—in addition to the rate of profits expanding by 8 times its size, from 1 percent to 8 percent.[32] The authors claim that "because passthrough [of cost savings from productivity growth to lower prices for consumers] is lower in the presence of higher market power, the rise in market power will give rise to [a] lower degree of adjustment of the variable inputs, including labor, for the same [productivity] shock process. The rise in market power thus can rationalize the decrease in labor reallocation across firms, even if the observed shocks to firm productivity [have] remained constant."[33]

Gustavo Grullon, Yelena Larkin, and Roni Michaely echo De Loecker et al.'s data and analysis on increasing market power, stating that such findings "are robust to the inclusion of private firms and factors that account for foreign competition, as well as the use of alternative measures of concentration. Overall, [their] findings suggest that the nature of US product markets has undergone a structural shift that has weakened competition."[34]

Furthermore, undergirding these findings regarding expanded market power are findings of not only rising concentration across firms but also rising concentration in ownership across firms, with a few large shareholders in multiple companies in a given industry.[35] Other related findings include relaxed antitrust enforcement, increased mergers and acquisitions, and other restraints on competition, including increases in occupational licensing by states, the growth of land use restrictions, a greater scope of intellectual property law, and increases in lobbying and political rent seeking.[36]

Additionally, it might be of interest that, in a slightly different analysis of the widening productivity dispersion of high-growth and low-growth firms found by Decker et al., Dan Andrews, Chiara Criscuolo, and Peter N. Gal have proposed that "stalling technological diffusion" may be a possible source of this widening productivity dispersion, theorizing that low-growth firms may be having a difficult time integrating new technologies.[37] However, Decker et al. caution and clarify that "while the diffusion hypothesis could play a role, [their] estimates of [MFP] persistence suggest that the group of 'frontier firms' is sufficiently fluid to somewhat limit the diffusion story's explanatory power. Increased adjustment frictions is an alternative, but not mutually exclusive, explanation."[38]

Income inequality

Escalating income inequality may also be a factor underlying the productivity slowdown, according to Jason Furman and Peter Orszag.[39] Namely, though low productivity growth may be leading to rising inequality, it may also be that rising inequality is reducing productivity growth, by stifling "the ability to harness the talents of potential innovators across the income spectrum." The authors caution, however, that "any plausible magnitude for such an effect would fall well short of explaining the 1.0- to 1.5-percentage-point drop in productivity growth."[40] Furman and Orszag further qualify that rising income inequality and low productivity growth may both "have a common cause, namely that reduced competition and reduced dynamism—in part caused by specific policy changes—have contributed to both issues."[41] Some empirical support for Furman and Orszag's hypothesis that income inequality may be a potential factor in sluggish productivity growth has been offered by Ruchir Agarwal and Patrick Gaulé, who examine income disparities on a global scale and observe that "talented individuals born in low- or middle-income countries are systematically less likely to become knowledge producers."[42]

The debate over innovation possibilities in the 21st century

At this point, it should be noted that a weighty qualifier exists with regard to all the foregoing material regarding the MFP slowdown, on the basis of a notably different perspective on the recent data taken by several economists, such as Robert J. Gordon and John G. Fernald.[43] These authors have hypothesized that a productivity slowdown has not occurred per se in recent years. Rather, they contend that a productivity *reversion* to the "new normal" of lower productivity growth, established in the early 1970s, has occurred.

More specifically, these economists assert that the information technology (IT)-based innovations of recent decades are no match for the world-changing impacts of widespread electricity, the internal combustion engine, and indoor plumbing that emerged in the late 1800s and early 1900s. They claim that productivity growth cannot be expected to sustainably continue on the same high-growth trend that previously had been seen as of the mid-20th century. Furthermore, they regard the productivity speedup of the late 1990s and early 2000s as the true

outlier and the subsequent low productivity growth as merely the expected case in this relatively lower innovation era.

One underlying rationale for this potential story is provided by Joseph A. Tainter.[44] This author offers that, in general, as complexity in a society increases following initial waves of innovation, further innovations become increasingly costly because of diminishing returns. As a result, productivity growth eventually succumbs and recedes below its once torrid pace: "As easier questions are resolved, science moves inevitably to more complex research areas and to larger, costlier organizations," clarifying that "*exponential* growth in the size and costliness of science, in fact, is necessary simply to maintain a *constant* rate of progress." Nicholas Bloom, Charles I. Jones, John Van Reenen, and Michael Webb offer supporting evidence for this view regarding the United States, asserting that given that the number of researchers has risen exponentially over the last century—increasing by 23 times since 1930—it is apparent that producing innovations has become substantially more costly during this period.[45]

However, at the same time, some other economists have a few qualifiers of their own regarding the hypothesis that we have long been in an essentially low-productivity era. Chad Syverson reminds us that productivity slowdowns did occur between the waves of innovation during the late 1800s and early 1900s, as seminal technologies such as electricity and the internal combustion engine emerged.[46] Ana Paula Cusolito and William F. Maloney add that "while this prior diffusion hardly implies that a second IT wave is imminent, it does show that productivity accelerations from general-purpose technologies do not have to be one-off events. Just because their resultant productivity growth sped up in the late 1990s and early 2000s does not mean it cannot speed up again."[47]

To sum up this section, from an economy-wide perspective, we can identify several plausible explanations for the slowdown in MFP growth, including

- declining rates of productivity-enhancing job reallocation,
- rising market power and industry concentration,
- greater restraints on competition,
- growing income inequality,
- the drag from the global financial crisis and Great Recession and its weak recovery,
- diminishing returns to innovation relative to that of the late-19th and early to mid-20th centuries, and
- a historically wavelike tendency of innovations.

It appears likely that the MFP slowdown is coalescing from a combination of these factors, though it may not be possible to place them into an integrated framework or decomposition, given that they address the issue of the MFP slowdown from widely different perspectives—some cyclical, some noncyclical, and some more qualitative in nature than quantitative—and as there may be other factors, which have not yet been discovered. However, these factors do provide us with an overall sense of what may be undergirding the slowdown.

It should also be noted that the story of the MFP slowdown does not end here. In the "Industry-level analysis of the U.S. labor productivity slowdown" section of this article, we will analyze the slowdown from an industry-level perspective, investigating the

- large negative contribution from the computer and electronic products industry,

- large negative contributions from the retail and wholesale trade industries, and

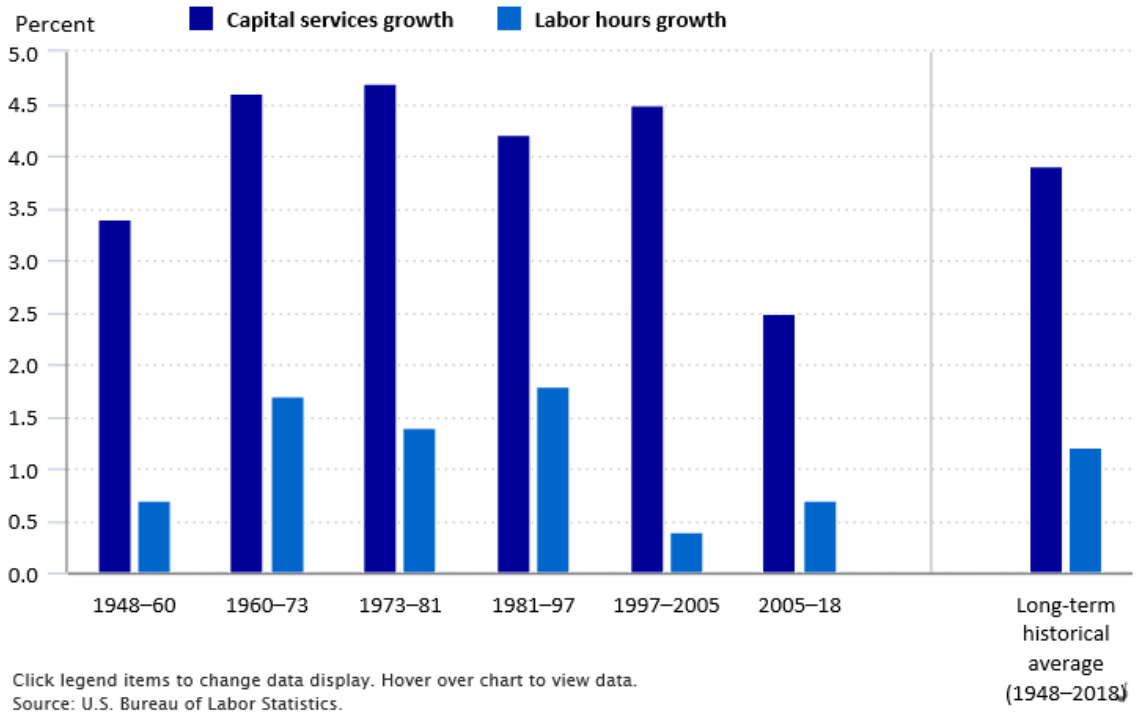
- small negative contributions from most other industries.

The slowdown in the contribution of capital intensity

Alongside the slowdown in MFP growth is the other contributor to the labor productivity slowdown: the contribution of capital intensity. This measure has exhibited an unprecedented variation and, from 2005 to 2018, was cut by nearly half relative to the 1997–2005 speedup period. As noted previously, the contribution of capital intensity grew just 0.7 percent during the 2005–18 slowdown period, which is lower than the 1997–2005 speedup period (1.3 percent) and the historical average rate (0.9 percent). As was also noted, the measure accounts for 34 percent of the labor productivity slowdown relative to that of the speedup period, explains 25 percent of the sluggishness relative to the long-term average percentage rate, and had the lowest growth among all the selected post-WWII periods (see figure 2).[48]

Given that the contribution of capital intensity is calculated as the difference in growth rates between capital and labor inputs, multiplied by the capital cost share, we can determine how much each of these three underlying factors contributed to its slowdown. As shown in figure 5, capital services grew during the slowdown period at a rate of 2.5 percent, which is well below both its rate for the speedup period (4.5 percent) and its long-term average (3.9 percent). Labor hours grew at a rate of 0.7 percent, which lies between its rate for the speedup period (0.4 percent) and its long-term average (1.2 percent). Capital's cost share was 38 percent during the slowdown period, which is higher than during the speedup period (33 percent) and the long-term average rate (34 percent).

Figure 5. Capital services and labor hours: average annual growth rates for selected periods, private nonfarm business sector, 1948–2018



Click legend items to change data display. Hover over chart to view data.
Source: U.S. Bureau of Labor Statistics.

Thus, we can say that it was the combination of a large deceleration in capital services growth with a slight acceleration in labor hours growth that drove down the change in the capital-labor ratio in the slowdown period. This dual effect overwhelmed a slight increase in the capital cost share and diminished the contribution of capital intensity to 0.6 percentage point below what it had been in the speedup period.

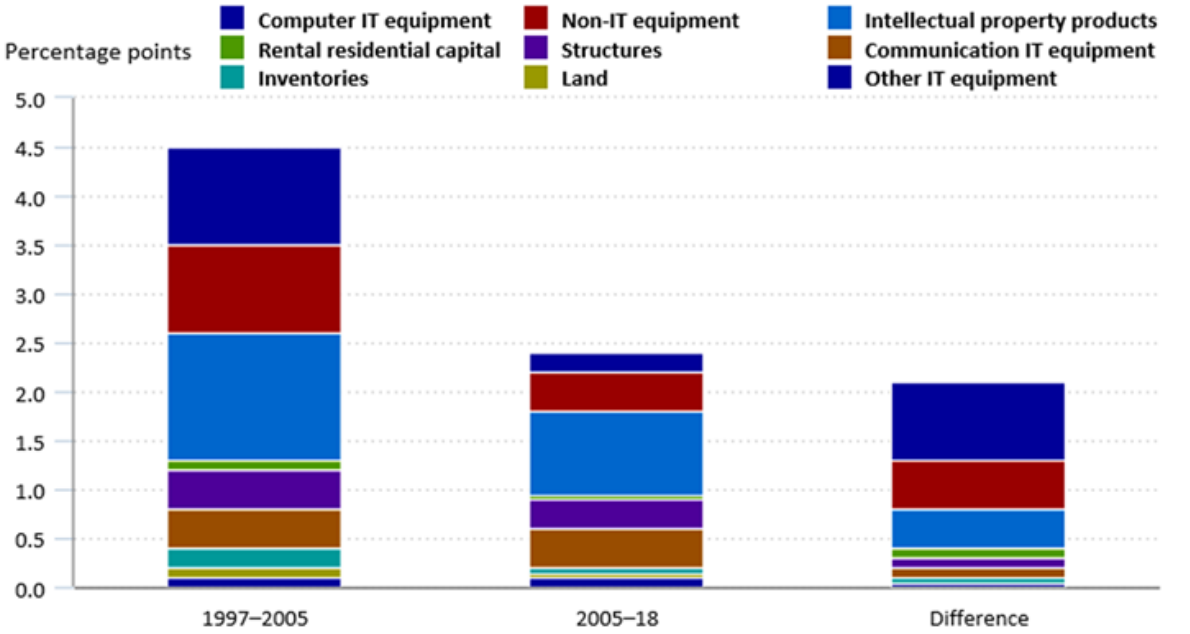
At the same time, relative to its long-term trend rate, the sluggishness in the contribution of capital intensity in the slowdown period was comparatively modest—just 0.2 percentage point below its long-term trend rate (see figure 2). Furthermore, the contribution of capital intensity in the slowdown period was not as much of an outlier as it had been during the speedup period, in which it was 0.4 percentage point *above* the long-term trend during these high-growth years. Nonetheless, both periods exhibited rates that were outside the norm. So, a question arises: What led to such a dramatic acceleration in the contribution of capital intensity and then led to a similarly sized deceleration not just back to normal during the slowdown period, but to slightly below the norm?

To answer the first part of this question, we must look back at the capital and labor components of the contribution of capital intensity during the 1981–97 pre-speedup period (see figure 5). What this reveals is that the vast majority of the acceleration in the contribution of capital intensity from the pre-speedup period to the speedup period was not due to capital services growth expanding but to labor hours growth shrinking. While capital services growth sped up slightly, from 4.2 percent to 4.5 percent, labor hours slowed substantially, from 1.8 percent to 0.4 percent. This drop in labor hours growth is not altogether surprising, given that the speedup period contained both the recession of 2001 and the “jobless recovery” of the early 2000s.

So, it can be said that the change in the capital-to-labor ratio—and thereby the contribution of capital intensity—during the speedup period was boosted up to such a high degree from unusually low labor hours growth, with capital services growth lying not far outside the norm. In contrast, for the slowdown period, it was the inverse: most of the slowing in the measure came from unusually low capital services growth, with labor hours growth not far outside the norm.

We can identify the contributions toward the recent slowdown in capital services growth, which are found in the far right stacked bar in figure 6. As previously noted, capital services growth slowed from 4.5 percent to 2.5 percent during the slowdown period. Of this 2.0-percentage-point deceleration, 0.8 percentage point was from a massive slowdown in computer IT equipment, which shrunk from providing a contribution of 1.0 percentage point in the speedup period to just making a 0.2-percentage-point contribution in the slowdown period. The other two notable contributors to the slowdown were from non-IT equipment (0.5 percentage point) and intellectual property products (0.4 percentage point). In addition, 0.1-percentage-point contributions were from rental residential capital, structures, communication IT equipment, and inventories.

Figure 6. Contributions to slowdown in capital services growth, from 1997–2005 period to 2005–18 period



Click legend items to change data display. Hover over chart to view data.
Note: IT = information technology.
Source: U.S. Bureau of Labor Statistics.

So, what factors may have undergirded such below-average capital services growth during the slowdown period? As noted earlier, Byrne, Oliner, and Sichel assert that the fragile financial condition of the economy following the Great Recession may have hindered investment during the recovery.[49] Robert E. Hall agrees, stating that "at the end of 2013 [the capital stock] was 13.2 percent below its trend path. The crisis and Great Recession, including amplification mechanisms, appear to be responsible for the shortfall."[50] Also, the work of Ravi Bansal, Mariano Max Croce, Wenxi Liao, and Samuel Rosen indicates specifically that uncertainty during and following the Great Recession may have also played a role and, especially, hurt innovative and productivity-driving firms, observing that "volatility shocks are more disruptive for innovation-oriented firms both in terms of market valuation and contraction in their investments. According to the data, when uncertainty increases, there exists a relative reallocation effect that penalizes investments in R&D-intensive firms, that is, investments that are important to sustain long-term growth."[51]

Taking a slightly longer view and analyzing the entire 2005–18 slowdown period, Germán Gutiérrez and Thomas Philippon point out that the U.S. business sector has underinvested relative to "measures of profitability and valuation, particularly Tobin's Q, and that this weakness starts in the early 2000's."[52] In terms of a theoretical underpinning that could explain this phenomenon, the authors specify that although it is possible for firms to underinvest either because of a low Q or despite a high Q, the data do not support the first case. So instead, the authors focus on the latter case, in which they find evidence of three main drivers: "rising intangibles, decreased competition, and changes in corporate governance that encourage payouts instead of investment."[53]

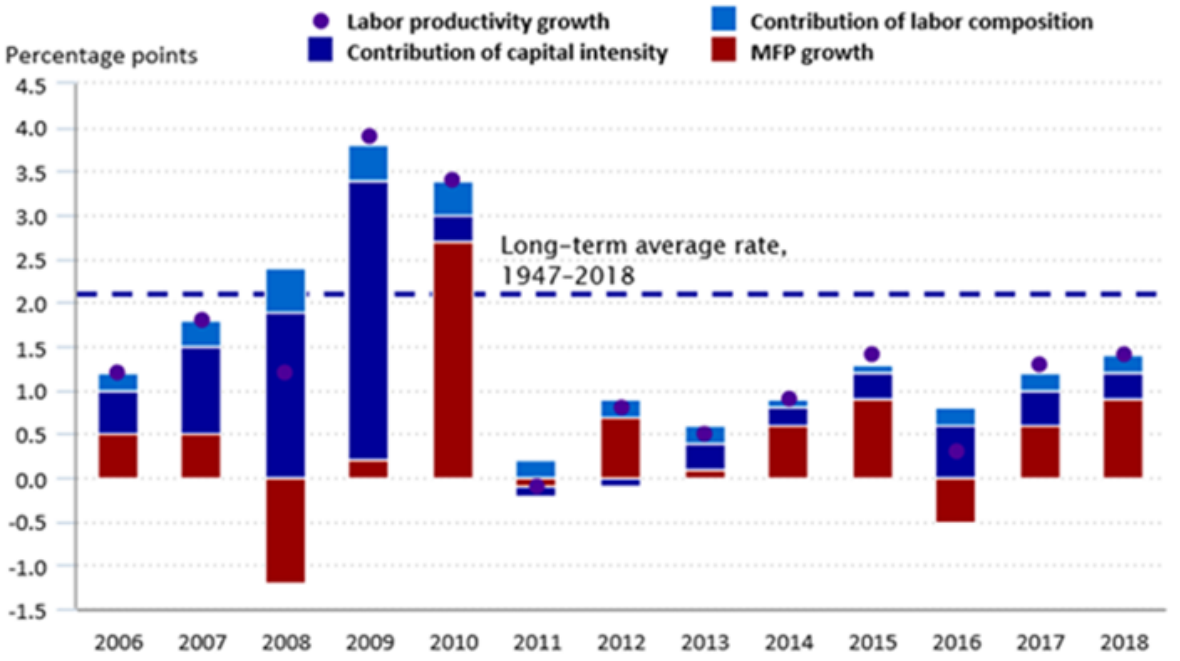
Regarding the rise of intangibles (intellectual property including software, R&D, patents, trademarks, and goodwill) as a share of overall capital investment, Gutiérrez and Philippon estimate that this component "can explain a quarter to a third of the observed investment gap."[54] This is because these assets are both difficult to measure, which may lead to their undercounting, and also "difficult to accumulate, due to higher adjustments costs," leading to "a higher equilibrium value of Q, even if intangibles are correctly measured."[55]

The remainder of the underinvestment likely comes from some combination of decreased competition and changes in corporate governance, according to Gutiérrez and Philippon. Regarding the former, the evidence indicates that "industries with more concentration and more common ownership invest less, even after controlling for current market conditions. Within each industry year, the investment gap is driven by firms that are owned by quasi-indexers and located in industries with more concentration and more common ownership.[56] These firms spend a disproportionate amount of free cash flows buying back their shares."[57] And, in terms of the latter, Gutiérrez and Philippon cite increased shareholder oversight, particularly in guarding against managers' desire to expand capital investments beyond an amount that would be in shareholders' best interests, as well as short-termism, in which "stock-based compensation incentivizes managers to focus on short-term capital gains" via share buybacks rather than making long-term capital investments in their firm.[58]

Annual contributions to the productivity slowdown

In addition to analyzing the labor productivity slowdown from a full-period perspective, as we have done thus far, we can also look at the individual years of the slowdown period itself, to determine how the path of each component developed over time. Figure 7 illustrates how the three series underlying labor productivity growth—MFP growth, the contribution of capital intensity, and the contribution of labor composition—progressed over the course of the slowdown period, from 2005 to 2018.

Figure 7. Contributions to labor productivity growth: MFP growth, contribution of capital intensity, contribution of labor composition, annual growth rates, private nonfarm business sector, 2005–18 period (i.e., annual rates for 2006–18)



Click legend items to change data display. Hover over chart to view data.
MFP = multifactor productivity.
Source: U.S. Bureau of Labor Statistics.

In the first year of the slowdown period—2006, which in figure 7 indicates the growth observed from 2005 to 2006, as we are displaying the growth from one year to the next—MFP growth and the contribution of capital intensity not only had the same rate of growth but they were also similarly below their respective long-term rates. A 0.5-percent increase in MFP in 2006 was below its long-term average of 1.1 percent, and a 0.5-percent increase in contribution of capital intensity was below its long-term average of 0.9 percent. However, over the next few years, it is remarkable how each of these measures diverged as the Great Recession began and wore on. In each year from 2006 through 2009, the contribution of capital intensity incrementally expanded, reaching a series-high 3.2 percent in 2009 and composing the majority of the above-trend labor productivity growth in that year. This acceleration in the contribution of capital intensity was due to an outsized decline in underlying labor hours; although capital services growth slowed from 3.7 percent in 2006 to 1.1 percent in 2009, labor hours growth plummeted from 2.3 percent in 2006 to –7.2 percent in 2009. This difference in magnitudes makes sense, given that it is easier for businesses to lay off workers than sell capital equipment during a recession.

At the same time as the contribution of capital intensity was expanding during the Great Recession, MFP growth was stagnating. After posting a below-average value in 2007 (0.5 percent), the measure sank well into negative territory in 2008 and then edged barely back into positive territory in 2009. What may have brought about this below-average MFP growth during the Great Recession? John G. Fernald notes that “Factor utilization . . . ‘explains’ the plunge and rebound in [MFP]. Utilization fell below the range of historical experience in the recession, [and] then recovered rapidly during the recovery.”[59] Nicholas Bloom, Max Floetotto, Nir Jaimovich, Itay Saporta-Eksten, and Stephen J. Terry cite uncertainty, noting that “plant-level [MFP] shocks increased in

variance by 76 percent during the recession" and that "bad times, defined in terms of low growth rates of output, are also uncertain times in terms of increased cross-sectional dispersion of [MFP] shocks."[60] In addition, Lucia Foster, Cheryl Grim, and John Haltiwanger claim that the Great Recession was an atypically detrimental recession in terms of its effect on MFP growth, in that there was not the usual boost from increased reallocation, which most recessions offer; the authors show that "the intensity of reallocation fell rather than rose and the reallocation that did occur was less productivity enhancing than in prior recessions."[61]

Following the end of the Great Recession in 2009, we observe another year of strong labor productivity growth (3.4 percent) in 2010, though with a sudden reversal in the underlying contributions: MFP growth and the contribution of capital intensity were virtually mirror images of one another in those 2 years, with MFP growth accelerating from 0.2 percent in 2009 to 2.7 percent in 2010 and the contribution of capital intensity slowing from 3.2 percent in 2009 to 0.3 percent in 2010. What might have brought about this result? As noted earlier, Fernald cites increased utilization as a potential explanation for the rebound in MFP growth during this early phase of the recovery.[62] Also, it is often the case when emerging from a recession—especially one as severe as the Great Recession—that firms may still remain apprehensive about hiring until the recovery begins in earnest, with a lag in employment recovery relative to output recovery. This was the case with the recovery from the Great Recession, with labor hours falling for an additional quarter more than output, in the third quarter of 2009, and then remaining virtually flat for two additional quarters—while output was simultaneously rising—and hours not beginning to recover in earnest until the second quarter of 2010.[63] This lag in the labor hours recovery contributed to both the dramatic increase of MFP growth in 2010 as well as the diminution of the contribution of capital intensity in that year.[64]

In the years following 2010, labor productivity growth stagnated, with an average rate of just 0.8 percent—well below the 2.1-percent long-term average rate since 1947. These early years of the recovery were particularly weak for the underlying measures, with the contribution of capital intensity receding into slightly negative territory in both 2011 and 2012, and MFP posting a decline in 2011 and a 0.1-percent increase in 2013. More recently, the situation has improved somewhat compared with those early years, with labor productivity rising above 1.0 percent during 3 of the last 4 years, though still remaining below the long-term historical trend and thus extending the productivity slowdown for over a decade.[65]

A noteworthy fact about the growth during the historically weak recovery period—specifically, after 2011—is how consistent and steady the growth rates have been during these years, with labor productivity growth staying within a historically narrow range of between 0.3 percent and 1.4 percent. This phenomenon reflects the combination of a steadily weak output recovery and a consistently moderate labor hours recovery. And, in terms of labor productivity growth's underlying series, MFP growth was below average during these years as weak output growth was paired with moderate combined-input growth from labor and capital. And, the contribution of capital intensity was also low throughout these years, as moderately increasing labor hours were paired with similarly moderate capital services growth.

Also, note that, in contrast to its typical steadiness during the full periods (see figure 2), the contribution of labor composition exhibited some within-period variation during the slowdown period from 2005 to 2018 (see figure 7) and thereby slightly amplified the swings in labor productivity during this period. Specifically, the contribution of labor composition rose at above-average rates during the Great Recession, with a high of 0.5 percent in 2008, and then grew at below-average rates since, of 0.1 or 0.2 percent. These shifts in the contribution of labor composition over the slowdown period—particularly within the post-2007 business cycle—are not surprising, given that lower-

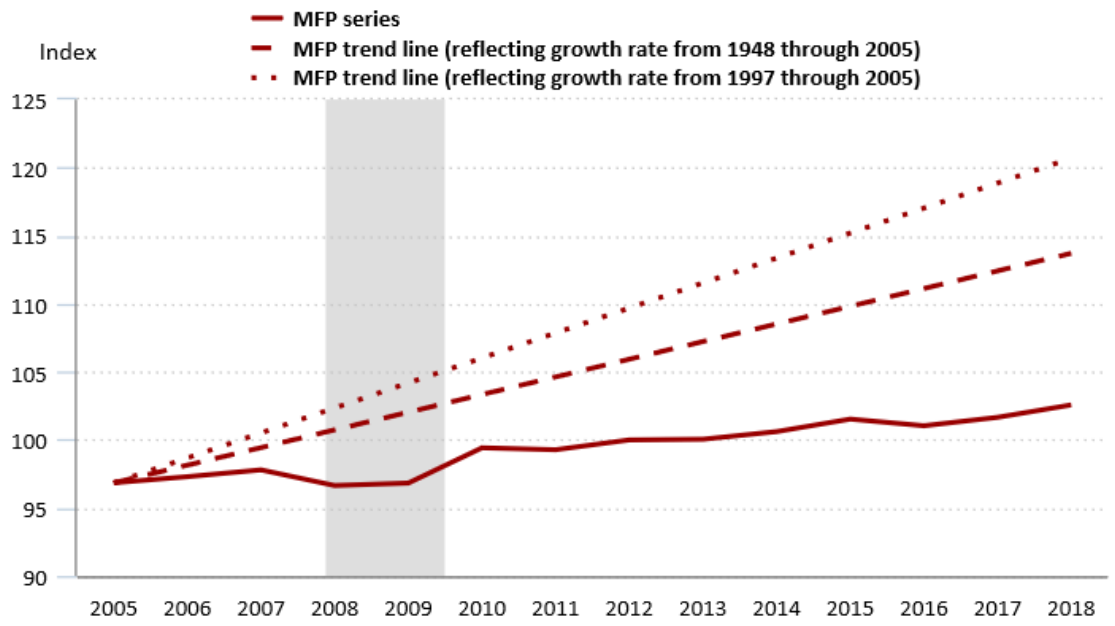
skilled or less-experienced workers are more likely to be laid off during recessions and then may gradually be reintegrated into the workforce as a recovery progresses.[66]

Trend comparisons for MFP and the contribution of capital intensity

In addition to determining the extent to which each component series contributed to labor productivity growth within each year of the slowdown period, we can also determine how each of these component series tracked during these years compared with its own previously observed growth trends, particularly its speedup period trend rate (1997–2005) and its long-term trend rate (1948–2005). This analysis allows us to see how much the movements after 2005 either stayed on course with, or diverged from, the growth trends that had been previously and historically observed for these series. We will do this for the two contributors to the slowdown: MFP growth and the contribution of capital intensity.

The path of the MFP index series over the slowdown period, as well as the long-term trend rate and the speedup period trend rate for this series, is shown in figure 8. We see that in 2006 and 2007, MFP was already falling slightly behind both the speedup period and long-term period trend lines, and this gap widened substantially during the recession. Then, in 2010, 1 year of high MFP growth partially shrank the gap, but subsequently, from 2011 to 2018, below-average MFP growth widened the gap substantially. Strikingly, we can see from the figure that every annual movement from 2005 to 2018 other than the gain in 2010 acted to widen the gap, either with a negative annual change or a positive change that was slower than the historical trend.

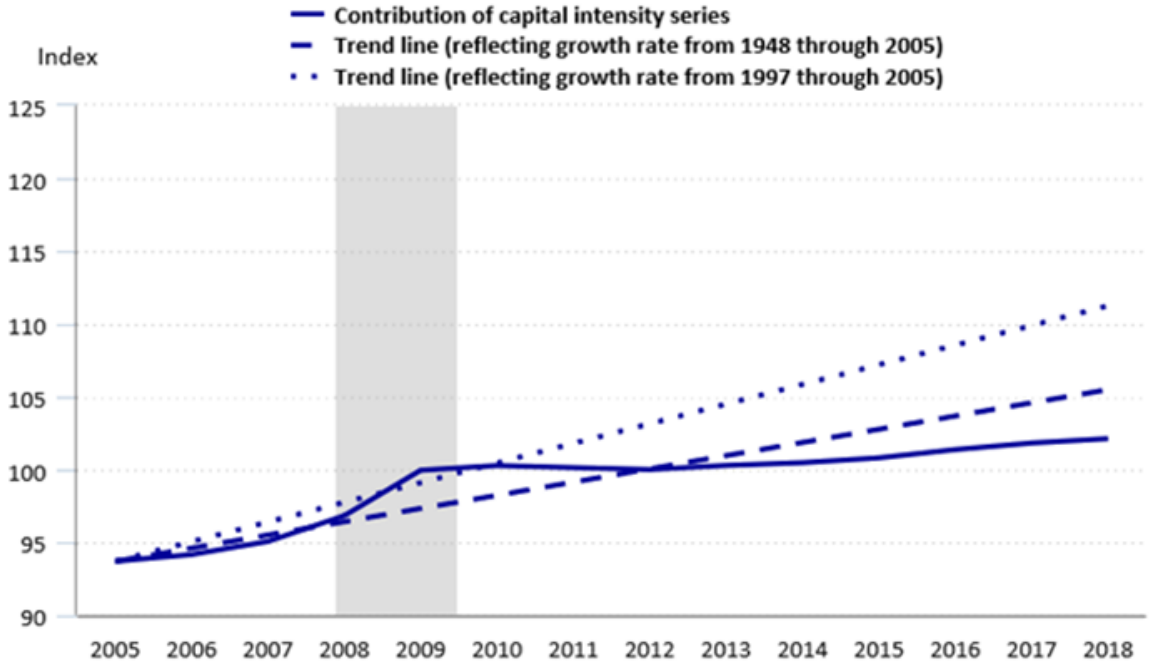
Figure 8. Comparing the MFP series during the slowdown period with past trends: private nonfarm business MFP, 2005 through 2018



Click legend items to change data display. Hover over chart to view data.
Notes: MFP = multifactor productivity. Shaded area represents a recession as determined by the National Bureau of Economic Research.
Source: U.S. Bureau of Labor Statistics.

The contribution of capital intensity index series took a much different path through the slowdown period, as is illustrated by figure 9. As just discussed, the contribution of capital intensity took an inverse path relative to MFP during the Great Recession, with an increase in 2008 and a surge in 2009 that sent the series above both the long-term and speedup period trend lines by 2009. However, the subsequent stagnation in the series, with virtually no growth over the next 4 years, submerged it below both trend lines by 2013 and widened the gap from that point onward. At the same time, note that this cumulative gap in the growth of the contribution of capital intensity was, as of 2018, less than that of MFP, which is cumulatively much further behind its historical trends (see figure 8).

Figure 9. Comparing the contribution of capital intensity series during the slowdown period with past trends: private nonfarm business contribution of capital intensity, 2005 through 2018



Click legend items to change data display. Hover over chart to view data.
Note: Shaded area represents a recession as determined by the National Bureau of Economic Research.
Source: U.S. Bureau of Labor Statistics.

Dollar and time costs of the productivity slowdown

In addition to analyzing the productivity slowdown in terms of percent changes, as we have done up to this point, we may also wonder: how much of a real-world impact did the labor productivity slowdown have in terms of dollars of lower output or hours of lost leisure time, for participants of the U.S. economy? Before undertaking this analysis, we should clarify that it is not possible to know in what combination the additional productivity growth—if growth had continued at average historical rates following 2005, rather than at the low rates we have observed—would have translated into greater output and additional leisure time. However, these calculations give us a sense of the losses that have been incurred by Americans, due to the productivity slowdown.

We will first estimate the loss from the productivity slowdown by assuming that the additional productivity growth (representing the difference between recorded productivity growth and what productivity growth would have been if

rates had continued at average historical rates following 2005) would have all contributed to producing additional output, and we will then make an analysis assuming that the added productivity growth would have all contributed to accumulating additional leisure time.

To estimate the total loss in output, we first ascertain how much total output was produced during the slowdown period. This amount is $175.2 trillion. We can then calculate a hypothetical total output, incorporating a consistent 2.3-percent labor productivity growth rate.[67] This amount is $186.1 trillion. So, the difference in output, representing the loss due to the productivity slowdown, is $10.9 trillion. Furthermore, as there were, on average, 114.6 million workers in the nonfarm business sector during these years, this result translates into a loss of $95,000 in output per worker.[68]

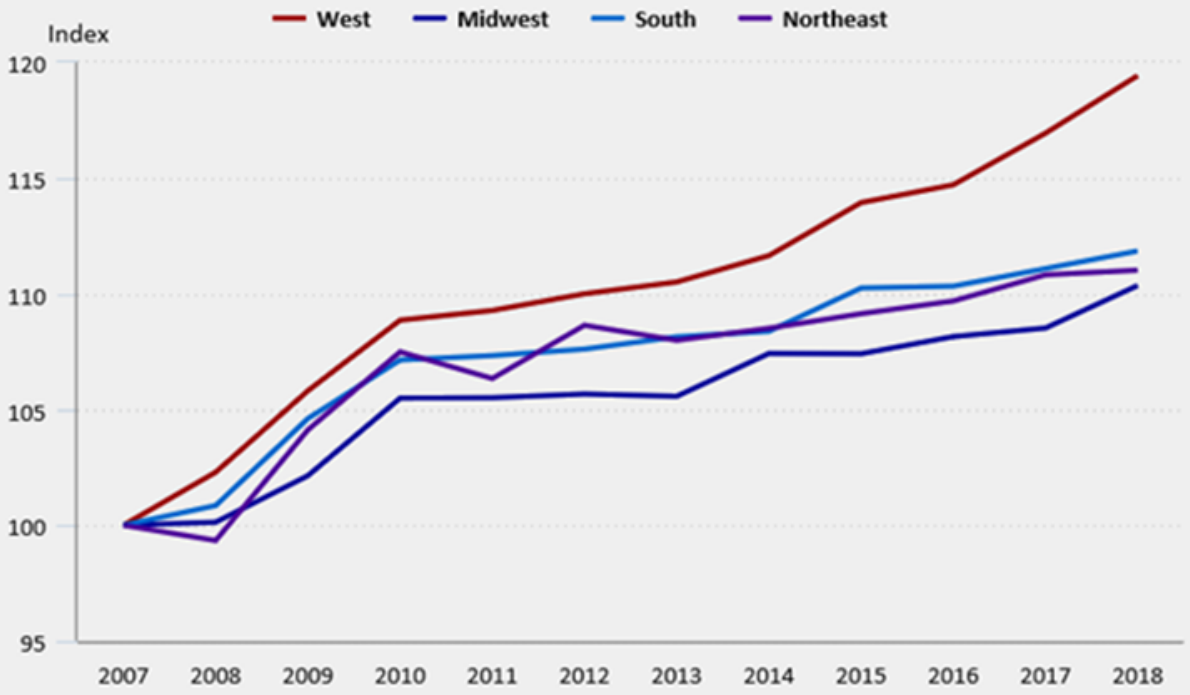
The productivity slowdown can also be framed in terms of lost time, specifically the lost leisure time that could have been available for workers to consume if a slowdown had not occurred.[69] To do this analysis, we first add up all hours worked during the slowdown period, which comes to 2.51 trillion. Then, assuming that labor productivity grew at a consistent rate of 2.3 percent throughout the period and that all of the effect of the added productivity growth contributed to a reduction in hours worked, this calculation would yield a total of 2.37 trillion hypothetical hours worked. Then, subtracting this hypothetical hours figure from the actual hours figure (2.51 trillion) would result in a hypothetical gain of leisure time of 138.5 billion hours, or 1,209 per worker. And, given that the average weekly hours during these years would have been 30.7 in this case,[70] this would result in a total of 39.4 weeks of leave lost because of the slowdown in productivity growth during this period or, correspondingly, 3.0 additional weeks of leave per year.

Did the productivity slowdown progress differently in U.S. regions?

Before we move on to the industry-level analysis, it might be of interest to some readers to know that there was some variation in how the economy-wide productivity slowdown progressed between states and regions of the United States. BLS publishes data on U.S. state and regional labor productivity for 2007 forward, and we can use these data to illustrate how the slowdown progressed in these areas for this portion of the post-2005 slowdown period.*

Box figure 1 tracks the progress of the labor productivity series for the private nonfarm sector in the four U.S. regions during the 2007–18 period. What this figure shows is that the Western United States outperformed the other three regions (Midwest, South, and Northeast) during these years. The West not only outperformed the other regions throughout and following the Great Recession, but its outperformance expanded during the recovery.

Box figure 1. Comparing labor productivity in U.S. regions: output per hour, West, Midwest, South, and Northeast regions, private nonfarm sector, 2007–18



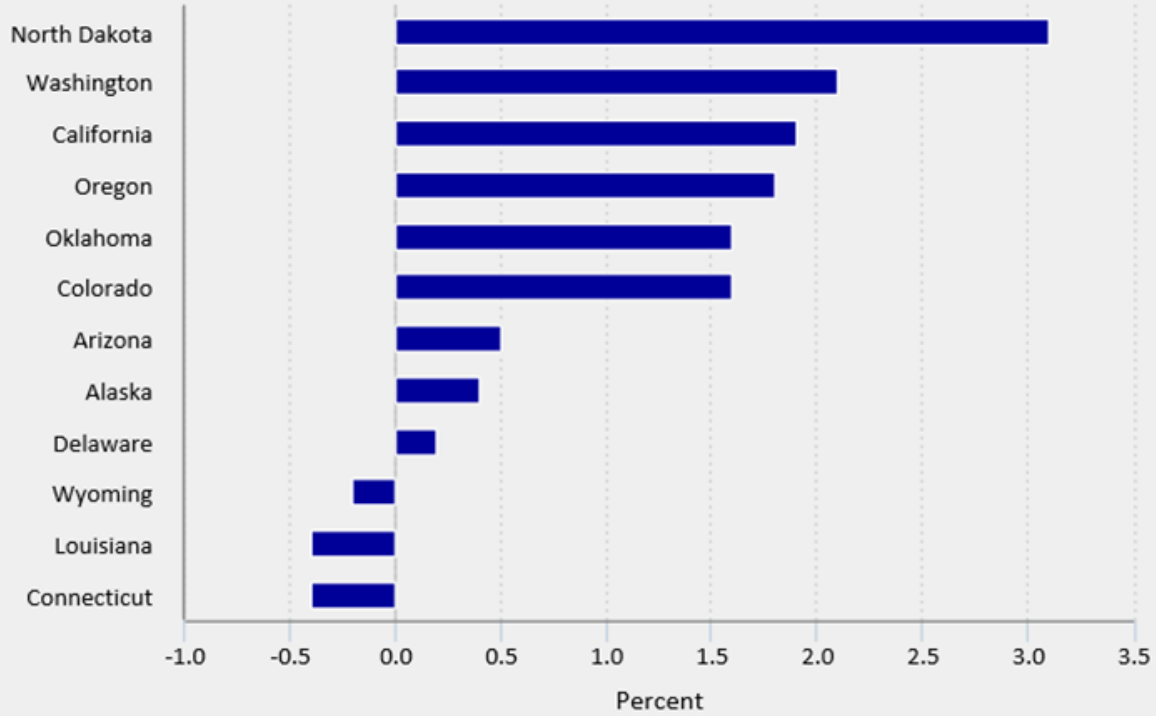
Click legend items to change data display. Hover over chart to view data.
Source: U.S. Bureau of Labor Statistics.

The West realized a 1.6 percent rate of labor productivity growth during these years, whereas the Midwest, South, and Northeast posted rates of 0.9 percent, 1.0 percent, and 1.0 percent, respectively. Given that the national rate for these years is 1.3 percent, we can see that, if not for the faster growth of the West during these years, the overall U.S. slowdown would have been around 0.3 percentage point lower than the already low rate observed during this period. This insight may offer researchers a potential avenue for future research, to look into what potential factors may have contributed to the somewhat higher productivity growth in the Western United States as compared with the rest of the country. At the same time, it is still the case that all four regions posted below-average growth, compared with the national long-term average rate since 1948 of 2.2 percent.

As for the individual states, box figure 2 reveals that, in addition to having the highest overall growth, the Western United States also had the most outliers, both on the high and low end (the figure shows the top six and bottom six state productivity growth rates). Washington, California, Oregon, and Colorado had four of the top six rates, which buoyed the overall growth of the West and more than counterbalanced very low growth in Arizona and Alaska and a decline in Wyoming. North Dakota took the top state rate, at 3.1 percent, and was the only state that had a growth rate that placed above the long-term average U.S. rate of 2.2 percent. As noted by YiLi Chien and Paul Morris, North Dakota underwent an oil boom during these years, “bringing a large influx of capital” to the state, with the authors concluding that the above-average labor productivity growth in this state “is very likely associated with the boom of the oil industry.”** (The turnaround

in this industry, as well as the results of other notable industries, will be discussed in detail in the next section.)

Box figure 2. Labor productivity growth: selected U.S. states, private nonfarm sector, average annual growth rates, 2007–18 period



Hover over chart to view data.
Source: U.S. Bureau of Labor Statistics.

* For more information on BLS state-level productivity data, see Sabrina Wulff Pabilonia, Michael W. Jadoo, Bhavani Khandrika, Jennifer Price, and James D. Mildenberger, "BLS publishes experimental state-level labor productivity measures," *Monthly Labor Review*, June 2019, https://www.bls.gov/opub/mlr/2019/article/pdf/bls-publishes-experimental-state-level-labor-productivity-measures.pdf. In addition, the data can be found at the BLS state productivity home page at https://www.bls.gov/lpc/state-productivity.htm.

** YiLi Chien and Paul Morris, "Slowdown in productivity: state vs. national trend," The Regional Economist (Federal Reserve Bank of St. Louis, first quarter 2017).

Industry-level analysis of the U.S. labor productivity slowdown

Up to this point, we have analyzed the U.S. labor productivity slowdown from an economy-wide perspective. We can also examine more detailed, industry-level data to extend our analysis and identify the industries that contributed the most to the slowdown in productivity growth from the 1997–2005 period to the 2005–18 period. In

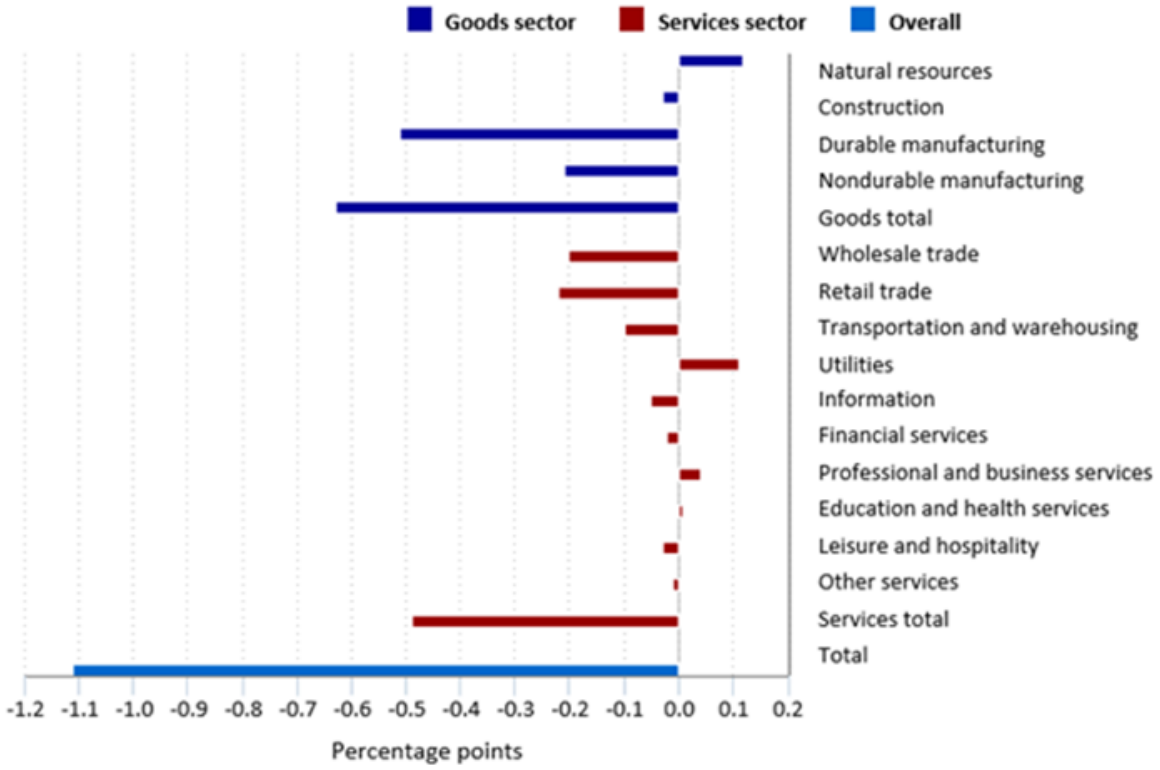
breaking out the U.S. labor productivity slowdown into its industry-level components, we will investigate the two series contributing to the slowdown—MFP growth and the contribution of capital intensity—to determine which industries contributed most to the economy-wide slowdown via these two factors. This can be done by calculating Domar-weighted growth rates of these two factors, for all the industries that make up the private nonfarm business sector.[71] First, we will be looking at the industry contributions to the MFP slowdown, followed by the industry contributions to the slowdown in the contribution of capital intensity.

Industry contributions to the MFP slowdown

When we break out the economy-wide MFP slowdown into its components, it is instructive for us to disaggregate the data into both sectors and industries, because each of these approaches provides a slightly different perspective and can deepen our understanding of the issue. As such, we will first look at contributions at the 14-sector level and then at contributions at the 60-industry level.[72]

The sector-level contributions to the economy-wide MFP slowdown are shown in figure 10, along with the corresponding contributions of the overall goods sector and services sector. First, we notice that the goods sector made a contribution (0.63 percentage point [ppt.]) to the MFP slowdown that is larger than the contribution made by the services sector (0.49 ppt.). The fact that the goods sector made a larger contribution is at first glance somewhat surprising, given that it is much smaller than the services sector and produces just 25 percent of private nonfarm business output. The potency of the contribution from the goods-producing sector can be isolated to the manufacturing sector and, most prominently, durable goods manufacturing, which itself contributed 0.51 ppt., or nearly half the overall contributions to the private nonfarm business sector (1.11 ppt.).[73] When the durable goods sector contribution is combined with the nondurable goods sector contribution, the total manufacturing sector accounted for 65 percent of the private nonfarm business MFP slowdown.

Figure 10. Contributions of sectors to slowdown in MFP growth in private nonfarm business sector, from 1997–2005 period to 2005–18 period



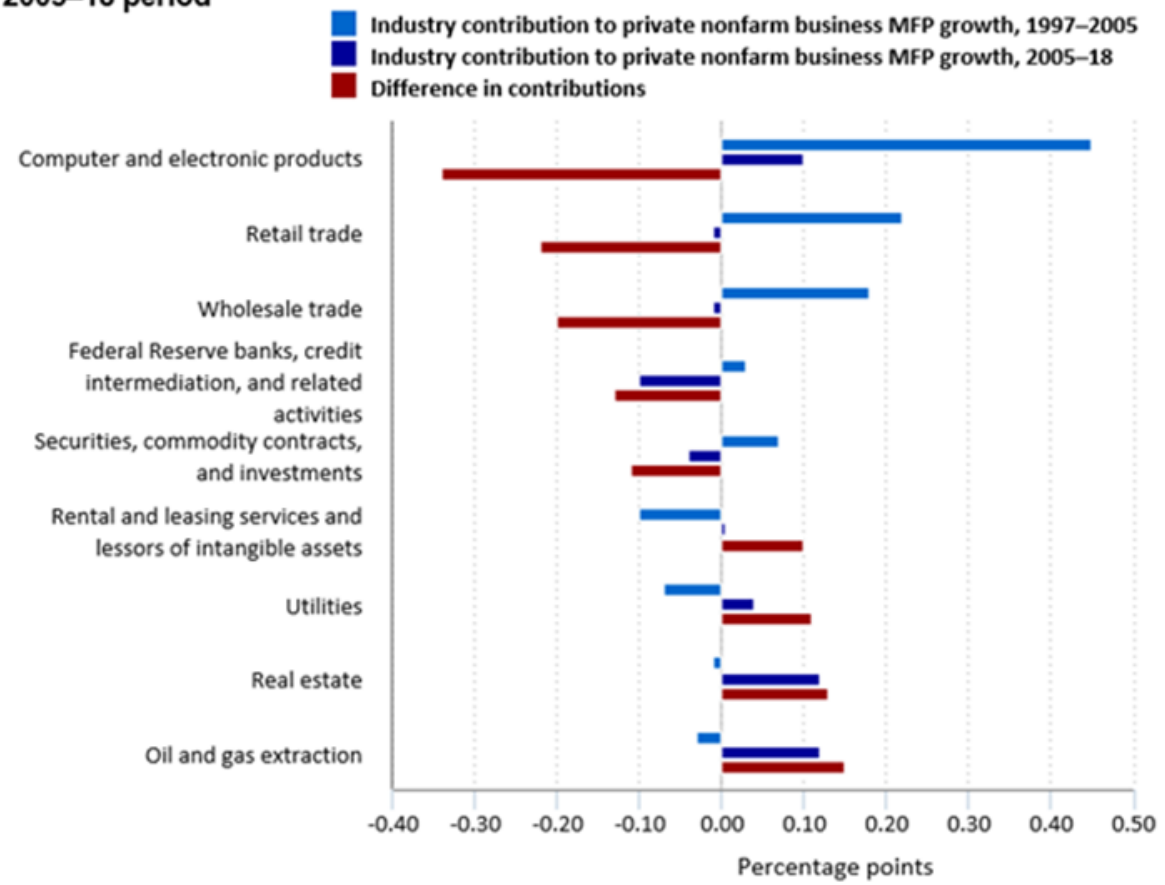
Click legend items to change data display. Hover over chart to view data.
MFP = multifactor productivity.
Source: U.S. Bureau of Labor Statistics.

For the services sector, the largest contributors to the slowdown were retail trade (0.22 ppt.), wholesale trade (0.20 ppt.), and transportation and warehousing (0.10 ppt.). These three sectors together more than explain the overall contribution to the MFP slowdown coming from the services sector (0.49 ppt.), as they made a combined contribution of 0.52 ppt. It is also worth pointing out that two sectors had notable productivity speedups, especially considering their small size—natural resources and mining (0.12 ppt.) and utilities (0.11 ppt.); natural resources and mining makes up just 2.7 percent of the private nonfarm business sector, and utilities makes up just 2.3 percent. Also, though the financial services sector and the professional and business services sector made relatively flat contributions to the slowdown, there were a number of industries within those two sectors that made notable contributions to the slowdown (these industries are discussed below). However, when these industry-level slowdowns are summed with speedups in other industries within the same sector, only a small overall contribution to the slowdown remains for these two sectors.

The industry-level contributions to the economy-wide MFP slowdown are shown in figure 11, specifically for a selection of the largest contributions (positive or negative). (Also, see appendix, table 1, for a full list of industry contributions to the MFP slowdown and industry contributions to the slowdown in the contribution of capital intensity, in the private nonfarm business sector.) It is not surprising that the largest industry-level contributor to the slowdown (computer and electronic products) is from within the largest sector-level contributor to the slowdown (durable manufacturing). Computer and electronic products incurred a massive slowdown, with a contribution to

MFP growth of 0.45 ppt. from 1997 to 2005 dwindling to 0.10 ppt. from 2005 to 2018. A startling fact about this industry is that, even after having the largest MFP slowdown among all the industries, computer and electronic products still possessed a positive contribution and, in fact, the third-largest contribution among all 60 industries during the 2005–18 period, behind only real estate (0.12 ppt.) and oil and gas extraction (0.12 ppt.).[74] The MFP slowdown in computer and electronic products represents 66 percent of the slowdown in durable manufacturing and 31 percent of the slowdown in the private nonfarm business sector.

Figure 11. Industries with largest percentage-point differences in contributions to private nonfarm business sector MFP growth, between 1997–2005 period and 2005–18 period



Click legend items to change data display. Hover over chart to view data.
MFP = multifactor productivity.
Source: U.S. Bureau of Labor Statistics.

Numerous researchers have focused on the historic acceleration and subsequent moderation in the growth of the computer and electronic products industry as being a major driver of the economy-wide productivity slowdown. Many had been aware of the remarkable growth of computer and electronic products in the late 1990s and early 2000s, with Stephen D. Oliner and Daniel E. Sichel observing that the trend at that time was already apparent and strong. They note that “the multifactor productivity contributions from computer and semiconductor producers moved up sharply during 1996–99, reaching 0.26 and 0.39 percentage point per year, respectively,” and that “the increases largely reflect the faster decline in the relative prices of computers and semiconductors . . . and the rising output shares of computer and semiconductor producers.”[75] David M. Byrne and Carol Corrado also

emphasize the rapidly declining prices during those years: "the greatest computer [price] declines, and the greatest gap, occurs [sic] in the 1994 to 2000 period, when [microprocessor unit] prices were falling especially fast."[76]

Then, however, during the mid-2000s, the pace of microprocessor unit price declines began to stall.[77] And, more recently, price declines have shrunk in size even more, with Byrne and Corrado citing "*extremely* small declines of late, after having gradually lost force since 2004."[78] At the same time, Byrne, Oliner, and Sichel argue that there has not been a slowdown in technological progress that the paltry price declines might indicate, clarifying that "technical progress in the semiconductor industry has continued to proceed at a rapid pace."[79] So, might there be some mismeasurement occurring with regard to these prices? Yes, there was, argue David M. Byrne, John G. Fernald, and Marshall B. Reinsdorf, who say that in "IT-related hardware and software . . . mismeasurement is sizable."[80]

However, these authors also caution that this measurement was not a new issue in the mid-2000s and that IT price mismeasurement was evident even before the productivity slowdown, clarifying that they "find no evidence that the biases have gotten worse since the early 2000s."[81] In fact, they point out that, if one were to consistently adjust for mismeasurement across time, it would actually make the labor productivity slowdown worse, given that "mismeasurement of IT hardware [was] significant prior to the slowdown," and also given that "the domestic production of these products has fallen, [and thus] the quantitative effect [of mismeasurement] on productivity was larger in the 1995–2004 period than since, despite mismeasurement worsening for some types of IT."[82]

Chad Syverson concurs with Byrne, Fernald, and Reinsdorf, agreeing that mismeasurement is unlikely to be a driver of the productivity slowdown,[83] and observes that "the productivity slowdown has occurred in dozens of countries, and its size is unrelated to measures of the countries' consumption or production intensities of information and communication technologies [ICTs]," further contending that "if measurement problems were to account for even a modest share of this missing output, the properly measured output and productivity growth rates of industries that produce and service ICTs would have to have been multiples of their measured growth in the data."

So, what factors might have led to the slowdown in the productivity growth of IT goods? Decker et al. point out that a dwindling of the "marginal employment growth response of businesses to idiosyncratic productivity draws . . . is especially large in the high-tech sector, with the responsiveness of young firms in the post-2000 period only about half (manufacturing) to two thirds (economy-wide) of the peak responsiveness in the 1990s." The authors conclude that "the timing of reallocation and responsiveness patterns in high-tech is consistent with the timing of the productivity slowdown, which evidence indicates was driven by ICT-producing and using industries."[84]

The waning responsiveness of young high-tech firms that is cited by Decker et al. could potentially be explained, at least in part, by the work of Mordecai Kurz, who finds growing market power in the IT sector, which may be stifling the entry and growth of young firms.[85] Kurz reports that "declining or slow growing firms with broadly distributed ownership have been replaced by IT based firms with highly concentrated ownership," and that "IT innovations enable and accelerate the erection of barriers to entry and once erected, IT facilitates maintenance of restraints on competition."[86] Foster, Grim, Haltiwanger, and Wolf also reference the concentration within high-tech industries, noting that, in contrast to the late 1990s, when "the productivity surge in the high-tech sectors [had] a high contribution of increased within-industry covariance between market share and productivity . . . the productivity slowdown in the post-2000 period in high tech is due to both a decrease in within-firm productivity growth but also

a decrease in this covariance."[87] Titan Alon, David Berger, Robert Dent, and Benjamin Pugsley offer further evidence to support this finding, noting that "over the last three decades, the U.S. business sector has experienced a collapse in the rate of new startups alongside an enormous reallocation of economic activity from entrants and young firms to older incumbents."[88] Alon et al. clarify that this finding is not just particular to high-tech industries but is "widespread across industries and geographic markets,"[89] so that while this could be relevant in high-tech industries, it could also help explain the productivity slowdowns in other industries. And, more generally, Grullon et al. observe that "more than 75% of U.S. industries have experienced an increase in concentration levels over the last two decades."[90]

Beyond the concentration argument, David Autor, David Dorn, Gordon H. Hanson, Gary Pisano, and Pian Shu propose another potential contributor to the productivity slowdown in IT, particularly in IT-intensive manufacturing industries, which is a reduction in U.S. innovation caused by increased foreign competition from China.[91] The authors observe that "despite accounting for less than one-tenth of U.S. private non-farm employment, U.S. manufacturing still generates more than two-thirds of U.S. R&D spending and corporate patents," and claim that "increased imports from China ramped up competitive pressure on publicly listed U.S. firms" and that "this increase in competitive pressure caused U.S. firms to *decrease* their output of innovations as measured by patent grants."[92] However, this phenomenon is more long-term and may not apply only or specifically to the 2005–18 slowdown period, although it could potentially be a contributor.

Now, shifting gears a bit, let us look beyond the large slowdown in the computer and electronic products industry and examine some other sizable contributors, located in the trade sector. Specifically, retail trade and wholesale trade contributed 0.22 ppt. and 0.20 ppt., respectively, to the MFP slowdown, and when combined, they actually exceed the size of the slowdown in computer and electronic products. These trade sectors transitioned from making sizeable positive contributions to MFP growth during the speedup period to being virtually flat during the slowdown period.

Might the size and coincidence of these slowdowns in the trade sectors and those in the IT-related industries be related? The answer is likely yes, according to several researchers, at least regarding the retail trade sector. Lucia Foster, John Haltiwanger, and C. J. Krizan assert that "the retail trade sector underwent a massive restructuring and reallocation of economic activity in the 1990s. Retail businesses changed their ways of doing business with intensive adoption of advanced information technology, including everything from improvements in inventory control to the introduction and widespread use of scanners and rapid credit card processing technologies. Structural changes occurred with entering establishments from large multiunit national firms displacing single-establishment firms."[93]

These changes were widely seen in the economy, with the proliferation of "big box" stores such as Wal-Mart, Home Depot, and Best Buy that swept the country and displaced many small businesses that could not compete with the advanced IT that these corporations were using.[94] Emek Basker argues that the effect was particularly powerful regarding Wal-Mart, "because Wal-Mart competes with retailers across many categories, including general merchandise stores, drugstores, apparel stores, and grocery stores."[95]

Moreover, Foster et al. contend that, in their firm-level analysis of the dispersion and reallocation dynamics within the retail trade sector, "virtually all of the productivity growth in the retail trade sector over the 1990s is accounted for by more productive entering establishments displacing much less productive exiting establishments," which

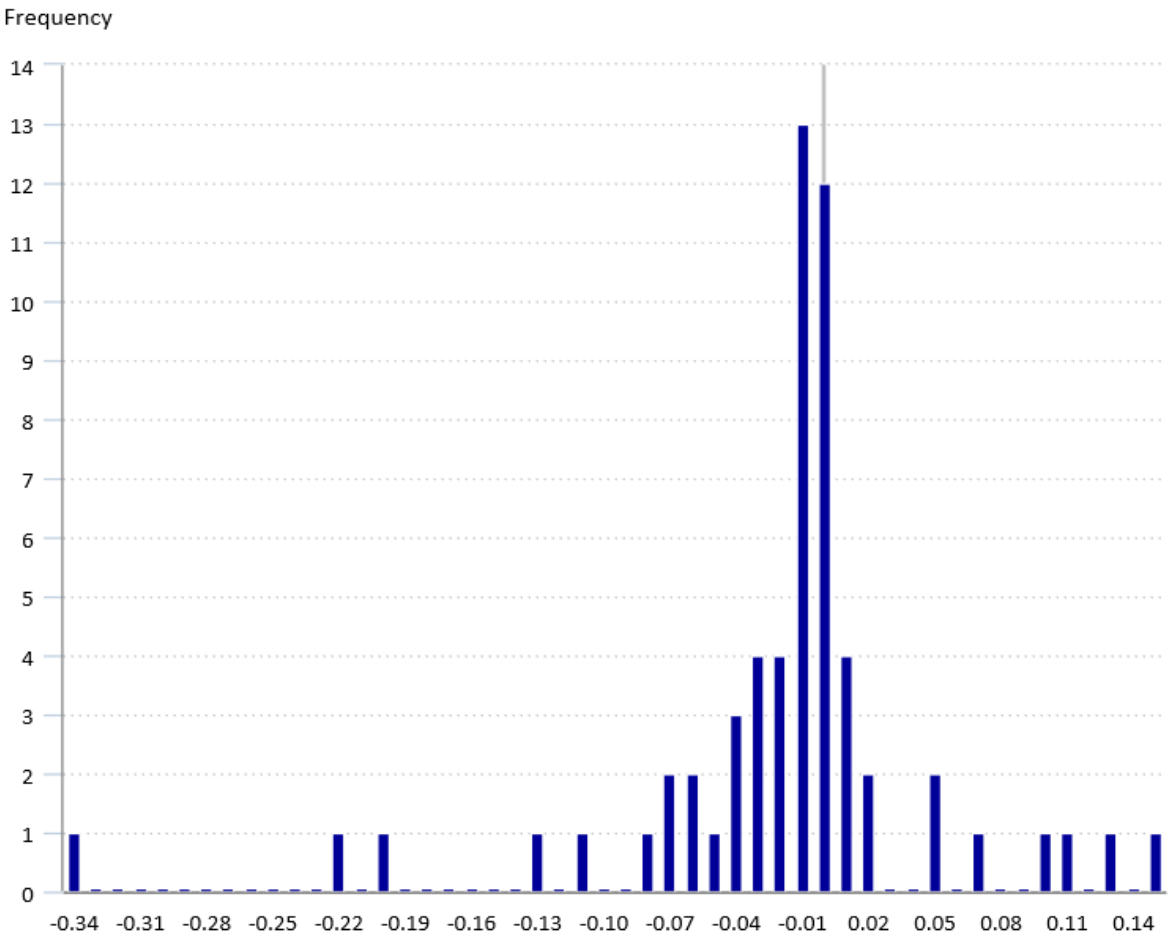
they clarify is due to a combination of "selection effects and post-entry learning effects. That is, establishments that enter might be immediately more productive than the establishments they are displacing, or it may take time for the productivity gap to widen or emerge."[96]

Also, looking beyond the trade sectors and the computer and electronic products industry, we see several other notable downward contributors to the slowdown in MFP growth: Federal Reserve banks and credit intermediation (0.13 ppt.), securities, commodity contracts, and investments (0.11 ppt.), and broadcasting and telecommunications (0.08 ppt.).

In addition, a few industries worked in the opposite direction of the overall slowdown and posted accelerations in MFP growth during this period: oil and gas extraction (0.15 ppt.), real estate (0.13 ppt.), utilities (0.11 ppt.), and rental and leasing services and lessors of intangible assets (0.10 ppt.). The increase for the oil and gas extraction industry during the slowdown period catapulted it from being the 56th ranked industry among all 60 industries as of the speedup period, to a rank of 2 as of the slowdown period. This astounding turnaround, note David Popp, Jacquelyn Pless, Ivan Haščič, and Nick Johnstone, may reflect technological innovations in this industry, in which the "rise of hydrofracturing lowered fossil fuel prices so much that natural gas is now the primary fuel for electricity generation in the U.S."[97] The real estate industry had a similarly extraordinary turnaround in its MFP growth contribution, rising from a rank of 51 to 1.

Given that there were both negative and positive contributors to the MFP slowdown, with sizable contributors on both sides, it may be of interest to look at the distribution of these industry-level data (see figure 12). The first item to note is that there were more large negative contributors (those slowing by 0.05 ppt or more) than large positive contributors (those expediting by 0.05 ppt. or more). The net slowdown of the large-contributing industries was 0.74 ppt., with 1.39 ppts. of the large contributors on the negative side and 0.66 ppt. on the positive side. The second item worth noting is that the remaining 0.38 ppt. of the slowdown comes from the small contributors—specifically, many more small negative contributors existed than small positive contributors. While just 6 industries contributed between 0.01 and 0.04 ppt., *24* contributed between –0.01 and –0.04 ppt. These negative small contributors had a combined slowdown of 0.44 ppt., greatly outweighing the positive small contributors, which had a combined speedup of just 0.08 ppt. So, we can say that, although there were numerous large contributors to the overall slowdown on the negative side (particularly computer and electronic products and the trade industries), there was also a widespread, generalized negative slide among the vast majority of the industries, which also helped bring about the historic decline in MFP growth.

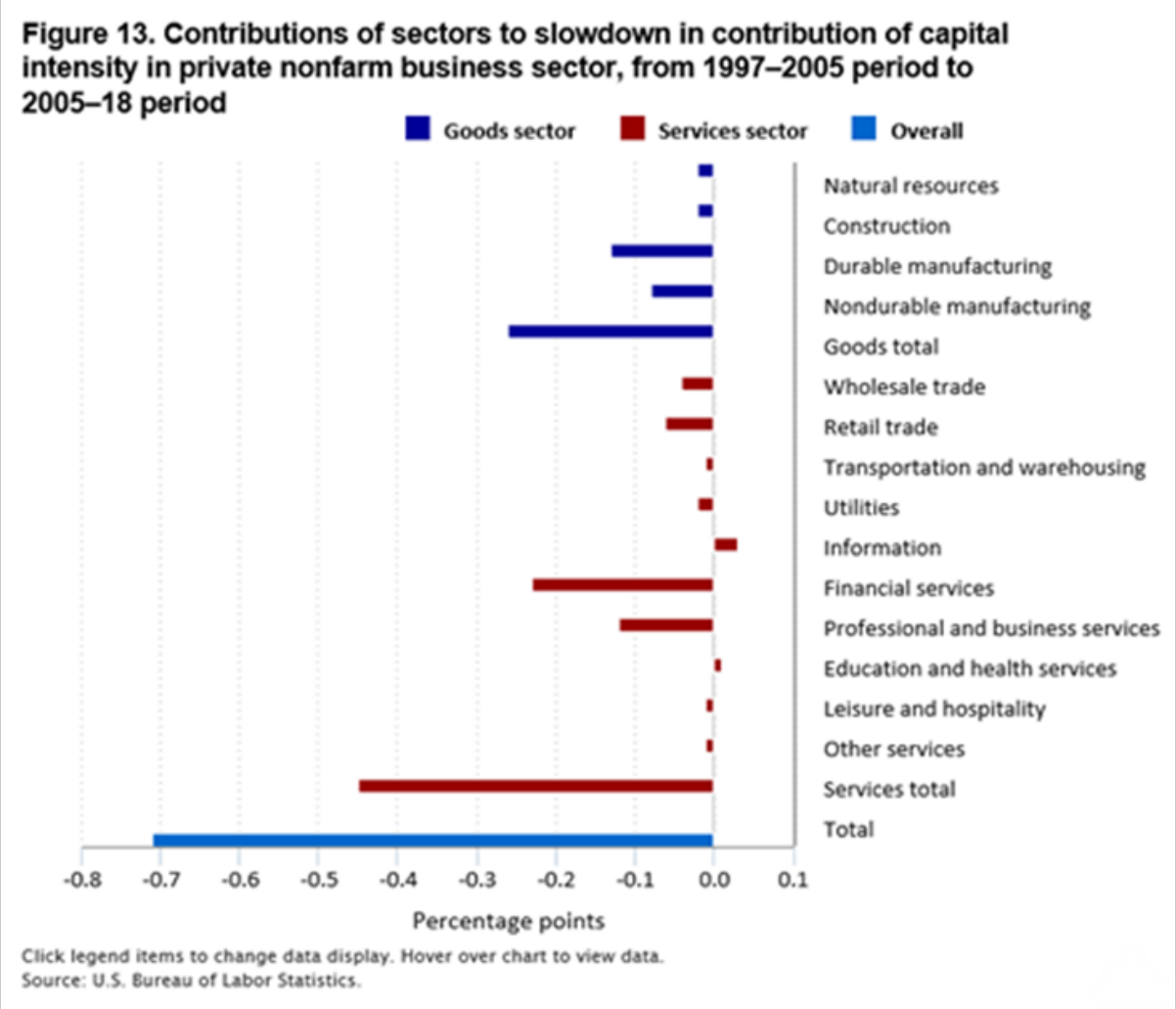
Figure 12. Distribution of percentage-point industry contributions to slowdown in MFP growth, private nonfarm business sector, from 1997–2005 period to 2005–18 period



Hover over chart to view data.
Note: MFP = multifactor productivity.
Source: U.S. Bureau of Labor Statistics.

Industry contributions to the slowdown of the contribution of capital intensity

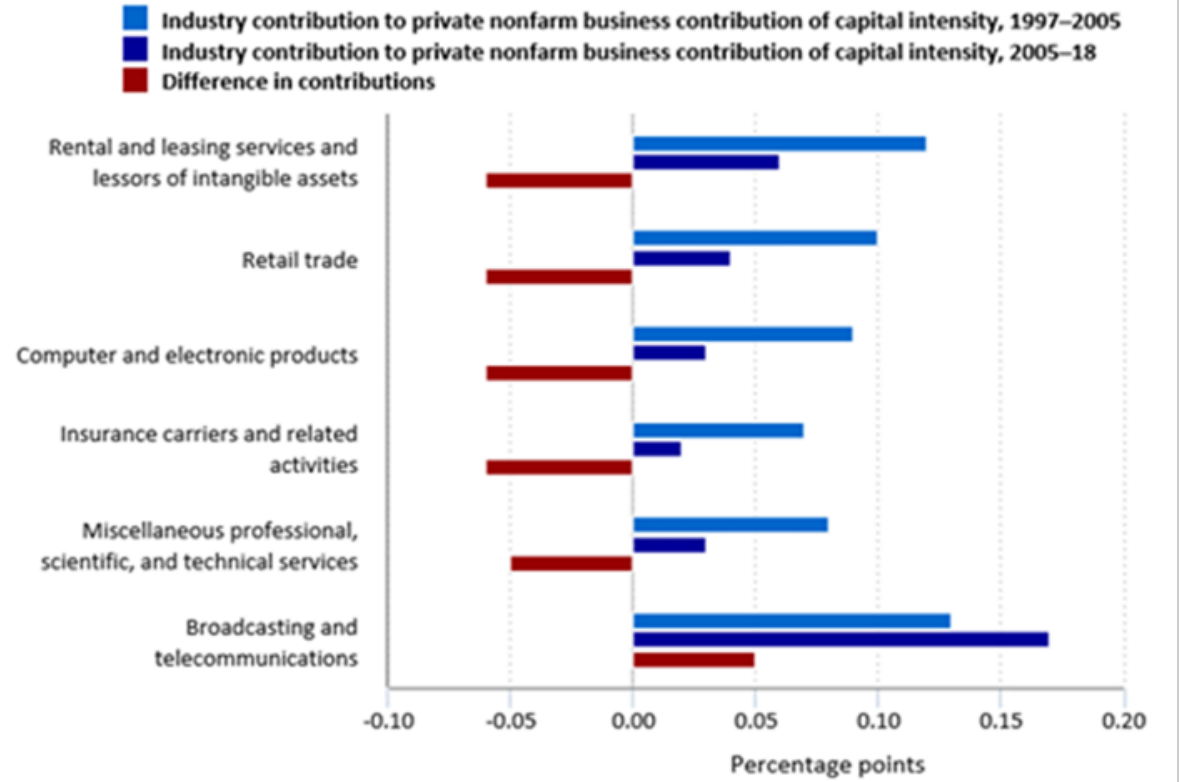
The slowdown in the contribution of capital intensity came more from the services sector than the goods sector. This finding can be seen in figure 13, which shows the sector-level contributions to the overall slowdown in the contribution of capital intensity. The services sector accounted for 0.45 ppt. of the overall slowdown in this measure, with the goods sector contributing 0.26 ppt.



The largest sector contribution to the slowdown was from the financial services sector, with a contribution of 0.23 ppt. There were also noteworthy contributions from professional and business services (0.12 ppt.), durable manufacturing (0.13 ppt.), and nondurable manufacturing (0.08 ppt.).

Figure 14 shows the large industry-level contributions to the slowdown in the contribution of capital intensity, including those with contributions of 0.05 or greater in either direction, positive or negative. Five of the six large contributors were negative and were of similar sizes. The four largest outliers each had slowdowns of 0.06 ppt.; these were rental and leasing services and lessors of intangible assets, retail trade, computer and electronic products, and insurance carriers and related activities. Miscellaneous professional, scientific, and technical services slowed by 0.05 ppt. The broadcasting and telecommunications industry had a speedup of 0.05 ppt.

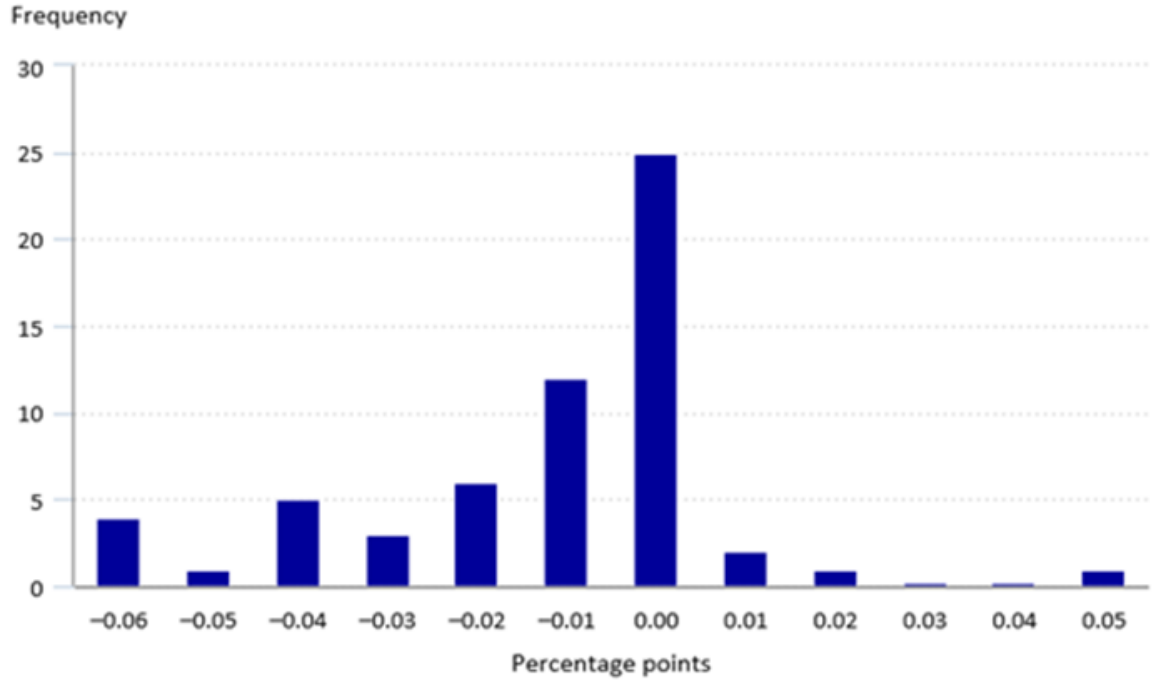
Figure 14. Industries with largest differences in contributions to private nonfarm business contribution of capital intensity, between 1997–2005 period and 2005–18 period



Click legend items to change data display. Hover over chart to view data.
Source: U.S. Bureau of Labor Statistics.

The distribution of industry contributions to the economy-wide slowdown in the contribution of capital intensity skews heavily negative (see figure 15), with 31 negative contributors and just 4 positive contributors. At the same time, the net contribution to the slowdown from the large contributors (0.24 ppt.) was lower than the net contribution from the small contributors (0.46 ppt.), indicating that there were relatively few outliers with regard to the slowdown in the contribution of capital intensity, especially when compared with the case of the MFP slowdown, which had some substantial outliers. To summarize this section, the bulk of the slowdown in the economy-wide contribution of capital intensity came from relatively small slowdowns in this measure that occurred in a substantial number of industries.

Figure 15. Distribution of percentage-point industry contributions to slowdown in contribution of capital intensity, private nonfarm business sector, from 1997–2005 period to 2005–18 period



Hover over chart to view data.
Source: U.S. Bureau of Labor Statistics.

Conclusion

At this point, we have a general understanding of the many factors—at both the economy-wide and industry levels—which may underlie the productivity slowdown since the mid-2000s. However, some questions remain, perhaps the most central one being: Is the U.S. economy now, as some researchers have suggested, in an intermittent lull in between waves of high growth, or, as others contend, in a “new normal” of lower growth that has resulted from fundamentally diminished returns to innovation? The answer is not known at the moment, and only time—and additional data in our time series—will tell us.

At the same time, one thing that we can say for certain about our present situation is that the productivity slowdown of the past decade and a half has left the U.S. economy in a weaker position—yielding a sizable loss of potential output during these years—and perhaps even more importantly, it has also left the economy in a weaker position going forward. This is because the productivity slowdown has resulted in a lower base of output from which to grow onward from here, relative to the more elevated starting position that the economy would instead now have if productivity had continued to grow at the long-term historical trend after 2005.

Thus, it will be important for participants of the U.S. economy to keep an eye on productivity data in coming years, to determine whether the slowdown since 2005 simply represented a periodic variation in trend, which can be explained from recent cyclical and noncyclical factors, as some observers have claimed, or whether it comes to be seen as a continuation of the low-growth economy of the last few decades of the 20th century. BLS productivity

data, including labor productivity, multifactor productivity, and capital and labor data, at both the economy-wide and industry levels, will continue to shed light on this issue.

Appendix. Full list of industry contributions

Table 1. Industry contributions to slowdown in private nonfarm business labor productivity growth, from 1997–2005 period to 2005–18 period, percentage points

Industry	Contributions from industry MFP growth			Contributions from industry contribution of capital intensity		
	1997–2005 period	2005–18 period	Difference	1997–2005 period	2005–18 period	Difference
Forestry, fishing, and related activities	0.011	–0.001	–0.012	0.002	0.002	0.001
Oil and gas extraction	–0.029	0.122	0.15	0.004	–0.035	–0.039
Mining, except oil and gas	0.014	–0.020	–0.034	0	0.014	0.014
Support activities for mining	–0.004	0.016	0.02	–0.004	–0.001	0.003
Utilities	–0.067	0.042	0.109	0.044	0.029	–0.015
Construction	–0.091	–0.122	–0.031	0.036	0.014	–0.023
Food and beverage and tobacco products	0.019	–0.020	–0.039	0.022	–0.001	–0.023
Textile mills and textile product mills	0.007	–0.001	–0.008	0.004	0.001	–0.004
Apparel and leather and applied products	0	–0.002	–0.002	0.007	0	–0.007
Wood products	0.001	0.004	0.003	0.002	0.001	–0.001
Paper products	0.003	0	–0.004	0.01	0.003	–0.007
Printing and related support activities	0.022	0.009	–0.013	0.006	0.003	–0.003
Petroleum and coal products	0.019	–0.021	–0.040	0.014	0.018	0.004
Chemical products	–0.001	–0.075	–0.074	0.103	0.071	–0.032
Plastics and rubber products	0.027	–0.002	–0.028	0.016	0.002	–0.014
Nonmetallic mineral products	0.003	–0.004	–0.006	0.005	0.003	–0.002
Primary metal products	0.027	0.004	–0.023	0.004	0.004	0.001
Fabricated metal products	0.007	–0.015	–0.022	0.014	0.006	–0.007
Machinery	0.027	–0.004	–0.030	0.023	0.007	–0.016
Computer and electronic products	0.445	0.104	–0.341	0.09	0.032	–0.058
Electrical equipment, appliances, and components	0.008	0.003	–0.006	0.009	0.003	–0.006
Motor vehicles, bodies and trailers, and parts	0.076	0.001	–0.074	0.037	0.001	–0.036
Other transportation equipment	0.009	0.015	0.006	0.01	0.009	–0.001
Furniture and related products	0	–0.003	–0.002	0.004	0.002	–0.002
Miscellaneous manufacturing	0.023	0.006	–0.017	0.012	0.007	–0.005
Wholesale trade	0.181	–0.015	–0.196	0.1	0.059	–0.041
Retail trade	0.216	–0.007	–0.223	0.099	0.041	–0.058
Air transportation	0.042	0.033	–0.009	0.009	0.005	–0.004
Rail transportation	0.014	0	–0.014	0.003	0.003	0
Water transportation	–0.005	0.008	0.012	–0.003	0.001	0.004
Truck transportation	–0.008	–0.007	0.001	0.007	0.008	0
Transit and ground passenger transportation	0.003	–0.003	–0.007	0.003	–0.001	–0.004
Pipeline transportation	0.009	0.007	–0.002	0.004	0.005	0.001
Other transportation and support activities	0.029	–0.035	–0.065	0.001	–0.004	–0.005
Warehousing and storage	0.015	–0.003	–0.017	–0.001	–0.002	–0.001

See footnotes at end of table.

Table 1. Industry contributions to slowdown in private nonfarm business labor productivity growth, from 1997–2005 period to 2005–18 period, percentage points

Industry	Contributions from industry MFP growth			Contributions from industry contribution of capital intensity		
	1997–2005 period	2005–18 period	Difference	1997–2005 period	2005–18 period	Difference
Publishing industries, except internet (includes software)	–0.006	0.042	0.048	0.073	0.053	–0.020
Motion picture and sound recording industries	0.025	0.021	–0.004	0.018	0.005	–0.012
Broadcasting and telecommunications	0.121	0.044	–0.077	0.125	0.173	0.048
Data processing, internet publishing, and other information services	0.027	0.015	–0.013	0.046	0.063	0.017
Federal reserve banks, credit intermediation, and related activities	0.03	–0.096	–0.126	0.112	0.071	–0.041
Securities, commodity contracts, and other financial investments and related activities	0.069	–0.042	–0.111	0.011	0.003	–0.009
Insurance carriers and related activities	0.05	0.046	–0.004	0.073	0.018	–0.055
Funds, trusts, and other financial vehicles	0.008	–0.003	–0.011	0.006	–0.020	–0.026
Real estate	–0.009	0.124	0.133	0.022	–0.015	–0.037
Rental and leasing services and lessors of intangible assets	–0.098	–0.002	0.095	0.117	0.057	–0.061
Legal services	0.006	–0.033	–0.039	0.012	0.006	–0.006
Miscellaneous professional, scientific, and technical services	–0.052	0.02	0.072	0.078	0.026	–0.052
Computer systems design and related services	0.047	0.095	0.048	0.019	–0.006	–0.024
Management of companies and enterprises	0.002	0.023	0.021	0.008	–0.003	–0.011
Administrative and support services	0.08	0.023	–0.057	0.046	0.019	–0.026
Waste management and remediation services	0.007	–0.003	–0.010	–0.002	–0.001	0.002
Educational services	–0.015	–0.007	0.008	–0.005	0.002	0.007
Ambulatory health care services	0.035	0.034	–0.002	0.004	0.002	–0.002
Hospitals and nursing and residential care facilities	–0.011	–0.015	–0.003	0.009	0.011	0.003
Social assistance	0.005	–0.003	–0.008	0	0	–0.001
Performing arts, spectator sports, museums, and related activities	0.006	0.011	0.005	0.005	0.002	–0.003
Amusements, gambling, and recreation industries	–0.014	0	0.014	0.006	0.004	–0.002
Accommodation	0.007	0.006	–0.001	0.015	0.008	–0.007
Food services and drinking places	0.041	–0.007	–0.048	–0.006	–0.008	–0.001
Other services, except government	–0.023	–0.032	–0.009	0.009	0.003	–0.005

Note: MFP = multifactor productivity.

Source: U.S. Bureau of Labor Statistics.

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NOTES

1 The overall estimated output loss figure ($10.9 trillion) represents the difference between (1) the sum of annual real output amounts in the nonfarm business sector from 2006 to 2018 and (2) the sum of annual real output amounts during this period assuming that labor productivity had continued to grow at the same long-term average rate observed from 1947 to 2005 and that all of the additional gains in labor productivity contributed to higher output rather than higher nonwork time. For more information on the estimation of this figure, as well as an example in which the additional gains in labor productivity contributed to higher nonwork time rather than higher output, see the section “Dollar and time costs of the productivity slowdown” in this article. Also, note that the loss for the entire U.S economy is likely sizably greater than the presented output loss figure. However, because we cannot measure the productivity of the noncovered sectors that represent the difference (including general government, nonprofit institutions, and private households, which include owner-occupied housing), since the output data for these sectors are not suitable for productivity measurement, we can only estimate what the effect would have been for the 76 percent of the U.S. economy covered by the nonfarm business sector. Also note that the estimated output loss per worker figure ($95,000) does not represent the loss in compensation per worker due to the slowdown, which would have been sizably less than that figure, given that only a portion of output accrues to workers as compensation for their labor. For more information on this aspect, see Michael D. Giandrea and Shawn A. Sprague, “Estimating the U.S. labor share,” *Monthly Labor Review*, February 2017, https://www.bls.gov/opub/mlr/2017/article/estimating-the-us-labor-share.htm.

2 See figure 2 of Martin Neil Baily and Nicholas Montalbano, “Why is U.S. productivity growth so slow? Possible explanations and policy responses,” Hutchins Center Working Paper 22 (Washington, DC: Brookings Institution, September 2016), p. 4. Baily and Montalbano provide an excellent overview of the productivity slowdown and also offer potential policy responses. In addition, other overviews of the slowdown include Alexander Murray, “What explains the post-2004 U.S. productivity slowdown?” *International Productivity Monitor*, no. 34, Spring 2018, p. 81–109; and Emily Moss, Ryan Nunn, and Jay Shambaugh, “The slowdown in productivity growth and policies that can restore it,” *The Hamilton Project* (Washington, DC: Brookings Institution, June 2020).

3 In Dale W. Jorgenson, Mun S. Ho, and Kevin J. Stiroh, “A retrospective look at the U.S. productivity growth resurgence,” *Journal of Economic Perspectives*, no. 1, vol. 22, Winter 2008, p. 4, the authors offer an anecdote illustrating the changed perspective during this period: “in just four years, from 1997 to 2001, the Congressional Budget Office more than doubled its ten-year projection of nonfarm business productivity growth from 1.2 to 2.7 percent!”

4 All percent changes in this article, unless otherwise noted, refer to average annual percent changes.

5 Although labor productivity growth theoretically provides a foundation for potential gains in worker compensation, it has historically been the case that commensurate gains in worker compensation do not necessarily accompany gains in labor productivity. Since the early 1970s, real hourly compensation growth has lagged far behind labor productivity growth. For more information, see Susan Fleck, John Glaser, and Shawn Sprague, “The compensation−productivity gap: a visual essay,” *Monthly Labor Review*, January 2011, https://www.bls.gov/opub/mlr/2011/01/art3full.pdf.

6 There are two main ways of dividing time periods when one is doing a historical productivity analysis such as the one in this article: using business cycles or using variation in trends that are apparent in the data. For the present article, I use variation in trends to define the speedup period (1997–2005) and the slowdown period (2005–18). I selected these two periods because they correspond to the periods that are generally discussed in the literature on this issue and because it is apparent from the data that the question at hand (“What were the sources of the slowdown?”) could not be addressed by operating strictly within the macroeconomic business cycle framework. One reason for this is that the industry-level sources of the slowdown exhibited their own trends that did not necessarily fit within the economy-wide business cycles. Another reason is that although using either a cyclical or trend approach for the slowdown period made little difference (because the business cycle that began in 2007 began just 2 years following the beginning

of the trend-based period [2005]), for the speedup period, it appeared to be preferable to use a trend-based approach. This preference was due to the fact that using the business-cycle break (in 2001) would have split the widely cited speedup period (1997–2005) roughly in half, disallowing for a one-to-one comparison of a speedup and slowdown period. If a business cycle approach had been taken instead, then the comparison would have been between two speedup periods (1990–2001 and 2001–07) and one slowdown period (2007–18), as parts of each of those two preceding periods contain a portion of the speedup in the trend, and the industry-level and broad-based changes in the economy during the speedup period from 1997 to 2005 would have been split into two separate periods. It is notable that this disjuncture between business cycles and trend-based periods in terms of the current productivity slowdown did not occur with the last major productivity slowdown, in the 1970s. This widely cited slowdown, which was apparent in the data beginning in 1973, represented both a business cycle break and a clear demarcation between extended periods of high growth (before 1973) and low growth (after 1973). This result contrasts the present slowdown, the period selection of which was not as clear-cut. As for defining the periods since 1947 that occurred before the speedup period (1997–2005), I use a grouped business cycle approach (by grouping adjacent business cycles with similar trends) to make the interperiod comparisons in the figures more concise and make the broad trends over the past 70 years easier to absorb. The fact that the last major productivity slowdown (in the 1970s) had a match between business cycle breaks and trend-period breaks makes the 1948–1997 period somewhat easier to break up into periods. Also, for a strictly business cycle analysis of the present slowdown, see Shawn Sprague, "Below trend: the U.S. productivity slowdown since the Great Recession," *Beyond the Numbers: Productivity*, vol. 6, no. 2 (U.S. Bureau of Labor Statistics, January 2017), https://www.bls.gov/opub/btn/volume-6/below-trend-the-us-productivity-slowdown-since-the-great-recession.htm.

7 Multifactor productivity (MFP) data for the U.S. private nonfarm business sector are available on an annual basis, beginning with data for 1948. This sector accounted for approximately 74 percent of the total U.S. economic output (gross domestic product [GDP]) as of 2017. As denoted by the term "business" in the series name, three nonbusiness sectors are excluded from GDP: general government, nonprofit institutions, and private households (including owner-occupied housing). These three sectors are excluded because their output is measured largely with the use of compensation data, which measure an input to production rather than an output from production, thus rendering these sectors inappropriate for productivity measurement. Also, farm sector data are excluded to reduce volatility in the overall measure. And, as denoted by the term "private" in the series name, government enterprises are excluded, because satisfactory capital measures are unavailable for this sector. In addition, note that the term "MFP" is synonymous with "TFP" or total-factor productivity, which is used throughout the economic literature and refers to the same measure. (For more information on this, see the U.S. Bureau of Labor Statistics (BLS) Division of Productivity Research and Program Development Frequently Asked Questions (FAQs) page at https://www.bls.gov/dpr/faqs.htm#Q01). On another note, although for this article we are looking at private nonfarm business MFP growth, which only includes labor and capital as inputs, BLS also publishes other measures of MFP growth, one of which is referred to as KLEMS (K-capital, L-labor, E-energy, M-materials, and S-purchased services), which includes additional inputs as well.

8 Although figure 2 shows a slight shift in the contribution of labor composition (from 0.2 percent to 0.3 percent) from the speedup period to the slowdown period, looking at these data with more precision reveals a trivial shift in the contribution of labor composition during the slowdown, with an upward shift of just 0.01 percentage point, from 0.24 percent in the speedup period to 0.25 percent in the slowdown period.

9 Alistair Dieppe, Neville Francis, and Gene Kindberg-Hanlon observe this phenomenon in both advanced economies and emerging market economies, in the period from 1980 to 2018: "The volatility of labor productivity is largely accounted for by [MFP] across both advanced economies and EMDEs, where [MFP] accounts for 75–80 percent of labor productivity variance. The high proportion of volatility present in [MFP] reflects its role as a residual, explaining all productivity variation not driven by slower-moving developments in the capital stock and human capital." Alistair Dieppe, Neville Francis, and Gene Kindberg-Hanlon, "A tale of two dynamics: exploring productivity and business-cycle drivers of developed and emerging market economies," working paper, July 24, 2020, p. 6.

10 For this article, we are looking at private nonfarm business MFP growth, which only includes labor and capital as inputs. However, BLS also publishes other measures of MFP growth that include other inputs, referred to as KLEMS (capital, labor, energy, materials, and services).

11 See Brian Resnick, "Dark matter, humility, and coming to grips with the unknown," *Vox*, November 25, 2020.

12 From 1929 to 1933, GDP fell by a cumulative 26.3 percent, whereas from 2007 to 2009, GDP fell by a cumulative 2.7 percent. For more information, see National Data, National Income and Product Accounts (NIPA), Table 1.1.6. Real gross domestic product, chained dollars (U.S. Bureau of Economic Analysis).

13 From 1933 to 1940, GDP grew at an average annual rate of 7.2 percent, and from 2009 second quarter to 2018 fourth quarter, GDP grew at an average annual rate of 2.3 percent. NIPA, Table 1.1.6.

14 The U.S. population grew at an average annual rate of 0.7 percent from 1929 to 1940 and from 2007 to 2018. NIPA, Table 7.1 Selected per capita product and income series in current and chained dollars, line 18 (U.S. Bureau of Economic Analysis).

15 Valerie Cerra and Sweta Chaman Saxena, "Growth dynamics: the myth of economic recovery," *American Economic Review*, vol. 98, no. 1, March 2008, pp. 439–57; Carmen M. Reinhart and Kenneth S. Rogoff, *This Time is Different: Eight Centuries of Financial Folly* (Princeton, NJ: Princeton University Press, 2009); and Carmen M. Reinhart and Vincent R. Reinhart, "After the fall," Working Paper 16334 (Cambridge, MA: National Bureau of Economic Research, September 2010).

16 International Monetary Fund, *World Economic Outlook, October 2009: Sustaining the Recovery* (Washington: International Monetary Fund, 2009), p. 125.

17 Daisuke Ikeda and Takushi Kurozumi, "Slow post-financial crisis recovery and monetary policy," Working Paper 347 (Federal Reserve Bank of Dallas Globalization Institute, October 2018), p. 4. As noted in endnote 7, in this article, I use MFP to refer to multifactor productivity, although others in the literature refer to the measure as TFP or total factor productivity. These acronyms and names refer to the same measure. For more information, see the BLS Division of Productivity Research and Program Development FAQ page at https://www.bls.gov/dpr/faqs.htm#Q01.

18 These changes in demographics "include, most prominently, the demographic shifts of the surge of women into the labor force in the 1970s–1990s and, more recently, the baby boom[ers] beginning to retire." James H. Stock and Mark W. Watson, "Why has GDP growth been so slow to recover?" (draft paper presented at the Boston Federal Reserve's conference, "The elusive 'great recovery': causes and implications for future business cycle dynamics," October 2016), p. 1.

19 Ray C. Fair, "Explaining the slow U.S. recovery: 2010–2017," Business Economics, vol. 53, no. 4, pp. 184–194, October 2018.

20 Robert E. Hall, "The routes into and out of the zero lower bound," in Proceedings—Economic Policy Symposium—Jackson Hole (Federal Reserve Bank of Kansas City, 2013), p. 3.

21 Robert J. Barro, "The job-filled non-recovery" (Cambridge, MA: Harvard University, September 2016), p. 6.

22 Ikeda and Kurozumi, "Slow post-financial crisis recovery and monetary policy," p. 4.

23 David M. Byrne, Stephen D. Oliner, and Daniel E. Sichel, "Is the information technology revolution over?" *International Productivity Monitor*, vol. 25, Spring 2013, p. 21.

24 Romain Duval, Gee Hee Hong, and Yannick Timmer, "Financial frictions and the great productivity slowdown," Working Paper 17/129 (International Monetary Fund Working Papers, May 2017), p. 1.

25 Duval et al., "Financial frictions and the great productivity slowdown," p. 17. Intangible assets are nonphysical assets such as intellectual property, including software, research and development, patents, trademarks, and goodwill. Germán Gutiérrez and Thomas Philippon, in "Investment-less growth: an empirical investigation," abstract, Working Paper 22897 (Cambridge, MA: National Bureau of Economic Research, December 2016), also cite decreased investment in intangibles; see section (in this article) "The slowdown in the contribution of capital intensity." In addition to having an indirect effect on the MFP growth measure, as noted by Duval et al., a slowdown in intangibles would also have a direct effect on the contribution of capital intensity measure, by explicitly reducing the numerator of the change in the capital-labor ratio. In addition, the fallout from the Great Recession may have also hampered rates of reallocation—the process of moving more resources toward high-productivity firms and away from low productivity firms—according to Lucia Foster, Cheryl Grim, and John Haltiwanger, "Reallocation in the Great Recession: cleansing or not?" abstract, Working Paper 20427 (Cambridge, MA: National Bureau of Economic Research, August 2014). These authors observe faltering rates of reallocation during the Great Recession, which is the inverse of the typical case for recessions, perhaps indicating that the magnitude of this recession adversely affected prospects for productivity growth. Even worse, they state that "the reallocation

that did occur [during the Great Recession] was less productivity enhancing than in prior recessions." Nicholas Bloom, Max Floetotto, Nir Jaimovich, Itay Saporta-Eksten, and Stephen J. Terry also cite weak rates of reallocation, which they claim is undergirded by an increase in uncertainty during recessions, contending that "increased uncertainty also reduces productivity growth because it reduces the degree of reallocation in the economy. Higher uncertainty leads productive plants to pause expanding and unproductive plants to pause contracting, which in the . . . U.S. economy drives much of aggregate productivity growth." Nicholas Bloom, Max Floetotto, Nir Jaimovich, Itay Saporta-Eksten, and Stephen J. Terry, "Really uncertain business cycles," Working Paper 18245 (Cambridge, MA: National Bureau of Economic Research, July 2012), p. 1–2.

26 John G. Fernald downplays the importance of the Great Recession in the post-2005 productivity slowdown, claiming that "the Great Recession seem[s] less important than trends related to information technology (IT) that predated the Great Recession." See his paper, "Productivity and potential output before, during, and after the Great Recession," Working Paper 2014–15 (Federal Reserve Bank of San Francisco, June 2014). (Note that the effect of IT-intensive industries on the slowdown will be addressed in the "Industry-level analysis of the U.S. labor productivity slowdown" section of this article.)

27 Ryan A. Decker, John C. Haltiwanger, Ron S. Jarmin, and Javier Miranda, "Changing business dynamism and productivity: shocks vs. responsiveness," Working Paper 24236 (Cambridge, MA: National Bureau of Economic Research, January 2018). Also, in addition to the works cited in this section on the topic of productivity dispersion, note that data on productivity dispersion are now available from BLS and the Census Bureau, via the Collaborative Micro-Productivity Project (CMP), which has developed and published experimental statistics on within-industry dispersion. The public-use statistics (referred to as the Dispersion Statistics on Productivity) developed via this project, were released in fall 2019 and cover all four-digit North American Industry Classification System industries in the manufacturing sector. Restricted-use establishment-level data with microbased estimates of productivity as well as its underlying components (e.g., output and input measures) are also available to qualified researchers on approved projects in secure Federal Statistical Research Data Centers. More information on these data can be obtained at https://www.bls.gov/lpc/productivity-dispersion.htm.

28 Michael Gort and Steven Klepper, "Time paths in the diffusion of product innovations," *Economic Journal*, vol. 92, no. 367, September 1982, pp. 630–653.

29 Decker et al., "Changing business dynamism and productivity."

30 Decker et al., "Changing business dynamism and productivity," p. 27. An in-depth discussion of high-tech industries, and their relationship to the economy-wide productivity slowdown, is in the "Industry-level analysis of the U.S. labor productivity slowdown" section of this article.

31 Ibid.

32 Jan De Loecker, Jan Eeckhout, and Gabriel Unger, "The rise of market power and the macroeconomic implications," working paper, 2018.

33 Ibid., p. 52.

34 Gustavo Grullon, Yelena Larkin, and Roni Michaely, "Are US Industries becoming more concentrated?" abstract, working paper, 2017.

35 Miguel Antón, Florian Ederer, Mireia Giné, and Martin C. Schmalz, "Common ownership, competition, and top management incentives," Finance Working Paper 511/2017 (Brussels: Belgium, European Corporate Governance Institute), February 2018; and José Azar, Sahil Raina, and Martin C. Schmalz, "Ultimate ownership and bank competition," working paper (SSRN, March 17, 2016).

36 John E. Kwoka, Jr. "Mergers, merger control, and remedies: a response to the FTC critique," working paper (SSRN, March 2017); Bruce A. Blonigen and Justin R. Pierce, "Evidence for the effects of mergers on market power and efficiency, " Working Paper 22750 (Cambridge, MA: National Bureau of Economic Research, October 2016); Council of Economic Advisers, "Occupational licensing: a framework for policymakers," The White House: Washington, DC, July 2015; Jason Furman, "Barriers to shared growth: the case of land use regulation and economic rents" (remarks at The Urban Institute, November 20, 2015); Jason Furman, "Market concentration —note by Jason Furman" (paper presented at Organisation for Economic Cooperation and Development [OECD], Directorate for

Financial and Enterprise Affairs Competition Committee Hearing on Market Concentration, June 7, 2018); and Brookings Institution, "The productivity puzzle: How can we speed up the growth of the economy?" panel discussion (Washington, DC, September 9, 2016). In addition, Ernest Liu, Atif Mian, and Amir Sufi theorize that the low interest rates of the past decade have helped increase concentration, asserting that "low interest rates encourage market concentration by raising industry leaders' incentive to gain a strategic advantage over followers, and this effect strengthens as the interest rate approaches zero." For more information, see Ernest Liu, Atif Mian, and Amir Sufi, "Low interest rates, market power, and productivity growth" abstract, Working Paper 25505 (Cambridge, MA: National Bureau of Economic Research, August 2019).

37 Dan Andrews, Chiara Criscuolo, and Peter N. Gal, "The global productivity slowdown, technology divergence and public policy: a firm level perspective," Hutchins Center Working Paper 24 (Washington, DC: Brookings Institution, September 2016), https://www.brookings.edu/research/the-global-productivity-slowdown-technology-divergence/, p. 3.

38 Decker et al., "Changing business dynamism and productivity," p. 24. Additionally, there is another widely cited firm-level theory that has been offered to explain the increased productivity dispersion, which is from Adalet McGowan, Andrews, and Millot. Müge Adalet McGowan, Dan Andrews, and Valentine Millot, "Insolvency regimes, zombie firms and capital reallocation," OECD Economics Department Working Papers No. 1399, June 28, 2017. Adalet McGowan et al. remark that the prevalence of so-called "zombie firms," or low-productivity firms that are unable to properly service their debts, have increased in OECD countries since the mid-2000s. The authors hypothesize that the stubborn persistence of these low-growth firms is potentially not only keeping resources from reallocating to high-growth firms, but it is also creating entry barriers and inhibiting the growth of new firms. However, this theory appears not to be relevant specifically for the United States, which, unlike other OECD countries and especially European countries, has actually had a decline in the share of zombie firms in recent years. For more information, see Dan Andrews and Giuseppe Nicoletti, "Confronting the zombies: policies for productivity revival" slide 7, OECD Economic Policy Papers, no. 21 (presented at the Peterson Institute for International Economics, January 23, 2018).

39 Jason Furman and Peter Orszag, "Slower productivity and higher inequality: Are they related?" Working Paper 18–4 (Peterson Institute for International Economics, June 2018).

40 Ibid., p. 2. See also Alexander M. Bell, Raj Chetty, Xavier Jaravel, Neviana Petkova, and John Van Reenan, "Who becomes an inventor in America? The importance of exposure to innovation," Working Paper 24062 (Cambridge, MA: National Bureau of Economic Research, November 2017); Frederico Cingano, "Trends in income inequality and its impact on economic growth," OECD Social, Employment and Migration Working Papers, no. 163 (Paris: Organisation for Economic Cooperation and Development Publishing, December 9, 2014); and Jonathan D. Ostry, Andrew Berg, and Charalambos G. Tsangarides. "Redistribution, inequality, and growth," Staff Discussion Note (Washington, DC: International Monetary Fund, February 2014).

41 Furman and Orszag, "Slower productivity and higher inequality, p. 2.

42 Ruchir Agarwal and Patrick Gaulé, "Invisible geniuses: Could the knowledge frontier advance faster?" abstract, International Monetary Fund Working Paper 18/268 (Washington, DC: International Monetary Fund, December 2018).

43 Robert J. Gordon, "Is U.S. economic growth over? Faltering innovation confronts the six headwinds," Working Paper 18315 (Cambridge, MA: National Bureau of Economic Research, August 2012); and John G. Fernald, "Productivity and potential output before, during, and after the Great Recession."

44 Joseph A. Tainter, *The Collapse of Complex Societies* (Cambridge, MA: Cambridge University Press, 1988), p. 114.

45 Nicholas Bloom, Charles I. Jones, John Van Reenen, and Michael Webb, "Are ideas getting harder to find?" Working Paper 23782 (Cambridge, MA: National Bureau of Economic Research, September 2017), p. 8; and Jay Bhattacharya and Mikko Packalen, "Stagnation and Scientific Incentives," abstract, Working Paper 26752 (Cambridge, MA: National Bureau of Economic Research, February 2020). Bhattacharya and Packalen argue that changing incentives may also be playing a role, specifically that an "emphasis on citations in the measurement of scientific productivity shifted scientist rewards and behavior on the margin toward incremental science and away from exploratory projects that are more likely to fail, but which are the fuel for future breakthroughs."

46 Chad Syverson, "Will history repeat itself? Comments on 'Is the information technology revolution over?'" *International Productivity Monitor*, no. 25, Spring 2013, pp. 37–40.

47 Ana Paula Cusolito and William F. Maloney, *Productivity Revisited: Shifting Paradigms in Analysis and Policy* (Washington, DC: The World Bank Group, 2018), p. 8.

48 Though figure 2 shows that both the 2005–18 slowdown period and the 1981–97 period posted the same low 0.7-percent rate, at slightly more precision, the 2005–18 rate (0.66 percent) was nearly a percentage point lower than the 1981–97 period rate (0.74 percent).

49 Byrne et al., "Is the information technology revolution over?" p. 21.

50 Robert E. Hall, "Quantifying the lasting harm to the U.S. economy from the financial crisis," Working Paper 20183 (Cambridge, MA: National Bureau of Economic Research, May 2014), p. 13.

51 Ravi Bansal, Mariano Max Croce, Wenxi Liao, and Samuel Rosen, "Uncertainty-induced reallocations and growth," Working Paper 26248 (Cambridge, MA: National Bureau of Economic Research, September 2019), p. 1.

52 Gutiérrez and Philippon, "Investment-less growth," abstract. Tobin's Q was first introduced by Nicholas Kaldor in 1966. For more information, see Nicholas Kaldor, "Marginal productivity and the macro-economic theories of distribution: comment on Samuelson and Modigliani," *Review of Economic Studies*, vol. 33, no. 4, October 1966, pp. 309–319. It was popularized a decade later, however, by James Tobin, who describes its two quantities: "One, the numerator, is the market valuation: the going price in the market for exchanging existing assets. The other, the denominator, is the replacement or reproduction cost: the price in the market for newly produced commodities. We believe that this ratio has considerable macroeconomic significance and usefulness, as the nexus between financial markets and markets for goods and services." James Tobin and William C. Brainard, "Asset markets and the cost of capital," in *Economic Progress, Private Values, and Public Policy* (Amsterdam: North-Holland Publishing Company, 1977).

53 Germán Gutiérrez and Thomas Philippon, "Investment-less growth: an empirical investigation," *Brookings Papers on Economic Activity* (Washington, DC: Brookings Institution, September 7, 2017), p. 90.

54 Ibid., p. 93.

55 Ibid., p. 136.

56 Regarding quasi-indexers, Gutiérrez and Philippon state, "Quasi-indexers have diversified holdings and low portfolio turnover—consistent with a passive, buy-and-hold strategy of investing portfolio funds in a broad set of firms." Gutiérrez and Philippon, "Investment-less growth," December 2016, p. 3.

57 Ibid., abstract.

58 Ibid., 2016, p. 19. See also Michael Jensen, "Agency costs of free cash flow, corporate finance, and takeovers," *American Economic Review*, vol. 76, no. 2, 1986, p. 323. Gutiérrez and Philippon, "Investment-less growth," September 7, 2017, p. 109. See also Christine Jolls, "Stock repurchases and incentive compensation," abstract, Working Paper 6467 (Cambridge, MA: National Bureau of Economic Research, March 1998).

59 Fernald, "Productivity and potential output before, during, and after the Great Recession," p. 9.

60 Bloom et al., "Really uncertain business cycles," p. 1.

61 Foster et al., "Reallocation in the Great Recession: cleansing or not?" abstract.

62 Fernald, "Productivity and potential output before, during, and after the Great Recession."

63 Sprague, "Below trend," https://www.bls.gov/opub/btn/volume-6/below-trend-the-us-productivity-slowdown-since-the-great-recession.htm.

64 In 2010, labor hours jumped up by more than 7 percentage points in a single year and transitioned from a 7.2-percent decline in 2009 to a 0.1-percent decline in 2010. This much smaller decline in labor hours growth for 2010 helped shrink the contribution of capital intensity and expand MFP growth compared with what they had been in 2009. Specifically, labor hours growth lowered the contribution of capital intensity in 2010 relative to that of 2009 because its low rate in 2010 (–0.1 percent) was then more similar to the rate for capital services (0.8 percent), thus shrinking the capital-to-labor ratio relative to the ratio of the prior year. In addition, MFP growth was dramatically accelerated as the below-average gains in both labor and capital in that year were paired with rapidly recovering output growth (3.3 percent).

65 Also, note that the low productivity growth of the 2005–18 period itself reduced the long-term rate since 1947 from 2.3 percent—what it had been as of 2005—to 2.1 percent as of 2018.

66 The data underlying the labor composition series bear this phenomenon out during the Great Recession: the labor cost share of workers under 45 and workers without a college degree plunged much more than it did for workers over 45 and workers with a college degree, during the Great Recession.

67 In this case, I use the long-term historical trend rate from 1947 to 2005, which is 2.3 percent, rather than the rate from 1947 to 2018, which is 2.1 percent. This is because, in this exercise, we are attempting to determine what growth would have been after 2005 if it had continued at the rate observed prior to 2005.

68 This per-worker loss in output technically should be viewed in terms of productivity analysis, with the output loss being represented relative to this input to production. Furthermore, the loss in output per worker does not equate to the loss in compensation per worker, which would have been a lesser amount, as only a portion of output accrues to workers as compensation for their labor. Giandrea and Sprague, “Estimating the U.S. labor share,” https://doi.org/10.21916/mlr.2017.7.

69 Note that, in this hypothetical case, some of this additional leisure or nonwork time could have been the result of layoffs (which could have resulted in unemployment, voluntary retirement from work, or, for some workers, another job), to the extent that the reduction in overall hours was distributed inequitably among workers and reduced employment rather than average weekly hours. To the extent that average weekly hours were reduced, this could have come in the form of increased vacation or sick leave offered and taken, a reduction in the workweek, or a transition from full-time to part-time work for some workers.

70 For this computation of hypothetical average weekly hours, we are assuming that all the reduction in overall hours went to a reduction in average weekly hours and not to employment. This approach was taken to show the additional leisure or nonwork time that would have been hypothetically available for this group of workers who were employed during 2005–18.

71 Evsey D. Domar, “On the measurement of technological change,” *Economic Journal*, vol. 71, no. 284, December 1961, pp. 709–729. In his article, Domar developed a method for estimating industry contributions to overall MFP growth for an aggregate sector. I use this approach for breaking out industry contributions to private nonfarm business MFP growth. Domar showed that a given industry’s contribution to an aggregate MFP growth rate is equal to the MFP growth rate for that industry, multiplied by a two-period average of the ratio of output in the industry to value-added in the sector. The sum of the Domar-weighted industry MFP growth rates approximates the private nonfarm business MFP growth rate. Also, to calculate the industry contributions to the private nonfarm business contribution of capital intensity, I use an approach that uses Domar’s general approach and allows for the breakout of this component. For more information regarding this approach, see Robert Inklaar, Mary O’Mahony, and Marcel Timmer, “ICT and Europe’s productivity performance industry-level growth account comparisons with the United States,” Groningen Growth and Development Centre (GGDC) Research Memorandum GD-68 (Netherlands: University of Groningen, GGDC, December 2003), pp. 12–13.

72 Farm industries are excluded from our analysis in this article, as we are looking at the contributions to the private nonfarm business sector.

73 The summed MFP contributions, using the Domar method, add to 1.11 percentage points, which is slightly different from the top-line private nonfarm business slowdown of 1.27 percentage points. For this section of the article, I use the 1.11 figure as the overall value because it is consistent with the summed contributions.

74 Byrne et al. report that “since 2004 IT has continued to make a significant contribution to U.S. labour productivity growth, though it is no longer providing the boost that it did during the productivity resurgence from 1995 to 2004.” See Byrne et al., “Is the information technology revolution over?” abstract.

75 Stephen D. Oliner and Daniel E. Sichel, “The resurgence of growth in the late 1990s: Is information technology the story?” *Journal of Economic Perspectives*, vol. 14, no. 4, Autumn 2000, p. 16.

76 David M. Byrne and Carol Corrado, “ICT prices and ICT services: What do they tell us about productivity and technology?” Working Paper 2017-015 (Board of Governors of the Federal Reserve System Finance and Economics Discussion Series, February 10, 2017), p. 21.

77 According to Byrne et al., “the official price indexes for semiconductors developed by BLS show that quality-adjusted semiconductor prices are not falling nearly as rapidly as they did prior to the mid-2000s.” See Byrne et al., “Is the information technology revolution over?” p. 23.

78 Byrne and Corrado, “ICT prices and ICT services,” p. 1.

79 Byrne et al., “Is the information technology revolution over?” p. 23.

80 David M. Byrne, John G. Fernald, and Marshall B. Reinsdorf, “Does the United States have a productivity slowdown or a measurement problem?” *Brookings Papers on Economic Activity* (draft paper presented at BPEA conference, March 10–11, 2016), p. 1, https://www.brookings.edu/wp-content/uploads/2016/03/ByrneEtAl_ProductivityMeasurement_ConferenceDraft.pdf.

81 Ibid.

82 Ibid., abstract. The authors also qualify that “the effect on [MFP of their adjustment] is more muted.”

83 Chad Syverson, “Challenges to mismeasurement explanations for the U.S. productivity slowdown,” abstract, Working Paper 21974 (Cambridge, MA: National Bureau of Economic Research, February 2016).

84 Decker et al., “Changing business dynamism and productivity,” p. 27.

85 Mordecai Kurz, “On the formation of capital and wealth,” Discussion Paper 17-016 (Stanford Institute for Economic Policy Research, June 25, 2017).

86 Ibid., abstract.

87 Lucia Foster, Cheryl Grim, John Haltiwanger, and Zoltan Wolf, “Innovation, Productivity Dispersion, and Productivity Growth,” U.S. Census Bureau Center for Economic Studies Working Paper 18-08, February 2018, p. 4.

88 Titan Alon, David Berger, Robert Dent, Benjamin Pugsley, “Older and slower: the startup deficit’s lasting effects on aggregate productivity growth,” Working Paper 23875 (Cambridge, MA: National Bureau of Economic Research, September 2017), p. 2.

89 Ibid., p. 2.

90 Grullon et al., “Are US industries becoming more concentrated?” abstract.

91 David Autor, David Dorn, Gordon H. Hanson, Gary Pisano, and Pian Shu, “Foreign competition and domestic innovation: evidence from U.S. patents,” working paper, September 2018.

92 Ibid., p. 2.

93 Lucia Foster, John Haltiwanger and C. J. Krizan, “Market selection, reallocation, and restructuring in the U.S. retail trade sector in the 1990s,” *Review of Economics and Statistics*, vol. 88, no. 4, November 2006, p. 748.

94 On this topic, also see Ronald S. Jarmin, Shawn D. Klimek, and Javier Miranda, “The role of retail chains,” in Timothy Dunne, J. Bradford Jensen, and Mark J. Roberts, eds., *Producer Dynamics: New Evidence from Micro Data* (Chicago: University of Chicago Press, January 2009), chap. 6.

95 Foster et al., “Market selection, reallocation, and restructuring in the U.S. retail trade sector in the 1990s,” p. 748, as cited in Emek Basker, “Job creation or destruction? Labor-market effects of Wal-Mart expansion,” *Review of Economics and Statistics*, vol. 87, no. 1, February 2005, pp. 174–183.

96 Foster et al., “Market selection, reallocation, and restructuring in the U.S. retail trade sector in the 1990s,” p. 749.

97 David Popp, Jacquelyn Pless, Ivan Haščič, and Nick Johnstone, “Innovation and entrepreneurship in the energy sector,” abstract, Working Paper 27145 (Cambridge, MA: National Bureau of Economic Research, May 2020).

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