TWO SIGMA

Street View

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EXECUTIVE SUMMARY Growth accounting disentangles GDP into three main drivers -- labor productivity, labor force participation rate, and population growth. Along all three of these factors, the latest reports from the US Bureau of Labor Statistics (BLS) provide disappointing news to anyone hoping that US GDP growth rates will return to the three percent per year (or higher) rate sustained prior to the Great Recession.

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Inside:
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US GROWTH ACCOUNTING MAY LEAD TO A LONG-TERM WRITE DOWN

From a statistician's perspective, some Generally Accepted Accounting Principles (GAAP) appear counterintuitive. For example, an illiquid asset like real estate may appear on a firm's balance sheet with a value equal to the original price the firm paid, even for decades-old transactions. Such accounting rules seem to target precision (i.e., an observable but stale price) over accuracy (i.e., an unobservable "market" price).[1] For a statistician craving unbiased data, these practices appear counterproductive.

These GAAP quirks notwithstanding, economists can actually make accountants look good in comparison. Consider GDP. To facilitate both intertemporal and cross-country comparisons, economists measure GDP as the market value of all goods and services produced within a country during a specified period. Complications to this measurement include both changes in market composition (e.g., unpaid household laborers joining the formal labor market and output like software applications given away for free) and changes in quality not reflected by price indices (e.g., improvements to video clarity that occur alongside declining television prices). Economists often defend GDP as a useful metric using similar logic as accountants – an imperfect but sufficiently precise metric that offers more insights than most alternatives. So it seems only a little ironic that there exists a branch of macroeconomics called "growth accounting."

Growth accounting helps disentangle the drivers of GDP. For market participants and others striving to forecast US GDP growth rates, growth accounting can simplify the problem. Specifically, GDP growth equals the sum of the changes in labor productivity, labor force participation, and population growth. Along all three of these factors, the latest reports from the Bureau of Labor Statistics (BLS) provide disappointing news to anyone hoping that US GDP growth rates will return to the three percent per year (or higher) rate sustained prior to the Great Recession.

A BRIEF PRIMER ON ECONOMIC GROWTH ACCOUNTING

Growth accounting resembles notebook stoichiometry. Through a series of algebraic manipulations, quantities on the left side of an equation transform into different values on the right. Consider a common formulation:[2]

Equation 1

Real GDP = (Real GDP / Worker)(Workers / Population) * Population*

In Equation 1, GDP / Worker represents average labor force productivity. The remaining terms in the equation translate to labor force participation multiplied by population size. Taking the logarithm of both sides of Equation 1 and totally differentiating reveals:

Equation 2

Real GDP growth ≈ producitivty growth + labor force participation growth + population growth

Table 1 reports the long-term trends for equation 2.

Table 1

Real GDP Growth Accounting

	1980s	1990s	2000s	2010+
Population growth	1.07	1.07	1.03	1.07
+ Labor force participation	0.44	0.08	0.00	-0.70
= Civilian Employment	1.51	1.15	1.03	0.37
+ Productivity growth	1.68	2.15	1.00	0.98
= Real GDP	3.19	3.29	2.03	1.35

Data fom the BLS.

1 There exists an ongoing and seemingly contentious debate among accountants and others on the merits of mark-to-market (i.e., "fair value") versus historical cost accounting. This Street View takes no position on the topic.

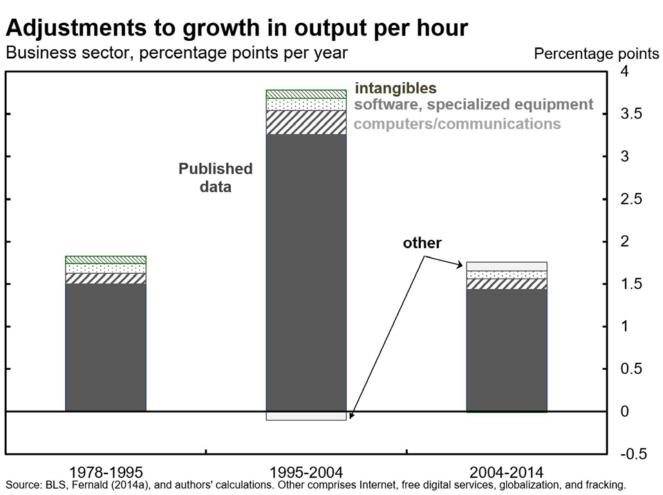
2 See the St. Louis Fed (https://www.stlouisfed.org/publications/regional-economist/october-2012/accounting-for-us-growth-is-there-a-new-normal).

PRODUCTIVITY MAY OR MAY NOT BOUNCE BACK

After trending higher for most of the 1990s, productivity peaked in 2002 around four percent per year. Since then, it has mostly trended down, though there was a brief respite in 2009 and 2010. Whether it can bounce back remains an open question. Two primary ingredients will likely inform the answer. First, has productivity actually declined, or do the latest figures represent a measurement issue? Second, will the world ride another great wave of innovation, or was the last great wave an unsustainable and unrepeatable fluke? Academic literature has weighed in on both questions.

Byrne, Fernald, and Reinsdorf (2016) examine the potential mismeasurement of productivity. Specifically, they describe a "paradox" whereby rapid innovation, particularly in information and communications technology, has not translated into higher output per worker. One potential explanation is that some of the innovation manifests as free or "non-market" digital services such as email, social networking, or other applications. More broadly, other intangible investments, globalization, and technical innovations in the energy sector may also prove challenging to incorporate into productivity measurements, even though they increase the real output per worker.

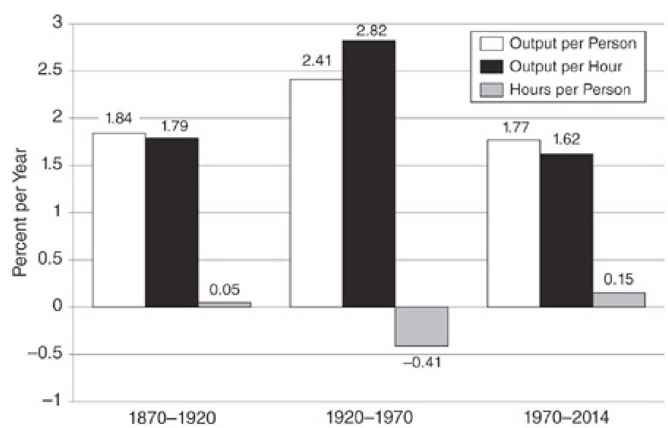
FIGURE 1



Notes: Figure from Byrne, Fernald, and Reinsdorf (2016). "Other" category includes internet, free digital services, globalization, and fracking.

Figure 1 summarizes the quantitative results in Byrne et al. (2016). Data published by the BLS (dark grey bars) reports labor productivity growth of approximately 1.5 percent per year since 2004, less than half the rate achieved between 1995 and 2004. After adjusting for a variety of factors, including information and communication technology (lighter grey regions), the absolute level of productivity growth – approximately 1.75 percent – in the past decade looks better. Yet on a relative basis, the overall slowdown in productivity appears steeper, because mismeasurement seemed even more prevalent from 1995-2004 than since 2004. In other words, Byrne et al. (2016) argue that labor productivity growth has, in fact, slowed. It is not measurement bias.

FIGURE 2



Notes: Figure from Gordon (2016).

If not due to mismeasurement, might the productivity slowdown reflect a decline in innovation? Gordon (2016) posits this argument. According to his research, the "Great Leap Forward" in US economic development that began with a series of inventions after 1870 mostly tapered out by 1970 (see Figure 2). Economic production shifted from a largely agrarian, muscle-powered society to one in which internal combustion engines and giant factories fostered and organized economic activities in previously unfathomable ways. The telegraph reduced cross-country and even intercontinental communication speeds from weeks to nearly instantaneous. Electricity facilitated after-sunset activities and reduced the risk of fires. Running water and sewer lines improved health and hygiene. While "techno-optimists" highlight some of the seemingly science fiction-like advancements that appear on the horizon today, these innovations pale in the view of Gordon (2016) relative to the advancements made during the late nineteenth and early twentieth centuries.

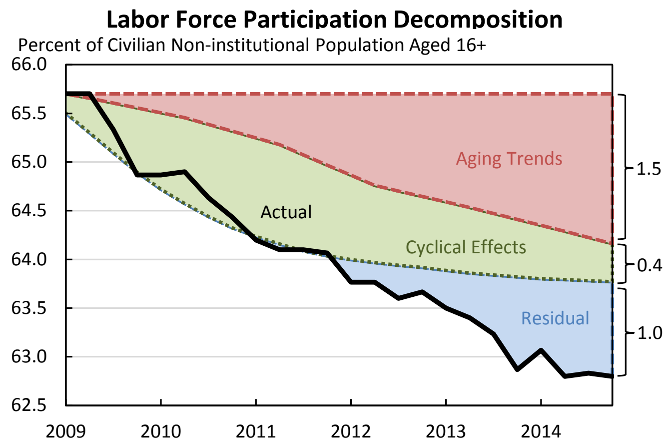
LABOR FORCE PARTICIPATION HAS TICKED UP, BUT MOST OF THE LONG-TERM DECLINE APPEARS STRUCTURAL, NOT CYCLICAL

Changes in the workforce also do not seem to offer much hope for a rapid revival of GDP growth. The long-term trend in hours worked per employee (Figure 2) appears nearly flat. US population growth has also slowed since the baby boom era to 0.8 percent per year.[3] If the experience of other developed markets, such as Western Europe and Japan offer a guide, this trend seems unlikely to reverse.

Labor force participation rates also famously fell during the Great Recession, but this may represent a long-term trend. In September 2015, the labor force participation rate reached a 38-year low. The February 2015 estimate from the BLS shows that the labor force participation edged 50 basis points higher.[4] Unfortunately, this improvement likely stems from a small cyclical strengthening of the US economy and not a structural change.

Recent research by the Council of Economic Advisers published as the Economic Report of the President (2015) tries to decompose changes in the labor force participation rate into their constituent parts: cyclical effects, aging trends, and an unexplained residual. Figure 3 plots the results. According to these estimates, cyclical effects explain less than 15 percent of the decline in labor force participation since 2009. More than half of the decline stems from population aging, a demographic headwind that seems set to blow even harder in coming years. If true, this implies that the labor force participation rate likely will not grow more than one percentage point per year without a structural change in the labor market, such as baby boomers reversing their retirement trends.

FIGURE 3



Notes: Figure from the Economic Report of the President (2015).

IMPLICATIONS

For the US economy to once again sustain three percent per year real GDP growth, one of these three trends – productivity growth, labor force participation, or population growth – will need to reverse. A reversal in all three seems possible. The technological frontier that an American in 1920 imagined likely proved far less impressive than the innovative advancements actually achieved during the twentieth century. Similarly, current expectations for technological advancement may prove insufficiently optimistic. Immigration could rapidly alter the population growth rate. Health improvements and (sadly) financial pressure could induce baby boomers to postpone retirement, thereby increasing labor force participation. Absent that, real GDP growth will remain slow due to the rules of growth accounting.

Perhaps another possibility exists: quirky rules or conventions that accountants and economists seem to take in stride could alter the values calculated in growth accounting metrics. One might hope for an alternative source of GDP growth.

3 See data from the US Census: https://www.census.gov/popest/data/national/totals/2015/index.html

4 See data from the BLS: http://www.bls.gov/news.release/empsit.toc.htm

References

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INTERESTING TECHNOLOGY-RELATED ARTICLES

Two Sigma views itself as a technology company that applies a rigorous, scientific method-based approach to investment management. Our technology is inspired by a diverse set of fields including artificial intelligence and distributed computing. Occasionally, we read articles in the popular press that describe applications of technology that we find interesting, thought-provoking, and relevant for people thinking about improving the investment management process. Below is a subset of the articles we read this month. Please do not view the inclusion of these articles as an endorsement by Two Sigma of their viewpoints or the companies discussed therein. Two Sigma welcomes discussions (and contributions) about these and other such technology-related articles.

"How Google's AI Viewed the Move No Human Could Understand" by Cade Metz, *Wired*, March 14, 2016 (http://www.wired.com/2016/03/googles-ai-viewed-move-no-human-understand/)

AlphaGo, the computer system Google programmed to play Go, has stunned practitioners of deep learning and gaming over the past two weeks by beating Lee Sedol, one of the game's top players. One momentous move, the 37th of Game 2, illustrated the prowess of the system as it confused and befuddled Go experts and AlphaGo's programmers alike. The program's creators pored over the record of its calculations and found that while the computer estimated a one in ten thousand chance of a human making the same move, the move nevertheless had a high statistical likelihood of success. Move 37 underscores the strength of the deep learning process. AlphaGo's deep learning training involved repeated machine learning trials of computer vs human, computer vs computer, and then another set of computer vs human trials to refine its game playing ability.

"What it's like inside the doomsday vault that stores every known crop on the planet" by Kevin Loria, *Tech Insider*, March 7, 2016 (http://www.techinsider.io/svalbard-doomsday-seed-vault-photo-tour-2016-3?utm_content=bufferd306b&utm_medium=social&utm_source=facebook.com&utm_campaign=buffer-ti)

We typically think of large-scale data storage as entailing a farm of computers. Now we have the chance to explore another type of "data" storage facility altogether: the seed bank that stores a growing sample of seeds from crops all over the world. Svalbard, a remote island north of Norway, hosts the vault, which has the capacity to store 4.5 million seeds and is currently home to 860,000 samples. The frigid temperatures, high security, and polar bears do their part to keep out would-be marauders. The bank can keep seeds viable for thousands of years, if necessary, and for up to 200 years without supplemental refrigeration should the power fail. The bank has already demonstrated near-term value, having restored samples to the Syria-based ICARDA Seed Bank, whose own facilities had been damaged by the war.

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