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A NEW METHOD OF ESTIMATING POTENTIAL REAL GDP GROWTH: IMPLICATIONS FOR THE LABOR MARKET AND THE DEBT/GDP RATIO

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This paper builds on previous research on changes in the historical behavior of the cyclical relationships captured in Okun's original 1962 "law." While I have been doing research since 1993 within the framework of the "output identity" used here, this paper has benefitted from Bob Hall's flagging the existence of a BLS series on aggregate labor hours based on the household survey. Thanks also to Bob Hall for providing the detailed data on structural changes in the labor-force participations rate that are an input into his latest paper (2014). I am grateful to John Fernald for our many exchanges on the substance and exposition of this paper and the reasons for the differences between my results and his (see Fernald, 2014). Dan Sichel contributed an extensive mark-up of the paper and I have faithfully adjusted it in response to his many constructive suggestions. This paper would not have been possible without the inspired research assistance of Leo Zhu, who performed the calculations within minutes, not hours, and who read my mind in creating elegantly formatted graphs almost before I thought them up. The views expressed herein are those of the author and do not necessarily reflect the views of the National Bureau of Economic Research.

A New Method of Estimating Potential Real GDP Growth: Implications for the Labor Market and the Debt/GDP Ratio

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ABSTRACT

Forecasts for the two or three years after mid-2014 have converged on growth rates of real GDP in the range of 3.0 to 3.5 percent, a major stepwise increase from realized growth of 2.1 percent between mid-2009 and mid-2014. However, these forecasts are based on the demand for goods and services. Less attention has been paid to how the accelerated growth of real GDP will be supplied. Will the unemployment rate, which has declined at roughly one percent per year, decline even faster from 6.1 percent in June, 2014 to 3.0 percent or below in 2017? Will the supply-side support for the demand-side optimism be provided instead by a major rebound of productivity growth from the average of 1.2 percent over the past decade and 0.6 percent for the last four years, or perhaps by a reversal of the minus 0.8 percent growth rate since 2007 of the labor-force participation rate?

The paper develops a new and surprisingly simple method of calculating the growth rate of potential GDP over the next decade and concludes that projections of potential output growth for the same decade in the most recent reports of the Congressional Budget Office (CBO) are much too optimistic. If the projections in this paper are close to the mark, the level of potential GDP in 2024 will be almost 10 percent below the CBO's current forecast. Further, the new potential GDP series implies that the debt/GDP ratio in 2024 will be closer to 87 percent than the CBO's current forecast of 78 percent.

This paper also has profound implications for the Federal Reserve. The unemployment rate has declined rapidly, particularly within the last year. Faster real GDP growth will accelerate the decline in the unemployment rate and soon reduce it beyond any estimate of the constant-inflation NAIRU, even if productivity growth experiences a rebound and the labor force participation rate stabilizes. The macro economy is on a collision course between demand-side optimism and supply-side pessimism.

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1. Introduction: The Basic Numerology of the Conundrum

A basic tenet of macroeconomics is that when the unemployment rate declines, actual real GDP is growing more rapidly than potential real GDP. Indeed, potential real GDP is a hypothetical concept, defined as the rate of real GDP growth consistent with an unemployment rate equal to its "normal" level. For the past two decades techniques have been devised to estimate the normal unemployment rate, now called the TV-NAIRU (time-varying non-accelerating inflation rate of unemployment) by fitting a model of the inflation process.[1] During the cyclical recovery between 2009 and 2014 the average growth rate of real GDP has been only 2.1 percent per year, and yet the unemployment rate has declined from 10 percent in late 2009 to 6.1 percent in June, 2014.

This dissonance between rapid unemployment decline and sluggish actual output growth implies a remarkably slow growth rate in potential real GDP. It is easy to do a back-of-the-envelope calculation of the implications for potential real GDP growth. Typically the unemployment rate declines by half of each percentage point of positive change in the output gap, which is defined as the difference between the growth rate of actual real GDP minus the growth rate of potential real GDP. Thus the four point decline in the unemployment rate since late 2009 implies that the output gap must have improved by eight percentage points. Divided by five years, this means that the output gap must have improved by 1.6 percentage points per year. Subtracting 1.6 from the 2.1 percent actual growth in real GDP yields an implied potential GDP annual growth rate of only 0.5 percent per year. As we shall see, this calculation is misleading because it does not take into account two anomalies that contribute to the rapid decline in the unemployment rate relative to output growth, namely the unusually slow 0.6 percent rate of productivity growth over the last four years and the unusual decline in the labor-force participation rate (LFPR) during a phase of the business cycle when that rate usually enjoys a cyclical rebound.

Potential real GDP growth matters a lot. Once actual real GDP recovers and reaches the level of potential real GDP, then any reduction in potential real GDP growth directly translates into slower output growth per capita, i.e., a reduction in the growth rate of the standard of living. Slower per-capita growth reduces the chance that today's generation of young people will double their parents' standard of living, as has historically occurred across generations, or for many individuals may even fail to achieve their parents' standard of living. Slower potential real GDP growth has a direct impact on the demand side of the economy, reducing the demand for investment goods, as firms feel a lesser need to build new factories and office buildings, and as households have less disposable income to support rents or mortgage payments on residential housing units.

[1] See Gordon (1997) and Staiger, Stock, and Watson (1997).

The implications are profound for monetary and fiscal policy. The output and unemployment gaps are central to monetary policy decision-making, and one or the other of those gaps is an input into John Taylor's famous monetary rule. For any given projection of actual real GDP growth, slower potential growth means that the output gap will narrow more rapidly than otherwise and increases the risk that the gap will turn from negative to positive, thus putting upward pressure on the inflation rate. Even more important is that a reduction in potential real GDP growth directly translates into a positive change in the debt/GDP ratio, since slower potential growth both reduces the denominator of that ratio for any given future year but also reduces tax revenues and hence raises the debt in the numerator of that ratio.

In contrast to the 0.5 percent annual growth rate of potential GDP during 2009-14 implied by the Okun relationship between output and unemployment, the Congressional Budget Office (CBO) currently estimates that potential real GDP growth will grow at an annual rate of 2.2 percent between 2014:Q2 and 2020:Q4, the span of time examined in this paper, and that actual real GDP will grow at an annual rate of 2.9 percent over the same period.[2] Given that the unemployment rate is already down to 6.2 percent as of July, 2014, the question naturally arises as to how this rapid real GDP growth on the demand side will be "funded" on the supply side, because real GDP growth is linked by an identity to real GDP per hour times the components of hours per capita times the working-age-population. Since population growth is exogenous, the CBO's forecast implies a sharp change in the behavior of productivity growth as well as the growth rate of hours per capita compared to the actual experience of the past five years, even though hours per capita have steadily increased between 2009 and 2014.

This paper attempts to find an exit route from the vise imposed by the oppressive recent history of slow output growth together with a rapidly declining unemployment rate. Forecasters universally predict that actual real GDP growth will increase from the 2.1 percent average of the past five years to between 3.0 and 3.5 percent per year over the next two to three years.[3] For output to grow at that rate without a decline in the unemployment rate to four or even three percent would require some combination of a much slower rate of decline in the labor-force participation rate or even a reversal toward an increasing LFPR, as well as a revival of labor productivity growth well above the 1.2 percent average growth rate of the past decade, not to mention the 0.6 percent average over the past four years.[4]

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[2] CBO quarterly forecasts of potential GDP are available for both real and nominal GDP through 2024:Q4 at www.cbo.gov/publication/45010.

[3] The "Blue Chip" forecast for the six quarters beginning in 2014:Q3 is for a steady 3.0 percent annual rate growth rate of real GDP. The New York Federal Reserve has that rate increasing to 3.5 percent in the last half of 2015. See www.newyorkfed.org/aboutthefed/frbnystaffoutlookpresentation.pdf.

[4] All discussion of output per hour in this paper refers to the total economy, not the private business economy for which the BLS publishes the widely distributed productivity data. Total economy productivity is equal to real GDP divided by an unpublished but accessible BLS series on total economy hours of work. It is essential that output per hour is expressed for the total economy in order to link up with data on the division of aggregate hours between hours per employee, the employment rate, and the labor force participation rate, all of which refer to the total economy rather than just the private sector.

This paper digs down into the basic components of potential real GDP growth. A statistical technique called the Kalman filter is used to disentangle trends from cycles in each of these definitional components of output growth. The resulting trends are compared with the more commonly used Hodrick-Prescott (H-P) filter. We learn that based on the actual data through 2014:Q2, the growth of potential real GDP is barely 1.0 percent as assessed by both the Kalman and H-P methods, much lower than the CBO estimate and in sharp contrast to the actual growth rate of real GDP of 2.8 percent between the business cycle peaks of 1990 and 2007. The recent discussion of "secular stagnation" may hinge on whether the CBO's forecasts of potential output growth are correct, or whether the data justify a substantially lower estimate of the future path of potential GDP growth. (Recent essays on secular stagnation by Paul Krugman, Lawrence Summers, myself, and others are available in Tueling and Baldwin (2014)).[5]

The basic tool of analysis is the output identity, a definition of the relationship between real GDP and its components on the supply side – labor productivity, hours per employee, the employment rate, the labor-force participation rate, and the working-age population.[6] The growth rate version of the identity expresses real GDP as the sum of the growth rate of these components. If real GDP is going to "break out" of its 2.1 percent path observed over the past four years, then some combination of responses are required by definition on the right-hand side of the identity – faster productivity growth, faster growth in hours per employee, faster growth in the employment rate (i.e., a more rapid rate of decline of the unemployment rate), and/or a slower rate of decline or even an increase of the labor-force participation rate.

The paper starts by displaying the historical growth rates for four selected intervals between 1950 and 2014. Also shown are the Kalman and H-P trends that are estimated from the actual data through 2014:Q2. Yet these trends are influenced by the poor performance of the economy in the last few years. How would the trends "bend" in response to faster actual real GDP growth as is widely forecast to occur over the next two to three years? The core contribution of this paper is to develop a set of three scenarios for growth on the supply side between 2014:Q3 and 2020:Q4, which we call "pessimistic," "baseline," and "optimistic". We justify the choices of the components of the output identity that will deliver these growth paths of real GDP. Then we pretend that these paths are the actual data and estimate the Kalman trends through 2020:Q4 – these then become our alternative estimates of potential real GDP growth.

[5] This e-book, released on August 15, 2014, is available for free download by googling "Tuelings Secular Stagnation"

[6] The four decades since 1972 can be divided into two periods of slow total-economy productivity growth lasting 34 years and a temporary revival period lasting eight years. The concept of total-economy productivity is real GDP divided by the BLS unpublished series of total economy aggregate hours of work. The growth rates are 1.42 percent per year during 1972:Q1-1996:Q1, 2.47 percent during 1996:Q1-2004:Q1, and 1.19 percent during 2004:Q1-2014:Q2. The two slow periods average out at 1.35 percent for 34 of the 42 years since 1972.

Even our optimistic version does not come close to the CBO forecast of 2.2 percent per year for potential output growth on average during 2014-2020. Our baseline forecast is closer to 1.6 percent per year. If our estimates are credible, slow potential growth implies that the Fed will be forced to tighten earlier than currently perceived expectations. The implication that the future growth of the debt/GDP ratio will be much greater than the CBO estimate changes the calculus relevant for fiscal policy decisions by Congress and the Administration.

This introduction concludes with a restatement of the conundrum. The unemployment rate has declined at a rapid rate over the past two years. Output growth has been mediocre. If the widespread expectations of break-out real GDP growth over the next three years at a rate of 3.0 percent or higher come true, the arithmetic begins to violate the realm of possibility. Some combination of the following must happen – a decline in the unemployment rate from 6 to 4 percent or below, an end to the decline of the labor force participation rate despite the retirement of the baby-boomers, or a break-out of total-economy productivity growth from its average of 0.5 percent in 2010-14 and 1.2 percent in 2004-14.

2. The Disheartening Performance of the U.S. Economy Since 2004

Remarkably few commentators on the current behavior of real GDP growth, the unemployment rate, and the labor-force participation rate discipline their remarks by referring to the "output identity," a relationship which cannot be controversial because it is a definition. The simplest version of the definition is that real GDP *(Y)* is equal to labor productivity *(Y/H)* times aggregate hours *(H)*. This paper focuses on the behavior of the unemployment and labor-force participation rate so we must introduce an extended version of the output identity that includes those terms[7]:

(1)
$$Y \equiv \frac{Y}{H^P} \cdot \frac{H^P}{H^H} \cdot \frac{H^H}{E^H} \cdot \frac{E^H}{L} \cdot \frac{L}{N} \cdot N$$

Here the "P" superscript refers to the payroll survey and the "H" superscript to the household survey data. Because the productivity data are based on the payroll-survey concept of total economy hours *(H^P)*, and yet the data on employment, labor force, and population come from the household survey, we need the "bridge term" *(H^P/H^H)* to convert hours from the payroll survey to hours from the household survey. This term shows no long-term trend, i.e., its level in 2014 is identical to its level in 1990, but its growth rate has deviated from zero in recent years and must be explicitly included in the analysis.

[7] The output identity was used to decompose the output trend and gap into the contribution of productivity and the components of hours per capita in Gordon (2003) and another paper published ten years earlier.

In words the identity in equation (1) states that real GDP is equal by definition to total-economy labor productivity; times the bridge term, which is the ratio of aggregate hours in the payroll to the household survey; times hours per employee from the household survey; times the employment rate (i.e., 1.0 minus the unemployment rate); times the labor force participation rate; times the working-age population aged 16 and above. This paper differs from all other studies of U.S. labor productivity by examining total-economy labor productivity instead of the published BLS data for the private business sector. The focus on the total economy is imperative in discussing the components of the output identity in equation (1), since all of the data on employment, the labor force, and the working-age population refer to the total economy, not the private business economy.

Since most of this paper discusses growth rates, we take equation (1) and create a growth rate version of the identity. For simplicity, we get rid of any superscripts, and abbreviate the "bridge term" (H^P/H^H) as R. Then, we take the log of each uppercase letter and denote it with its lowercase counterpart. For example, y would be the growth rate of Y (output).

(2) $$y \equiv y\text{-}h + r + h\text{-}e + e\text{-}l + l\text{-}n + n$$

From the above equation, we see that the growth rate of output is made up of the sum of the growth rates of each of the components on the right side of equation (1).

Our starting point in understanding the behavior of the components of the identity in the above equations is Table 1, shown below, which reports annual growth rates of each component between benchmark quarters, which are chosen to be "cyclically neutral," i.e., to have roughly the same unemployment rates. The range of unemployment rates across the benchmark years is quite narrow and hence they all qualify as years in which the economy was operating roughly at a normal rate of utilization, neither too hot nor too cold. The unemployment rates for each benchmark interval are 5.6 (1950:Q2), 5.8 (1972:Q1), 5.5 (1996:Q1), 5.7 (2004:Q1), and 6.2 (2014:Q2). The rest of this paper recognizes that 2014:Q2 was not a period of normal utilization, and a major issue in our discussion is how far the economy was operating from normal utilization in 2014:Q2.

Table 1.

Growth Rates of Variables in the Output Identity Across Specific Intervals

Interval	Output	Labor Productivity	Hours Ratio ("Bridge Term")	Hours per Employee	Employment Rate	Labor Force Participation Rate	Working Age Population
1950:Q2 - 1972:Q1	3.89	2.62	0.06	-0.27	-0.01	0.08	1.40
1972:Q1 - 1996:Q1	3.03	1.42	-0.27	0.03	0.01	0.41	1.42
1996:Q1 - 2004:Q1	3.42	2.45	-0.12	-0.06	-0.02	-0.09	1.26
2004:Q1 - 2014:Q2	1.57	1.17	0.05	-0.14	-0.06	-0.49	1.04

The epochal decline in the growth rate of U.S. potential GDP growth has been noted, but its magnitude has not been sufficiently appreciated.[8] The growth rate of actual real GDP fell from 3.89, 3.03, 3.42 in the three periods up to 2004 to a mere 1.57 percent per year over the decade 2004-2014. From the third to fourth period, output growth fell by more than half. A crucial factor in causing the decline of potential GDP growth was the behavior of labor productivity. In contrast to the 2.62 growth rate registered during 1950-72, productivity growth after 1972 exhibited unambiguous evidence of a secular slowdown, interrupted briefly by an eight-year revival between 1996 and 2004. The average growth rate of labor productivity during the last 34 years that excludes 1996-2004 was 1.31 percent per year, exactly half of the achievement of 1950-72. More than any other reason, the decline of productivity growth over the past four decades is at the heart of the slow growth of potential real GDP over the past decade and into the future.

The past few years have witnessed a debate about the future of technology in which I have participated. A group of techno-optimists, most notably Erik Brynjolfsson and Andrew McAfee of MIT, and my colleague Joel Mokyr from Northwestern, proclaim that technology is at a "point of inflection" toward an explosion of productivity growth that has never before been experienced.[9] These optimists spin stories but never confront the awkward fact that after 1972, productivity growth has declined by almost half. What is more relevant for the next decade or two, the actual recorded experience of 34 out of the past 42 years, or the unsubstantiated hopes and dreams about technological marvels which are hard to discern in everyday life?[10] The world has been transformed by free information, e-commerce, and the internet, yet where is the productivity growth?[11]

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[8] All data in this paper are current, reflecting the benchmark GDP revisions released on July 30, 2014, as well as the unpublished aggregate hours data released on August 8.

[9] See Brynjolfsson and McAfee (2013).

[10] Four reasons are provided in Gordon (2014) as to why the brief revival of productivity growth experienced during 1996-2004 has not been repeated during 2004-2014. (1) The growth rate of productivity exhibited an eight-year spike but then fell back to a rate during 2004-2014 below the much-discussed productivity slowdown period of 1972-96. (2) The growth of manufacturing capacity peaked at about 5 percent per year in the late 1990s but in the past six years that growth rate has been zero. (3) The share of the value-added of information and communication technology (ICT) equipment in the total of U.S. manufacturing value-added rose from 3 percent to 8 percent in 1998-2000 but has decreased until now back to 3 percent. (4) The growth rate of the BEA hedonic price deflator for ICT equipment fell ever faster until it reached a maximum rate of decline of -15 percent in 1998, but then that rate of decline retreated to -1 percent per year in 2013.

[11] I have treated elsewhere the contention of Brynjolfsson, McAfee, and Mokyr that real GDP is useless as a measure of output because the internet has provided so much free information. People no longer need to buy encyclopedias, dictionaries, alarm clocks, music players, GPS stand-alone devices, Zagat restaurant guides, because they are all there for free on the smart phone. These critics forget that GDP has always understated the value of new inventions. The slowdown of productivity growth after 1972 persisted for 24 years before the arrival of free internet information, making it entirely implausible that free internet information can be blamed for slow productivity growth since 1972. No credit is given in real GDP for the safety, convenience, and brightness of the electric light, or the elevator, or air conditioning, or the replacement of the horse by the motor vehicle, or the end of the dismal task of cleaning the streets of horse manure, or of the epochal decline of infant mortality in the first half of the 20th century. For a further discussion of these issues, see Gordon (2014) and Brynjolfsson-McAfee

Here the "bridge term" (the ratio of payroll survey aggregate hours to household survey aggregate hours) makes no contribution to understanding the difference between 1950-72 and 2004-14. The next term in the identity, hours per employee, has declined slowly over long intervals but declined more slowly after 1972, helping slightly to buffer the impact of slower productivity growth on realized GDP growth. Since the years chosen to divide the intervals had roughly equal unemployment rates, it is not surprising that the growth rate of the employment rate was close to zero during the first three periods and slightly negative in 2004-2014.

Aside from productivity growth, the main explanation for changes in growth in real GDP over these four intervals involves the labor-force participation rate, which remained stable during 1950-72 and 1996-2004 but exhibited a sharp increase in 1972-96 when females entered the labor force in their millions. Then in 2004-14 the participation rate declined even faster at an annual rate than it had increased during 1972-96. Note that the turnaround in the growth rate of the participation rate between the two intervals (1972-96 vs. 2004-14) was a full 0.90 percentage points per year (0.41 minus -0.49). This explains 0.90 points of the total 1.47 point decline in output growth between those intervals, while the decline in the growth rate of the population in the final column explains most of the rest, 0.38 points.

Overall, economic growth has been dismal since 2004, but it has become increasingly implausible to attribute that to a cyclical shortfall of demand in the economy. The assumption that "all will be well in the end" because of massive economic slack has become dubious as the unemployment rate has slipped steadily from 10 to 6 percent. There is not much more room for the unemployment rate to decline. If the realized 2004-14 growth rate of real GDP of 1.56 percent is to be raised up to 2.0 percent or beyond, something radical must happen. The two leading candidates are that productivity growth will suddenly revive as it did in the late 1990s or that the labor-force participation rate will stop declining and start to increase. Based on what has been happening over the past four years, it is very difficult to make the case that either will occur.

In the following sections we display the trends that can be estimated from the existing data through 2014:Q2 by two separate methods. They both conclude that trend real GDP growth was below 1.5 percent per year by 2014:Q2, and in fact may have been as low as 1.0 percent. Obviously these estimated trends are sensitive to the poor performance of the economy in 2013 and the first half of 2014, and we can demonstrate that the estimated trends turn around if we make more optimistic assumptions about the evolution of the economy beyond 2014:Q2.

(2013). Gordon (2015, forthcoming) provides new quantitative measures of the consumer surplus not included in GDP created by previously unmeasured improvements in consumer appliances and TV sets.

Since the methods of trend forecasting can be "bent" by better performance of the future actual values, we construct three alternative scenarios for the evolution of the components of the output identity between 2014:Q2 and 2020:Q4. We first create hypothetical scenarios for the evolution of the actual values and then apply the Kalman filter technique to provide statistical estimates of the implied trends. The conclusion of the rest of the paper is that it is impossible to find a combination of plausible paths for the variables that would come remotely close to justifying the CBO's forecast of a 2.2 percent growth rate of potential output on average between mid-2014 and the end of 2020.

Table 1 shows that output growth in the past decade has been a mere 1.57 percent per year. Yet the consensus is that the output gap has narrowed to somewhere between two percent (Fernald, 2014) and four percent (CBO). How much faster than 1.57 percent per year would output need to grow to close those alternative estimates of the output gap between mid-2014 and mid-2016? If the Fernald estimate of the gap is correct, then cumulative annual growth of real GDP between 2004 and 2016 will be 1.74 percent, and if the CBO gap is correct growth of real GDP over the same interval will be 1.90 percent. Thus neither the Fernald nor CBO gaps is consistent with their potential output growth rates for 2014-2020 of 2.1 and 2.2 percent, respectively. In short, the Fernald and CBO forecasts are logically impossible.

3. Trends Estimated From Historical Data through 2014:Q2

We begin by estimating trends in the components of the output identity through 2014:Q2 by two methods. The first is the familiar univariate H-P filter. No information about the economy is used except the observed behavior of a single time series. Any observed change in the growth rate of that series is arbitrarily parsed into a fraction of the change that represents a change in the trend from a previous value, and the remaining part of the change that represents a change in the gap between actual and trend. The parsing fraction is chosen arbitrarily by the user.[12]

The second method is less familiar – the Kalman trend. The version of that technique used here is a simple variant of a general technique that can accommodate much more complex multivariate models.[13] The Kalman technique allows us to go beyond a single variable and use additional information on what is happening in the economy. For instance, as we observe the behavior of real GDP growth, it would be helpful to know what is happening to the gap between the actual unemployment rate and the normal unemployment rate, or NAIRU. If we

[12] In past work we have found that a H-P smoothing parameter of 6400 delivers more plausible trends without implausible responses to business cycles than the conventional 1600 parameter. The 1600 parameter implies that potential real GDP growth suddenly collapsed during the recession of 1981-82 and then soared during 1983-84, whereas those years are more plausibly interpreted as a major recession accompanied by an unusually rapid recovery.

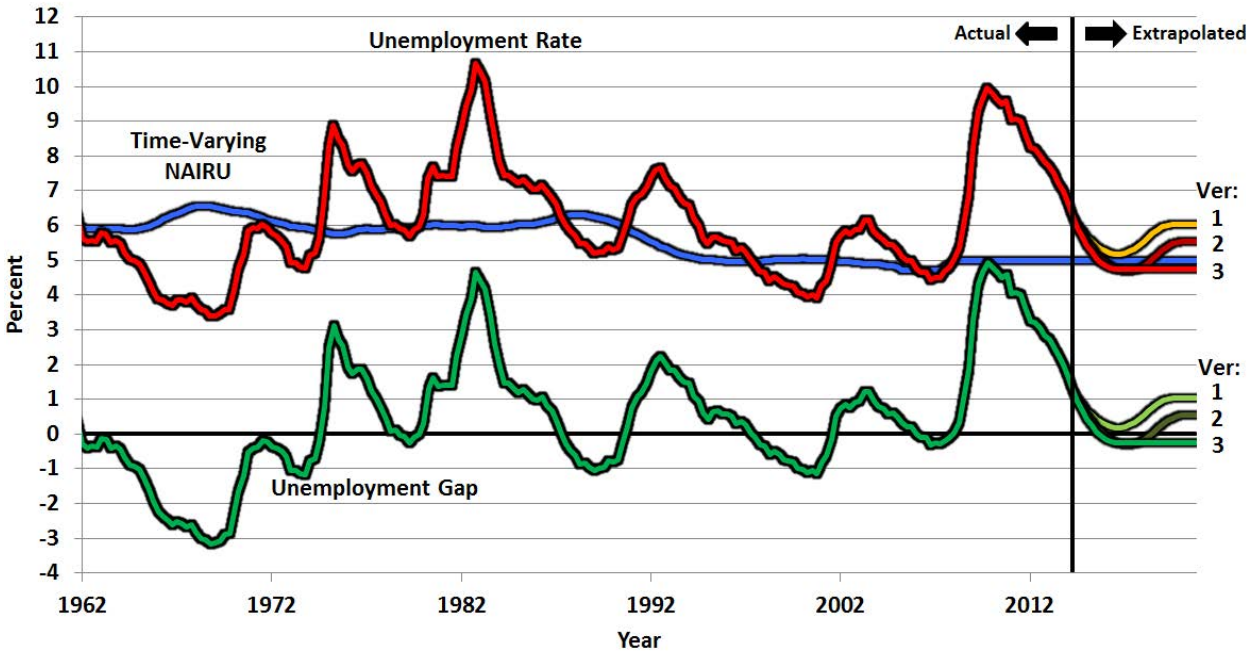
[13] See Hamilton (1994, Chapter 13).

have some way of identifying that unemployment gap, we can feed that information back to the Kalman software and reach a conclusion about the behavior of trend real GDP growth given information not just about actual real GDP growth but also about the historical relationship of the unemployment gap and the output gap. For instance, the H-P filter shows an upward bulge in trend output growth in the mid-1960s, but the Kalman technique uses its information on the unemployment gap to conclude that the main reason that output grew so rapidly during that period is that the unemployment rate fell to below four percent. In contrast, the univariate nature of the H-P technique prevents it from making use of the information that the unemployment gap was unusually low in the mid-1960s.

The Kalman filter formalizes the "back-of-envelope" exercise in the introduction. Knowing the history of the unemployment gap, it "sees" that the unemployment gap was nearing zero in 2014:Q2 and concludes that the output gap was also nearing zero. This then allows the technique to back out the growth rate of potential real GDP. In my recent inflation research, (Gordon, 2013), I determined that the NAIRU had increased during 2007-13 from 4.8 to 6.0 percent. However, since this paper is an exercise in optimism, an attempt to find ways in which the supply side can match the buoyant demand forecasts for the next several years, we set the NAIRU arbitrarily at a fixed level of 5.0 percent, roughly its value in 2007. To the extent that reducing the total unemployment rate of 5.0 percent unemployment is unrealistic because of the long-run inflation consequences, then all the trends in this paper are too optimistic.

Figure 1 displays the history since 1962 of the actual unemployment rate, the time-varying NAIRU, and the implied unemployment gap. After 2007 the NAIRU is set at 5.0

Figure 1. Extrapolated Total Unemployment Rate, NAIRU, and Unemployment Gap, Versions 1 through 3, 2014:Q2 to 2020:Q4



percent forever, even though the evidence provided in Gordon (2013) suggests that the inflation rate would gradually creep up if the unemployment rate were allowed permanently to decline below 6.0 percent. To take an optimistic spin on the possibilities, we allow the unemployment rate to decline to 5.0 percent in the three versions shown on the right side of Figure 1. The justification for the particular paths chosen for the post-2014 interval is discussed further below.

The Kalman and H-P trends for real GDP growth are displayed in Figure 2. The H-P filter displays cycles in the trend that are inherent as it reacts to periods of slow or negative growth (1981-82) and rapid growth (1964-66) without any access to information about how the unemployment rate was behaving at that time. Its only interpretation of deep recessions like 1981-82 or 2007-09 is that the output trend must be slowing down. In contrast the Kalman trend is much smoother, displaying virtually no cyclical fluctuations. Its diagnosis is that the slowdown in potential real GDP growth occurred in two phases – a reduction in the trend during 1973-83 from 4 to 3 percent, and then another reduction in trend from 3 to 0.7 between 2000 and 2014. The collapse in trend growth between 2009 and 2014 reflects the same factors as the numerical exercise in the introduction above. With slow actual real GDP growth and a rapidly declining unemployment rate, the only possible conclusion is that potential real GDP was hardly growing at all. Due to the excess cyclical sensitivity of the H-P trend technique, the remaining discussion of trends will rely only on the Kalman technique.

Figure 3 on the next page decomposes the Kalman trend of real GDP *(Y)* into its two definitional components, labor productivity *(Y/H)*, and aggregate hours *(H)*. Both components contributed to the history of potential real GDP growth, but the timing is quite different. The

Figure 2. Growth Trend of Output, Kalman vs. H-P Filter, 1953:Q1 to 2014:Q2

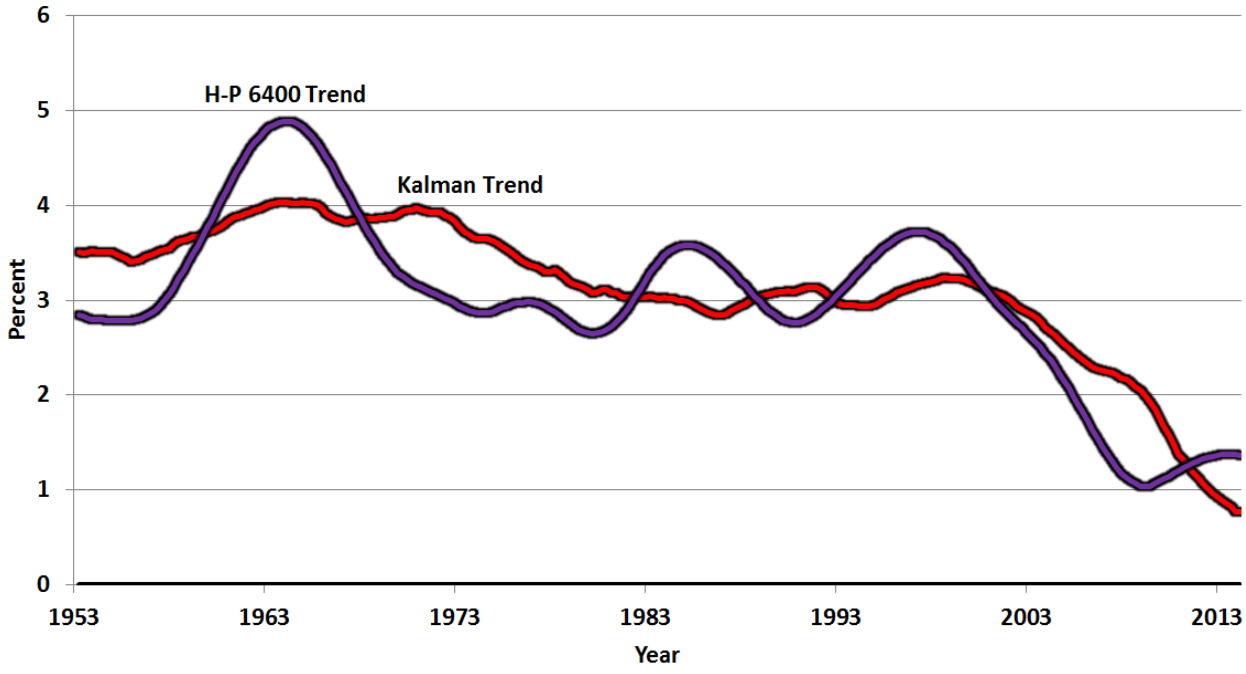
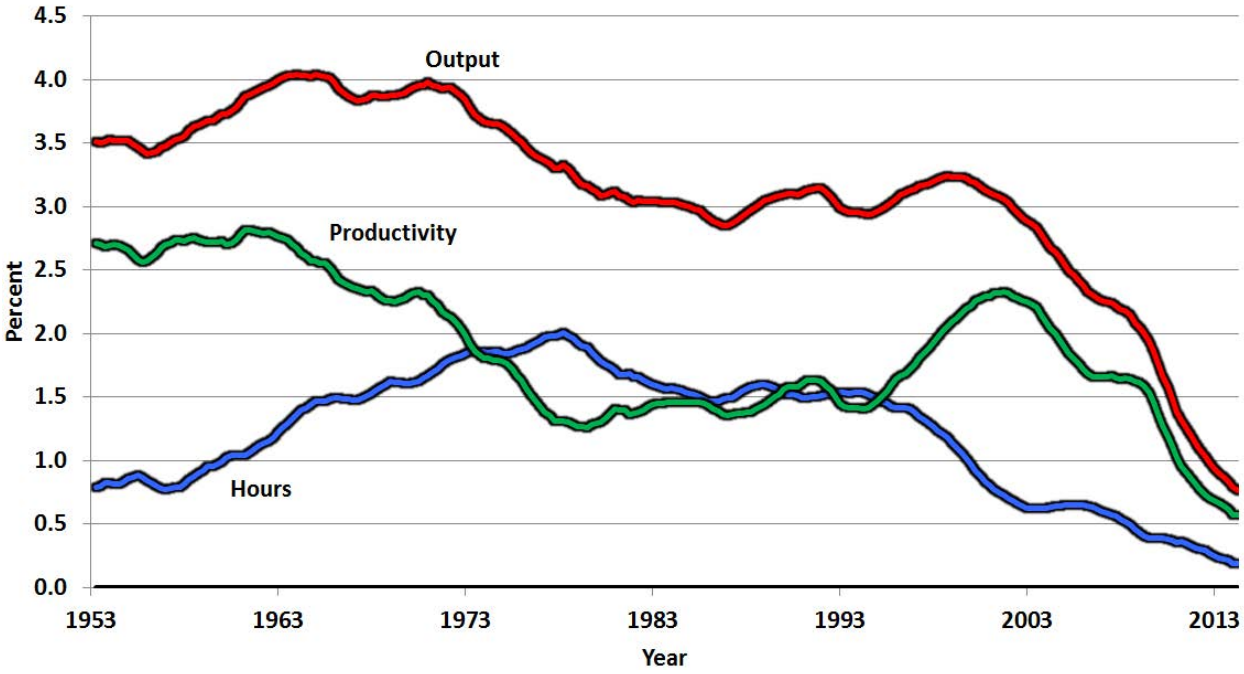


Figure 3. Kalman Growth Trends of Output, Hours, and Productivity, 1953:Q1 to 2014:Q2

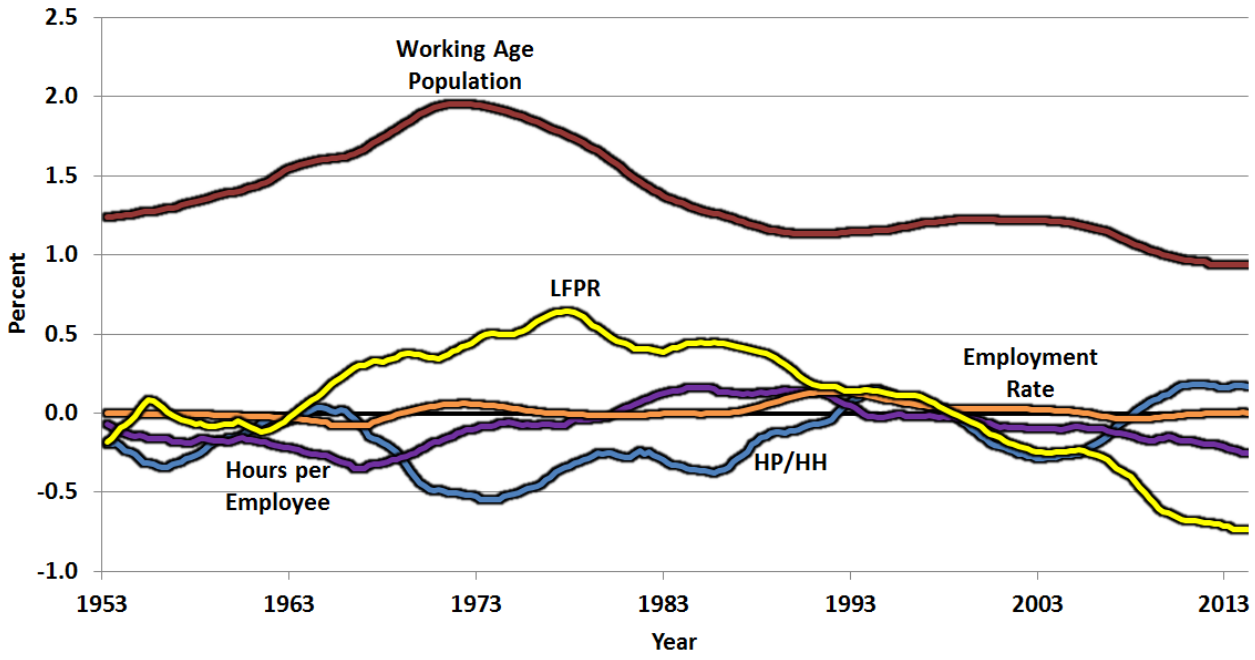


productivity trend slowed very gradually from its peak growth rate of 2.8 percent per year in 1961 to a trough of 1.3 percent in 1978. During most of this period the decline in productivity growth was partly offset by faster growth in the hours trend as baby-boom teenagers and women entered the labor force. In fact, the trough year of 1978 for productivity growth coincided with the peak year of growth in hours. The applied macroeconomic literature of that era often cited the arrival in the labor force of inexperienced teenagers and adult females as the main reason why productivity growth slowed between the early 1960s and late 1970s.

During the 1980s the trends in productivity and hours were quite stable at 1.5 percent per year each, and so the output trend was also stable at 3.0 percent. But during the 1993-2003 interval there was a radical change. The famous productivity growth "revival" brought the trend up from 1.5 to 2.4 percent while the growth of hours began its collapse. Since 2003 the trends have been on an unvarying descent, and in 2014:Q2 have reached 0.7 percent for output, 0.6 percent for productivity, and 0.1 percent for hours.

How could trend hours growth be as slow as 0.1 percent per year? A limit is set by growth in the working-age population of roughly 0.9 percent growth per year over the past few years. As shown in Figure 4, the dominant cause of the decline in the growth rate of hours was the decline in growth in the labor-force participation rate trend from a peak of +0.65 in 1977 to -0.73 in 2013, a massive 1.38 percent growth turnaround. Most of the decline in the growth of the working-age population occurred between 1973 and 1990, but there was a small additional downward contribution during 2003-2014.

Figure 4. Kalman Growth Trends of Payroll/Household Hours Ratio, Hours per Employee, Employment Rate, LFPR, and Population, 1953:Q1 - 2014:Q2



4. How Can the Forecast of Demand-Side Growth Be Achieved on the Supply Side?

The pessimistic values of the Kalman trends in 2014:Q2 are not credible. In the first half of 2014 output grew at only 0.9 percent at an annual rate while aggregate hours rose rapidly, implying a substantial decline in labor productivity. Macroeconomic forecasters have a consensus forecast that the growth rate of real GDP over the next two or three years will equal or exceed 3.0 percent per year. If that occurs it will be such a sharp change from the 2.1 percent average growth rate from 2010:Q2 to 2014:Q2, and this increase in growth would have to be matched by a shift in the sums of the growth rate version of the output identity.

With the unemployment rate already down to 6.2 percent in July 2014 and the employment rate rising at 1.3 percent per year over the four quarters ending in 2014:Q2, continued growth at that rate would push the unemployment rate below 5.0 percent in mid-2015 and below 4.0 percent in 2016. Thus we know that the additional growth on the demand side is going to have to be supported by major supply-side changes in the sources of growth. Productivity growth will have to revive and the labor-force participation rate will have to stop dropping so rapidly.

In this section we develop hypothetical scenarios for the most important of the right-side components of the output identity in order to see what would be necessary to support a

demand-driven increase in the growth rate of GDP to 3.0 and above over the two years between mid-2014 and mid-2016. The time span of these hypothetical scenarios runs from 2014:Q3 to 2020:Q4. Three separate versions are created for the hypothetical path of actual real GDP growth, and then in the next section the Kalman filter is applied to this artificial data set in order to extract the implications for future growth in potential real GDP. These are labelled as the pessimistic "Version 1", the baseline "Version 2," and the optimistic "Version 3." The optimistic option is of particular interest, because it shows the radical changes on the supply side of the U.S. economy that will be necessary to support demand-side forecasts of 2014-2016 growth of 3.0 percent to 3.5 percent.

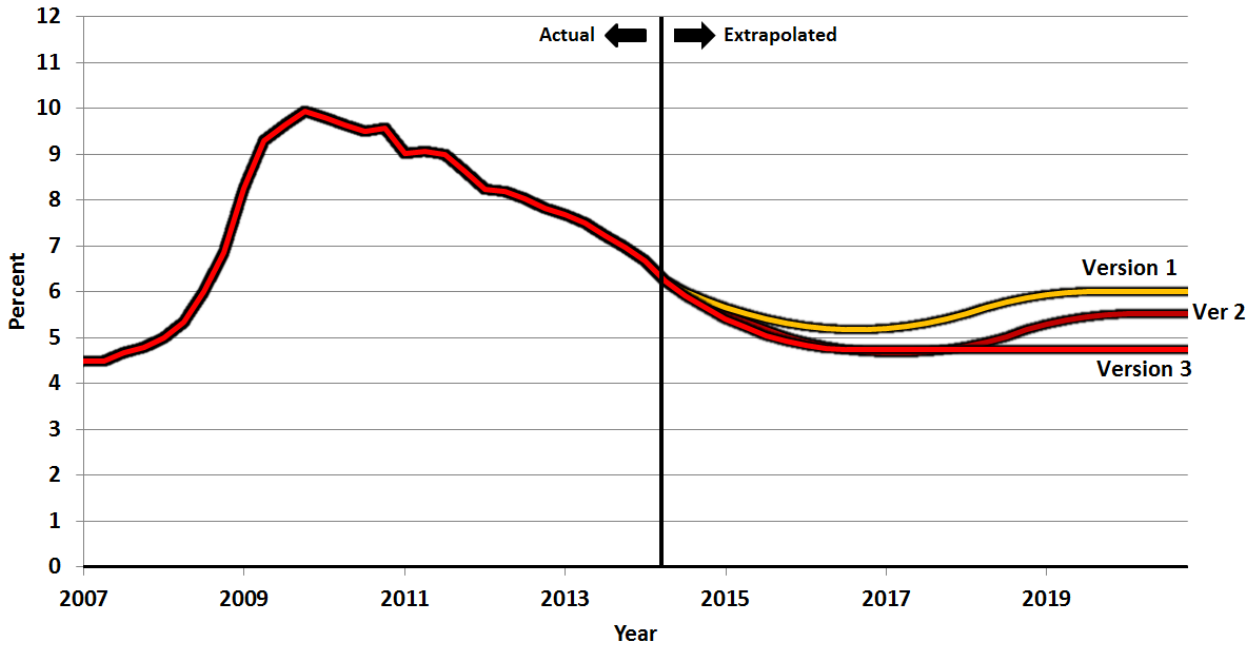
There are six terms on the right side of the output identity, equation (1) above. Three are treated uniformly across the three versions. The future growth rate of the population is taken from official Census Bureau forecasts of the growth of the population aged 16+, which gradually declines from 0.90 percent in 2014 to 0.77 percent in 2020. The "bridge term," the ratio of payroll to household hours (H^P/H^H) as shown in Table 1 has shown no net change over 2004-14 but grew at 0.13 percent per year in the four quarters ending in 2014:Q2. This is gradually tapered to zero after mid-2018.

The third term that is uniformly applied across the three versions is the future behavior of hours per employee (H^H/E). In the long-run, hours per employee exhibits a secular decline, for instance at the rate of -0.14 percent per year during 2004-2014 as shown in Table 1 above. But as is typical in a business-cycle recovery, hours per employee have exhibited a temporary cyclical recovery after a large decline during the 2007-09 recession. The realized growth rate of hours per employee between mid-2010 and mid-2014 was a positive 0.3 percent per year. All three scenarios taper this down gradually from an initial value of 0.3 in 2014:Q3 to zero by 2018:Q2 and then to a long-run negative growth rate of -0.20 by 2020:Q4.

The assumptions that differ across the three scenarios involve the time paths of the unemployment rate, productivity growth, and growth in the labor-force participation rate, and these are all exhibited in Figures 5 and 6. The most important decision is how to represent the path of the unemployment rate over the next six years. In mid-2014 the economy inherits a history of a rapidly falling unemployment rate, as shown in Figure 5 (next page) that displays actual values of the total unemployment rate from 2007 to mid-2014.

All three versions (hereafter V1, V2, and V3) allow the momentum of declining unemployment to continue through 2015, but then they smoothly diverge to different end-points. The pessimistic V1 accepts the verdict of my Phillips Curve research (Gordon, 2013) that the increase of long-term unemployment has raised the NAIRU from 5.0 percent in 2007 to 6.0 percent in 2014, and so the V1 unemployment rate path in Figure 5 glides up gradually to reach 6.0 percent by 2018. There is, of course, a strong possibility that the NAIRU could be lower than in my inflation research, and so the baseline V2 allows the unemployment rate to decline to 5.0 percent but then to settle down in the long-run at 5.5 percent, which conveniently is the same

Figure 5. Extrapolated Total Unemployment Rate, Versions 1 through 3, 2007:Q2 to 2020:Q4

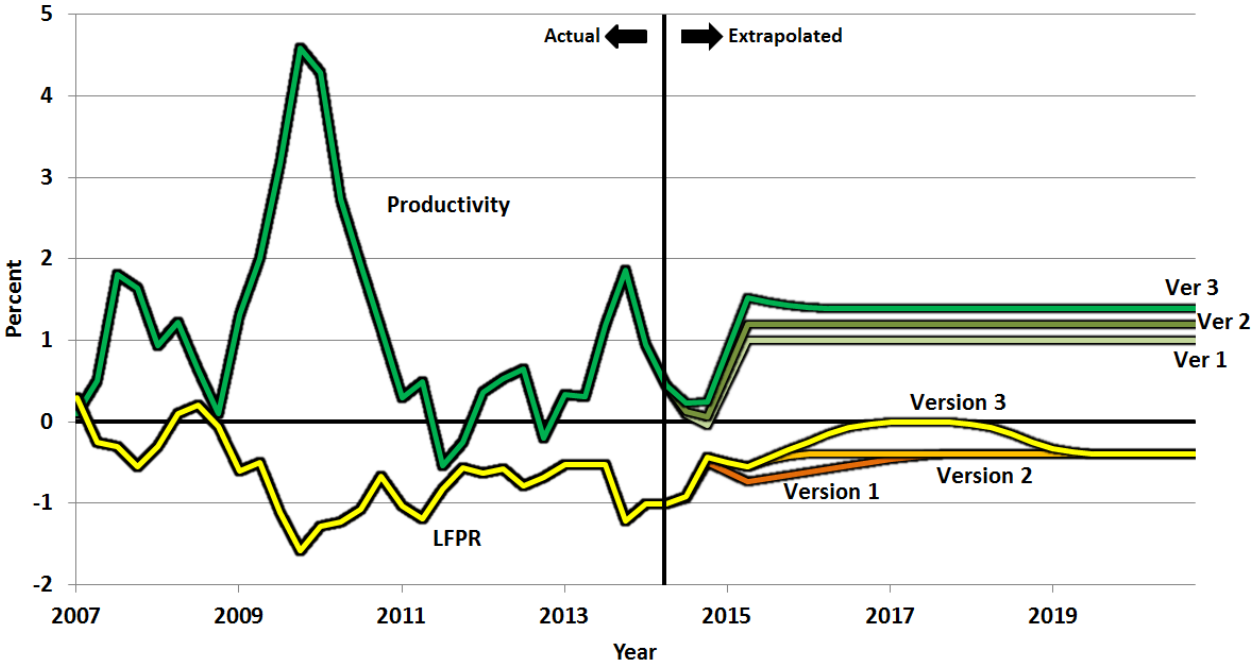


NAIRU as is assumed by the CBO. The optimistic V3 allows the unemployment rate to remain forever at 4.8 percent and ignores the available statistical evidence that this would cause a steady acceleration of inflation.

The next component of the output identity that is allowed to vary over the three paths is the growth rate of labor productivity. As shown in Figure 6 on the next page, the 2011-14 period has seen cycles in labor productivity's four-quarter growth rate ranging from -0.5 to 1.9 percent and averaging about 0.5 percent. There is no way the economy can grow faster unless productivity growth accelerates well beyond the performance of 2011-14. It is natural to assume that as demand pulls actual real GDP growth to 3.0 percent and above, productivity growth will follow and increase well beyond the historical record of the past four years. However, this widespread assumption flies in the face of evidence that the gap between labor productivity growth and its trend has not been correlated at all with the output gap since the mid-1980s (see Gordon, 2010).

Instead, the three paths are informed by the performance of labor productivity growth not over the four years since 2010 but rather over the decade since 2004, during which total-economy productivity growth was 1.17 percent. All paths are allowed suddenly to jump starting in 2014:Q3. The pessimistic V1 goes to 1.0 percent forever, the baseline V2 goes to 1.2 percent forever, and the optimistic V3 rises immediately to 1.6 percent. The assumption of V3 is that the demand-side expansion of 2014-16 will pull up productivity growth so much that the observed 2011-14 shortfall below the historic 2004-14 growth rate of 1.2 will be partially made up in 2014-16. Figure 6 displays these alternative growth paths of output per hour.

Figure 6. Four Quarter Growth Rate of Productivity and LFPR, Actual and Extrapolated, Versions 1 through 3, 2007:Q1 to 2020:Q4



Perhaps the single biggest uncertainty about the future growth outlook is labor-force participation (LFPR) which has declined during 2004-14 at an annual rate of -0.49 percent (Table 1) and since 2007 at an annual rate of -0.8 percent. This sharp decline in the LFPR, which reached -1.0 percent per year in the four quarters ending in 2014:Q2, has largely offset the steady increase in the employment rate (i.e., decline in the unemployment rate). This accounts for the quite unbelievable central phenomenon of the 2009-14 economic recovery, that the ratio of household employment to the population (E^H/N) has remained almost constant.

Robert Hall's (2014) careful decomposition of the 2007-2013 decline in the LFPR using annual data divides up the -0.8 percent annual rate of decline in the LFPR evenly between two sources. The first is the "within-group" effect. This is the decline of participation within particular age groups, such as males aged 25-54, a group which has experienced a steady slow decline of participation since the late 1960s. The second source is the decline of participation caused by a change in the shares of the various age groups, most notably the increased share of the population in the 55+ age group. The second effect captures the impact of the retirement of the baby-boom generation.

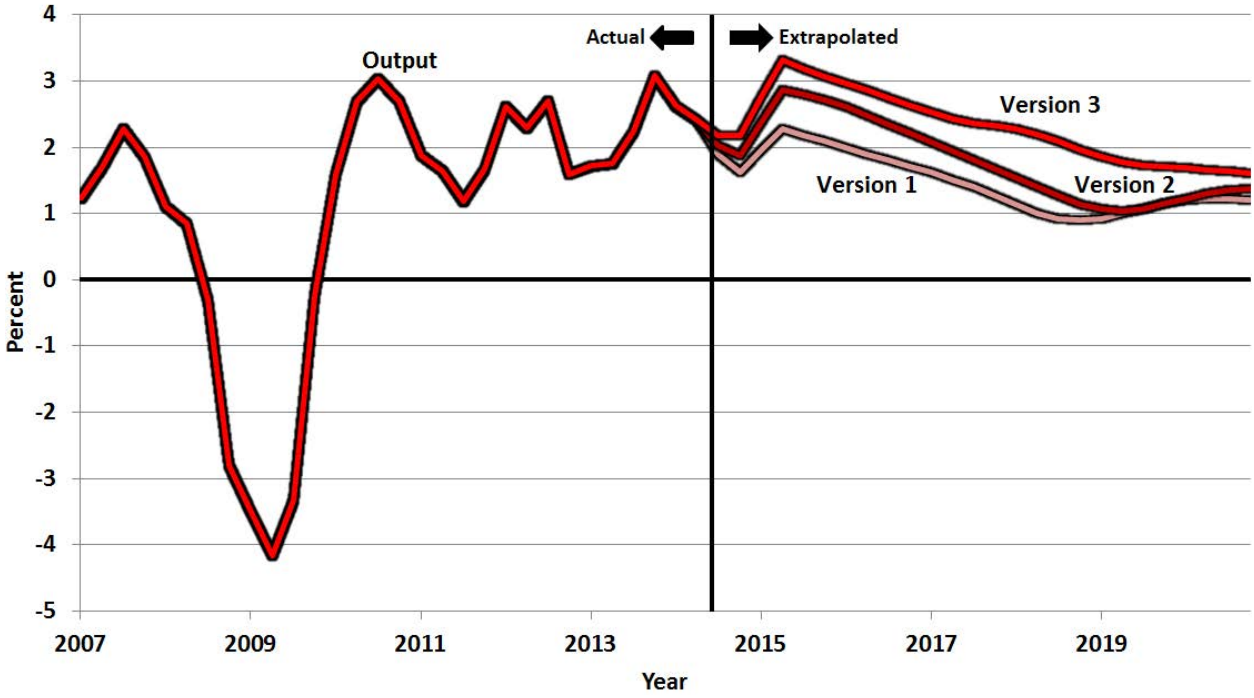
Our hypothetical scenarios for the future are all relatively optimistic, in that they sharply truncate the within-group decline in the LFPR immediately. In the pessimistic V1 the rate of decline of the LFPR transitions from -0.8 to the baby-boom effect (-0.4 percent per year) gradually through 2017. In the baseline V2 that transition occurs twice as rapidly. But the optimistic V3 goes far beyond eliminating the within-group participation decline. Instead, the rate of decline is allowed to move rapidly from -0.8 per year to zero, allowing the within-group

participation rates to rise and reverse part of their previous declines. In all three versions after 2018 the annual rate of decline of the LFPR converges to -0.4 percent. The three versions are also shown in Figure 6.

Once all the components of the growth rate version of the output identity are determined, simple addition yields the implied growth rate of real GDP, as seen from equation (2). Figure 7 below extends from 2007 to 2020 and displays the four-quarter moving average of real GDP growth. The zigs and zags up and down between 2010:Q3 and 2014:Q2 can be summarized with their average growth rate of 2.2 percent per year. The optimistic V3 prediction peaks at a four-quarter real GDP growth prediction for 2015:Q2 of 3.3 percent per year, consistent with the demand-side growth projections but lasting for a shorter time. By mid-2016 the growth rate has declined from 3.3 to 2.8 percent, reflecting supply-side constraints.

The baseline V2 supply-side assumptions allow real GDP growth to reach a peak in 2015:Q2 of 2.9, while the pessimistic V1 assumptions cannot support more rapid real GDP growth and peak in the same quarter as 2.3 percent per year. Growth in all versions tapers down after mid-2015 for obvious reasons. The unemployment rate cannot decline forever and indeed turns around in the V1 and V2 scenarios. The turnaround in the LFPR decline assumed in V3 cannot avoid the baby-boom retirement effect eventually taking over as the dominant source of decline. And the growth of hours per employee throughout all the versions gradually

Figure 7. Four Quarter Growth Rate of Output, Actual and Extrapolated, Versions 1 through 3, 2007:Q1 to 2020:Q4



tapers down from +0.3 percent per year to a long-run -0.20 percent per year in 2019-2020. By 2020, the supply-side "support" for real GDP growth has declined to 1.6 percent per year for V3, 1.4 percent for V2, and 1.2 percent for V1.

The logic for these pessimistic forecasts has not been widely appreciated. Eventually the unemployment rate will stop declining. Eventually growth in hours per employee will transition to the usual long-run decline. Even if labor-force dropping out within age groups totally ceases, the baby-boom retirement effect will still be there during 2008-34.[14] This leaves productivity growth as the economy's only "escape hatch" but the history is daunting. We defer to the conclusion further discussion of the potential for an explosion of labor productivity growth. In that discussion we shall contrast the slow productivity growth of 1972-96 and 2004-14 with the much more rapid growth of 1996-2004. Fernald (2014) has argued that the 1996-2004 interval experienced a jump in the level of productivity rather than a permanent increase in its growth rate. Our discussion will supplement Fernald's conclusion with some specific reasons why the 1996-2004 was a one-time-only event unlikely to be repeated.

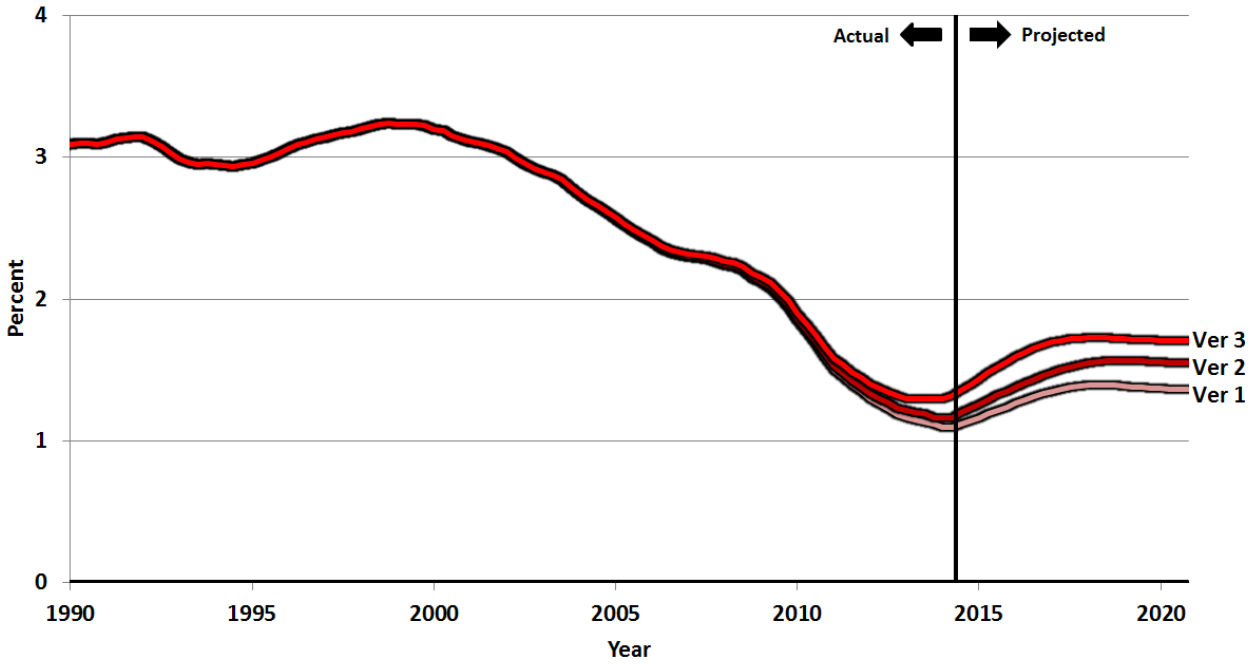
5. Implications for Potential Real GDP Growth

The motivation for this paper is that the dismal performance of the economy through 2014:Q2 has influenced the behavior of statistical trends. Whether one scribbles on the back of an envelope or uses a Kalman filter that uses information on the unemployment gap to unscramble trend real GDP growth from actual real GDP growth, the outcome is a growth rate of potential real GDP in 2014:Q2 of less than 1.0 percent. Yet we insisted that the Kalman trend would respond to a future scenario in which output grows more rapidly while the unemployment gap gradually stops its headlong descent of 2010-2014.

This paper has motivated and constructed three alternative scenarios for actual growth in real GDP and its output-identity components during 2014:Q3 to 2020:Q4. Everything fits together by definition. The assumptions for the behavior of the individual components are motivated by plausible changes from their historic behavior, and the implied path of real GDP during 2014-20 emerges by the push of a button. After we construct the three hypothetical alternative paths that are based on specific assumptions about the trajectory of the unemployment rate, the growth rate of productivity, and the labor-force participation rate, we then apply the Kalman filter technique to this synthetic set of data that pretend to represent the "actual" behavior of the economy between mid-2014 and late 2020.

[14] The baby boom lasted from 1946 to 1964. Baby-boomers taking early retirement at age 62 began to retire in 2008. The 1964 boomers who chose to delay retirement to age 70 will retire in 2034. Thus we regard the baby-boom retirement phenomenon as relevant to the time interval 2008-2034.

Figure 8. Projected Kalman Growth Trend of Output, Versions 1 through 3, 1990:Q1 to 2020:Q4



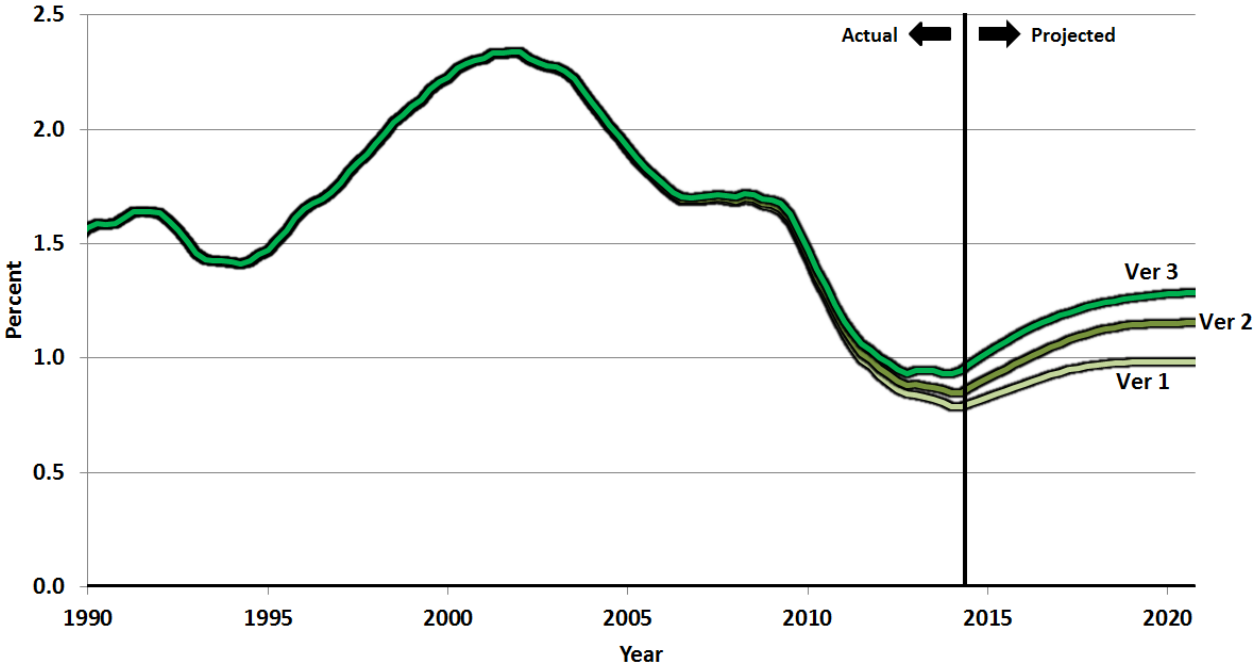
From the start, this paper had the aim of determining whether or not the potential real GDP forecasts of the CBO are realistic. The verdict of Figure 8 is a resounding "no". Despite its optimistic projections, V3 yields a long-term growth rate of potential real GDP of only 1.8 percent per year.[15] The alternative assumptions of V2 drop this to 1.6 percent per year, and those of V1 to 1.4 percent per year. These are all far below the CBO average growth rate forecast of 2.2 percent from mid-2014 to late 2020.[16]

Figure 9 below shows that all three alternative scenarios yield trend growth rates of labor productivity substantially faster than the Kalman trend estimated through the actual data of 2014:Q2. The baseline V2 ignores the sub-par performance of 2010-14 and winds up at 1.2 percent per year, the same as the achieved rate of 2004-14. The pessimistic V1 places some weight on the past few years and marks down the long-term growth rate from 1.2 to 1.0. The optimistic V3 has a long-run productivity growth trend of 1.4, somewhat above the realized

[15] The" optimistic" potential growth rate of 1.8 percent is identical to that of Fernald (2014, Table 4, line 7) that is based on the behavior of productivity over the ten years 2004-14, exactly the same rate as is displayed on the bottom line of Table 1 above.

[16] The CBO potential GDP forecast rises from 1.9 percent in mid-2014 to 2.4 percent in late 2018 and then declines gradually back to 2.0 after 2020. This unusual variability in the growth rate of potential GDP by the CBO is caused by the CBO assumption of a future revival of fixed investment to occur after 2014. But it makes no sense for the year-to-year variability of investment to influence potential GDP growth, which depends on the capital stock, not the flow of new investment goods. The technique used in this paper of providing estimates based on labor productivity, not total factor productivity, avoids any need to provide guesstimates of future investment behavior.

Figure 9. Projected Kalman Growth Trend of Labor Productivity, Versions 1 through 3, 1990:Q1 to 2020:Q4

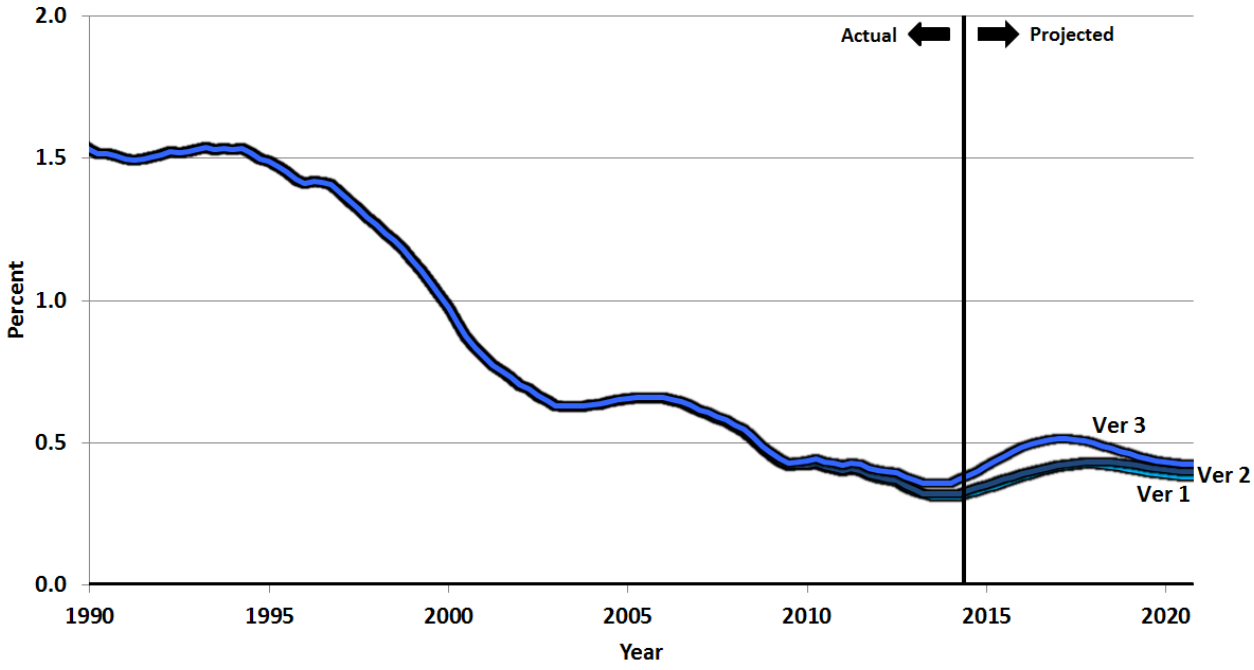


growth rate average of 1.2 percent during 2004-14 and of the average growth rate of 1972-96 combined with 2004-14.

Since the problem of slow future potential output growth does not seem to lie in labor productivity, it must be that the core of the problem lies in hours. We see this immediately in Figure 10 on the next page, which shows the three versions of the Kalman filter estimate of the trend growth in aggregate hours of work. Recall that when exposed only to the actual numbers through 2014:Q2, the estimated hours trend in Figure 4 is a mere 0.1 percent per year. The forecasts of faster future growth after 2014:Q2 raise the Kalman trend estimate to 0.3 in 2014:Q2 and indeed it reaches as high as 0.5 in mid-2017 in the optimistic V3 projection. Yet it is not enough. Here we arrive at the core issue – as recently as 1995, hours growth was at 1.5 percent per year, but now it looks likely to converge at a meager 0.3 to 0.4 percent per year.

The causes of slow hours growth are perhaps the easiest to list of any macroeconomic topic. With Census forecasts of working-age population growth trending down to 0.77 percent per year by 2020, and with a baby-boom retirement effect of -0.4 percent per year, the starting point for discussions of long-term hours growth is 0.37 percent per year. To make things worse, hours per employee tend to decline in the long run. The employment rate and the "bridge" term don't help either, as the former is constant once it settles down to a long-run path that is consistent with the avoidance of accelerating inflation, while the second, representing the ratio of hours from the payroll survey to hours from the household survey, has exhibited no trend at all over the last 25 years.

Figure 10. Projected Kalman Growth Trend of Hours, Versions 1 through 3, 1990:Q1 to 2020:Q4



6. Conclusion: Implications of Slower Potential Real GDP Growth

There is an almost unanimous consensus among business economists that real GDP growth will be at a rate of 3.0 to 3.5 percent over the next two to three years. However plausible this may be from the demand side by those who add up projected growth in consumption, investment, government spending and net exports, it strains credulity from the supply side. This paper applies the discipline of the "output identity" that relates real GDP growth to productivity, the unemployment rate, the labor-force participation rate, and other components, and asks how the consensus forecast of real GDP growth of 3.0 to 3.5 percent in 2015 and 2016 can be achieved.

The output identity is like an iron vise, because it is true by definition. For output to grow that much faster than the 2.1 percentage point average of the last five years, something radical has to happen. The unemployment rate has been declining at one percentage point per year over the last four years, and even if that rate of decline were to continue and drive the unemployment rate to 5 percent in mid-2015, to 4 percent in mid-2016, and to 3 percent in mid-2017, there would still need to be other components of the identity to supply the demand-side assumption of faster growth. The only two available levers to achieve this growth are labor productivity and the labor-force participation rate.

	Annual Growth Rates		
	Labor	**Capital**	Total Factor
Interval	Productivity	Deepening	Productivity
1890-1920	1.50	0.91	0.59
1920-1970	2.82	0.98	1.84
1970-2014	1.68	1.05	0.63

This paper introduces a new technique for projecting potential real GDP. The traditional growth accounting method takes an estimate of future total factor productivity (TFP) growth and adds an estimate of future capital deepening, that is, the future rate of increase of the capital-labor ratio. The method used in this paper skips over the step of requiring a guesstimate of the health of future investment spending. This short-cut is justified by 124 years of data on the U. S. economy. As shown in the above table, all the variance in the growth rate of labor productivity is accounted for the variance of TFP growth and none by capital-deepening, i.e., the growth rate of the capital-labor ratio.[17] This table also contains the startling news for the techno-optimists that TFP growth in the past four decades has been only one-third of its stellar performance of the central decades of the 20th century, 1920 to 1970

We conclude that there are three preconditions for real GDP to grow at a rate of roughly 3 percent during 2015 and 2016. The first requirement is that the unemployment rate be allowed to decline steadily to 4.8 percent. Second, the ongoing decline in the labor-force participation rate (LFPR) must not only slow down but must stop. Not only must the within-age-group decline in participation cease, but instead it must increase by enough to offset the ongoing retirements of the baby-boomer generation.

The possibility of a reversal in the secular decline in labor-force participation intrigues specialists in labor economics, but the implications for productivity growth evoke a wider range of references. The central "baseline" estimate of future labor productivity growth is 1.2 percent per year, the same as was actually achieved from 2004 to 2014.[18] An alternative long-term growth rate estimate is 1.3 percent, advocated in my recent paper on long-run growth (2014) and by Dale Jorgenson.[19] To put these productivity growth estimates into perspective, we can cite the highly relevant history of productivity growth since 1972. This growth rate soared temporarily for eight years in 1996-2004, and most analysts have associated this with the invention of the internet, web browsing, and e-commerce. If we omit that eight-year interval, labor productivity has grown only at 1.31 percent during the 34 years between 1972:Q1 and

[17] The data shown in the table are from my forthcoming book (Gordon, 2015, Chapter 10) and include the development of an innovative new series on capital input.

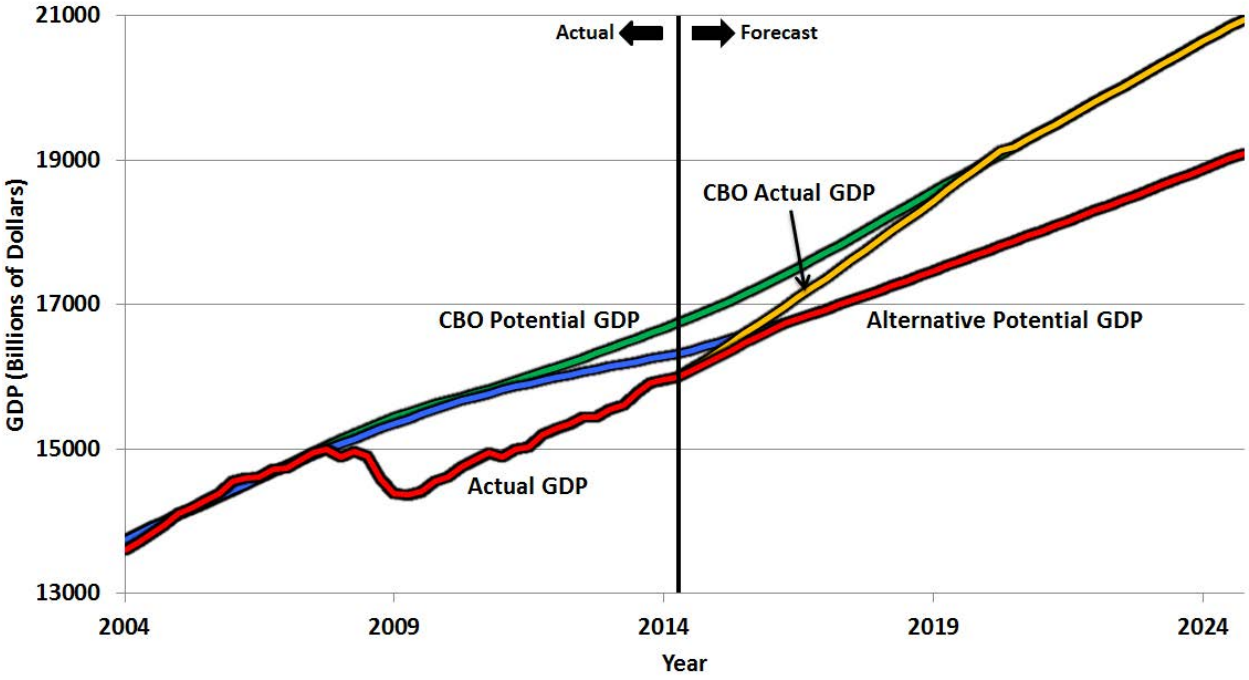
[18] Like all data in this paper, the zig-zag down in 2014:Q1 and back up in 2014:Q2 is ignored by using averages of first-half 2014 growth for all variables in our data set.

[19] The Jorgenson 1.3 percent projection was provided as verbal support for my similar 1.3 percent projection at an AEA session in Philadelphia in January 2014.

2014:Q2. The rate of productivity growth that has been so slow in most of the last four decades is a basic constraint on potential real GDP growth.[20] A key source of disagreement is over the relevance for near-term productivity growth of the temporary eight-year revival of productivity growth between 1996 and 2004. I have argued (2014) that the outstanding performance of those eight years was a one-time-only event unlikely to be repeated over the next decade, implying that the relevant productivity history is the 42 years since 1972 minus the growth achieved in 1996-2004.[21] Fernald (2014) agrees that the 1996-2004 episode represented a a one-time jump in the *level* of productivity with no implications for the long-run growth of productivity.

Could productivity growth break out of the range of 1.2 percent achieved in 2004-14 and 1.3 percent in the future forecasts by Jorgensen and myself? This is the core of a debate that has emerged involving the techno-optimists already identified above. The first reason for skepticism is that there has been no cyclical response of labor productivity to changes in the

Figure 11. Actual GDP vs. Potential GDP, CBO vs. Alternative Measures, 2004:Q1 to 2024:Q4



[20] While Fernald (2014) estimates potential output growth to be 1.8 percent when he uses productivity growth in 2004-14 as the relevant horizon, he instead chooses 2.1 percent as his baseline estimate because he believes that the performance of 1996-2004 is still relevant to a forecast of productivity growth over the next decade whereas I do not for the reasons laid out in the previous footnote.

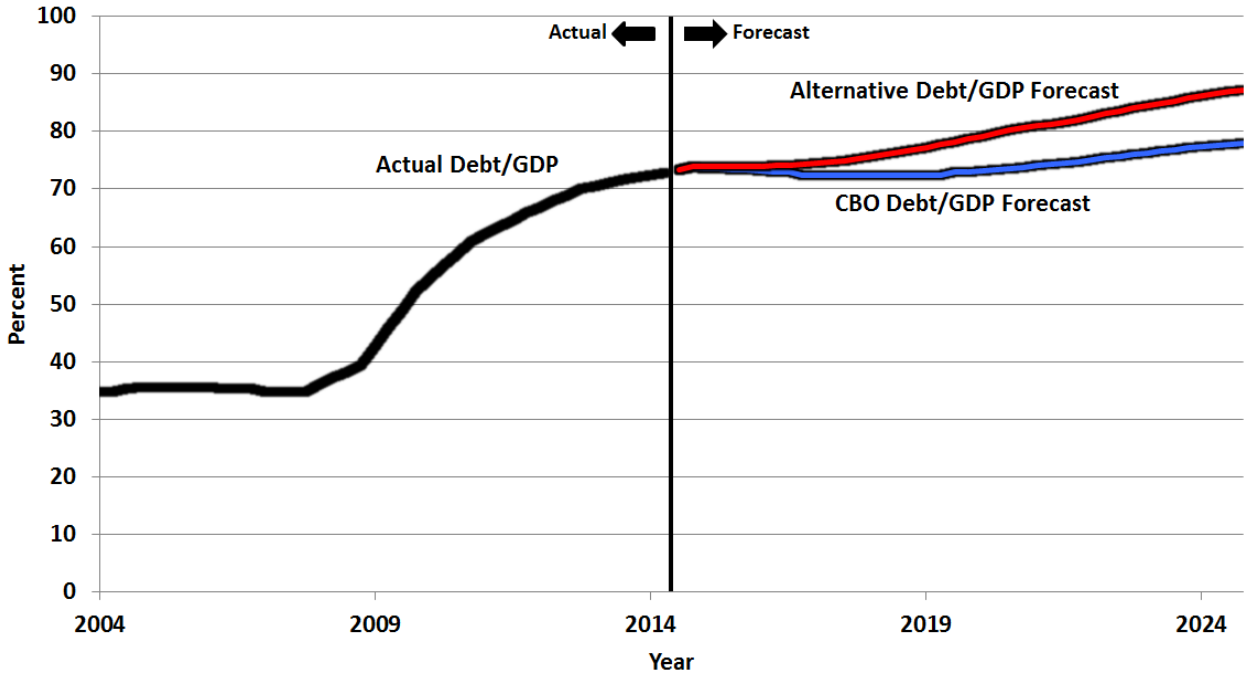
[21] The three reasons put forth in Gordon (2014) for the outlier nature of the eight years compared to the surrounding 34 years are the temporary bubble in the growth rate of manufacturing capacity compared to its growth of zero over the past six years, the temporary bubble in the share of information and communication technology (ICT)-production as a share of total manufacturing, and the temporarily rapid decline in the ICT deflator in contrast to its much slower rate of decline over the past decade.

output gap since the mid-1980s (see Gordon, 2010). This means that optimists cannot rely on any certainty that productivity growth will "fund" the excess of demand-side forecasted real GDP compared to the capability of the supply side.

The implications of this paper are summarized in two final graphs. Figure 11 above displays the trajectory of actual real GDP, the CBO estimate of potential GDP, our alternative forecast of potential GDP, and paths that allow actual real GDP to catch up to the two alternative potential estimates during the time period of 2014-2018.[22] The differences between the CBO forecasts and our alternative forecasts are profound. Our projected path implies a level of real GDP in 2024:Q4 will be nine percent or $1.9 trillion below the CBO estimate, and this amounts to $6000 per member of the total population.

As for the debt/GDP ratio, the implications of our projections can be seen in Figure 12. We begin with the CBO series on the projected debt/GDP ratio and replace the denominator with our alternative projected nominal potential GDP (using the CBO projected ratio of nominal to real GDP). Then we adjust the numerator, the net debt, by reducing projected growth in federal tax revenues by the same proportion that our alternative GDP falls short of that of the CBO. That is, if our GDP series is 95 percent of the CBO, we reduce CBO estimated tax revenue by five percent and then cumulate year-by-year to calculate a new nominal value of the

Figure 12. Debt/GDP, Actual and Forecast, CBO and Alternative Projections, 2004:Q1 to 2024:Q4



[22] To convert our growth rate forecasts into levels, we use John Fernald's (2014) estimate that the GDP gap in mid-2014 is about two percent, considerably less than the CBO's assumption of four percent.

government debt. Our resulting debt/GDP ratio in 2024 will not be the CBO forecast of 78 percent but rather 87 percent, a significant 9 percentage points higher.

Initially, one may react that there are no implications for monetary policy in this paper. All the Fed cares about is the output or unemployment gap, not the growth rate of potential GDP. While that may be appropriate for debates about whether the GDP gap in mid-2014 is currently two or four percent, it neglects the implications of the interplay between government and private sector forecasts of an acceleration of actual real GDP growth over the next year or two. Holding constant those forecasts, the slower growth of potential real GDP suggested in this paper means that the GDP and unemployment gaps will narrow more rapidly than the Fed is currently forecasting, and that the date at which the output gap turns from negative to positive will occur sooner than is widely assumed.

We are at a collision point between the demand-side forecasts and the capabilities of the supply side. The output identity can evoke no argument or quarrel. It is true by definition as it calls attention to the near-term collision. The policy environment over the next several years will depend on the mix of supply-side reactions to faster forecast real GDP growth. Will the unemployment rate decline faster than its stellar one-point per year performance since 2010? Will productivity growth break out of its slump since 1972 (excepting the brief 1996-2004 period)? Will the labor-force participation rate end its rapid decline and, despite the retirement of the baby-boomers, turn around and stabilize or begin to rise?

How will the conundrum identified in this paper ultimately be resolved? Our supply-side analysis leaves open a relatively simple answer. The optimistic demand-side forecasts will not happen, at least not in 2016 and 2017. The Fed will tighten, and higher interest rates will bring the universally expected 2014-16 growth rate of three percent or above back from the stratosphere to the reality that the economy is not capable in the long run of achieving the CBO's projection of 2.2 percent per year for 2014-20 but at rates forecast in this paper that center on 1.6 percent with a plausible range extending from 1.4 to 1.8 percent.[23]

By coincidence in mid-July 2014 as this paper was written, the *Economist* magazine featured a jockey in American stars and stripes on the top of a turtle, trying to get it to move faster. The title on the cover is "America's Lost Oomph: Why Its Long-term Growth rate has

[23] Fernald (2014) has a central estimate of future potential output growth of 2.1 percent, little different than the CBO's 2.2 percent. However, Fernald has an alternative estimate of 1.8 percent, equal to this paper's V3, when information only on productivity growth of 2004-14 is used. While Fernald's paper provides a convincing case that the much higher productivity growth of 1996-2004 was a one-time-only event, he still allows that unique experience to influence his estimates of growth beyond 2014. In this paper we take literally Fernald's conclusion, and our own based on a different set of reasons, that 1996-2004 is irrelevant, and that the baseline for total economy labor productivity growth is 1.31 percent, which is the growth rate from 1972 to 2014 when the unique interval 1996-2004 is omitted from the calculation.

Slowed."[24] The issues are familiar – slowing population growth, a decline in labor-force participation, and slow productivity growth. No solutions are provided, nor are any policy recommendations included here. Figure 11 showing a $1.9 trillion shortfall of real GDP in 2024 combined with Figure 12 showing a debt/GDP ratio of 87 percent instead of the currently forecast CBO ratio of 78 percent should be a wake-up call. The American economy has evolved from a fast-moving rabbit to a slow-moving turtle, and the community of academic economists, business economic forecasters, and policymakers inside the government have been slow to recognize this profound transformation.

[24] *Economist,* cover and first leader of the issue of July 19-25, 2014.

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