Stephanie Aaronson
Gianni Amisano
Andrew Figura
Charles Fleischman
Paul Lengermann

May 30, 2018

Improvements to the Staff Judgmental Estimation of the Output Gap

Introduction

The staff estimate of the output gap is one of the most important variables in the Tealbook projection. It directly informs the FOMC of the staff's judgment of where the economy stands relative to maximum employment and feeds into our assessment of the likely path of future inflation. Over the past few years, we have introduced into our judgmental forecast process new methods and procedures to sharpen our inference about the current level of the output gap. The changes to our process more formally account for the noisiness of published gross domestic product (GDP) data and better incorporate signals about the state of the economy from other economic indicators. In recent years, our estimates of the output gap have reflected these changes, but our procedures have been a work in progress, and it is only now that they have become developed enough to be introduced formally into the Tealbook. In this memo, we describe the motivation for our new approach, the conceptual framework that underpins it, and some of the information we take into account when estimating the output gap. At the end of the memo, we preview some changes to the Tealbook exhibits, to be introduced in the June edition, designed to highlight the output gap and some of the data we find useful in estimating it. We also briefly describe our plans for the future.

Why develop a new method for estimating the output gap?

GDP is measured with error. In the economics literature, and in the Tealbook until recently, the output gap has typically been calculated as the percent difference between GDP and an estimate of its potential level, often assumed to evolve very gradually. However, GDP (as well as other important macro variables) is measured with error. This reality is demonstrated, among other ways, by the fact that gross domestic income (GDI), which theoretically measures the same concept of aggregate economic activity, differs from GDP, sometimes quite noticeably. Moreover, quarter-to-quarter movements in GDP are sometimes at odds with other indicators of economic growth, such as employment growth and the change in the unemployment rate.[1] As a result, a significant amount of the high-frequency movement in traditional measures of the output gap likely reflects measurement error.

[1] GDP and GDI are also subject to revisions, which can substantially change our understanding of economic growth even years after the fact (Nalewaik, 2010).

Our new process aims to improve on traditional methods by inferring measurement error in GDP when its movement seems out of line with that of other informative macro variables.[2] We believe our method produces a less noisy estimate of the output gap and provides a clearer signal about the current state of the economy.

A variety of variables provide information about the cycle. It has long been our practice to look to data beyond GDP, especially data from the labor market, for insight into the state of the economy. However, the insight gained from these alternative sources was not systematically brought to bear when estimating the output gap. In the past few years, as we have sought to produce a better estimate of the output gap, we have increased the variety of data and range of models we use to inform our judgment, recognizing that all of these sources themselves provide imperfect signals. The intuition for this multivariate approach to identifying the cycle is supported by a variety of research, including Fleischman and Roberts (2011; hereafter, FR) and Trimbur (2009). FR and Gonzalez-Astudillo and Roberts (2016) also suggest that multivariate model-based estimates of the output gap are subject to less revision than estimates from a model that relies only on GDP data.

As noted earlier, the measure of the output gap presented in the Tealbook for the past few years has been produced using this judgmental multivariate approach. During this time, we have allowed what we considered to be uninformative movements in GDP (that is, movements in GDP that are neither cyclical nor indicative of the underlying pace of economic growth) to be mirrored in our estimates of potential output; this practice served the goal of insulating our estimate of the output gap from those movements. As a result, the judgmental estimates of potential output growth during this time conflated true potential output—which we believe is informative for our forecast of economic activity in the medium term—and measurement error. With the June Tealbook, we are introducing measurement error explicitly into our accounting of GDP growth, which also allows us to produce an estimate of potential output free from what we judge to be measurement error.[3]

An illustration of the procedure: 2014:Q1

We make our new procedure more concrete and illustrate its benefits by looking at a particular historical episode, the first quarter of 2014, in which taking published GDP at face value would have led us to misjudge the direction of the economy. The BEA's third release for 2014:Q1 showed GDP declining at an annual rate of 2.9 percent, a rate of change hardly ever seen outside of recessions. But the unemployment rate fell in Q1 and continued to decline in Q2. Moreover, payroll employment increased at a healthy clip. It was impossible to tell an economically

[2] Our current approach does not assume that all high-frequency volatility in GDP (or GDI) is necessarily measurement error. High-frequency swings in published GDP could reflect real factors that may, or may not, be picked up by other economic indicators. For example, unseasonably cold weather during winter months often results in large increases in PCE energy services, which can sometimes show through to top-line GDP. Because utility output can be increased by raising capital utilization without significantly increasing labor input, such weather-induced changes in GDP would not be typically reflected in data on the labor market. We would thus ascribe such changes in GDP to a temporary increase in aggregate demand and in nonlabor inputs to production, not to measurement error.

[3] Note that even when potential output was contaminated with measurement error in history, our projection for potential output growth over the medium term was our best guess of its true growth rate.

coherent story about the divergent paths of the data on aggregate spending and the labor market, and we concluded that one, if not both, of these pieces of data were measured with significant error and looked to other information that could help us decide which.

Our models placed a significant weight on the signal from the labor market data and pointed toward continued economic growth in Q1. Other indicators of economic activity, such as industrial production, the ISM manufacturing index, and GDI, were also consistent with a further expansion in activity, albeit at a somewhat slower pace than suggested by the labor data. At the same time, the BEA's estimate of health-care services spending showed an unusual decline in Q1 that was inconsistent with other information we had on health-care services spending and accounted for about 1 percentage point of the deceleration in GDP growth. Considering all of this information, we estimated that some, although not all, of the drop in GDP in Q1 was due to measurement error in GDP. So while the decline in GDP in Q1 would have, all else being equal, been consistent with a 1 percentage point deterioration in the output gap, we showed the output gap declining by half as much in the July 2014 Tealbook and showed an outright decline in potential output to account for the noisy GDP data. In addition, because we did not expect the mismeasurement of Q1 GDP to be fully corrected in subsequent quarterly GDP estimates, we expected GDP growth for 2014 as a whole to also be held down by measurement error.

In retrospect, our decision to attribute much of the surprising decline in GDP in 2014:Q1 to measurement error appears to have served us well. The GDP data now show a much smaller, 0.9 percentage point decline in 2014:Q1, suggesting there was a significant amount of noise in the third estimate. Moreover, GDP rose briskly in Q2 and Q3 of that year (GDP growth over the year is now reported to have been 2.6 percent), the unemployment rate continued to fall, and, by the end of the year, the level of measured health-care services spending had come back into line with the fundamentals. Taken together, the current data on 2014 are consistent with our judgment at the time that the BEA's third estimate of Q1 GDP was not a good signal of economic activity. In fact, the staff now shows a roughly flat output gap between 2013:Q4 and 2014:Q1. The one aspect of our reaction to the Q1 GDP data that remained uncomfortable to us was our inclusion of GDP measurement error in the estimate of potential output published in the Tealbook. This problem is what we solve now with our explicit accounting of measurement error, which allows us to publish an estimate of potential output that excludes the effects of measurement error.

The underpinnings of our new procedures to estimate the output gap

Since 2014, the staff has worked to systematize the joint judgmental estimation of the output gap, potential output, and measurement error in published GDP using a broad range of data available in real time. An important contribution to this work has been FR, who model the output gap as the common cyclical component of a broad set of indicators of the state of the economy.

In the FR model, a system of equations—including equations for aggregate output (GDP and GDI), important labor market variables (unemployment, employment, labor force participation, the workweek, and productivity), and inflation—is jointly estimated. Each real-side variable, x_i,

is modeled as the sum of three unobserved components: a trend component, τ_i, which is specific to that variable; a cyclical component, $cycle$, which is common across all variables; and an idiosyncratic transitory component, ε_i.[4] As GDP and GDI represent the same economic concept, they are assumed to share a common trend.

$$x_{i,t} = \tau_{i,t} + \sum_{j=0}^{N_i} \beta_i^j * cycle_{t-j} + \varepsilon_{i,t}$$

Common movements in these variables over the business cycle are used to identify the common cyclical component, permanent movements in the variables identify the trend components, and the remaining variation in the variables is reflected in the idiosyncratic transitory components.

Under a certain set of restrictions (details are in the FR paper), $cycle_t$ is the cyclical component of aggregate output and can be interpreted as the output gap, while the common trend component of GDP and GDI, $\tau_{Output,t}$, can be interpreted as potential output. Under these interpretations and given the identity that (true) output is equal to potential output plus the output gap, the transitory idiosyncratic movements in GDP and GDI, ε_{GDP} and ε_{GDI}, are equal to measurement error in published estimates of GDP and GDI, respectively.[5]

$$x_{i,t} = \overbrace{\tau_{Output,t}}^{Potential} + \overbrace{cycle_t}^{Output\ Gap} + \overbrace{\varepsilon_{i,t}}^{Measurement\ error}, i = GDP, GDI$$

According to the estimated model, a key variable for identifying the output gap is the unemployment rate. The signal from the unemployment rate is particularly high because its movements are largely cyclical and it derives from relatively high-quality data.[6] That said, the model's estimate of the output gap is also influenced by data on output (GDP and GDI), inflation, and employment.

The judgmental approach to estimating the output gap

The new staff judgmental process for estimating the output gap broadly mimics the FR model and attempts to discern trend, cycle, and idiosyncratic movements in the spending, labor market, and inflation data. Like the model, our judgmental procedure puts a fair amount of weight on the unemployment rate—more so than we did in the past. We also have a strong prior that variation

[4] The trends of the variables that together sum to aggregate output (employment, the workweek, and productivity) are restricted to sum to the trend component of aggregate output. The model takes the trend in inflation as exogenously given. FR builds on earlier work in this area, including Clark (1987), Kuttner (1994), and Laubach and Williams (2003).

[5] The statistical discrepancy, $GDP - GDI$, is equal to $\varepsilon_{GDP,t} - \varepsilon_{GDI,t}$. Our model estimates that $\varepsilon_{GDP,t}$ and $\varepsilon_{GDI,t}$ are transitory but still quite persistent.

The transitory idiosyncratic components of other variables in the model reflect both measurement error and transitory movements in these variables that depart from their usual dynamic correlation with $cycle$.

[6] See Gonzalez-Astudillo and Roberts (2016).

in potential output and its components is concentrated at low frequencies.[7] And we infer the existence of GDP measurement error when the behavior of GDP seems out of line with other important indicators of activity (particularly the labor market).[8] Indeed, the staff has developed an improved suite of models, including variants of the FR model, to inform its judgmental decomposition of the published level of GDP into potential output, the output gap, and measurement error, and it has presented model-based estimates of the output gap and natural rate of unemployment to the Board and the FOMC.

However, the staff's judgment can also differ from our models' estimates because the staff conditions on several types of information that the model does not. First, the staff consults data not currently included in our relatively parsimonious models, including variables with important cyclical components, such as industrial production and ISM indexes of general activity and new orders. In addition, the staff at times consults data from our Expanded Measurement program, including high-frequency, detailed geographic data on consumption and employment, which, among other uses, helped the staff gauge the economic effects of the hurricanes last fall.

Second, the staff uses information on how estimates of important macroeconomic variables are constructed and on the behavior of disaggregated components of these macro variables to assess whether measurement error is distorting published data. One example, described earlier, was the staff's judgment that the highly unusual decline in published estimates of 2014:Q1 health-care services expenditures was likely spurious. Staff analysis also indicates that the Census Bureau's methods for estimating retail sales have led to measurement problems in personal consumption expenditures (and GDP) when there are large changes in gasoline prices from quarter to quarter. In addition, we have carefully considered whether inadequate seasonal adjustment of important components of GDP or top-line GDP has distorted published GDP.[9] Of course, measurement problems extend beyond GDP, and the staff also judgmentally assesses the presence of measurement error in labor market variables and inflation.[10] In its assessments, the staff takes into consideration that initial estimates of GDP (and some other variables) are particularly imprecise, as source data are incomplete or of lesser quality. Our models do not yet have the ability to condition on the vintage of data, but we are working on one that does.

[7] DSGE models are often cited as delivering estimates of potential GDP growth that have high-frequency fluctuations. However, those estimates typically do not directly confront the reality that GDP is rife with error. Moreover, these models often have concepts of the output gap that differ from that in the Tealbook forecast.
[8] Of course, even before introducing our new procedures, the staff made an effort to distinguish signal from the noise in the spending data, but our new procedures focus these efforts on estimating the current level of the output gap. In addition, our accounting for measurement error as separate and distinct from potential and the output gap has improved the quality of our estimates of these latter two variables.
[9] See, for example, Gilbert and others (2015) and Lengermann and others (2017).
[10] Abrupt changes in seasonal patterns not captured by statistical agencies' seasonal adjustment procedures or changes in the timing within the month of the CPS survey week can produce spurious changes in the household and payroll survey data, including in the unemployment rate and payroll employment growth. Large and unusual changes in industry-level payroll data and sharp changes in labor force flows are also signs of possible measurement error. Changes in inflation due to large idiosyncratic movements in individual prices likely have less signal for the output gap than common movements in prices across product categories, though idiosyncratic movements are not necessarily due to measurement error.

Third, in contrast to our models, which treat each piece of data and each cyclical episode similarly, the staff takes into account the unique characteristics of a period's economic environment. For example, we judge that in 2009 and 2010, the shock of the financial crisis increased firms' assessment of and sensitivity to downside economic tail risks, leading them to cut employment more than the historical response of unemployment to aggregate demand would have suggested and to hire more hesitantly once the recovery started. We judge the output gap during this time was narrower than suggested by the unemployment rate alone because productivity—boosted by firms operating with the bare minimum of workers and cutting back on activities not essential to current production—was unusually cyclically elevated. More generally, any unusual aspect of the economic environment could potentially inform the staff's judgmental estimates of the output gap or potential output. Changes in fiscal policy, for example—including changes to taxes or emergency unemployment compensation—can influence the staff's judgment about potential output growth, the natural rate of unemployment, or the trend level of labor force participation, while the model will be unaware of these structural changes.

Over time, the staff, like the model, may change its initial interpretation of the data. For example, if a movement in GDP that initially was thought to be measurement error persists and corresponds to a similar persistent movement in GDI, the staff would likely eventually estimate most of this movement to be due to a change in potential output, not measurement error. Alternatively, if GDP data are revised so that an initial puzzling movement in GDP that the staff attributed to measurement error is no longer present, the staff would correspondingly revise its estimate of GDP measurement error in that quarter.

Changes to Tealbook charts and tables

To highlight the staff's judgmental estimate of the output gap, we have created a new exhibit for the Tealbook titled "Cyclical Position of the U.S. Economy: Near-Term Perspective." In addition, we reorganized the exhibit "Decomposition of Potential GDP" and retitled it "Cyclical Position of the U.S. Economy: Longer-Term Perspective." The numbers in the table in the latter exhibit now show growth rates of true potential output and structural productivity, whereas in recent years they have shown growth rates of potential output and structural productivity inclusive of measurement error. Both of these exhibits are shown in the appendix.[11] Regarding the new near-term exhibit, the first four lines of the table at the top of the exhibit show the output gap, GDP growth, the contribution of measurement error to GDP growth, and potential output growth. The change in the output gap from one period to the next will equal $GDP\ growth - potential\ output\ growth - Contribution\ of\ measurement\ error\ to\ GDP\ growth$.[12] The top two panels in the lower part of the exhibit show the staff estimate of the output gap and the estimate of the output gap from our workhorse model. Both panels include 90 percent confidence intervals.[13] The bottom two panels compare recent data on the unemployment rate

[11] The numbers in the exhibits may change before the June Tealbook is published.

[12] For quarterly growth rates expressed at an annual rate, this quantity needs to be multiplied by ¼ to map it to a change in the level of the output gap.

[13] The confidence intervals around the staff estimate are derived in Berge (2018), which was sent to Reserve Bank Research Directors on May 30, while the intervals around the model estimate are produced by the model.

and inflation—two inputs, in addition to GDP, into our assessment of the level of the output gap—with the staff's estimates of the natural rate of unemployment and trend inflation, respectively.

We have also revised our estimates of the output gap, potential output growth, and structural productivity growth over history. Estimates up to 2016:Q1 are now based on a simplified FR-type model that takes into account the presence of measurement error in published data. As noted earlier, estimates of potential output in more recent years have also been revised to exclude the contribution of GDP measurement error to GDP growth. Figures 1 and 2 in the appendix compare the staff's current estimates of the output gap and the growth rate of potential output before 2016:Q1 with previous estimates.[14] The staff's estimate of the natural rate of unemployment over history is unrevised.

Plan for the future

Going forward, the staff plans to continue to refine and improve our methods for estimating the output gap, potential, and GDP measurement error. For instance, we hope to increasingly incorporate nontraditional data sources (e.g., "big data") into our judgmental and model-based assessments of the cyclical position of the economy. We have noted earlier our use of high-frequency detailed geographic data—both on employment, from ADP, and on consumer spending, from First Data—to estimate the economic effects of last fall's hurricanes. But there are other data, such as highly disaggregate data on wages from ADP, which we have only begun to explore, and we are working to gain access to additional alternative data. As we gain further experience with extracting information about the cycle from nontraditional data, these data will likely play a larger role in our efforts to estimate the current state of the economy. Model development is also a priority, and we will continue to search for ways to enable our models to capture aspects of the data that are most informative (and filter out aspects that are least informative) about the output gap. For example, as noted earlier, we are currently working on a model that can take into account the revision properties of data when extracting signal from these data for the output gap.

Currently, we do not have enough data to quantitatively assess whether our new procedures have improved our forecasting performance relative to our previous performance or relative to some counterfactual. But we intend to explore ways to produce such assessments going forward. That said, as noted earlier, we believe our new approach has served us well in situations where the GDP data or other individual pieces of macrodata have behaved unusually. For example, taking the GDP data in 2014:Q1 at face value would have led us to report a highly misleading estimate of the output gap in that quarter and potentially to predict a weakening in unemployment, whereas our new procedures provide a natural way to insulate our projection from such anomalous data.

[14] The noticeable high-frequency volatility in previous estimates of potential output growth beginning in 2014 reflects the inclusion of measurement error in these estimates.

References

Berge, Travis (2018). "Measuring the Uncertainty of Judgmental Estimates of Unobserved Variables," memorandum, Board of Governors of the Federal Reserve System, Division of Research and Statistics, March 15.

Clark, Peter K. (1987). "The Cyclical Component of U.S. Economic Activity," *Quarterly Journal of Economics*, vol. 102 (November), pp. 797–814.

Fleischman, Charles A., and John M. Roberts (2012). "From Many Series, One Cycle: Improved Estimates of the Business Cycle from a Multivariate Unobserved Components Model," Finance and Economics Discussion Series 2011-46. Washington: Board of Governors of the Federal Reserve System, April, https://www.federalreserve.gov/pubs/feds/2011/201146/201146pap.pdf.

Gilbert, Charles E., Norman J. Morin, Andrew D. Paciorek, and Claudia R. Sahm (2015). "Residual Seasonality in GDP," FEDS Notes. Washington: Board of Governors of the Federal Reserve System, May 14, https://www.federalreserve.gov/econresdata/notes/feds-notes/2015/residual-seasonality-in-gdp-20150514.html.

Gonzalez-Astudillo, Manuel, and John M. Roberts (2016). "When Can Trend-Cycle Decompositions Be Trusted?" Finance and Economics Discussion Series 2016-099. Washington: Board of Governors of the Federal Reserve System, December, https://www.federalreserve.gov/econresdata/feds/2016/files/2016099pap.pdf.

Kuttner, Kenneth N. (1994). "Estimating Potential Output as a Latent Variable," *Journal of Business and Economic Statistics*, vol. 12 (July), pp. 361–68.

Laubach, Thomas, and John C. Williams (2003). "Measuring the Natural Rate of Interest," *Review of Economics and Statistics*, vol. 85 (November), pp. 1063–70.

Lengermann, Paul, Norman Morin, Andrew Paciorek, Eugenio Pinto, and Claudia Sahm (2017). "Another Look at Residual Seasonality in GDP," FEDS Notes. Washington: Board of Governors of the Federal Reserve System, July 28, https://www.federalreserve.gov/econres/notes/feds-notes/another-look-at-residual-seasonality-in-gdp-20170728.htm.

Nalewaik, Jeremy J. (2010). "The Income—and Expenditure—Side Estimates of U.S. Output Growth," *Brookings Papers on Economic Activity*, Spring, pp. 71–127, https://www.brookings.edu/wp-content/uploads/2010/03/2010a_bpea_nalewaik.pdf.

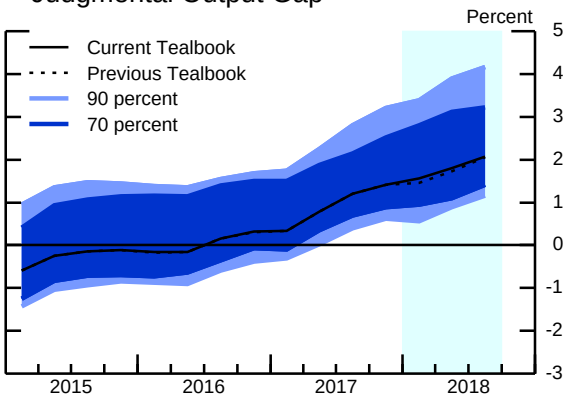
Trimbur, Thomas M. (2009). "Improving Real-Time Estimates of the Output Gap," Finance and Economics Discussion Series 2009-32. Washington: Board of Governors of the Federal Reserve System, July, https://www.federalreserve.gov/pubs/feds/2009/200932/200932pap.pdf.

Cyclical Position of the U.S. Economy: Near-Term Perspective
(Percent change at annual rate from final quarter of preceding period except as noted)

Measure	2015	2016	2017	2018 Q1	2018 Q2	2018 Q3
Output gap[1]	**-.1**	**.3**	**1.4**	**1.6**	**1.8**	**2.1**
Previous Tealbook	-.1	.3	1.4	1.5	1.7	2.1
Real GDP	2.0	1.8	2.6	2.3	2.9	2.8
Previous Tealbook	2.3	2.1	2.6	1.9	2.8	3.0
Measurement error in GDP	-.3	-.2	-.1	.0	.3	.0
Previous Tealbook	-.3	-.2	-.1	-.1	.0	.0
Potential output	1.5	1.6	1.5	1.7	1.7	1.7
Previous Tealbook	1.5	1.6	1.5	1.7	1.7	1.7

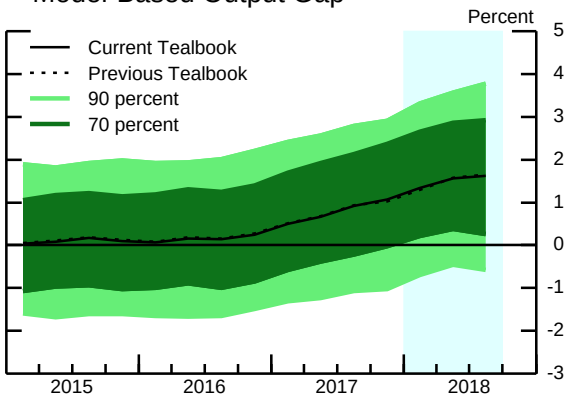
Note: The output gap is the percent difference between actual and potential output; a negative number indicates that the economy is operating below potential. The change in the output gap is equal to real GDP growth less the contribution of measurement error less the growth rate of potential output. For quarterly figures, the growth rates are at an annual rate, and this calculation needs to be multipled by 1/4 to obtain the quarterly change in the output gap.
1. Percent, average for the final quarter in the period.

Judgmental Output Gap



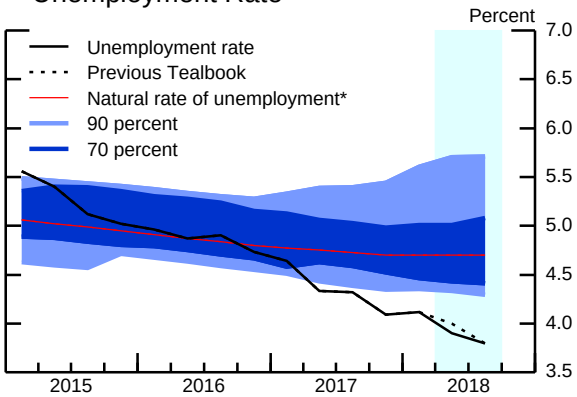
Note: Shaded regions show the distribution of historical revisions to the staff's estimates of the output gap.
Source: Various macroeconomic data; staff assumptions.

Model-Based Output Gap



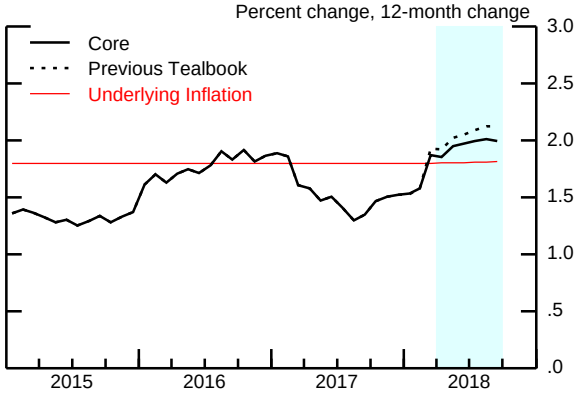
Note: Shaded regions denote model-computed uncertainty bands.
Source: Various macroeconomic data; staff assumptions.

Unemployment Rate



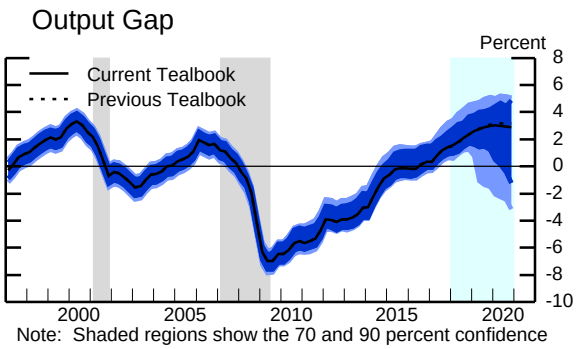
Note: Shaded regions show the distribution of historical revisions to the staff's estimates of the natural rate.
Source: U.S. Department of Labor, Bureau of Labor Statistics; staff assumptions. *Staff estimate including the effect of EEB.

Core PCE Price Inflation

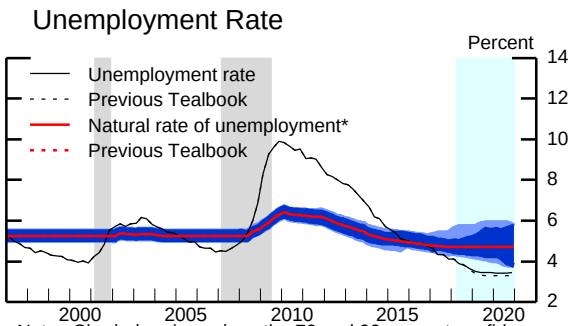


Source: U.S. Department of Commerce, Bureau of Economic Analysis; staff assumptions.

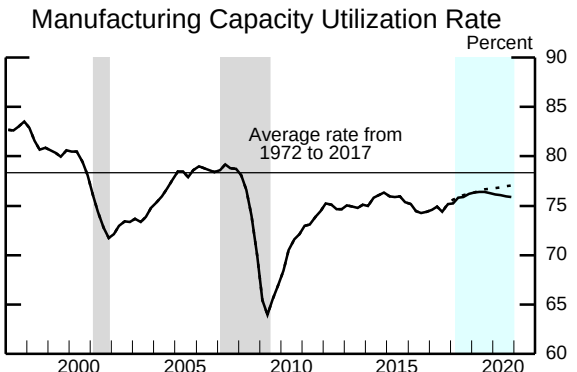
Cyclical Position of the U.S. Economy: Longer-Term Perspective



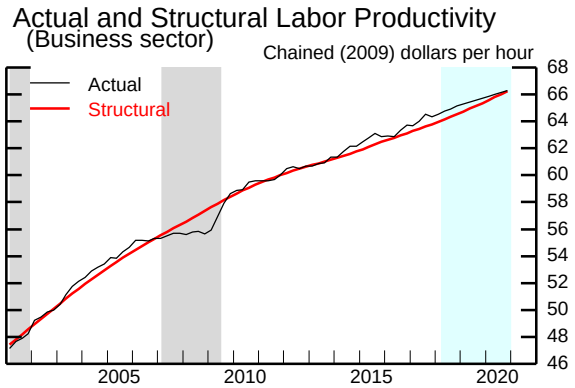
Note: Shaded regions show the 70 and 90 percent confidence intervals of the distribution of historical revisions to the staff's estimates of the output gap.
Source: Various macroeconomic data; staff assumptions.



Note: Shaded regions show the 70 and 90 percent confidence intervals of the distribution of historical revisions to the staff's estimates of the natural rate.
Source: Various macroeconomic data; staff assumptions.



Source: Federal Reserve Board, G.17 Statistical Release, "Industrial Production and Capacity Utilization."



Source: U.S. Department of Labor, Bureau of Labor Statistics; U.S. Department of Commerce, Bureau of Economic Analysis; staff assumptions.

Note: The gray shaded bars indicate a period of business recession as defined by the National Bureau of Economic Research.

Decomposition of Potential Output
(Percent change, Q4 to Q4, except as noted)

Measure	1974-95	1996-2000	2001-07	2008-10	2011-15	2016	2017	2018	2019	2020
Potential output	3.1	3.5	2.7	1.8	1.4	1.6	1.5	1.7	1.8	1.9
Previous Tealbook	3.1	3.5	2.7	1.8	1.4	1.6	1.5	1.7	1.9	1.9
Selected contributions[1]										
Structural labor productivity[2]	1.7	3.0	2.7	1.7	1.1	1.0	1.1	1.2	1.3	1.4
Previous Tealbook	1.7	3.0	2.7	1.7	1.1	1.0	1.0	1.2	1.2	1.3
Capital deepening	.7	1.5	1.0	.3	.5	.5	.5	.6	.6	.6
Multifactor productivity	.7	1.1	1.5	1.2	.3	.3	.4	.5	.5	.6
Structural hours	1.6	1.0	.8	.4	.5	.8	.2	.7	.6	.6
Previous Tealbook	1.6	1.0	.8	.4	.5	.8	.2	.7	.6	.6
Labor force participation	.4	-.1	-.2	-.5	-.6	-.3	-.3	-.3	-.2	-.2
Previous Tealbook	.4	-.1	-.2	-.5	-.6	-.3	-.3	-.3	-.2	-.2
Memo:										
Output gap[3]	-1.5	2.5	.2	-5.5	-.1	.3	1.4	2.4	3.0	2.9
Previous Tealbook	-1.5	2.5	.2	-5.5	-.1	.3	1.4	2.4	3.1	3.2

Note: For multiyear periods, the percent change is the annual average from Q4 of the year preceding the first year shown to Q4 of the last year shown.
1. Percentage points.
2. Total business sector.
3. Percent difference between actual and potential output in the final quarter of the period indicated. A negative number indicates that the economy is operating below potential.

Figure 1: Potential Output Growth

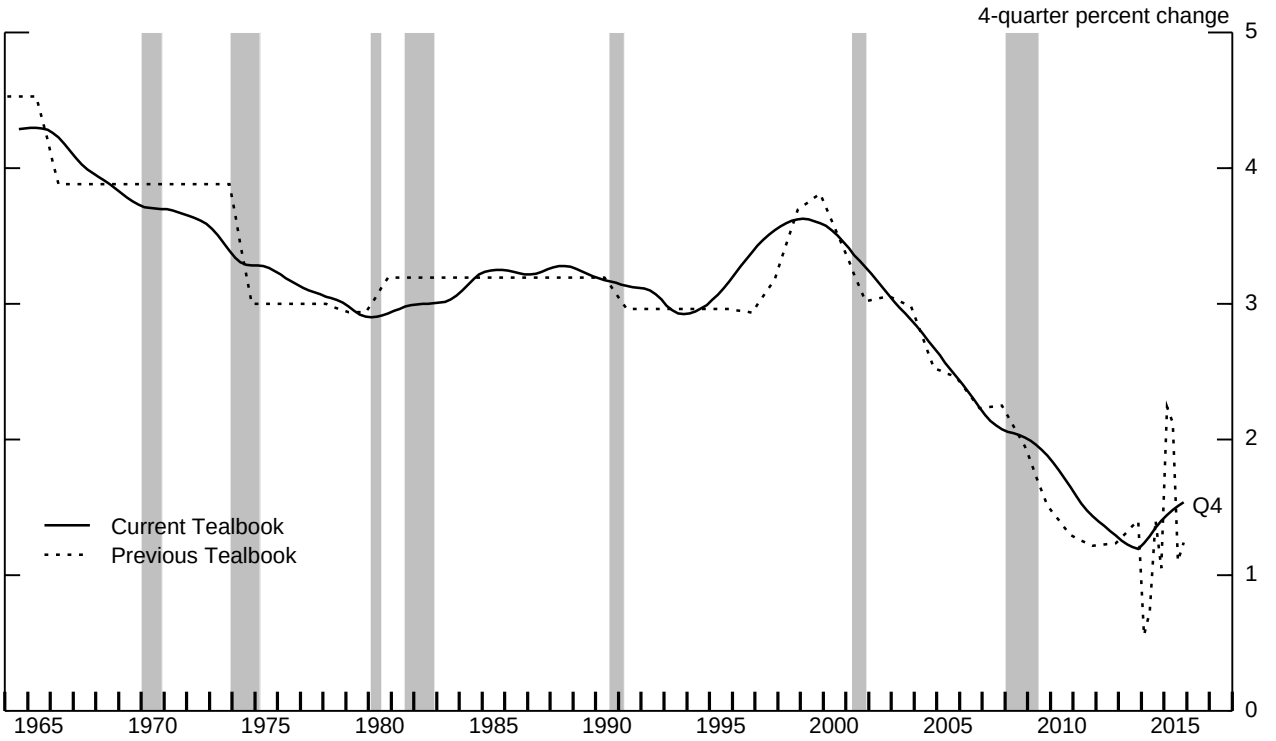
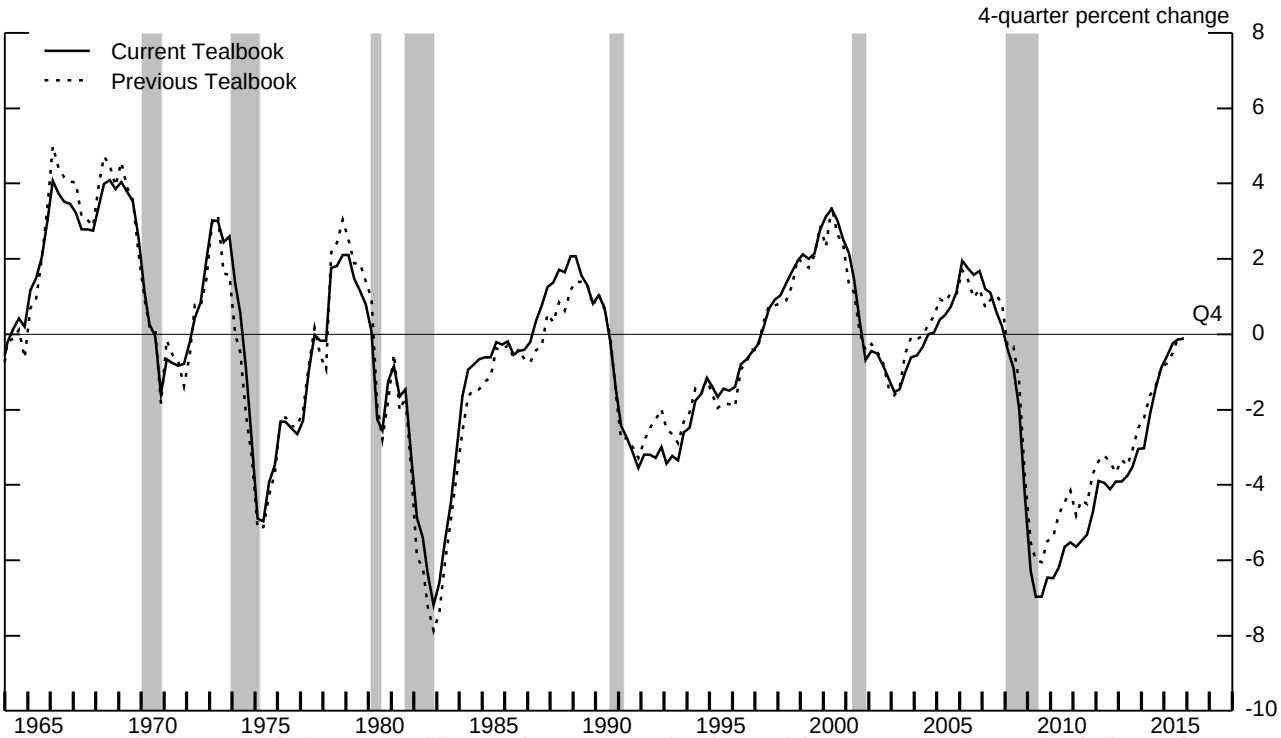


Figure 2: Output Gap



Note: The output gap is the percent difference between actual and potential output; a negative number indicates that the economy is operating below potential.
Source: U.S. Department of Commerce, Bureau of Economic Analysis; staff assumptions.
Note: The gray shaded bars indicate a period of business recession as defined by the National Bureau of Economic Research.