April 17, 2019

Economics Group

WELLS FARGO SECURITIES

Special Commentary

Azhar Iqbal, Econometrician
azhar.iqbal@wellsfargo.com • (212) 214-2029

A New Framework to Estimate Potential GDP

Executive Summary

At last year's Jackson Hole Economic Policy Symposium, Federal Reserve Chair Jerome Powell highlighted the importance of the natural unemployment rate, potential GDP and the equilibrium interest rate for monetary policy. He suggested such measures are similar to the celestial stars and will help the Federal Open Market Committee (FOMC) select an appropriate policy stance to achieve its dual mandate of price stability and maximum employment. Powell also addressed concerns that shifts in the market structure have created uncertainty around existing estimates.[1]

Previously, we developed a new methodology to measure the equilibrium interest rate (*r-optimal)*[2] and natural unemployment rate (*u-optimal*).[3] In this report, we present a new methodology for estimating potential GDP, *GDP-optimal*. Our method is an alternative to the Congressional Budget Office (CBO) potential GDP measure, which is widely used to gauge U.S. potential output. Changes in macroeconomic variables over time have caused traditional methods, like the CBO's, to be an imprecise guide for monetary policy.

We present a new methodology for estimating potential GDP.

Our approach incorporates the evolving nature of the economy to estimate potential GDP, creating a more flexible method. We utilize a modified Okun's law with *u-optimal*, growth expectations as inputs and time-varying weights. When actual GDP is near *GDP-optimal* it suggests that monetary policy may be neutral (neither accommodative nor restrictive) and inflationary or deflationary risks will be roughly balanced. *GDP-optimal* is consistent with various business cycle phases. Our approach to estimating potential GDP is therefore more effective than traditional methods, and would help policymakers gauge appropriate monetary policy.

Re-evaluating the Benchmark: CBO's Potential GDP

In theory, if actual GDP is *below* potential output, then resources are underutilized and inflationary pressure is limited. In such a scenario, the FOMC would want to maintain an accommodative policy stance in order to boost economic output to potential. However, when actual GDP rises *above* its potential level, it suggests a risk of an overheating economy and rising inflation. When this occurs, the FOMC would want to hike rates in an effort to slow growth.

One of the most widely known methods of estimating potential GDP is Okun's law.

One of the most widely known methods of estimating potential GDP is Okun's law.[4] Okun's law investigates the inverse relationship between GDP and the unemployment rate. It states that GDP will exceed its potential level when unemployment falls below the natural unemployment rate. Conversely, when the unemployment rate exceeds its natural level, GDP drops below potential.

CBO estimates potential GDP using the non-accelerating inflation rate of unemployment (NAIRU) as a measure of the natural unemployment rate. In a previous report (footnote 3), we highlighted issues with the NAIRU and presented a more accurate measure of the natural unemployment rate

---

[1] **Powell, Jerome H. "Monetary Policy in a Changing Economy." (August 24, 2018)**
[2] **"A New Framework for Estimating the Optimal Policy Interest Rate" (September 12, 2018)**
[3] **"Finding Dory: A New Framework to Estimate the Natural Unemployment Rate" (October 25, 2018)**
[4] **Congressional Budget Office. (2004). A Summary of Alternative Methods for Estimating Potential GDP. Okun, Arthur M. (1962). Potential GNP: Its Measurement and Significance. Cowles Foundation, Yale University paper 190.**

(*u-optimal*). Staiger, Stock and Watson (1997) suggested the NAIRU is not an effective proxy for the natural rate of unemployment due to its wider estimated range. They estimated the NAIRU in 1990 was 6.2% with a range from 5.1% to 7.7%.[5] CBO's potential GDP not only relies on NAIRU but is also based on fixed weights. Okun's law assigns fixed coefficients to model the relationship. This means for the entire sample period, estimated coefficients of the model and the strength of the relationship remain constant. This method does not allow for the relationship between economic variables to evolve over time. More recently, Powell (2018) suggested real-time estimates of long-run economic variables are prone to error, since they cannot be directly observed. For instance, observers in the mid-1960s through the 1980s significantly underestimated the natural unemployment rate, and overestimated it in the 1990s. Therefore, a time-varying weights approach is needed to reliably estimate Okun's law.

We utilize a modified Okun's law to estimate GDP-optimal.

In addition to *u-optimal* in the final model, we also include growth outlook probabilities to account for potential GDP level fluctuations in relation to the phases of a business cycle.[6] Our model utilizes growth outlook probabilities as a proxy for the business cycle to improve the model's fit and provide more accurate results.

Figure 1

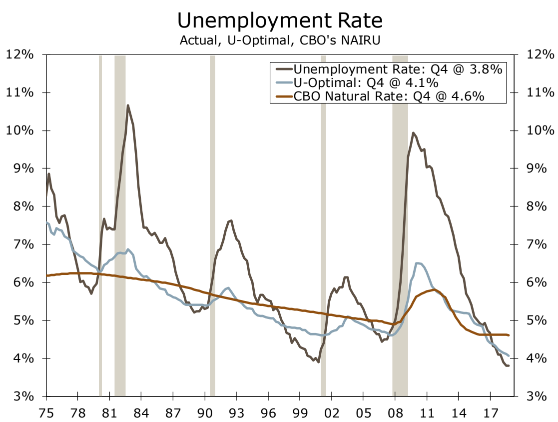
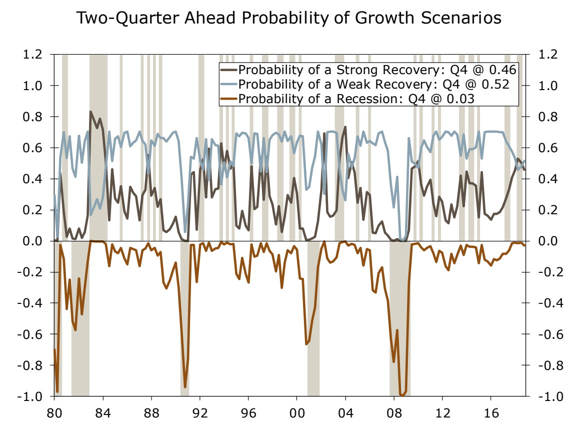


Figure 2



Source: Congressional Budget Office, U.S. Department of Labor, IHS Markit and Wells Fargo Securities

A New Method to Estimate *GDP-Optimal*

The GDP-optimal rate should not be a constant estimate.

Given the evolving nature of the economy, the *GDP-optimal* rate should be a time-varying measure to capture different economic regimes. To estimate *GDP-optimal*, our framework includes *u-optimal* based on time-varying coefficients and incorporates structural breaks (Figure 1). Following the research of Ball and Mankiw[7], our measure of *u-optimal* includes inflation outlook probabilities to capture current and near-term inflation expectations. Similarly, we also include probabilities of the growth outlook. Ball and Mankiw suggest a structural break in the inflation/unemployment relation is the result of demographic and productivity dynamics. Based on this, we incorporate the labor force participation rate to capture demographic trends and the productivity series to estimate *u-optimal*.

Since the risks to the economic outlook constantly change, an evolving set of coefficients is necessary when estimating *u-optimal*. For example, in the early 1980s inflationary pressures were high, with double-digit inflation rates. The economy adjusted post-1990 when inflation rates averaged close to 2%. The past three recoveries have been labeled as jobless recoveries, indicating

[5] Staiger, D. James Stock and Mark Watson. (1997). "How Precise are Estimates of the Natural Rate of Unemployment?" in *Reducing Inflation: Motivation and Strategy* by Romer, C and Romer D. University of Chicago Press.
[6] Arnold, Robert. (2009). The Challenges of Estimating Potential Output in Real Time. *Federal Reserve Bank of St. Louis Review*, July/August 2009.
[7] Ball, Laurence and N. Gregory Mankiw. (2002). The NAIRU in Theory and Practice. Journal of Economic Perspectives. Vol 16, No 4.

another shift in the economic outlook. Therefore, a time-varying set of coefficients is more effective to address contemporary risks and estimate the *u-optimal* rate.

To account for variations in the business cycle, our model incorporates the growth outlook.

To account for variations in the business cycle, our model incorporates the growth outlook. In 2016, we presented a framework that characterized growth in three categories: recessions, weaker expansions and stronger expansions.[8] We developed an ordered Probit model to estimate the probabilities of these three growth scenarios up to two quarters ahead (Figure 2). The model accurately predicted all episodes of the three growth scenarios in a simulated real-time analysis. Therefore, we can utilize these probabilities to predict the current and near-term growth outlook.

Estimating *GDP-Optimal*

We compare our model against two different benchmarks to show its effectiveness.

To show the effectiveness of our approach, we compare our model against two different benchmarks, the CBO measure of potential GDP[9] and the Hodrick-Prescott (H-P) filter, a statistical method. The H-P filter estimates a long-run trend for GDP, which can be interpreted as potential GDP.

We use data through Q4-2018 to compute *GDP-optimal* based on several different methods. The results are reported in Figure 3. We also added a column, "gap", to evaluate the difference between the upper and lower values of the range. A wider gap reduces the effectiveness of estimates of potential GDP growth for policymakers according to Staiger, Stock and Watson (1997). The H-P filter has the largest gap of 2.0%, followed by CBO's gap of 1.6%. Okun's law with *u-optimal* (but without the growth probabilities) produced a smaller gap (1.4%) than the CBO and H-P filter methods.

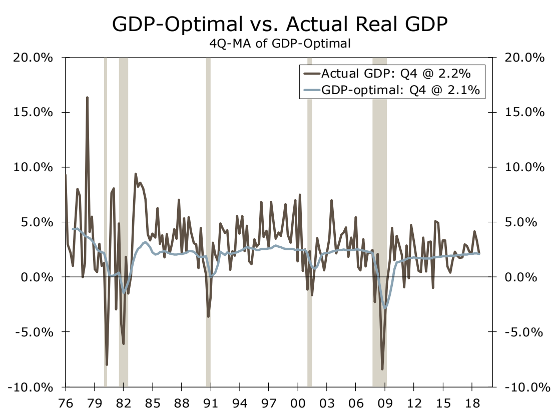
Our preferred method, *GDP-optimal*, has a gap of 1.2%. The *GDP-optimal* method includes *u-optimal* and growth probabilities. By including probabilities of the growth outlook, the model's fit improves. The four quarter-moving average (4Q-MA) of *GDP-optimal* produced the smallest gap and therefore is the most precise.

Figure 3

Method	Estimate	Upper-Limit	Lower-Limit	Gap*
The H-P Filter	2.3%	3.3%	1.3%	2.0%
Okun's law with u-optimal	2.1%	2.8%	1.4%	1.4%
CBO Estimate	2.1%	2.9%	1.3%	1.6%
GDP-optimal	2.1%	2.7%	1.5%	1.2%
4Q-MA of GDP-optimal	2.1%	2.6%	1.6%	1.0%

*** Difference between the upper and lower values of the range**

Figure 4



Source: U.S. Department of Commerce, Congressional Budget Office and Wells Fargo Securities

The estimated potential output should be consistent with the phases of the business cycle.

To better assist policymakers, the estimated potential output should align with the phases of the business cycle. During a recession, output falls below the potential level and during an expansion output returns to the pre-recession level. Standard macroeconomics books define recessions as a temporary shock that reduces output in the short-run. Based on the performance of the U.S. economy and other developed nations since the Great Recession, recessions have proven they can be much longer-lasting and can even depress *potential* GDP growth. Previously, we developed a

[8] "Predicting the Probability of Recession and Strength of Recovery: An Ordered Probit Approach." (July 19, 2016).
[9] For additional detail see the CBO website.

framework to estimate the cost of a recession for the U.S. economy.[10] The study concluded that the level of real GDP was, on average, 9.9% lower during the 2008-2015 period than it otherwise would have been.

To estimate the severity of a recession, we analyze potential GDP relative to the zero threshold. During the recessions of 1981-1982 and 2007-2009 *GDP-optimal* dropped below the zero line, indicating the severity, particularly during the Great Recession.

In 2008, the average growth for CBO's potential GDP reached 1.8%, a slight decline from the 2006-2007 period's growth (2.0%). The decline suggests minor losses from the Great Recession. CBO's potential GDP growth never dropped below zero in the sample period of 1976-2018, though *GDP-optimal* fell into negative territory in 2008-2009. CBO's slight decline in potential GDP growth during the Great Recession perhaps suggested that the usual accommodative monetary policy may suffice. Yet the FOMC had to resort to unprecedented accommodative monetary policy, bringing the fed funds rate to 0-0.25% in December 2008 and until December 2015. Additionally, the Fed implemented several rounds of quantitative easing and its balance sheet surpassed $4 trillion.

Our proposed model was able to accurately identify the severity of the Great Recession.

Our proposed model was able to accurately identify the severity of the Great Recession. It incorporates time-varying methods and accounts for business cycle phases, and is overall more helpful than CBO's potential GDP measure.

A Statistical Rationale for Regime-Switching *GDP-Optimal*

We divided the dataset into five sub-samples to represent different economic regimes. On average, the sample period 1976-1989 portrays relatively higher growth, inflation and interest rates compared to other sub-samples. The post-1990 period experienced moderate growth/inflation/interest rates and the post-2000 era experienced even lower growth/inflation/interest rates.[11] The strength of the relationship between *u-optimal* and *GDP-optimal* is also different in each sub-sample, hence why the coefficients for Okun's law must be allowed to vary.

To test the model's accuracy we use the root mean squared error.

To test the model's accuracy we use the root mean squared error (RMSE). Smaller values of RMSE imply better model accuracy. The 1976-1989 sample period has the largest RMSE, which indicates a relatively poor fit. The various RMSEs for different sub-samples support the idea that a time-varying coefficient approach is appropriate.

For an accurate comparison, we calculate the ratio of the RMSE to *GDP-optimal*. For example, among sub-samples, the 1976-1989 period has the largest RMSE, though this period has the second highest average *GDP-optimal*. Considering both the RMSE and average *GDP-optimal*, the ratio allows us to compare samples fairly. The 1976-89 period still shows the worst fit as it has the largest ratio of 1.54. The complete period's RMSE is 2.47, the second highest in our analysis. If we utilize the complete period's RMSE to construct the upper and lower limits of *GDP-optimal*, it would be the widest interval for all sub-samples except the 1976-89 period. This strongly suggests that we should not use the fixed-coefficient approach to estimate *GDP-optimal*.

[10] Estimating the Cost of a Recession: Temporary or Long Lasting? February 06, 2017.
[11] The other possible choice to divide the dataset into sub-samples is the data division according to business cycles. However, lengths of business cycles vary significantly from a range of 12 (1980-1981 business cycle) to 120 months (1991-2001 business cycle). Furthermore, some business cycles' shorter time span may affect the statistical accuracy of our results. Therefore, we divide data into sub-samples to represent different economic regimes and to avoid shorter time spans.

Figure 5

Sample Period	RMSE*	GDP-Optimal	Ratio of RMSE to GDP-Optimal*
1976-2018	2.47	1.95	1.27
1976-1989	3.32	2.16	1.54
1990-1999	1.37	2.23	0.61
2000-2009	2.06	1.45	1.42
2010-2018	1.5	1.85	0.81

***A higher value indicates higher uncertainty.**

Source: IHS Markit and Wells Fargo Securities

Conclusion

Our new methodology to estimate potential GDP (*GDP-optimal*) relies on time-varying methods and accounts for the growth outlooks. This approach is an alternative to CBO's potential GDP measure, and the model's improved accuracy could help the Fed implement monetary policy more effectively.

Our model relies on time-varying methods and accounts for the growth outlook.

Wells Fargo Securities Economics Group

Jay H. Bryson, Ph.D.	Global Economist	(704) 410-3274	jay.bryson@wellsfargo.com
Mark Vitner	Senior Economist	(704) 410-3277	mark.vitner@wellsfargo.com
Sam Bullard	Senior Economist	(704) 410-3280	sam.bullard@wellsfargo.com
Nick Bennenbroek	Macro Strategist	(212) 214-5636	nicholas.bennenbroek@wellsfargo.com
Tim Quinlan	Senior Economist	(704) 410-3283	tim.quinlan@wellsfargo.com
Azhar Iqbal	Econometrician	(212) 214-2029	azhar.iqbal@wellsfargo.com
Sarah House	Senior Economist	(704) 410-3282	sarah.house@wellsfargo.com
Charlie Dougherty	Economist	(704) 410-6542	charles.dougherty@wellsfargo.com
Erik Nelson	Macro Strategist	(212) 214-5652	erik.f.nelson@wellsfargo.com
Michael Pugliese	Economist	(212) 214-5058	michael.d.pugliese@wellsfargo.com
Brendan McKenna	Macro Strategist	(212) 214-5637	brendan.mckenna@wellsfargo.com
Shannon Seery	Economic Analyst	(704) 410-1681	shannon.seery@wellsfargo.com
Matthew Honnold	Economic Analyst	(704) 410-3059	matthew.honnold@wellsfargo.com
Dawne Howes	Administrative Assistant	(704) 410-3272	dawne.howes@wellsfargo.com

WELLS FARGO SECURITIES