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**Francesca Vinci and Omar Licandro**

Produced By:

Centre for Finance, Credit and  
Macroeconomics  
School of Economics  
Sir Clive Granger Building  
University of Nottingham  
University Park  
Nottingham  
NG7 2RD

[www.nottingham.ac.uk/cfc](http://www.nottingham.ac.uk/cfc)

# Potential Output, the Taylor Rule and the Fed

Francesca Vinci<sup>†</sup> and Omar Licandro<sup>\*</sup>

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## Abstract

The Taylor Rule is widely considered a useful tool to summarise the Fed's policy, but the information set employed in practice to assess the state of economic activity is still an object of debate. The contribution of this paper is to provide evidence in favour of the following hypotheses. First, the original Taylor Rule is a valid representation of the actual working of the Fed's monetary policy. Second, the real time beliefs of the Fed concerning potential output can be proxied by the estimates published by the Congressional Budget Office. Third, potential output estimates were revised down following the Great Recession.

**Keywords:** Monetary Policy, Taylor Rule, Great Recession, Economic Recovery

**JEL Codes:** E52,E58,D24

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<sup>†</sup> European Central Bank, francesca.romana.vinci@ecb.europa.eu.

<sup>\*</sup>University of Nottingham, IAE-CSIC and Barcelona School of Economics,  
omar.licandro@nottingham.ac.uk.

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# 1 Introduction

Since its publication by [J. Taylor \(1993\)](#), the Taylor rule has had a huge impact on the theory, empirics and practice of monetary policy as an instrument to promote stability of both prices and economic activity, which has been the main objective of the Federal Reserve System since its inception.<sup>1</sup> The research staff at the Federal Reserve Board of Governors regularly prepares projections about how the U.S. economy will fare in the future, which include, among other information, estimates of the output gap. These projections are published in the Greenbook of the Federal Reserve Board before each meeting of the Federal Open Market Committee, and are part of the information set setting the ground for monetary policy decisions. The dataset includes projections for several variables covering real GDP and its components, nominal GDP, the output gap, five measures of inflation, unemployment, industrial production and housing. As a result, pinning down the precise weight assigned to each piece of information is challenging, making [J. Taylor \(1993\)](#)'s way of pragmatically summarizing the information set all the more useful.<sup>2</sup>

Nevertheless, output gap projections in the Greenbook are made available with a six year lag, which makes it harder for researchers to gain an accurate picture of the Fed's beliefs concerning the level potential output at the time decisions are taken. For this reason, estimates of potential output made available by the Congressional Budget Office (CBO) twice per quarter are a useful proxy for the changes in the Fed's beliefs about potential output.

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<sup>1</sup>For a detailed historical account of monetary policy objectives in the United States see [Orphanides \(2003\)](#).

<sup>2</sup>For an in depth discussion see [Bernanke and Boivin \(2003\)](#).

In this paper, we use available data from the Greenbook and the CBO to check for discrepancies between the two data sources, and test whether they matter in estimating the Taylor rule. These are our main findings. The potential output projections of the CBO provide a good approximation of the output gap estimates in the Greenbook. For both measures of the output gap, the Taylor rule approximates well the behaviour of the Fed. The Fed's beliefs about potential output were revised down after the Great Recession.<sup>3</sup>

## 2 Output-Gap and Taylor Rule

This section aims at answering the following questions: Do the potential output projections of the CBO proxy the output gap beliefs of the Fed? When using these measures, does the Taylor Rule summarise the working of the Fed's monetary policy? In order to answer them, we first build measures of the nominal interest rate consistent with the Taylor rule, and compare them with the Federal Funds Rate (FFR). We do that by measuring the nominal interest rate (in annual terms) emerging from the original [J. Taylor \(1993\)](#) rule<sup>4</sup>

$$\text{TR}_t = \underbrace{r^*}_{\overline{\text{TR}-\bar{\pi}}} + \pi_t + \phi_\pi (\pi_t - \bar{\pi}) + \phi_y x_t, \quad (1)$$

with  $\phi_\pi = \phi_y = 0.5$ . The real interest rate  $r^*$  is set to 2%. Inflation  $\pi_t$  is measured as year on year percentage changes in the quarterly GDP deflator, and

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<sup>3</sup>All these findings are in strong support of the switching-track interpretation of the Great Recession in [Vinci and Licandro \(2021\)](#)

<sup>4</sup>Which is in line with the Board of Governors of the Federal Reserve System. See FRED Blog (St Luis Fed) [link here](#).

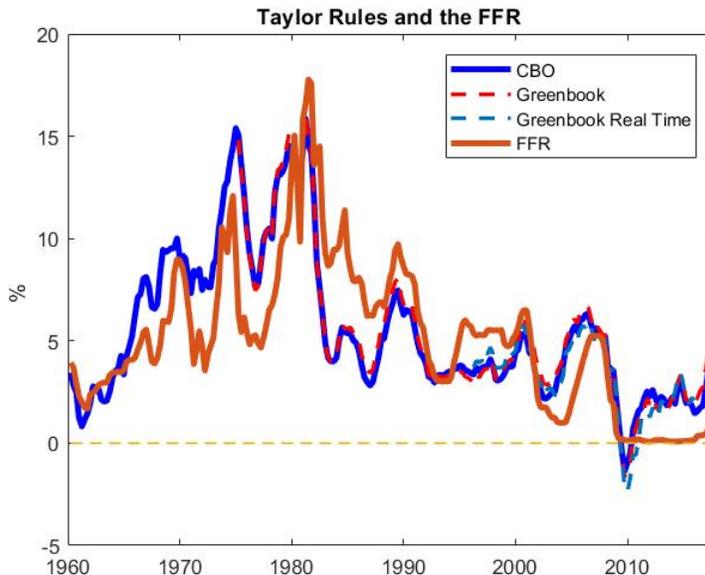


Figure 1: Taylor rule with alternative output gap measures

$\bar{\pi}$  is set to 2%. The output gap  $x_t$  is one of the three following measures: the CBO’s output gap (as reported in the February 2021 revision), the Greenbook output gap (as reported in February 2021), as well as a real time measure of the latter, *i.e.* using for each quarter the last historical estimate of the output gap published in the corresponding quarter. As it can be observed in Figure 1, the nominal interest rate series that emerge from the above Taylor rule, for the three different measures of the output gap, closely follow the Federal Funds Rate.<sup>5</sup>

Second, we estimate the policy parameters  $\phi_\pi$  and  $\phi_y$  of the standard Taylor rule, following the approach suggested by Kahn (2012), and considering

<sup>5</sup>Note that here CBO data corresponds to the time series published in 2021.

the Federal Funds Rate as the policy instrument. To allow the target FFR, measured by  $\overline{\text{TR}}$  to change, we estimate (1) between 1960 and 2019 for the following sub-periods:

- 1960Q1-1979Q3: Great Relaxation (GRel)
- 1979Q4-1986Q4: Great Disinflation (GD, Volcker era)
- 1987Q1-2001Q1: Great Moderation (GM)
- 2001Q2-2019Q4: Great Deviation and Great Recession (GDe-GR).<sup>6</sup>

The results of the estimations in Table 1 show that the output gap is generally a strong predictor of the FFR, and coefficients are in line with the original [J. Taylor \(1993\)](#) rule.<sup>7</sup> The only exception is the Volcker era, which comes at no surprise as the effort associated with reducing inflation levels likely generated a deviation from the standard Taylor rule during this period.<sup>8</sup>

**In summary:** The output gap beliefs of the Fed can be proxied by the estimates published by the CBO, and the Taylor Rule is a valid representation of the actual working of the Fed’s monetary policy.

**Alternative Rules.** We showed that the classic Taylor rule can adequately summarise the Fed’s policy making, but the impact of economic activity on

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<sup>6</sup>Here we refer to [J. B. Taylor \(2011\)](#), who points out that policy makers started deviating from the TR already at the beginning of the century, giving rise to a Great Deviation ahead of the Great Recession.

<sup>7</sup>As a robustness check, we also estimated the policy parameters for the whole period, accounting for changes in the policy target through period dummies, and found comparable results.

<sup>8</sup>Similarly, the historical account of [Orphanides \(2003\)](#) found that the largest deviations from the Taylor rule occurred before the Great Relaxation and during the Volcker disinflation period.

	(GRel)	(GD)	(GD)	(GM)	(GM)	(GDe-GR)	(GDe-GR)	(GDe-GR)
	FFR							
	b/se							
Inflation Gap	0.823 (0.062)	1.088 (0.111)	1.090 (0.111)	1.731 (0.102)	1.422 (0.094)	0.921 (0.185)	1.138 (0.195)	1.062 (0.236)
CBO	0.391 (0.057)	0.078 (0.104)		0.682 (0.081)		0.425 (0.061)		
GB			0.024 (0.089)		0.522 (0.067)		0.266 (0.047)	
GB_RT								0.333 (0.068)
TR	3.402 (0.118)	7.453 (0.428)	7.274 (0.346)	5.462 (0.121)	5.29 (0.133)	2.217 (0.161)	1.860 (0.152)	2.391 (0.240)
Number obs.	79	29	29	57	57	75	71	59
R <sup>2</sup>	0.762	0.812	0.810	0.763	0.753	0.621	0.588	0.612

Note: Robust standard errors in parentheses.

Table 1: Taylor rule estimation - Output Gap

monetary policy, as represented by the Taylor rule, could be modelled in different ways. Two other measures of economic activity are widely considered as alternatives to the output gap in the Taylor rule: the unemployment gap and the growth gap.<sup>9</sup> The former is measured as the difference between the unemployment rate and the non-accelerating inflation rate of unemployment (NAIRU), while the latter is measured as the gap between the actual and the long term growth rate. Firstly, it is important to stress that the NAIRU is estimated similarly to potential output, so that the unemployment gap in the data looks like the mirror image of the output gap, as shown by the left panel of Figure 2.<sup>10</sup> As a consequence, a Taylor rule targeting the unemployment gap will yield similar results as a Taylor rule targeting the output gap.

As for the growth gap, we measure it as the distance between quarterly GDP growth, year on year, and the long term growth rate of 2.2%. The

<sup>9</sup>For example see [Christiano, Eichenbaum, and Trabandt \(2015\)](#) for a policy rule featuring the growth gap and [Benigno and Fornaro \(2018\)](#) for a policy rule responding to unemployment.

<sup>10</sup>Unemployment data was retrieved from the U.S. Bureau of Labor Statistics, while the NAIRU estimate is taken from CBO data.

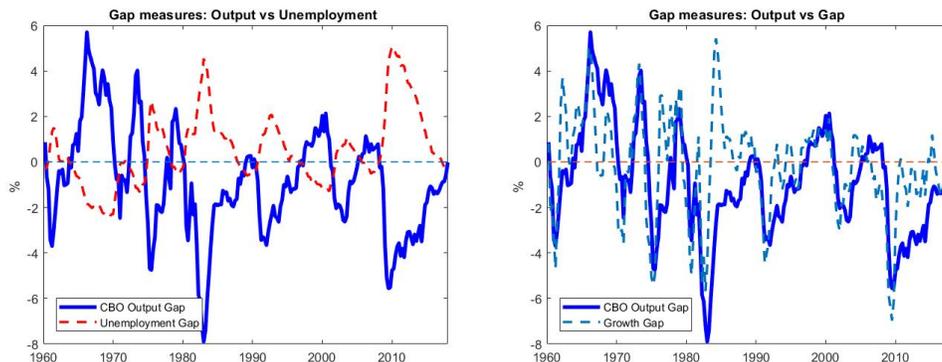


Figure 2: Alternative output gap measures

resulting growth gap is depicted in the right panel of Figure 2, and although it clearly moved in line with the output gap, it tends to shrink faster.

Table 2 shows the estimation of the Taylor rule using the growth gap instead of the output gap. The growth gap performs similarly to the output gap during the Great Moderation, but much worse after the year 2000, as the coefficient turns negative.

### 3 Switching-Track after the Great Recession

In the previous sections, we showed that the Fed’s beliefs about the output gap matter for monetary policy, but when evaluating them, we need to consider two components: the level of GDP and its potential level. Whilst both components are important to drive decision-making, the latter suffers from uncertainty more severely because the estimation methodologies can vary widely, as showed by Coibion, Gorodnichenko, and Ulate (2017). Thus inferring the Fed’s beliefs concerning the level of potential output when decisions are taken is not trivial.

	(GRel)	(GD)	(GM)	(GDe-GR)
	FFR	FFR	FFR	FFR
	b/se	b/se	b/se	b/se
InflationGap	0.782 (0.074)	1.266 (0.075)	1.615 (0.149)	1.724 (0.212)
GrowthGap	0.118 (0.076)	0.283 (0.115)	0.441 (0.083)	-0.167 (0.096)
$\overline{TR}$	3.632 (0.134)	6.712 (0.284)	5.063 (0.187)	1.453 (0.135)
Number of obs.	79	29	57	75
$R^2$	0.634	0.855	0.550	0.492

Legend: GRel= Great Relaxation: 1960Q1-1979Q3; GD=Great Disinflation: 1979Q4-1986Q4; GM= Great Moderation: 1987Q1-2001Q1; GDe-GR= Great Deviation-Great Recession: 2001Q2-2019Q4. Note: Robust standard errors in parentheses.

Table 2: Taylor rule estimation - Growth Gap

Nevertheless, in the previous sections we showed that the output gap measure published by the CBO is a good proxy for the Fed's measure of the output gap, which suggests that the same can be true about potential output.

Potential output projections published regularly by the Congressional Budget Office are computed following a production function approach, whereby potential output results from a Cobb-Douglas production function combining projected capital, labour and total factor productivity. Moreover, as stated in [Shackleton \(2014\)](#), the methodology tends not to respond to cyclical fluctuations, so that potential output is not usually revised down in recessions. Conversely, in the aftermath of the Great Recession a large, unprecedented, downward revision took place. The left panel of [Figure 3](#) clearly shows that potential output estimates produced by the CBO were revised down during the Great Recession. Did the Fed's beliefs about potential output, implicit in

its output gap measures, change consistently? The revisions of the output gap measure in right panel of 3, together with the findings in previous sections on the similarity between output gap measures published by the Fed and the CBO over time support this view. The Fed’s beliefs concerning potential output can be proxied by the CBO’s estimates. In Vinci and Licandro (2021), we argue that the revision of potential output estimates that followed the Great Recession, the so-called *switching-track*, played a role in determining the shape of the recovery by influencing monetary policy, and the findings presented in this paper constitute supporting evidence. We can thus conclude that observed variations in the estimates of potential output published by the CBO can help researchers infer the Fed’s real time beliefs and rationalise policy decisions.

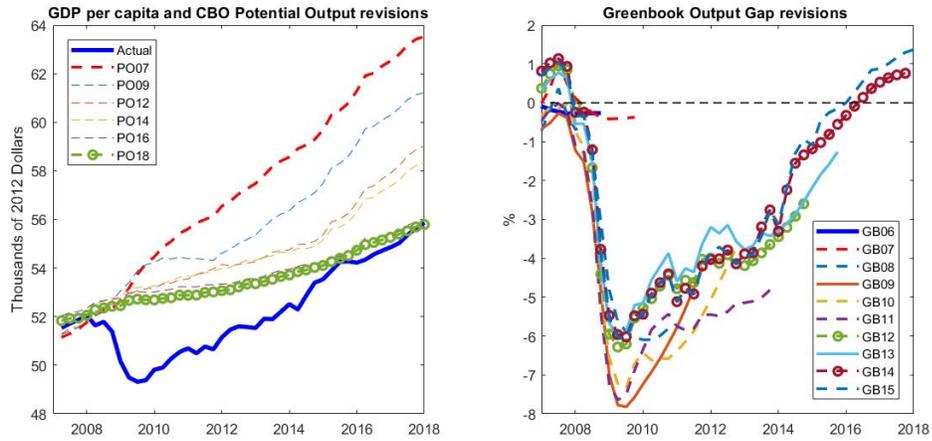


Figure 3: CBO Potential Output revisions and Fed’s output gap revisions

## 4 Conclusion

This paper shows that the classic Taylor rule remains a good representation of the Fed's policy making. We also find evidence in support of using potential output estimates published by the Congressional Budget Office as proxies for the Fed's beliefs on potential output. Finally, our findings support the view that that the Fed revised down these beliefs during the Great Recession.

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