



SPECIAL REPORT

FEDERAL RESERVE BANK OF PHILADELPHIA

Monetary Policy Report: Using Rules for Benchmarking

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Introduction

This special report highlights ongoing work to benchmark the stance of monetary policy using a range of policy rules that are widely employed in studies of monetary economics.¹ We perform the exercise with a specific, publicly available model of the macroeconomy developed by researchers at the Federal Reserve Board of Governors. We then employ this model to explore the expected behavior of economic variables, including the policy rate, under alternative policy rules. The policy rules help to benchmark not only the current stance of the federal funds rate but also guidance on how the path of policy is likely to evolve in the context of the model. Such an exercise as part of a more comprehensive quarterly monetary policy report would enhance communication and promote a more systematic approach to monetary policy.

We begin with an overview of the economy and then discuss the benchmark model we use to generate our forecasts with different policy rules. The remainder of the report highlights the outcomes of different robust policy rules and discusses why policymakers might choose to deviate from the rules.

¹ The views expressed here are those of the authors and do not necessarily reflect those of the Federal Reserve Bank of Philadelphia or the Federal Reserve System.

Economic Overview

Over the past few months, the labor market has continued its strong performance, with 280,000 net new jobs added in May. Job growth has been broad based, and the economy has added more than 500,000 net new jobs during the past two months, returning close to its pace in 2014, when job growth was extremely robust by historical standards. Because the labor force participation rate has also risen to 62.9 percent in May from 62.7 in March, the strong job growth has not resulted in further declines in various measures of unemployment. The most cited measure, referred to as U3, has remained at 5.5 percent, which is quite close to its natural rate, while U6, which includes marginally attached workers and those who report that they are working part time for economic reasons, has remained elevated at 10.8 percent. Because there is little expectation that the labor force participation rate will increase much further, continued job growth near its present pace will lower the unemployment rate further over the remainder of the year. Moreover, data from the Job Openings and Labor Turnover Survey indicate a dynamic labor market, with the highest level of job openings since the series' inception in December 2000 and quit rates that are near their prerecession levels.

After what appeared to be a relatively weak first quarter, consumer demand has recently picked up as witnessed by the May retail sales report. Over the past three months, core sales have grown at a healthy 6.8 percent. Thus, consumer behavior now appears to be more in line with strong fundamentals, and consumer confidence remains high. Furthermore, it now seems that a significant fraction of the first quarter's weakness can be chalked up to seasonal adjustment problems in the data.² Better indicators of first quarter growth would appear to be gross domestic income, which grew at 1.4 percent and does not suffer from seasonality problems, or the GDPplus series, published by the Federal Reserve Bank of Philadelphia, that showed growth at a 2.0 percent clip in the first quarter.

Manufacturing has been rather sluggish recently, and the most recent data showed a decline in both total industrial production (IP) and manufacturing production in May. The decline in manufacturing IP basically offset the gains we had seen in the previous two months. The only bright spot was the strength in motor vehicle assemblies. The May Institute for Supply Management report was also not very strong, showing a small increase in the headline number, from 51.8 in April to 52.8 in May. However, holding out a bit of hope, the forward-looking new

² For a detailed investigation of the first quarter seasonality problem, see: Stark, Tom. "First Quarters in the National Income and Product Accounts," Federal Reserve Bank of Philadelphia *Research Rap Special Report*, (May 14, 2015), <http://www.philadelphiafed.org/research-and-data/publications/research-rap/2015/first-quarters-national-income-product-accounts.pdf>, and Rudebusch, Glenn D., Daniel Wilson, and Tim Mahedy. "The Puzzle of Weak First-Quarter GDP Growth," Federal Reserve Bank of San Francisco *Economic Letter* (May 18, 2015), <http://www.frbsf.org/economic-research/publications/economic-letter/2015/may/weak-first-quarter-gdp-residual-seasonality-adjustment/>.

orders index rose to 55.8 in May. The most recent *Manufacturing Business Outlook Survey (MBOS)* published by the Philadelphia Fed mirrored that sentiment, with its forward-looking component rising to 39.7 in June. Nevertheless, recent readings make it unlikely that manufacturing will be a source of near-term economic strength.

The news was a bit better on the housing sector. Although housing starts declined by 129,000 in May, the 11 percent drop followed a 22.1 percent surge in April. Additionally, housing permits increased 11.8 percent in May, following a 9.8 percent increase in April. Thus, the recent data point to a modest improvement in residential construction going forward.

Net exports declined significantly in the first quarter, subtracting 1.9 percentage points from real GDP growth. The effects caused by the appreciation of the dollar should wane, but on net, this sector is expected to subtract from overall economic activity.

The significant decline in energy prices has resulted in zero year-over-year headline inflation and appears to have seeped into core measures as well. In the latest reading, year-over-year core inflation, as measured by the price index of personal consumption expenditures (PCE), declined to 1.2 percent. The most recent reading on core inflation — core consumer price index (CPI) inflation for May — came in at 1.7 percent year over year, little changed from the pace since the beginning of the year. The strength of core CPI gives credence to the view of most forecasters that headline inflation will move back toward the 2 percent target set by the Federal Open Market Committee (FOMC) over the next few years, although residual effects from the decline in energy prices and appreciation of the dollar should slow price increases over the near term.

Overall, economic growth has rematerialized, and much of the first quarter's weakness is attributable to temporary factors, including significant residual seasonality. Most forecasts see growth returning to trend or above-trend rates over the second half of this year, a view that is supported by strong job growth, a more solid reading on consumer expenditures, and solid economic fundamentals. Likewise, the recent weakness in inflation can be attributed to factors that appear to be temporary in nature. Gasoline prices have risen a bit recently, so the low readings on inflation fueled by low energy prices have likely run their course. Economic slack continues to wane and is nonexistent by many measures. So, we continue to believe that the economy has returned to a fairly normal state of activity, and as we discuss here, our benchmarking indicates that monetary policy should follow suit.

The Benchmark Model

To create our forecasts and to carry out our monetary policy benchmarking exercises, we use a structural forecasting model called Estimated Dynamic Optimization (EDO) developed by researchers at the Board of Governors. This medium-scale model shares many features of

standard New Keynesian Dynamic Stochastic General Equilibrium (NKDSGE) models that are at the forefront of macroeconomic modeling and forecasting. The EDO model features households and firms that are forward looking and that make decisions facing resource constraints. The model includes multiple sectors, a rich menu of shocks, and adjustment costs that make wages and prices less than fully flexible in responding to changes in economic conditions. Detailed documentation on the model structure and computer programs that implement model simulations can be found at the Board of Governors’ website at www.federalreserve.gov/econresdata/edo/edo-models-about.htm. We generate forecasts from a version of this model using several different monetary policy rules to provide a sense of how the economy might perform under a reasonable set of policy paths, given current and expected economic conditions.

The key parameters that we change under the various policy alternatives are those that govern the response of the short-term interest rate to changes in economic conditions. The monetary policy response function is of the form

$$R_t = \rho R_{t-1} + (1 - \rho)[\Psi_\pi(\pi_{t|t-4} - \pi^*) + \Psi_y ygap_t] + \varepsilon_t^R,$$

where R_t is the deviation of the effective federal funds rate from its long-run equilibrium value, $\pi_{t|t-4}$ is the four-quarter change in core PCE inflation, and $ygap_t$ is a measure of the output gap.³ We run forecast simulations under four different versions of this basic rule shown here:

Table 1

Rule	ρ	Ψ_π	Ψ_y
Baseline	0.83	1.46	0.26
Taylor (1993)	0.0	1.50	0.50
Taylor (1999)	0.0	1.50	1.0
Inertial Taylor (1999)	0.85	1.50	1.0

The baseline rule uses parameter values that are estimated from the data using the full EDO model. That is, the baseline rule depicts the historical behavior of monetary policymakers. The Taylor rule alternatives are parameterizations of the policy rule taken from the economics literature and are widely used in simulations of macroeconomic models.

³ The model calibration implies that the long-run equilibrium value of the federal funds rate is 4.1 percent. The output gap is calculated using the Beveridge-Nelson decomposition, which decomposes a data series into stochastic trend and stationary cycle components. The gap is then measured by the cycle component. It is important to note that the output gap is computed as part of the model solution and is not an exogenous input into the simulations.

Model Forecasts Under the Baseline

We first generate forecasts assuming that monetary policy follows the baseline policy rule. The forecast is generated using observed data through the first quarter of 2015. The forecast begins in the second quarter of 2015 and extends through the fourth quarter of 2017. The forecasts under the baseline and the alternative policy rules are shown in Figures 1 through 4. The baseline forecast is represented by the dark solid line. The colored bands around the baseline forecast represent 10 percent confidence intervals of the predictive distribution around the median of the baseline forecast.⁴

The key features of the baseline forecast are as follows:

- Real output is forecast to grow at an average pace of about 1.8 percent in 2015 and 2.9 percent in 2016 and 2017.
- PCE inflation averages 1.4 percent in 2015, rising to 1.9 percent in 2016 and 2 percent in 2017.
- The unemployment rate falls gradually to about 5 percent at the end of 2017.⁵
- The federal funds rate begins rising immediately and reaches 0.8 percent in the fourth quarter of 2015, 1.9 percent in the fourth quarter of 2016, and 2.6 percent in the fourth quarter of 2017.
- We now anticipate weaker real GDP growth and inflation in 2015 and a slightly lower federal funds rate at year-end compared with the March forecast. The forecast for 2016 and 2017 is largely unchanged from March, though the path for the federal funds rate is somewhat steeper (Figure 5).

The baseline forecast calls for output growth to accelerate from -0.75 percent in the first quarter of 2015 to 2.5 percent in the second quarter. Output growth then rises gradually toward its longer-term value of about 3 percent.⁶ The unemployment rate continues to decline, reaching just below 5 percent in 2016 and then edging up to 5.1 percent at the end of 2017. Moderately strong growth and anchored long-run inflation expectations lead to an acceleration of core PCE inflation from 1.4 percent in 2015 to 2.3 percent at the end of 2017. Under the baseline policy parameterization, the output growth and inflation outcomes correspond to a gradually rising federal funds rate over the next three years. The model predicts that the

⁴ The forecast simulations are generated using Bayesian methods. The fan charts show 10 percent quantiles around the median of the posterior predictive distribution.

⁵ The baseline unemployment rate forecast is add-factored to more accurately reflect our views on the likely evolution of labor market conditions. The modifications to the baseline forecast are kept in place when the model is simulated under the alternative policy rules.

⁶ The model estimates long-run real per capita output growth of about 2 percent. We then assume that population growth averages 1 percent per year over the forecast horizon.

federal funds rate will lift off from the zero bound immediately, reaching 0.4 percent in the second quarter of 2015. Thereafter, the federal funds rate will rise at a gradual but steady pace to 2.6 percent by the end of 2017.

The baseline forecast is broadly similar to the median projections from the second quarter 2015 *Survey of Professional Forecasters (SPF)*. In that survey, the respondents expected real output growth of 2.4 percent in 2015 and 2.8 percent in 2016 and 2017 (note that the *SPF* reports GDP growth on an annual average-over-annual average basis). The *SPF* core PCE inflation forecast is 1.4 percent (Q4/Q4) for 2015, 1.7 percent for 2016, and 1.9 percent for 2017. The forecasters' path for the unemployment rate is slightly stronger than the baseline model: The median *SPF* forecast for the average unemployment rate is 5 percent for 2016 and 4.8 percent for 2017.

The June 2015 Summary of Economic Projections (SEP) by FOMC participants shows the central tendency for output growth in 2015 at 1.8 to 2 percent, rising to 2.4 to 2.7 percent in 2016, and then edging down to 2.1 to 2.5 percent in 2017. The central tendency of the unemployment rate falls to a range of 4.9 to 5.1 percent for the fourth quarter of 2017, from 5.2 to 5.3 percent in the fourth quarter of 2015. Core PCE inflation is projected to run between 1.3 and 1.4 percent in 2015, rising to 1.9 to 2 percent in 2017. The model's baseline forecast for the federal funds rate (Figure 4) is generally within the central tendency of the June 2015 SEP for the fourth quarters of 2016 and 2017 and well above market expectations for the federal funds rate for the fourth quarter of 2017 (which is about 1.7 percent). The model generally suggests that the sooner the short-term interest rate lifts off from the zero lower bound, the more gradual the required pace of tightening to keep the output gap, inflation gap, and interest rate aligned as per the baseline rule parameterization.

Behavior Under Alternative Taylor Rules

To gauge the robustness of the model's benchmark prescription for monetary policy, we also generate forecasts assuming that the policymaker adopts one of the alternative Taylor rules shown in Table 1.⁷

The key features of the forecasts under the alternative policy rules are as follows:

- All of the policy rules suggest that monetary policy should lift off from the zero lower bound by the end of 2015.

⁷ When generating the forecasts under the alternative policy rules, we assume that the state of the economy up to and including the third quarter of 2014 would be the same as that implied by the baseline rule calibration of the model. Given the state variable history, we then switch rules and forecast under the alternatives beginning in the fourth quarter of 2014. In this framework, the switch in policy rules is not anticipated by the model agents, and they expect the new rule to be in place for all future periods.

- The more accommodative monetary policies are associated with more rapid output growth, lower unemployment, and higher inflation.
- Most of the differences among the forecasts appear in output growth and not in inflation or unemployment. The model estimates somewhat persistent inflation measures that respond sluggishly to shocks.
- By the first quarter of 2016, the forecasts for output, inflation, and the federal funds rate have largely converged across the policy alternatives. The entire future path of the interest rate — rather than the current rate — is key for the dynamics of the economy.
- The federal funds rate under all of the alternative rules nears 2 percent by the end of 2016, which is well above current market expectations of what the federal funds rate will be at that time.

The alternative policy rules suggest somewhat different near-term levels of the appropriate federal funds rate beginning in the second quarter of 2015. The Taylor (1993) rule calls for the most policy tightening, with the funds rate averaging 0.5 percent over the second quarter. The Taylor (1999) rule has the funds rate at -0.5 percent. In implementing the models for this exercise, we have not constrained the federal funds rate to remain zero or above.

Consequently, the Taylor (1999) rule suggests that monetary policy should be eased further in response to the weak output growth reading in the first quarter of 2015. Note: There is some concern that the data may have overstated the weakness in the first quarter and that underlying real output growth may not have been as weak as suggested by the U.S. Bureau of Economic Analysis (BEA) release. The Inertial Taylor (1999) rule puts the federal funds rate at 0.1 percent. Note, though, that all of the rules suggest that the funds rate should be close to 1 percent by the first quarter of 2016. So, even though the Taylor (1999) rule calls for current policy easing, the extra accommodation is short lived.

The path of output growth is weaker under the Taylor (1993) rule, which calls for the highest near-term interest rate, with output growth at 2.4 percent in the second quarter of 2015. The Inertial Taylor (1999) rule, which is the most accommodative policy over the forecast horizon, has real output growth at 4.1 percent in the second quarter of 2015. Note, though, that the output growth forecasts largely converge in 2016. The alternative policy rules have little impact on the future path of inflation. Inflation adjusts gradually to shocks in the model and depends on the expected future path of the economy, which is similar across the policy rules in the medium and longer run. Core inflation runs at about 1.9 percent (Q4/Q4) in 2016 and shows little dispersion over the forecast horizon across the alternative policies. The inflation paths are all close to the baseline path and show relatively small differences across paths over the next three years.

Although all of the rules we examine in the EDO model for some time have suggested that it is appropriate to begin normalizing policy quickly, the FOMC has taken a more deliberate approach and has not yet lifted policy off from the zero lower bound on interest rates. Why might this be? First, the results of any benchmarking experiment should not be interpreted as optimal policy; they are only suggestive. The results depend on the view of a particular model and particular rules, which are based on a narrow set of variables. One plausible explanation for departing from these rules is that the Committee is concerned about asymmetric risk in raising the inflation rate back to its target when interest rates are at the zero lower bound. It may be much more difficult to raise inflation than it would be to lower it under current circumstances. Long-term departures from the target on either side incur economic costs, and accommodation may be a way of minimizing these costs. Another possible explanation is that relatively weak worldwide demand has depressed real interest rates and that the neutral federal funds rate is low by historical standards. Both of these reasons would be consistent with maintaining a more accommodative monetary policy stance.

Summary

The policy alternatives are now giving somewhat mixed signals about the appropriate current stance of monetary policy. The baseline rule and the Taylor (1993) rule suggest that the federal funds rate should rise immediately. The Inertial Taylor (1999) rule suggests that current policy is about appropriate. The Taylor (1999) rule suggests that policy should be more accommodative, whereas its reading in March tracked closer to the other rules. However, the alternative policy rules agree that the federal funds rate should be somewhere in a range of 0.5 percent to 1 percent by the end of 2015 and call for a liftoff from the zero bound in 2015. Note that this prediction is now in line with the central tendency for the federal funds rate in the SEP for the June FOMC meeting.

Even though inflation is below the FOMC's longer-run target, economic conditions are still consistent with a gradual tightening of policy according to the various rules we analyze. Accompanying this gradual tightening, the economy is expected to transition to full employment and to achieve its long-run inflation target.

Figure 1: Real GDP Growth

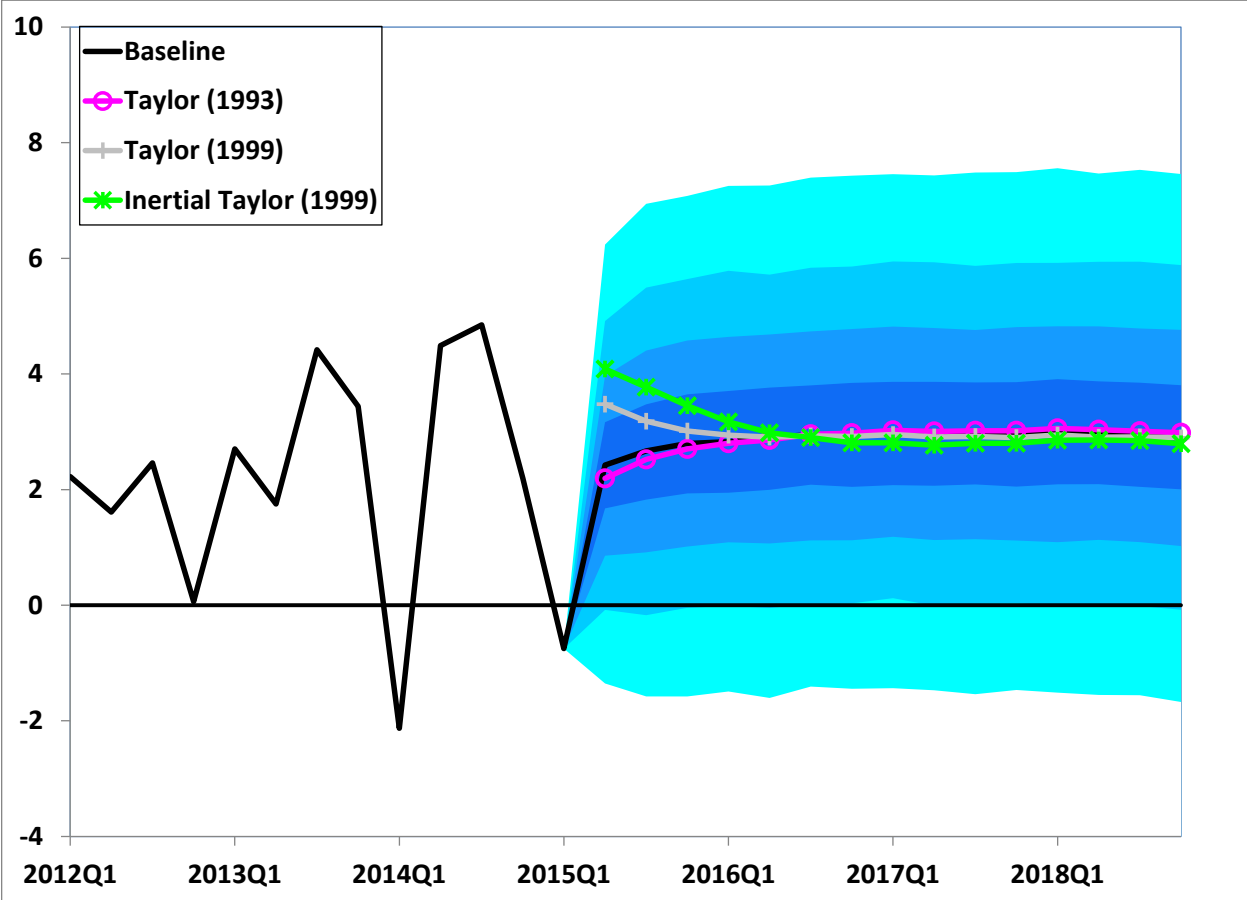


Figure 2: PCE Core Inflation

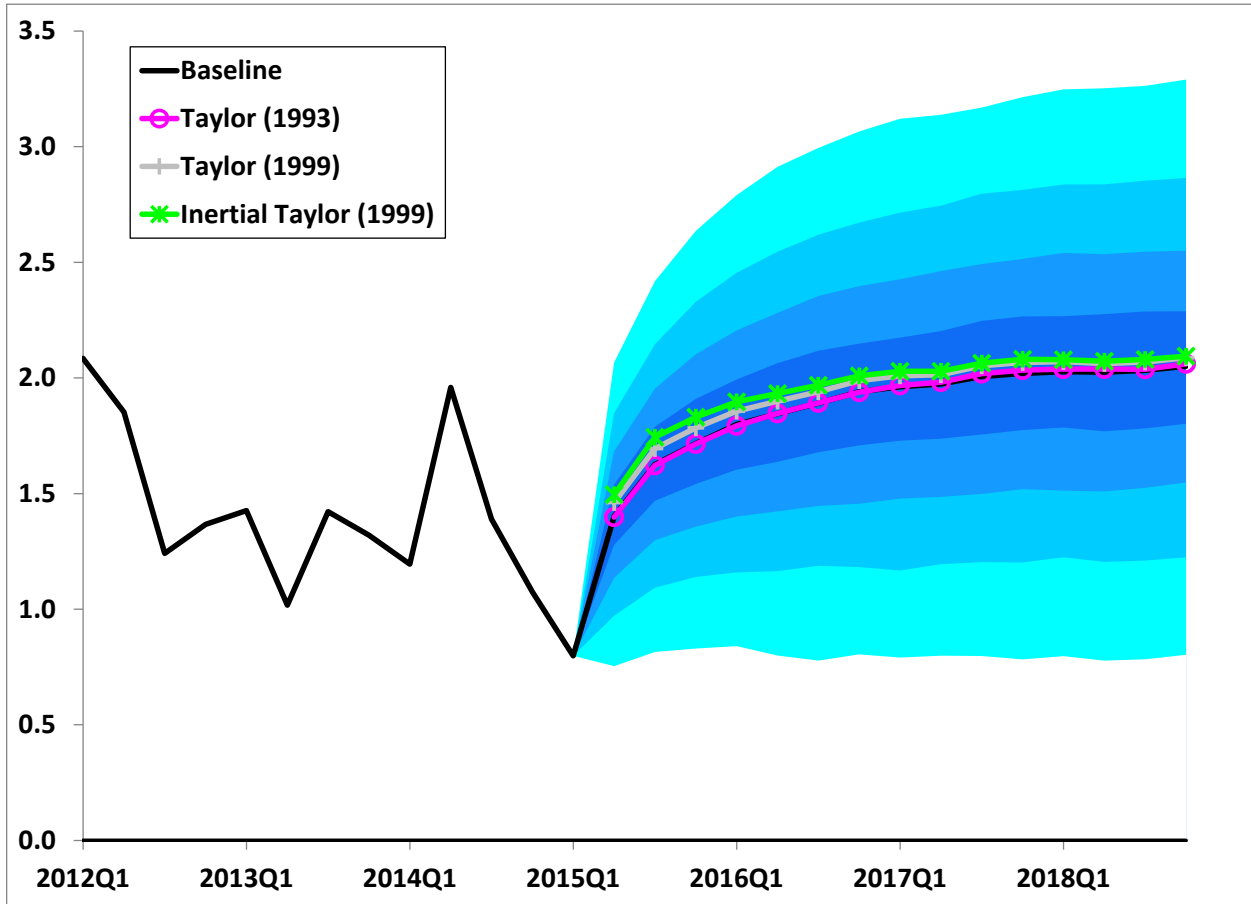


Figure 3: Unemployment Rate

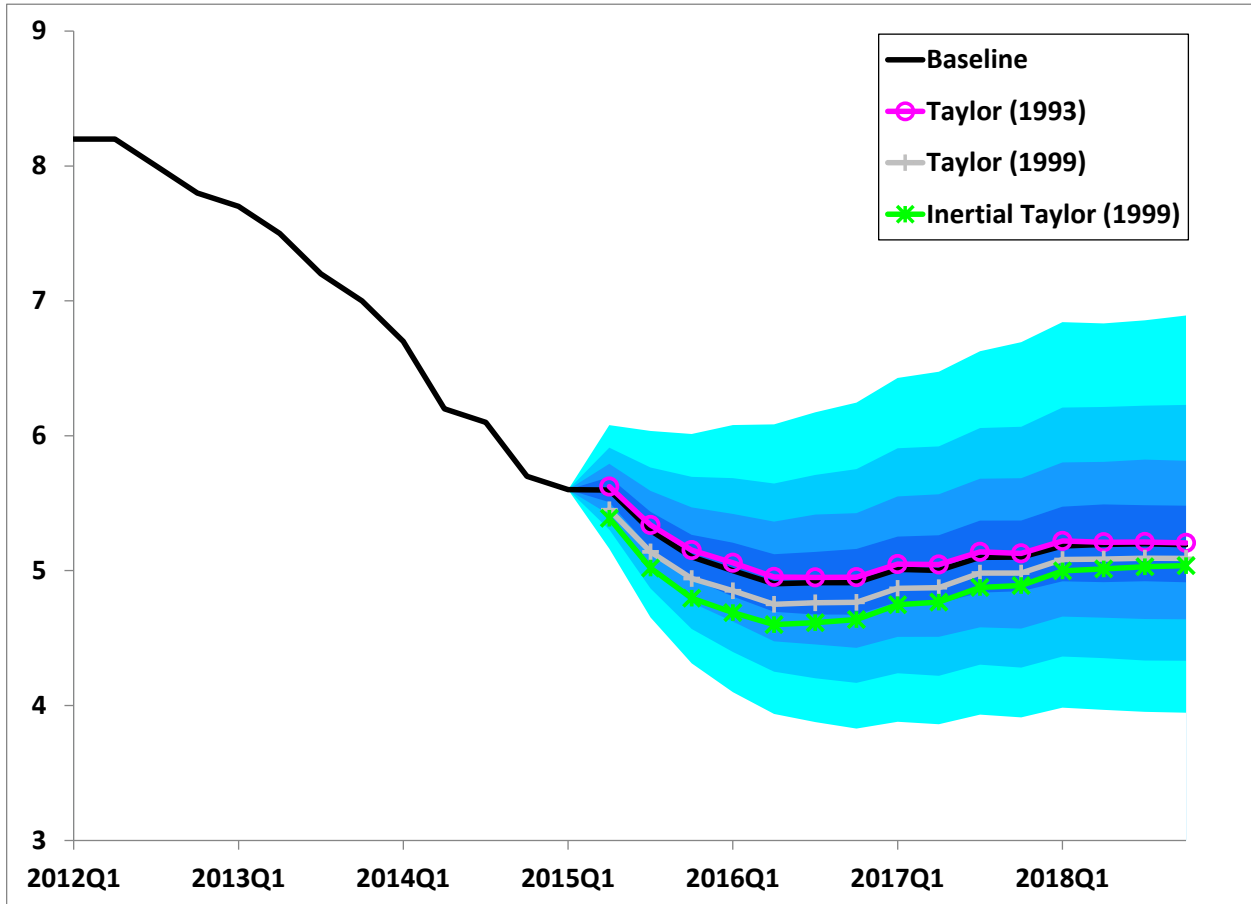


Figure 4: Federal Funds Rate

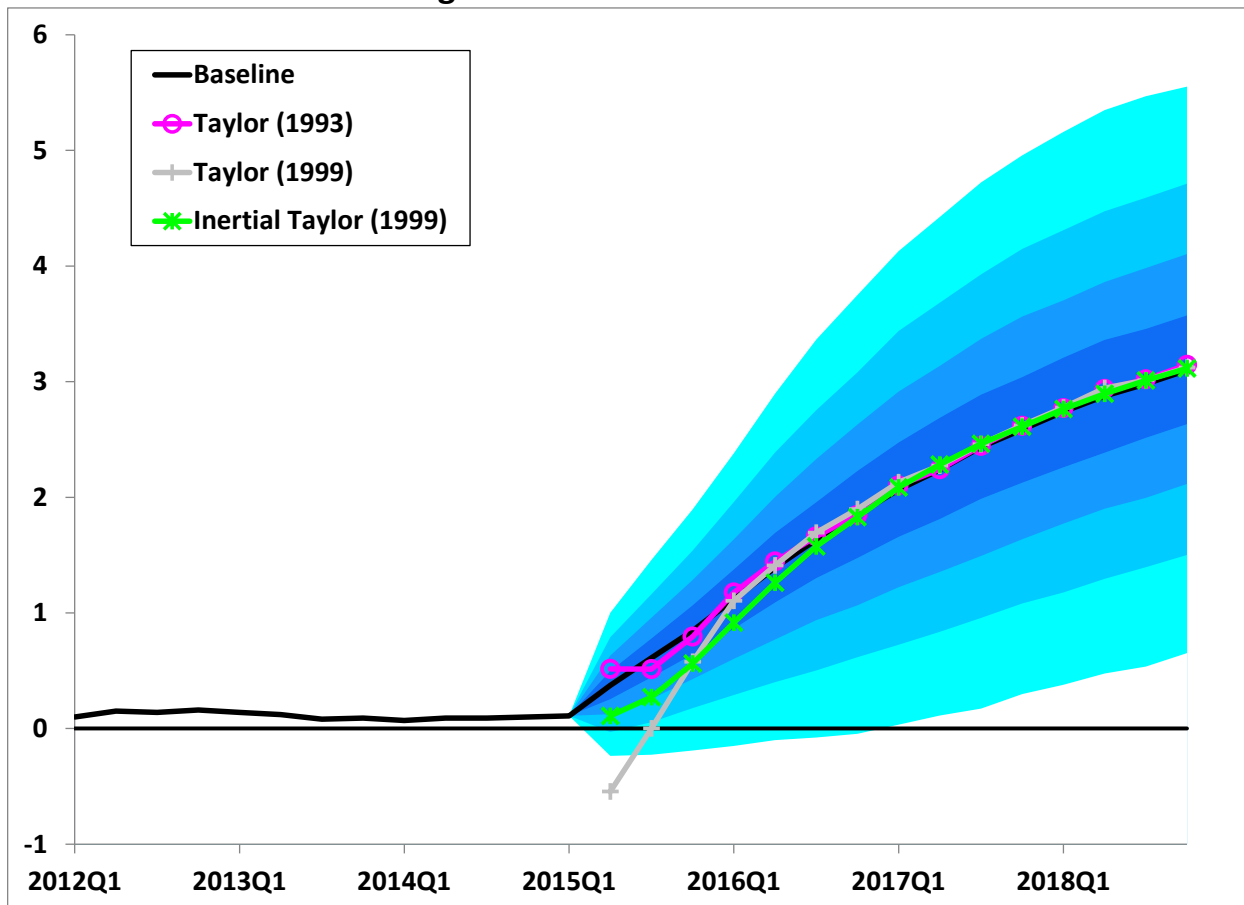


Figure 5: Baseline Forecast Comparisons

Figure 5a: Real GDP Growth

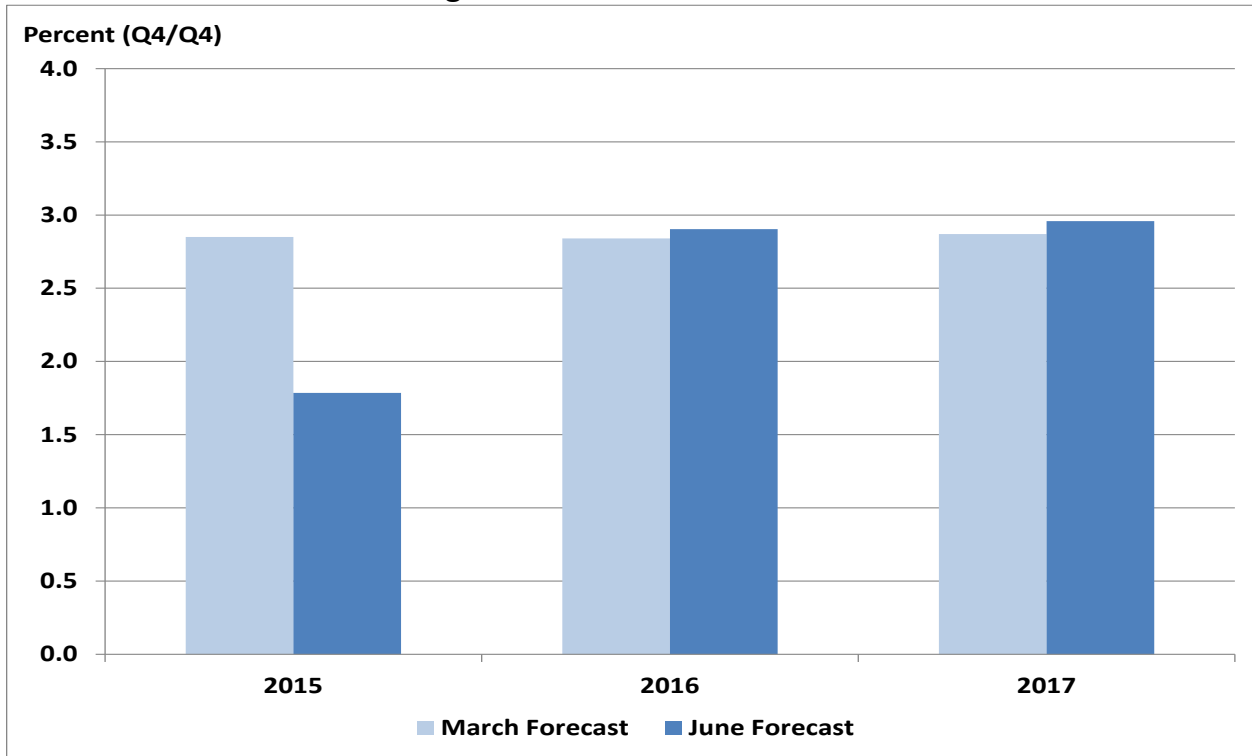


Figure 5b: PCE Inflation Growth

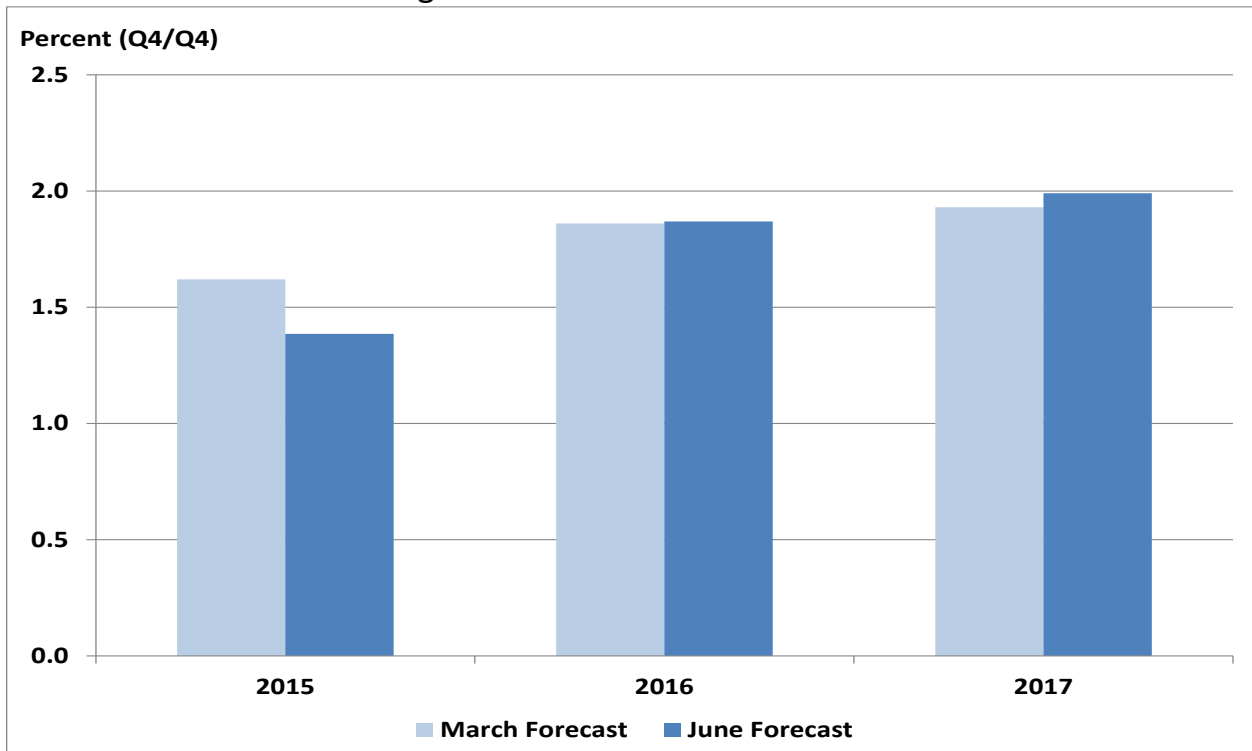


Figure 5c: Unemployment Rate

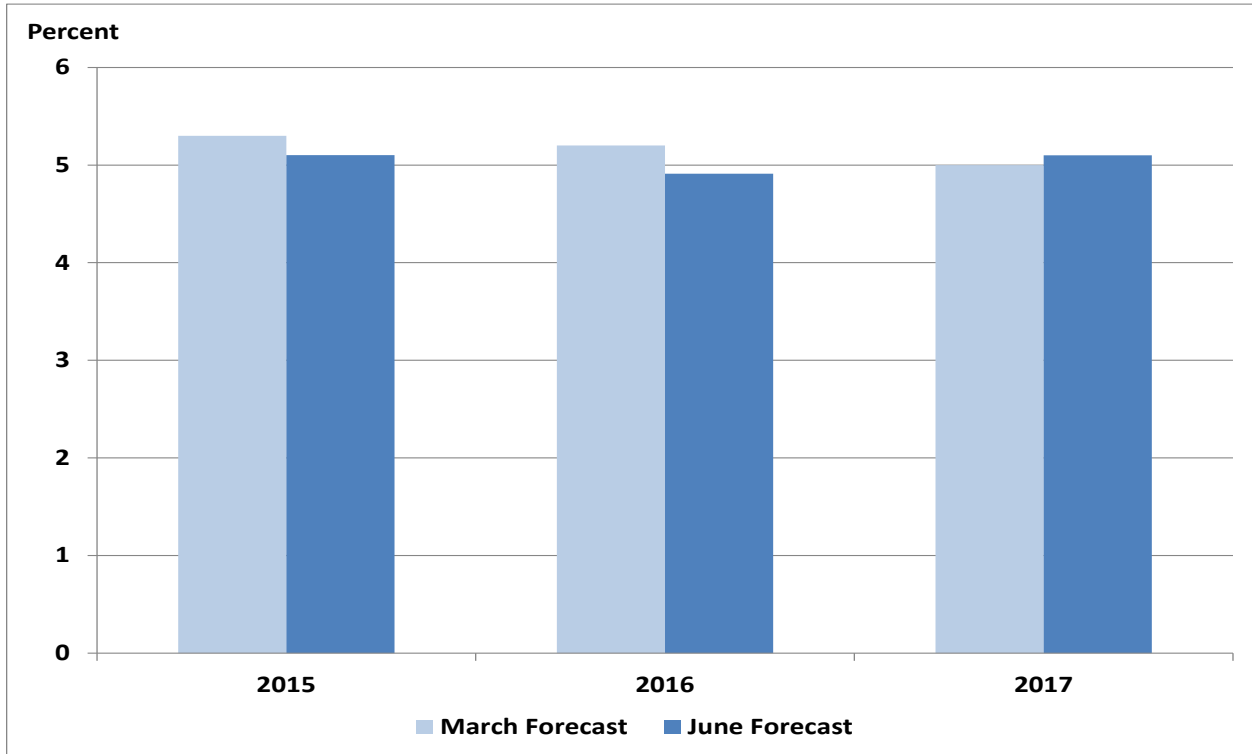


Figure 5d: Federal Funds Rate

