



SPECIAL REPORT

FEDERAL RESERVE BANK OF PHILADELPHIA

Monetary Policy Report: Using Rules for Benchmarking

Michael Dotsey
Senior Vice President and Director of Research

Charles I. Plosser
President and CEO

Keith Sill
Vice President and Director, Real-Time Data Research Center

Federal Reserve Bank of Philadelphia

December 2014

Introduction

This special report highlights ongoing work to benchmark the stance of monetary policy using a range of policy rules that are widely used in studies of monetary economics.¹ The exercise illustrates an approach to a monetary policy report, as proposed in speeches by Charles I. Plosser earlier this year.² We perform the exercise using a specific, publicly available model of the macroeconomy developed by researchers at the Federal Reserve Board of Governors. We then use 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.

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

² See Charles I. Plosser, [“Systematic Monetary Policy and Communication,”](#) remarks to the Economic Club of New York, New York, NY, June 24, 2014; and Charles I. Plosser, [“Monetary Rules: Theory and Practice,”](#) remarks to the Hoover Institution, Stanford, CA, May 30, 2014.

We will begin with an overview of the economy and then proceed with a discussion of the benchmark model we use to generate our forecasts using different policy rules. The remainder of the report highlights the outcomes of different robust policy rules, why policymakers might choose to deviate from the rules, and the potential consequences of doing so.

Economic Overview

Economic conditions have strengthened throughout the year following a severe winter, with strong and extraordinarily steady employment gains and robust GDP growth in the second and third quarters of 4.6 percent and 5.0 percent, respectively. The third-quarter estimate was the strongest quarterly growth in more than a decade. More encouraging is the fact that four of the past five quarters have seen growth rates of 3.5 percent or more, suggesting that the economy may be accelerating to above-trend growth. Looking forward to the final quarter of 2014, the *Survey of Professional Forecasters'* most recent estimate is for fourth-quarter growth to moderate to 2.7 percent.

The labor market has also shown consistent improvement. Nonfarm employment expanded by 321,000 jobs in November, giving us 10 consecutive months of 200,000-plus job growth, for the most consistent labor market strength since the late 1990s. Employment gains have resulted in a steady decline in the unemployment rate, to 5.8 percent. The labor force participation rate has also stabilized, despite demographic factors that continue to suggest participation rates should be in a slow decline. A broader measure of unemployment that includes marginally attached workers and those working part time for economic reasons, referred to as U6, has fallen from a peak of 17.2 percent to 11.5 percent. Although the broader measure is still above prerecession levels, steady progress is being made. Meanwhile, job openings have returned to prerecession rates, and the quit rate has also increased, pointing to renewed confidence among workers concerning their job prospects.

Recent healthy growth in retail sales and strong growth in automobile purchases indicate a more confident consumer. Personal income and outlays for November were mostly reassuring, with real personal consumption expenditures (PCE) and real personal income growing at 0.7 and 0.5 percent, respectively. Real PCE has grown at a 4.5 percent annual pace over the past three months. Ongoing improvement in creditworthiness, significant improvement in household balance sheets, modest house price appreciation, and strong growth in equity prices all provide a solid foundation for consumption currently and going forward. Consumer sentiment is consistent with this view. The preliminary reading for the University of Michigan index of consumer sentiment was the highest it has been since the beginning of the recession. Falling prices at the pump will also add to purchasing power, and early indications suggest a healthy holiday shopping season.

Manufacturing continues to be a modest source of strength. The Philadelphia Fed's *Manufacturing Business Outlook Survey*, the national ISM manufacturing index, and November's industrial production indicate that the manufacturing sector is solidly in expansion territory. However, recent readings on factory orders for core capital goods have been somewhat disappointing. Data on nonresidential construction (a three-month growth rate of 6.4 percent), coupled with the latest readings on manufacturing, indicate that investment should contribute to above-trend economic activity.

Residential investment has started to show some signs of improvement, with construction spending increasing 5.8 percent over the past three months. However, we have yet to see any robust improvement in new home sales, although existing home sales have been trending upward. Consistent with this modest growth, home price increases have been modest.

Inflation is well contained, as most measures suggest year-over-year inflation rates running at about 1.5 percent. This is somewhat below the Fed's long-term target of 2 percent, as measured by the year-over-year change in the price index for PCE, but most forecasters see inflation gradually moving back toward target. In the near term, the dramatic fall in oil prices over the past six months is likely to result in some softness in headline measures of inflation in the coming months. For example, due to the sharp 3.8 percent decline in energy prices, the overall consumer price index (CPI) fell 0.3 percent in November, and year-over-year inflation fell to 1.3 percent. The core CPI index increased 0.1 percent, and the 12-month percentage change fell slightly to 1.7 percent. Such relative price shocks tend not to persist, and as oil prices stabilize, or perhaps recover, inflation is likely to increase.

Overall, the economy continues to grow at a very steady and fairly robust pace after surviving the severe winter-related weakness in the first quarter. Due largely to energy prices, inflation is drifting down below the Federal Open Market Committee's target, but this is likely to be transitory, and economic slack continues to wane. In summary, we believe the economy has returned to a more normal footing, and as we discuss below, our benchmarking indicates that monetary policy should follow suit.

The Benchmark Model

To create our forecasts and 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
Taylor Inertial	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.

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 up through the third quarter of 2014; it does not incorporate the recent large drop in energy prices, nor does it reflect the most recent revisions

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.

in third-quarter GDP. The forecast begins in the fourth quarter of 2014 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 the following:

- Real output is forecast to grow at an average pace of about 3.1 percent in 2015 and 2.9 percent in 2016 and 2017.
- The four-quarter change in the core PCE inflation rate rises from 1.5 percent at the end of 2014 to 1.8 percent at the end of 2017.
- The unemployment rate falls gradually to about 5 percent at the end of 2017.⁵
- The federal funds rate begins rising immediately to 0.5 percent in the fourth quarter of 2014, reaches 1.1 percent in the second quarter of 2015, and then climbs gradually to 2.8 percent by the end of 2017. That is, the model and data indicate that the zero bound is no longer the place monetary policy should be.

The baseline forecast calls for output growth to taper down gradually from the second estimate of third-quarter GDP of nearly 4 percent pace to its longer-term value of about 3 percent.⁶ With strong headline growth, the unemployment rate continues to decline, reaching about 5 percent at the end of the forecast horizon, which is a bit below our estimate of the natural rate of unemployment. Moderately strong growth and anchored long-run inflation expectations cause core PCE inflation to accelerate from 1.5 percent (four-quarter change) in the third quarter to about 1.8 percent in 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 funds rate lifts off from the zero bound immediately, reaching 0.5 percent in the fourth quarter of 2014. Thereafter, the funds rate rises at a gradual but steady pace to 2.8 percent by the end of 2017.

The baseline forecast is broadly similar to the median projections from the fourth quarter 2014 *Survey of Professional Forecasters (SPF)*. In that survey, the respondents expect real output growth at 3 percent or a bit below per year over the period 2015–2017. The SPF core PCE

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.

inflation forecast is 1.8 percent (Q4/Q4) for 2015 and 2016. The forecasters are slightly less optimistic than the model in terms of the unemployment rate, but not by much: Respondents expect the unemployment rate to average 5.2 percent in 2017, compared with 5 percent for the EDO model baseline.

The December 2014 Summary of Economic Projections (SEP) shows the Committee's central tendency for output growth in 2015 and 2016 at about 2.5 to 3 percent, falling to a range of 2.3 to 2.5 percent in 2017. The central tendency of the unemployment rate falls to a range of 4.9 to 5.3 percent in 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 1.5 and 1.8 percent in 2015, rising to 1.8 to 2 percent in 2017. The model's baseline forecast of the funds rate (Figure 4) is somewhat below the central tendency of the December 2014 SEP (3.1 to 4 percent) and somewhat above market expectations of the funds rate for the fourth quarter of 2017 (about 2.1 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 become less accommodative beginning in the fourth quarter of 2014.
- The more accommodative monetary policies are associated with more rapid output growth, lower unemployment, and higher inflation.
- Most of the differences between the forecasts show up in output growth and not in inflation or unemployment. The model estimates a somewhat persistent inflation process that responds 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.

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 is 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 federal funds rate under all of the alternative rules is about 1.8 percent in the first quarter of 2016, which is much higher than current market expectations of what the 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 fourth quarter of 2014. The Taylor 1993 rule calls for the most aggressive response, with the funds rate averaging 1.2 percent over the fourth quarter. The Taylor 1999 rule has the funds rate at 0.17 in the fourth quarter, while the Taylor Inertial rule puts the federal funds rate at 0.24 percent. By the second quarter of 2015, all of the rules have the funds rate well off the zero bound: The Taylor 1993 rule has the funds rate at 1.3 percent, compared with 1.1 percent under the Taylor 1999 rule and 0.9 percent under the Taylor Inertial rule.

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 2.6 percent in the fourth quarter of 2014. The Taylor Inertial rule, which is the most accommodative policy, has real output growth at 4.6 percent in the fourth quarter of 2014. Note, though, that the output growth forecasts largely converge by the end of 2015. The alternative policy rules do not lead to much 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 1.5 percent (Q4/Q4) in the fourth quarter and shows little dispersion over the forecast horizon across the alternative policies. Similarly, the inflation paths are all close to the baseline path and show relatively small differences across paths over the next three years.

Actual Monetary Policy — Deviating from the Benchmarks

Although all of the rules we examine in the EDO model suggest that it is appropriate to begin normalizing policy immediately, the FOMC has decided not to begin normalization, and the December 16–17, 2014, statement language has been largely interpreted as implying that the federal funds rate will begin to rise off the zero bound in mid-2015 or later. 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 than is suggested by the above exercise.

However, a risk of departing from the benchmark rules is that policy might get behind the curve and have to become more aggressive than it otherwise would need to be to prevent a spurt of inflation. That type of behavior is reminiscent of the go-stop policies of the late 1960s and 1970s. It is illustrated by the following exercise.

The Potential Consequences of Delay

To investigate the effect of delaying liftoff, we also consider how the forecast for the federal funds rate differs from what was forecast one year ago. Figure 5 shows the baseline model forecast for the interest rate as it looked from the vantage point of the third quarter of 2013 and compares that forecast with the forecast path today. In the fourth quarter of 2013, the model predicted an immediate and steady rise in the federal funds rate beginning in the first quarter of 2014. The forecast path today is steeper, rising more quickly to about the same level in the fourth quarter of 2016 as in the fourth quarter of 2013 forecast. The model predicts that because policymakers did not act in 2014, policy will have to rise at a more aggressive pace to keep inflation contained and to keep a balance among the output gap, inflation, and the short-term interest rate. Thus, if the beginning of policy normalization is delayed further into 2015, the policy path is also likely to steepen once interest rate increases begin. Of course, that ultimately depends on whatever shocks the economy faces between now and then.

Summary

All of the policy rules we have analyzed indicate that maintaining the funds rate at the zero lower bound is unusually accommodative by historical standards. 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. Additionally, delaying liftoff well into 2015 runs the risk of requiring more aggressive future monetary policy than would otherwise be needed. These risks need to be balanced with the prospect that inflation could run persistently below target.

Figure 1

Real GDP Growth

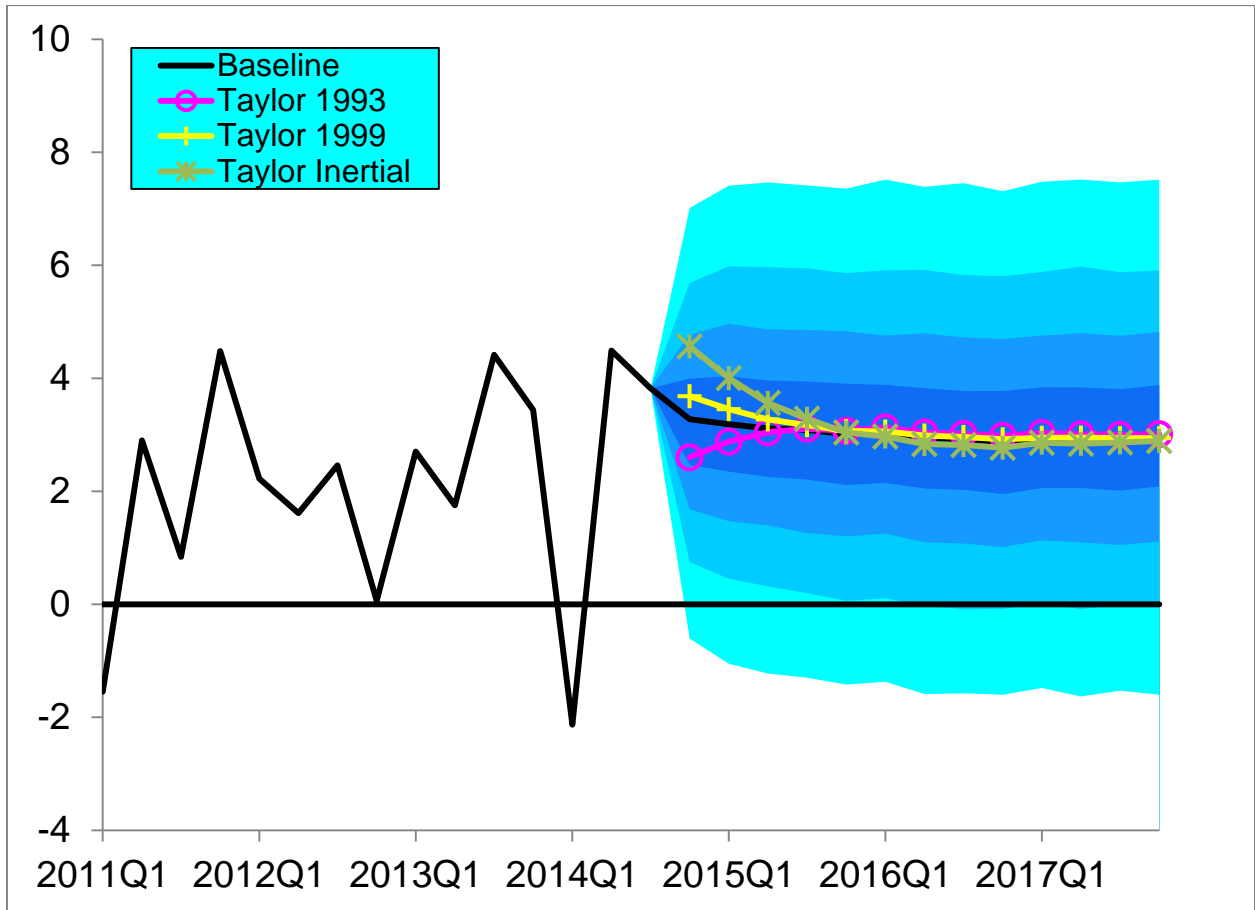


Figure 2

PCE Core Inflation (four-quarter change)

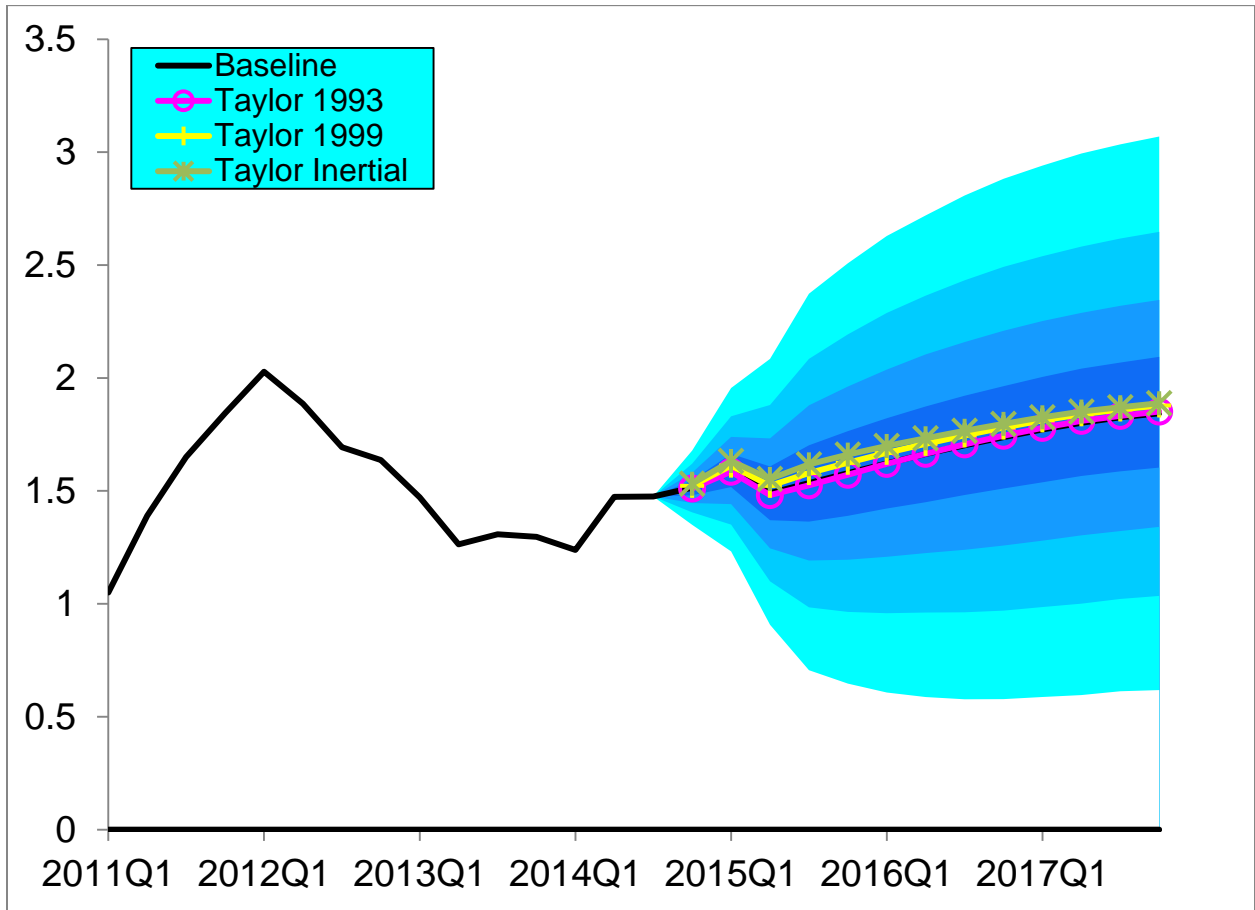


Figure 3

Unemployment Rate

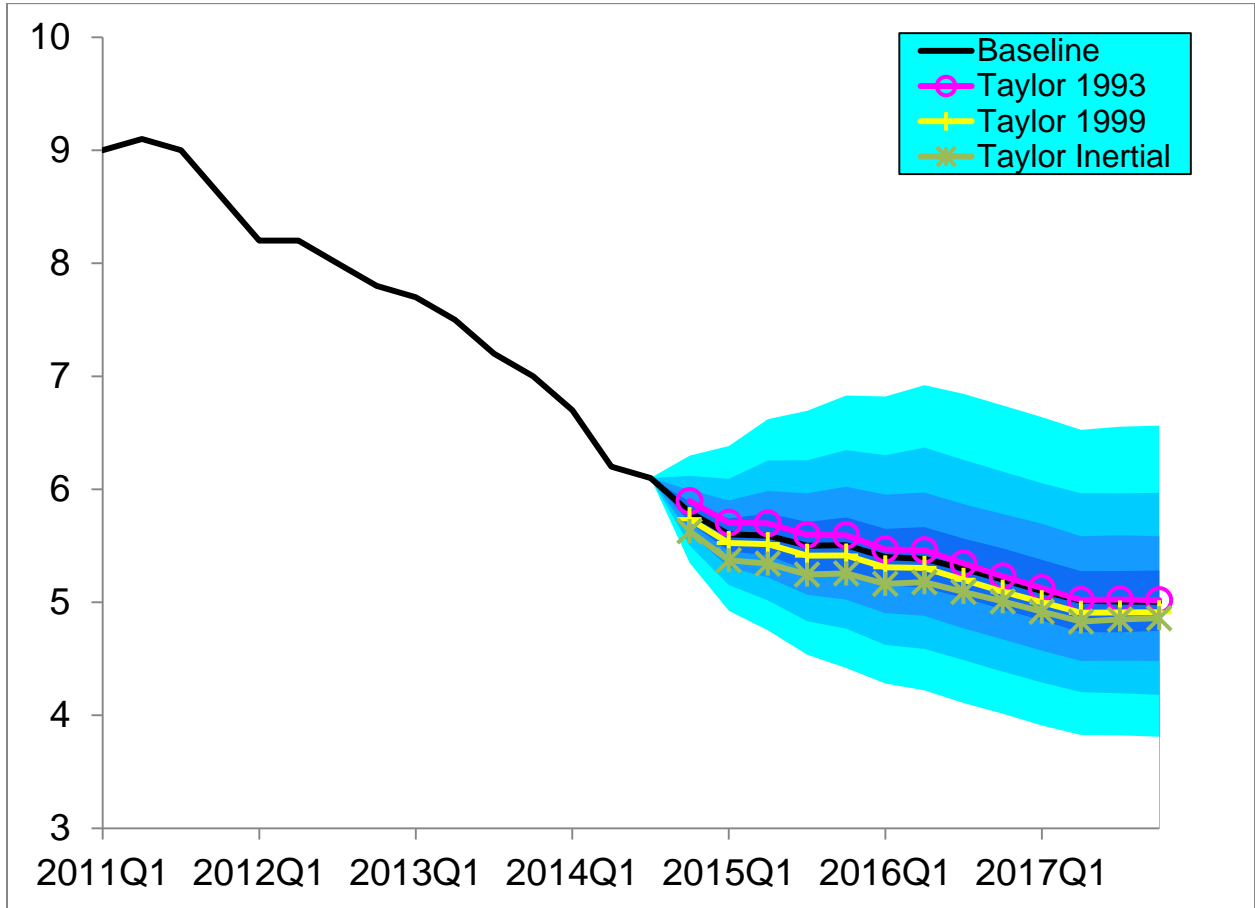


Figure 4

Federal Funds Rate

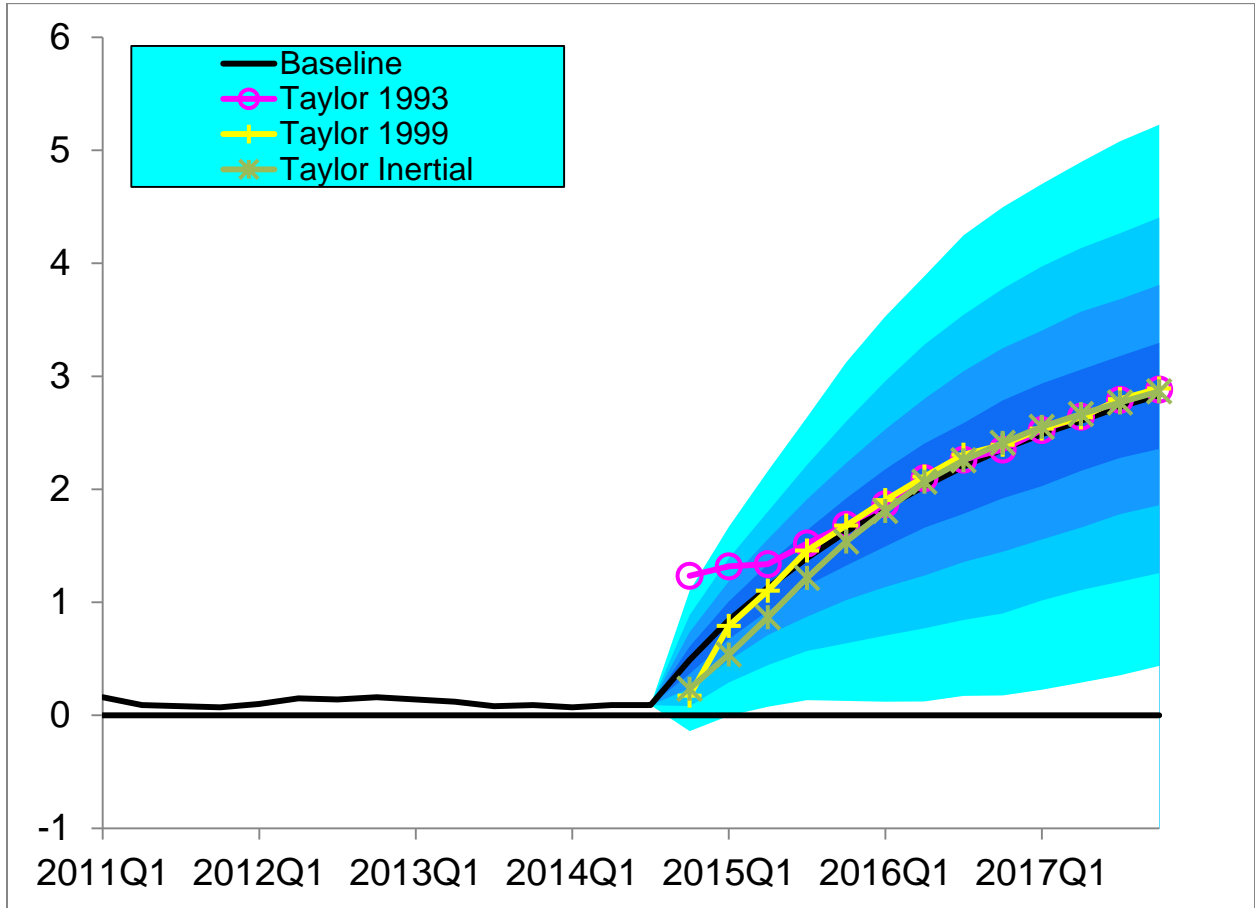


Figure 5

Federal Funds Rate Forecast as of 2013Q4

