SPECIAL REPORT
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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 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. This report updates the special report issued in December 2014.

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

[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.

outcomes of different robust policy rules and discusses why policymakers might choose to deviate from the rules.

Economic Overview

Over the past few months since the last report, the labor market has continued its exceptional performance, with 295,000 net new jobs added in February. Job growth was broad based, and the economy has added more than 1 million net new jobs during the past four months, a pace that matches some of the fastest job growth on record. The strong job growth has resulted in further declines in various measures of unemployment. The most cited measure, referred to as U3, has fallen to 5.5 percent, a decline of 1.2 percentage points over the past 12 months. Other measures such as U6, which includes marginally attached workers and those who report that they are working part time for economic reasons, also declined, but that measure remains elevated at 11 percent. Labor force participation has remained relatively stable at roughly 62.8 percent and, given demographic forces, it is unlikely to rebound sharply. Thus, continued job growth at anywhere near its present pace will further lower the unemployment rate over the remainder of the year. Moreover, data from the Job Openings and Labor Turnover Survey indicate a dynamic labor market with a high level of job openings and quit rates that are near their prerecession levels.

While the labor market has remained strong, demand has slowed noticeably. Recent retail sales reports have been disappointingly weak, with declines in each of the past three reports. The decline in gas prices was disproportionately responsible, but core sales, which exclude gasoline and automobiles, have also been relatively flat. The retail sales numbers indicate that the robust consumption growth of 3.7 percent over the second half of last year will not have been part of the economic landscape in the first quarter of this year. However, fundamentals remain strong, consumer confidence remains high, and we may yet see an uptick in spending due to the boost consumers are receiving from lower prices at the pump.

Manufacturing has also slowed, and industrial production has been approximately flat since November. No doubt, the rapid and steady appreciation of the dollar has had an effect, as has the temporary disruption caused by labor disputes at West Coast ports. Manufacturing industrial production fell 0.2 percent in February, and the ISM manufacturing index fell further in February but still remains in positive territory. Regional surveys, such as the Philadelphia Fed's *Manufacturing Business Outlook Survey* (*MBOS*), are painting a similar picture. The *MBOS* general activity index has fallen over the past few months, and though it also remains in positive territory, recent readings are below those associated with an economic expansion. However, the index for future activity shows a high degree of optimism, indicating that the recent slowdown is projected to be temporary.

Business investment has also been contributing less to GDP growth over the past few quarters, and data on new orders and shipments point to a continuation of this trend. With regard to residential investment, housing construction remains sluggish. The latest data on housing starts and permits have been disappointing, with both indicators declining much more than expected. House price growth has attenuated. A cautiously optimistic note may be found in the recent dramatic increase in household formations and in the latest data on new home sales, which exceeded expectations to equal their highest level since the spring of 2008. Of perhaps a more temporary nature with respect to implications for future activity, net exports declined significantly in the fourth quarter, subtracting more than 1 percentage point from real GDP growth, and government spending was unexpectedly weak.

As expected, the significant decline in energy prices has resulted in negative headline inflation and appears to have seeped into core measures. In the latest reading, year-over-year core inflation, as measured by the price index of personal consumption expenditures (PCE), declined to 1.3 percent, but the more recent reading on core inflation, as measured by the consumer price index (CPI), was positive for the first time in three months, and the 12-month average core CPI inflation rate bounced back to 1.7 percent. This rebound in core CPI gives credence to the view of most forecasters that inflation will move back toward the Federal Open Market Committee's 2 percent target over the next few years, although the decline in energy prices and appreciation of the dollar should slow price increases over the near term.

Overall, economic growth has attenuated noticeably from its rapid pace in the second and third quarters of last year. Most forecasts see the slowdown as temporary. That view is based on strong job growth and solid economic fundamentals. Moreover, much of the recent weakness has been attributed to factors that appear to be temporary in nature. Due largely to falling energy prices, inflation is drifting below the FOMC's target, but this movement is also likely to be transitory, and economic slack continues to wane. So, we continue to believe the economy remains on a fairly 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 on 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.[2] 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.

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 fourth quarter of 2014 and a nowcast of 2 percent headline growth for 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

[2] 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.

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.[3]

The key features of the baseline forecast are as follows:

- Real output is forecast to grow at an average pace of about 2.8 percent in 2015 and 2016 and 2.9 percent in 2017.
- The four-quarter change in the core PCE inflation rate rises from 1.6 percent in 2015 to 1.9 percent in 2017.
- The unemployment rate falls gradually to about 5 percent at the end of 2017.[4]
- The federal funds rate begins rising immediately to reach 1.3 percent in the fourth quarter of 2015, 2.2 percent in the fourth quarter of 2016, and 2.8 percent in the fourth quarter of 2017.
- That is, the model and data indicate that the zero bound is no longer the place monetary policy should be.
- Compared with the December forecast, we now anticipate slightly weaker real GDP growth over the forecast horizon, slightly stronger core inflation, and a weaker path for the federal funds rate in 2015 and 2016 (Figure 5).

The baseline forecast calls for output growth to accelerate from an average pace of 2.1 percent for the fourth quarter of 2014 through the first quarter of 2015 to its longer-term value of about 3 percent.[5] 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 percent (four-quarter-over-four-quarter change) in the third quarter to about 1.9 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 second quarter of 2015. Thereafter, the funds rate rises at a gradual but steady pace to 2.8 percent by the end of 2017.

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

[4] 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.

[5] 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.

The baseline forecast is broadly similar to the median projections from the first quarter 2015 *Survey of Professional Forecasters* (*SPF*). In that survey, the respondents expect real output growth of 3 percent or a bit below per year over the period 2015–2017. 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 similar to the baseline model: The median *SPF* forecast for the unemployment rate is 5.1 percent for 2016 and 5 percent for 2017.

The March 2015 Summary of Economic Projections (SEP) by participants at the FOMC shows the central tendency for output growth in 2015 and 2016 at about 2.3 to 2.7 percent, falling to a range of 2 to 2.4 percent in 2017. The central tendency of the unemployment rate falls to a range of 4.8 to 5.1 percent in the fourth quarter of 2017 from 5 to 5.2 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 1.8 to 2 percent in 2017. The model's baseline forecast for the funds rate (Figure 4) is toward the low end of the central tendency of the March 2015 SEP for the fourth quarter of 2017 (at about 2.7 to 3.7 percent) and well above market expectations for the funds rate for the fourth quarter of 2017 (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.[6]

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 second quarter of 2015.
- The more accommodative monetary policies are associated with more rapid output growth, lower unemployment, and higher inflation.
- Most of the differences between the forecasts appear in output growth and not in inflation or unemployment. The model estimates somewhat persistent inflation measures that respond sluggishly to shocks.

[6] 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.

- 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 in the second quarter of 2016, which is well above the 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 second quarter of 2015. The Taylor (1993) rule calls for the most aggressive response, with the funds rate averaging 1.5 percent over the second quarter. The Taylor (1999) rule has the funds rate at 0.5 percent in the second quarter, while the Inertial Taylor (1999) rule puts the federal funds rate at 0.3 percent. By the third 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 1.6 percent, compared with 1.2 percent under the Taylor (1999) rule and 0.7 percent under the Inertial Taylor (1999) 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 2.4 percent in the second quarter of 2015. The Inertial Taylor (1999) rule, which is the most accommodative policy, has real output growth at 4.6 percent in the second quarter of 2015. Note, though, that the output growth forecasts largely converge in 2016. The alternative policy rules do not have 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 about 1.6 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.

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 March 17–18, 2015, statement language has been largely interpreted as implying that the federal funds rate will not begin to rise off the zero bound until 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. Given the underlying strength in the economy, the benchmark rule features a very gradual rise in the funds rate from the zero lower bound, so its prescription still represents an accommodative policy stance that to some extent would balance the risks mentioned in the preceding paragraph. Waiting much longer than indicated by the benchmark rule increases the risks of returning to the go-stop policies of the late 1960s and 1970s.

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 monetary policy in the future than would be needed otherwise. These risks need to be balanced with the prospect that inflation could run persistently below target.

Figure 1: Real GDP Growth

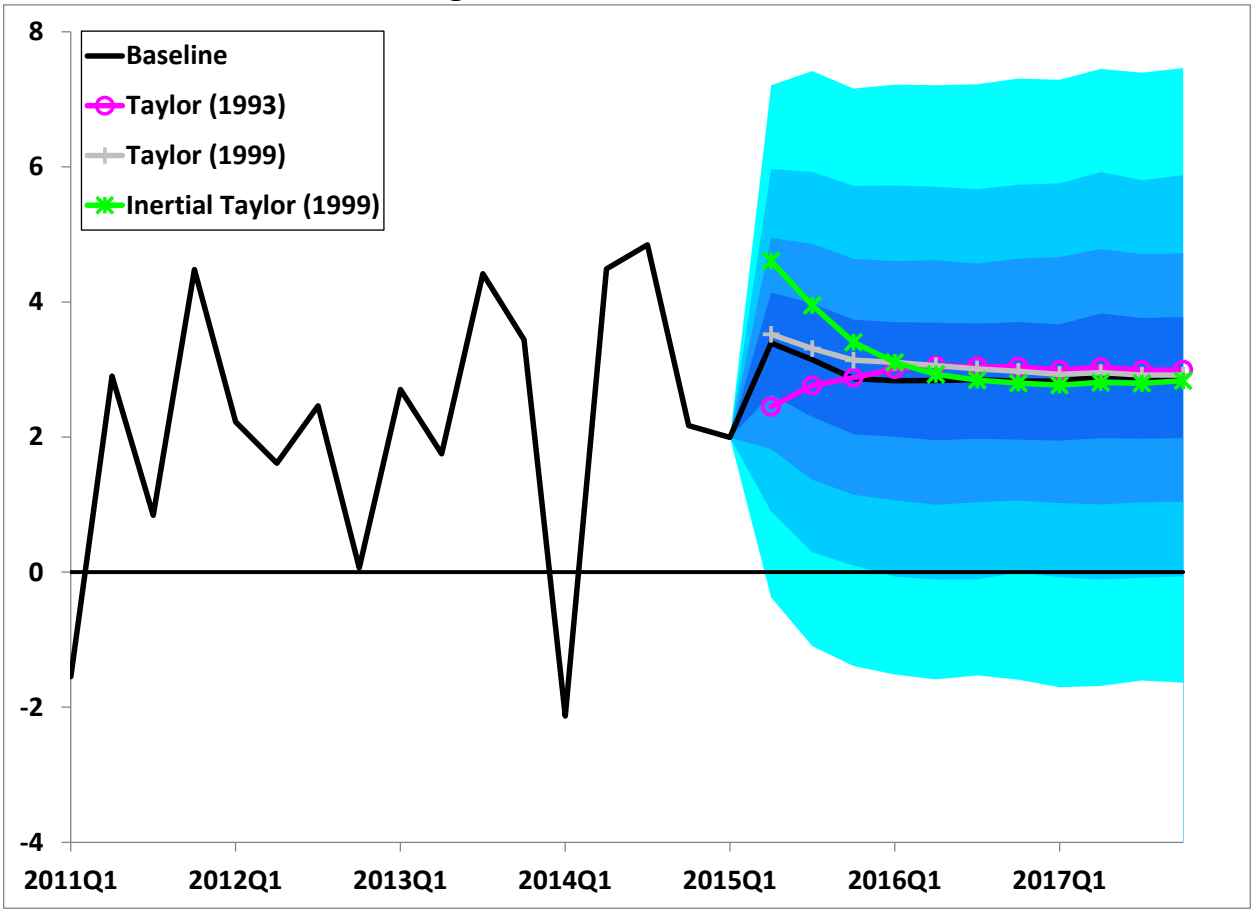

Figure 2: PCE Core Inflation

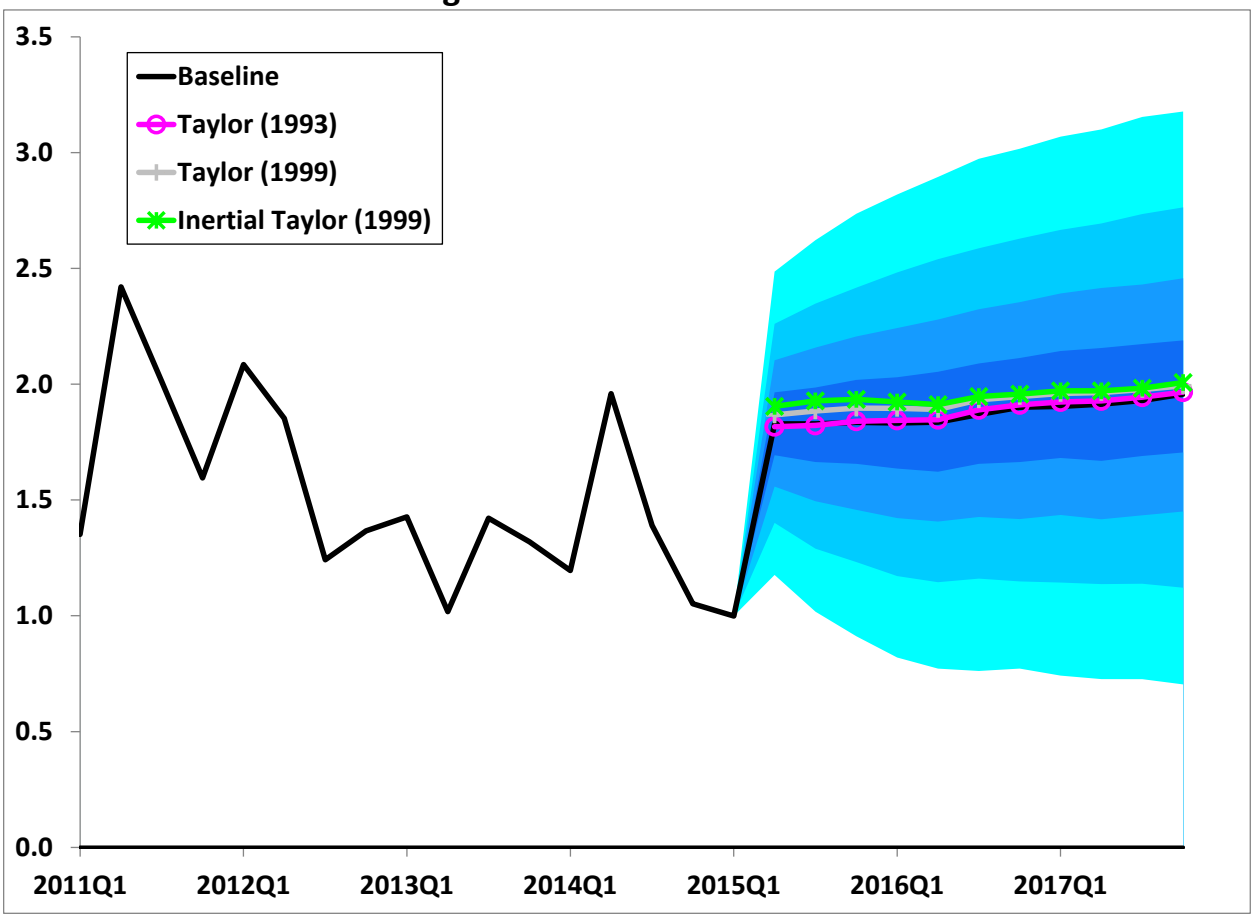

Figure 3: Unemployment Rate

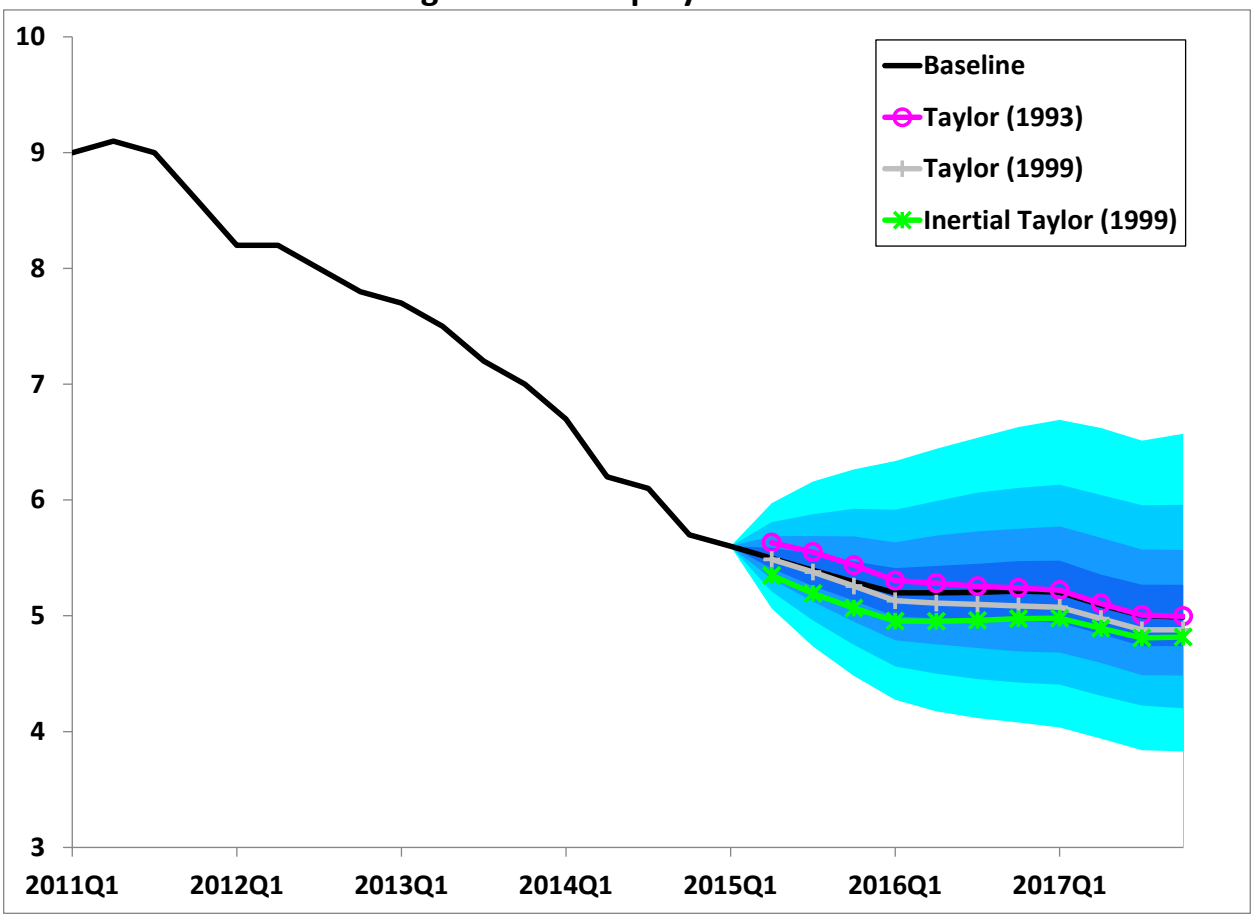

Figure 4: Federal Funds Rate

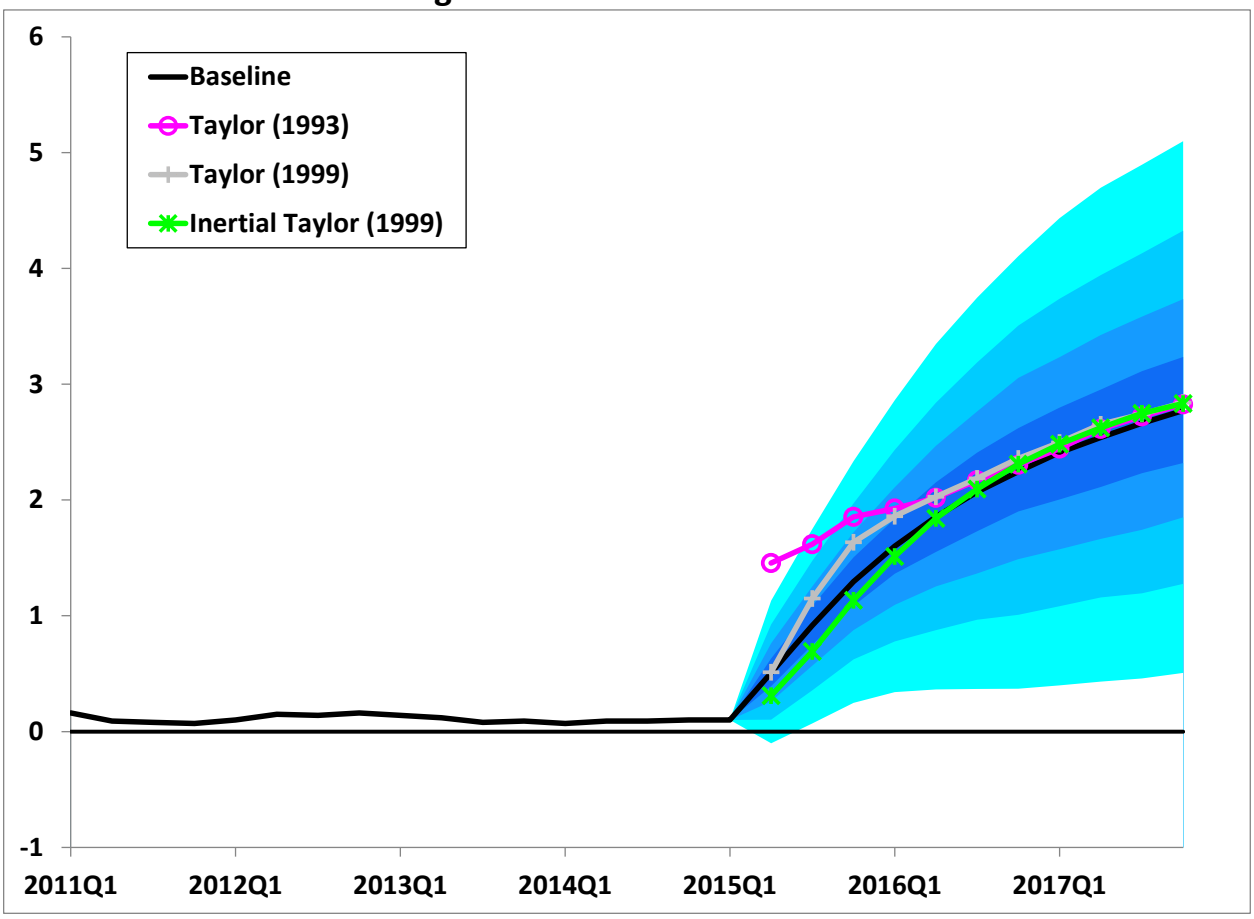

Figure 5: Baseline Forecast Comparisons

Figure 5a: Real GDP Growth

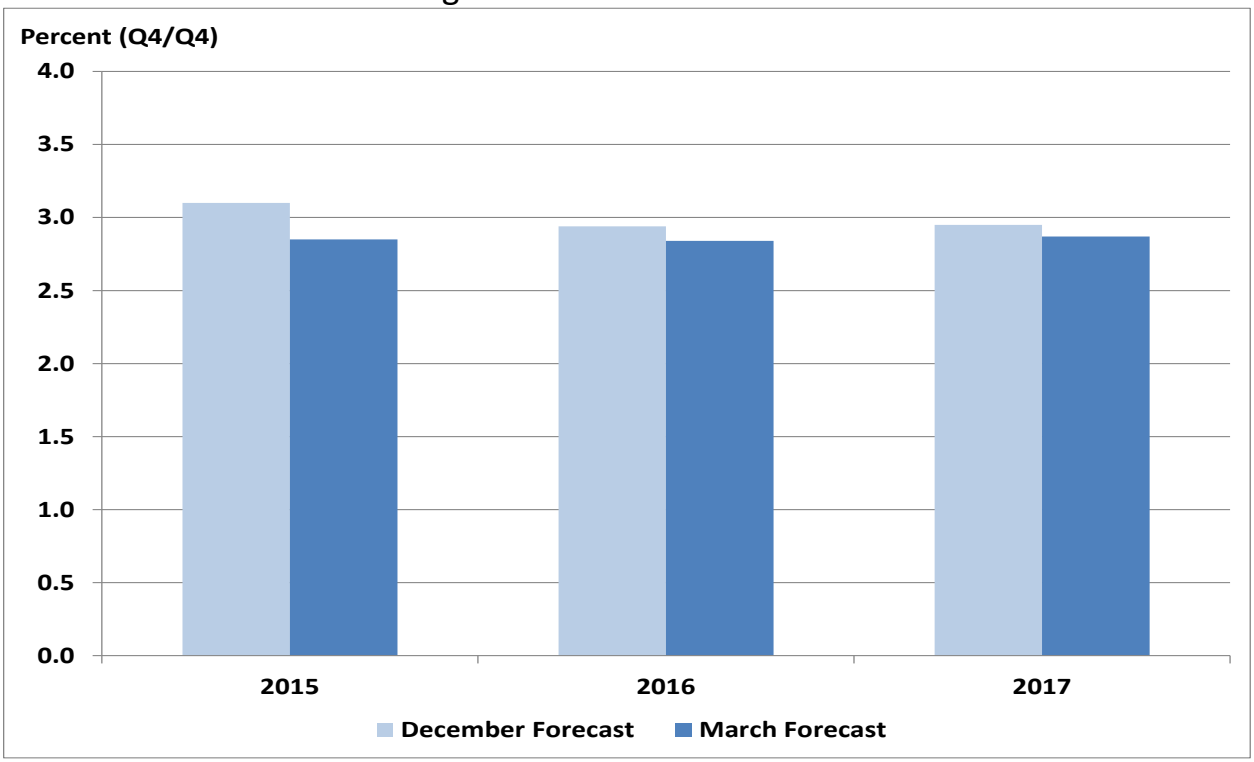

Figure 5b: PCE Inflation Growth

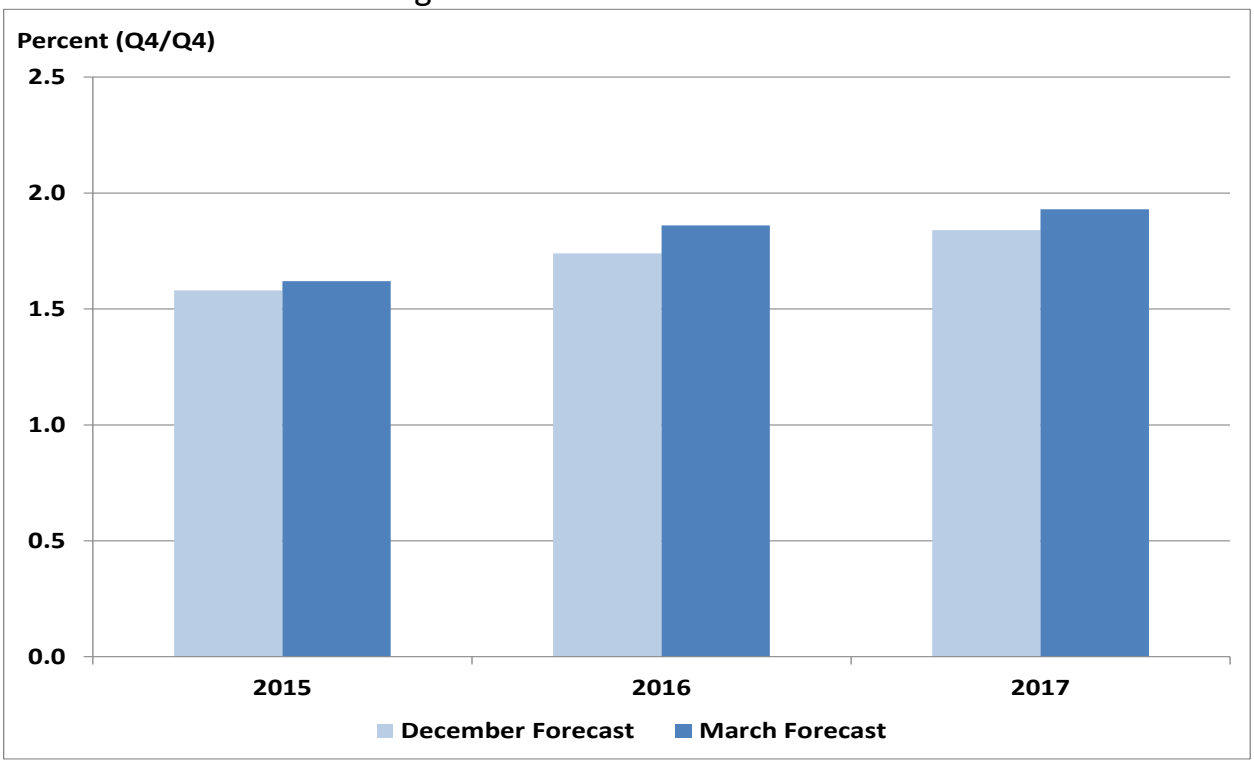

Figure 5c: Unemployment Rate

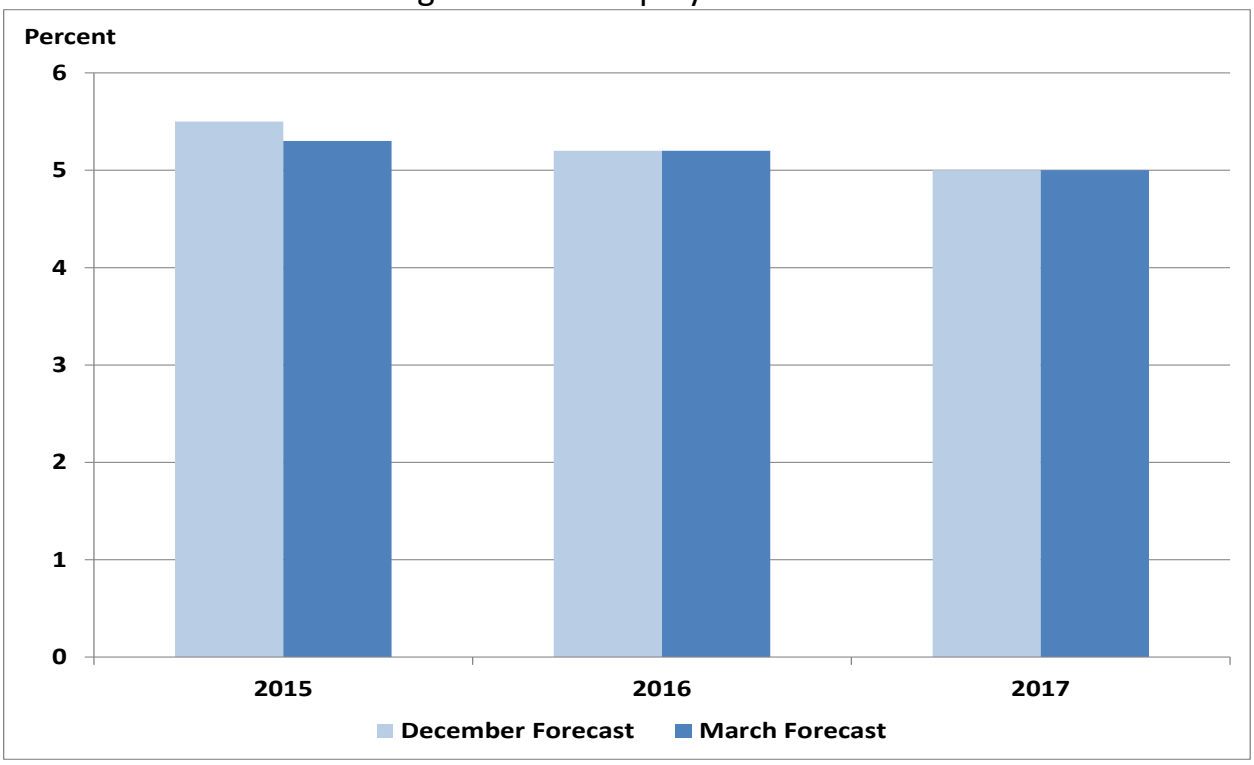

Figure 5d: Federal Funds Rate