



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 Board of Governors of the Federal Reserve System. 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. We thank Brie Coellner for her assistance.

Economic Overview

Economic growth in the second quarter has accelerated largely due to a healthy pickup in consumption and continued steady growth in housing. Financial volatility, which was prevalent last quarter, has waned, and oil prices have recovered somewhat. The recent rise in oil prices is contributing to the gradual return of inflation to the target rate, although year-over-year core PCE (personal consumption expenditures) inflation remains below target. For the most part, economic fundamentals appear to be solid. After a weak first quarter in which GDP grew at a mere 0.8 percent, nowcasts of the current quarter generally indicate that growth is now above trend. [GDPplus](#) indicates that some of the weakness in the first quarter GDP report may be due to seasonal adjustment problems in GDP, as GDPplus grew at 2.3 percent in the first quarter. But not all is rosy: Employment grew by a scant 38,000 net new jobs in May, and April's employment was revised down significantly. Thus, the robust first quarter growth in employment has attenuated markedly. In addition, manufacturing and investment remain quite weak.

The latest data on retail sales place consumption on a solid trajectory over the near term, perhaps as high as 4.0 percent at an annualized rate over the second quarter. Retail sales increased by 0.5 percent in May following a very healthy gain of 1.3 percent in April. Auto sales also remain at fairly high levels. The strengthening in consumption is buttressed by solid fundamentals, such as healthy personal income growth, a modest increase in equity prices, and continued steady growth in home prices. Additionally, consumers appear fairly confident, measured by various indices of consumer sentiment, and household balances sheets are in good shape.

However, the employment report of June 3 sent waves of unease over the outlook. May witnessed the creation of only 38,000 net new jobs, and job growth in April was revised downward to 128,000. Even factoring in the Verizon strike, second quarter job growth is proceeding at a pace of less than 100,000 net new jobs per month after increasing by nearly 200,000 net new jobs per month in the first quarter. Although the unemployment rate declined 0.3 percentage points in May, the decline was entirely due to a 0.2 percentage point drop in the labor force participation rate. That rate has now returned to where it was at the end of last year. Demographic trends are likely to produce continued declines in the participation rate. The only bright spot in the report was the pickup in wage growth, which has accelerated to 3.2 percent over the past three months.

Data from the April Job Openings and Labor Turnover Study (JOLTS) were substantially more upbeat, but the report reflects conditions before May. Job opening rates remain at high levels, and the quits rate indicates that workers feel fairly confident in their ability to change jobs. Contacts in our region noted that they continue to search for workers but that finding those

people with sufficient skills is getting increasingly more difficult. Nevertheless, the disconnect between the labor market and economic activity is puzzling. The first quarter saw strong employment growth and fairly weak output growth, while the current quarter is witnessing just the opposite. That behavior is creating uncertainty for both forecasters and policymakers.

The housing sector continues on a fairly steady upward trajectory. Although activity has slowed this quarter, both starts and pending home sales remain at levels that are consistent with moderate growth in residential investment. Single-family home sales grew a robust 16.6 percent in April, and house prices continue to rise at modest rates with the Case-Shiller 20-City Composite Home Price Index increasing by 5.4 percent over the past year.

The manufacturing and energy sectors continue to struggle, although there have been some signs of improvement in the current quarter. The ISM Manufacturing Index has been in positive territory for each of the past three months with May's index reading at 51.3. However, May's manufacturing IP fell by 0.4 percent, so it is not clear whether this sector has bottomed out. Regional contacts appear a bit more upbeat than they were a few months ago, but the durable goods part of the market is still having a rough time. The data on core orders in April also do not point to any near-term strength in investment.

On the inflation front, there are signs of firming; the dollar has stabilized, and oil and gas prices have risen substantially. Consumer price inflation continued to firm this quarter with both the 12-month headline PCE and CPI (Consumer Price Index) indices rising at an annual rate of 1.1 percent in April and May, respectively. Core measures were a bit firmer with the core PCE rising at an annual rate of 1.6 percent in April and core CPI increasing by 2.2 percent in May. Meanwhile, inflation expectations, as measured by the spread between nominal Treasury yields and Treasury Inflation-Protected Securities (TIPS), remain below the 2 percent target set by the Federal Open Market Committee (FOMC), whereas survey measures on longer-run inflation expectations, such as those contained in the *Survey of Professional Forecasters*, remain consistent with the FOMC's long run target. Given the recent behavior of price indices and the firming in energy prices, we continue to believe that inflation will slowly converge to target.

Overall, this quarter's economic growth appears to be accelerating to above-trend rates, but employment growth has decelerated at a somewhat alarming rate. Most forecasts, including those made by FOMC participants, have not been overly affected by the latest employment numbers, but as noted, the disconnect between the overall economy and the labor market has created an air of uncertainty for policymakers. The decision of Britain to leave the EU introduces additional uncertainty to financial markets and economic forecasts. Financial markets have trended down in the immediate aftermath of the referendum, and, if a decreased appetite for risk takes hold, investment is likely to be adversely affected. Headline and core

measures of PCE inflation remain below the FOMC’s target, but there are signs that inflation is gradually returning to its desired 2.0 percent rate. We continue to believe that the economy has returned to a fairly normal state of activity and that May’s employment numbers will turn out to be an aberration. However, we also must admit to being a bit nervous about that prediction.

Given the fairly unchanged view of the economy in June’s Summary of Economic Projections, the decision to ratchet down the appropriate path of tightening was mostly driven by the continued decline in what Committee members believe is the long-run neutral funds rate. The median projection of that rate now stands at 3.0 percent, down from 3.5 percent last December.

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.² We run forecast simulations under four different versions of the 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 2015 and a nowcast for the first quarter of 2016. The forecast begins in the second quarter of 2016 and extends through the fourth quarter of 2018. 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.³

The key features of the baseline forecast are as follows:

- Real output is forecast to grow at a pace of about 2.1 percent (Q4/Q4) in 2016, rising to 2.4 percent in 2017 and 2.7 percent in 2018.
- Core PCE inflation reaches 2.2 percent (Q4/Q4) in 2016, rising to 2.4 percent in 2017 and 2018.

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.

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

- The unemployment rate falls to a low of 4.4 percent in the fourth quarter of 2017 and remains at about that level through the end of 2018.⁴
- The federal funds rate rises to 1.3 percent at the end of 2016 and reaches 2.4 percent at the end of 2017 and 3 percent at the end of 2018.
- Compared with the December forecast, real GDP growth is slightly weaker over the forecast horizon, while inflation is higher over the forecast horizon (Figure 5).

The baseline forecast calls for output growth to accelerate from 0.8 percent in the first quarter of 2016 to 2.7 percent in the second quarter. Growth then hovers in a range of 2.4 percent to 2.7 percent over 2017 and 2018.⁵ The unemployment rate continues to decline, reaching 4.4 percent at the end of 2017 and remaining near that level through the end of 2018. Moderately strong growth and anchored long-run inflation expectations lead to an acceleration of core PCE inflation from 1.3 percent at the end of 2015 to 2.3 percent in the fourth quarter of 2016. 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 federal funds rate continues to rise from the zero lower bound, hitting 0.5 percent in the second quarter of 2016 and 1.3 percent by year-end. Thereafter, the federal funds rate rises at a gradual but steady pace to 3 percent by the end of 2018.

The baseline forecast is somewhat stronger than the median projections from the second quarter 2016 *Survey of Professional Forecasters (SPF)*. In that survey, the respondents expected real output growth of 1.7 percent in 2016, 2.4 percent in 2017, and 2.4 percent in 2018. (Note that the *SPF* reports GDP growth as annual average over annual average). The *SPF* core PCE inflation forecast is 1.8 percent (Q4/Q4) for 2016, 1.9 percent for 2017, and 2 percent for 2018. The forecasters' path for the unemployment rate is a bit higher than in the baseline model: The median *SPF* forecast for the unemployment rate averages 4.8 percent in 2016, falling slightly to 4.6 percent in 2017 and 2018.

The June 2016 SEP by FOMC participants shows the median projection for output growth at 2 percent in 2016–2018. The median forecast of the unemployment rate is 4.7 percent in the fourth quarter of 2016, falling to 4.6 percent in the fourth quarter of 2017 and holding at 4.6 percent in the fourth quarter of 2018. Core PCE inflation is projected at 1.7 percent in 2016, rising to 1.9 percent in 2017 and 2 percent in 2018. Headline inflation is weaker in 2016 at 1.4

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.

percent, but as energy prices stabilize, headline inflation is expected to run at a similar pace as core inflation in 2017 and 2018. The model's baseline forecast for the federal funds rate (Figure 4) is now above the central tendency of the March 2016 SEP over the forecast horizon and remains well above market expectations for the funds rate, a bit below 1 percent for the fourth quarter of 2018. The model generally suggests a somewhat more rapid pace of policy normalization compared with market expectations 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 continue to suggest that the federal funds rate should rise at a fairly rapid pace over the next three years — much more rapidly than suggested by the financial markets.
- The more accommodative monetary policies are associated with more rapid output growth, lower unemployment, and higher inflation.
- The major difference between the forecasts is in output growth and not in inflation or unemployment. The model estimates somewhat persistent inflation measures that respond sluggishly to shocks.
- By mid-2017, 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 the alternative rules reaches 2.4 percent by the end of 2017, which is well above current market expectations of what the federal funds rate will be at that time.

The alternative policy rules suggest different current levels of the appropriate federal funds rate. The baseline puts the funds rate at 0.55 percent in the second quarter of 2016, compared with 1.1 percent for the Taylor (1993) rule. The Taylor (1999) rule suggests a more

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.

accommodative policy, with the federal funds rate at -0.1 percent in the second quarter of 2016. In implementing the model, we have not constrained the federal funds rate to be nonnegative. Consequently, the Taylor (1999) rule suggests that monetary policy should be eased further in response to the weak output growth and inflation readings up through the first quarter of 2016. The inertial Taylor rule suggests the funds rate should be 0.3 percent in the second quarter of 2016, which is close to the current actual rate. Looking ahead, all the rules indicate a further tightening of policy in the third quarter of 2016 when the fund rate stands at 1.3 percent for the Taylor (1993) rule, 0.8 percent for the Taylor (1999) rule, and 0.6 percent for the inertial Taylor rule. Note, though, that all the rules suggest that the federal funds rate should be close to 2 percent by the second quarter of 2017. So, even though the Taylor (1999) rule calls for more near-term policy easing, the extra accommodation is fairly short lived.

The path of output growth is slightly weaker over the near term under the Taylor (1993) rule, which calls for the highest near-term interest rate, with output growth at 2.3 percent in the third quarter of 2016. The inertial Taylor (1999) rule, which over the forecast horizon is the most accommodative policy, has real output growth at 3.8 percent in the third quarter of 2016. Note, though, that the output growth forecasts largely converge by the middle of 2017. 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 runs. Core inflation runs at about 2.2 percent (Q4/Q4) in 2016 and shows little dispersion over the forecast horizon across the alternative policies. Core inflation is higher over the forecast horizon compared with the March projection largely due to the strong reading for core PCE that was realized in the first quarter of 2016. The inflation paths are all close to the baseline path and show relatively small differences across paths over the next three years.

Summary

The policy alternatives continue to give somewhat mixed signals about the appropriate near-term stance of monetary policy, but the discrepancy remains short lived. The baseline rule and Taylor (1993) rule suggest that the federal funds rate should be somewhat higher than its current prevailing rate of about 0.38 percent in the second quarter. The inertial Taylor (1999) rule suggests that current policy is about right. The Taylor (1999) rule suggests that policy should be more accommodative. However, the alternative policy rules agree that the federal funds rate should be somewhere in the range of 1 percent to 1.7 percent by the end of 2016 and call for more aggressive liftoff from the zero lower bound compared with financial market expectations. Note that the model predictions are largely 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

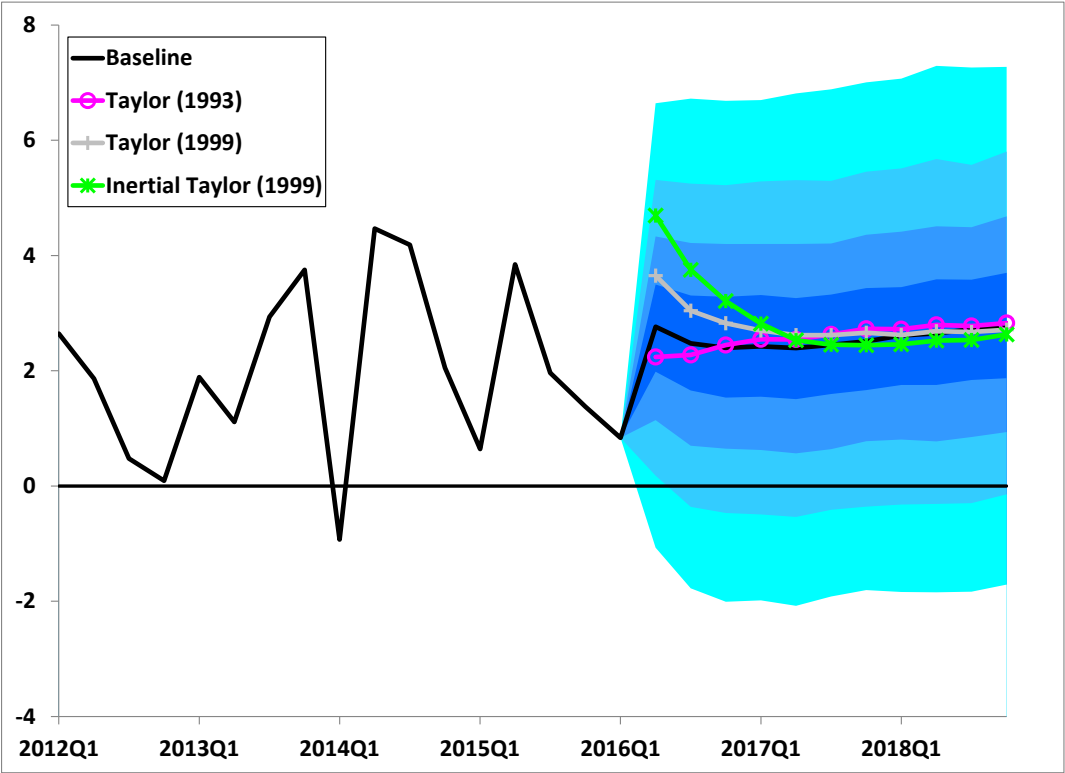


Figure 2: PCE Core Inflation

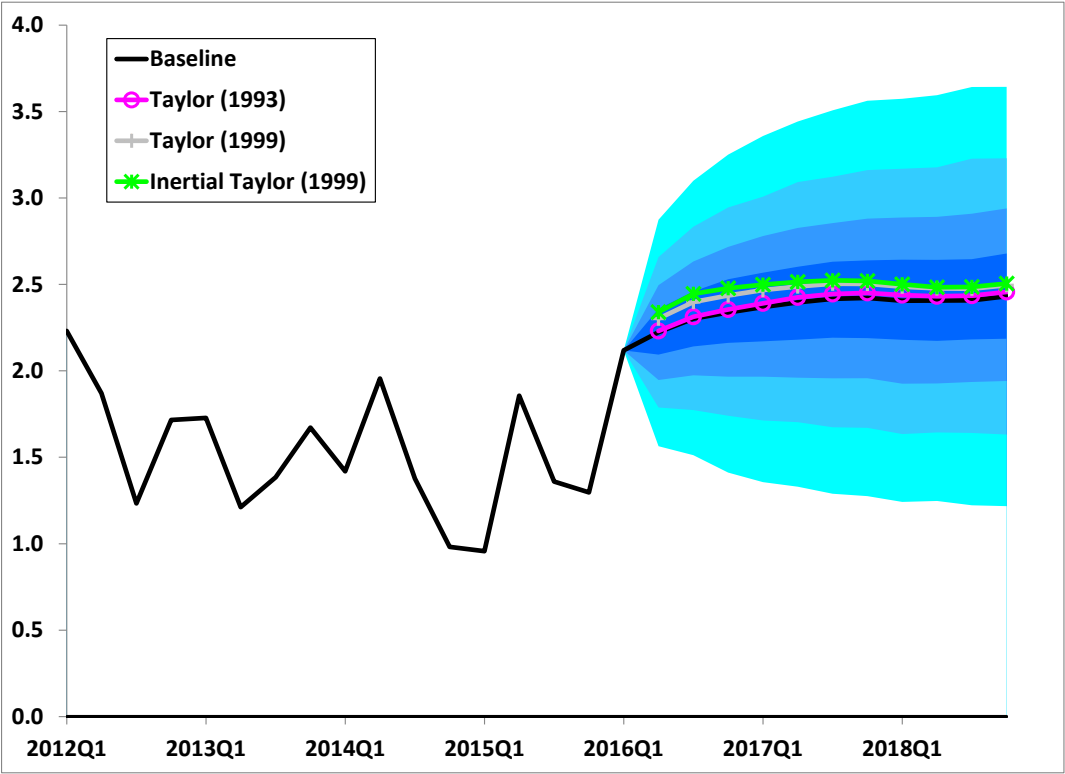


Figure 3: Unemployment Rate

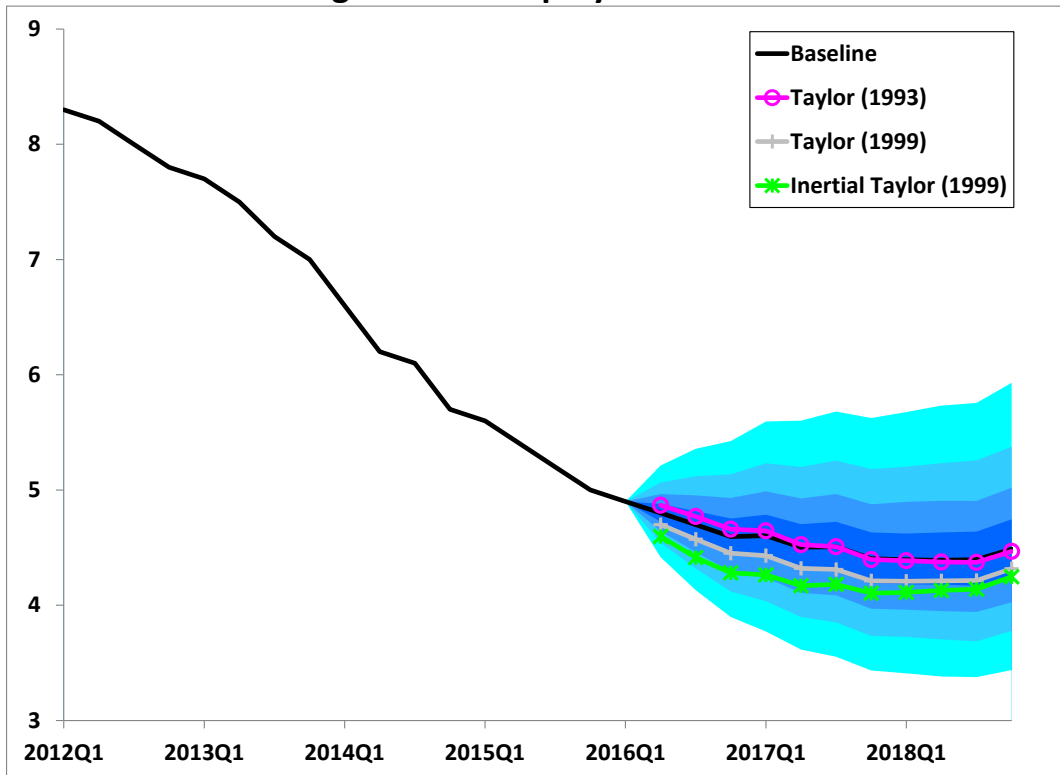


Figure 4: Federal Funds Rate

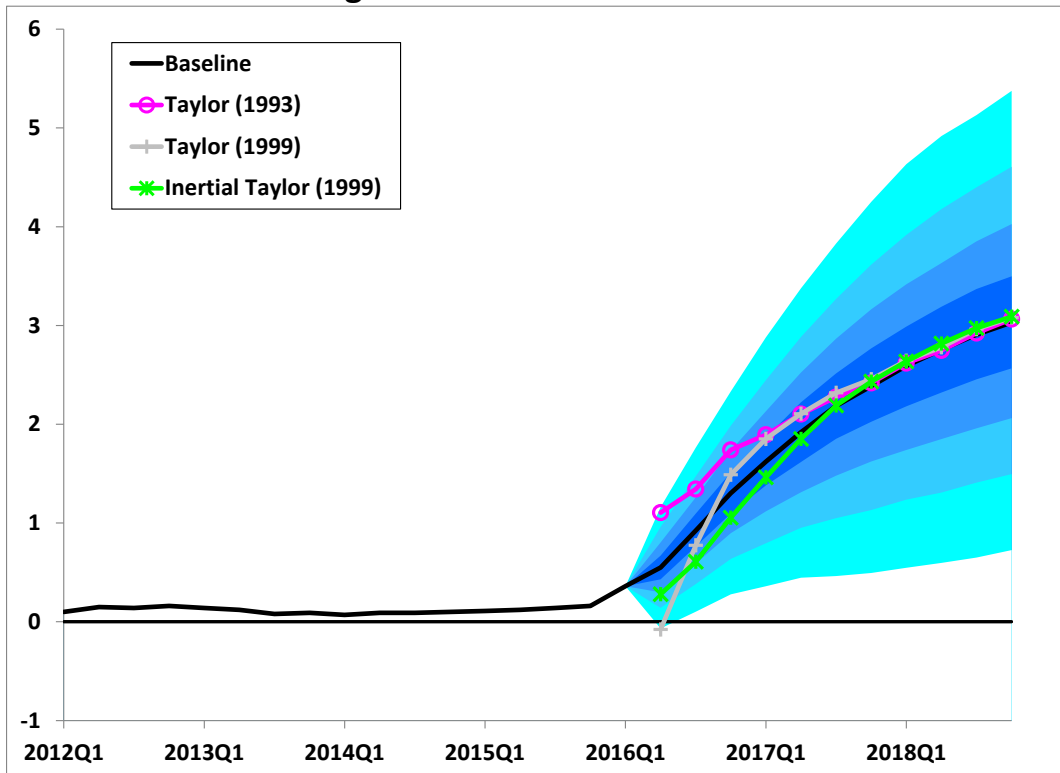


Figure 5: Baseline Forecast Comparisons

Figure 5a: Real GDP Growth

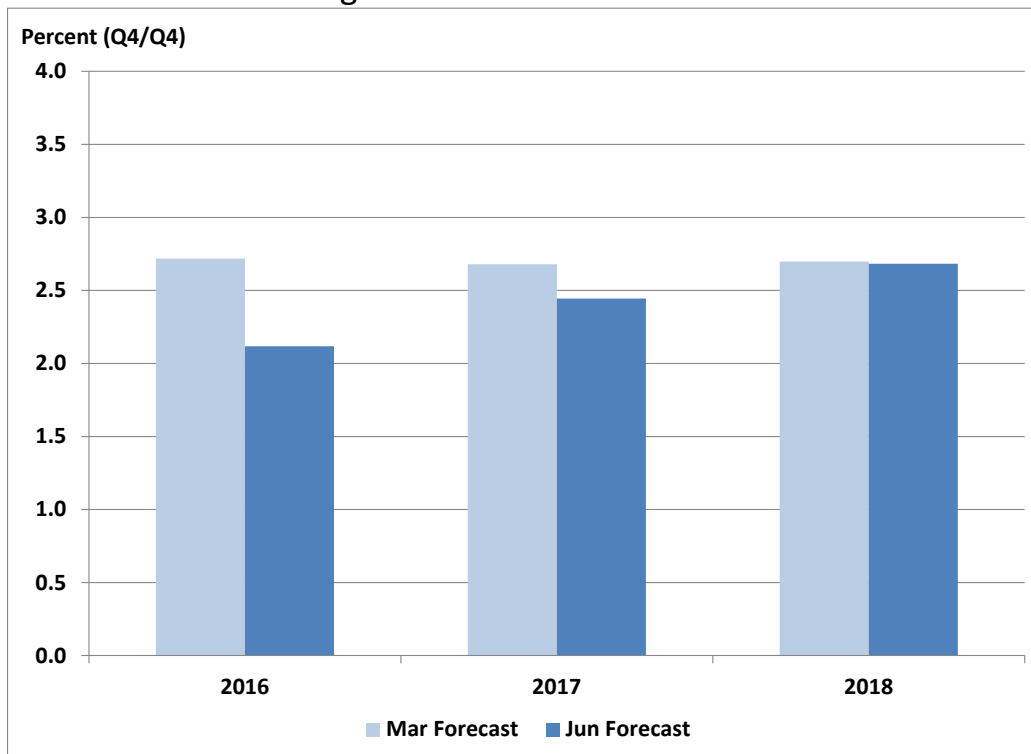


Figure 5b: PCE Inflation Growth

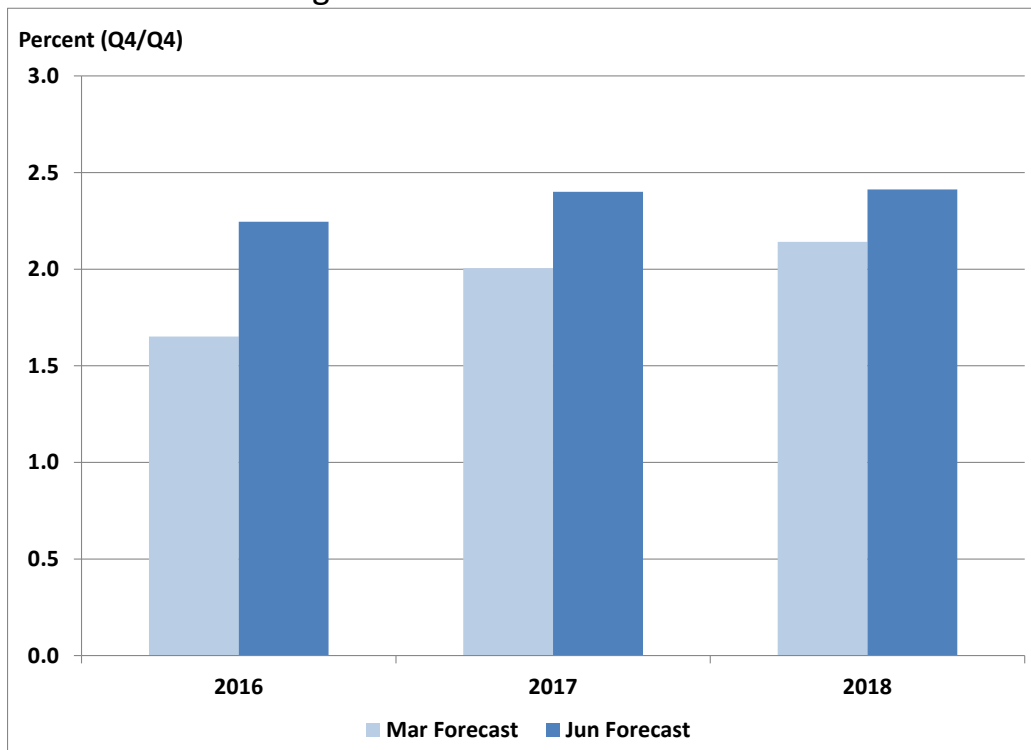


Figure 5c: Unemployment Rate

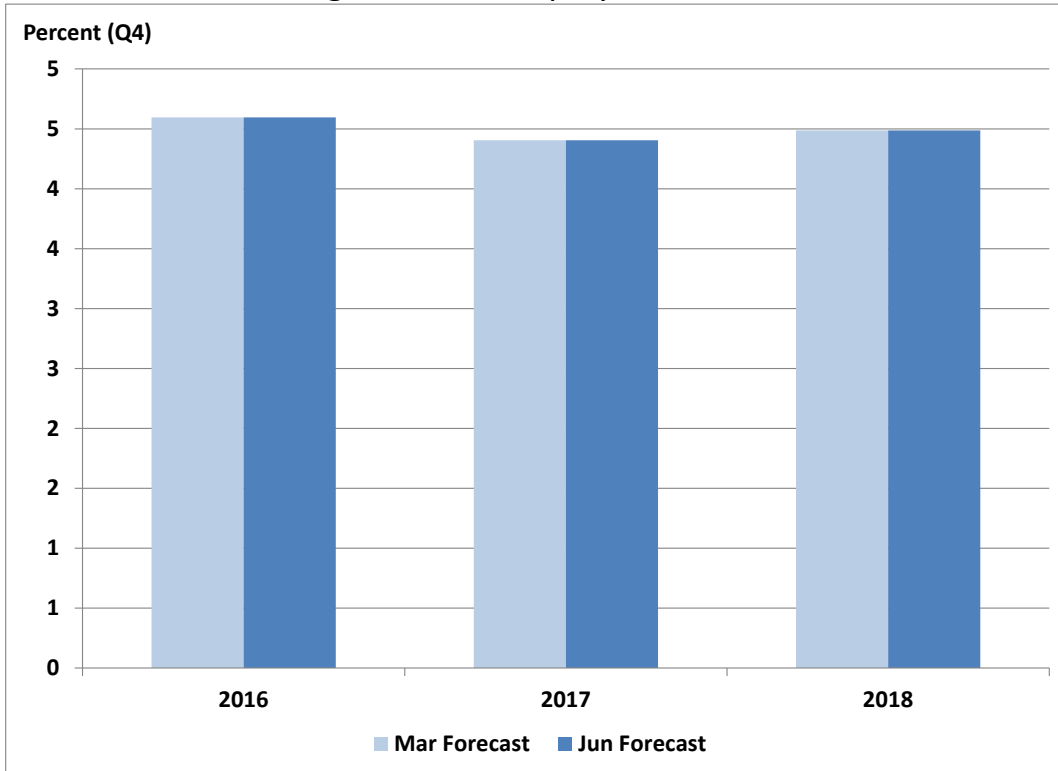


Figure 5d: Federal Funds Rate

