



SPECIAL REPORT

FEDERAL RESERVE BANK OF PHILADELPHIA

Monetary Policy Report: Using Rules for Benchmarking

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September 2016

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

For the most part, economic fundamentals appear to be solid. Economic growth in the third quarter appears to have accelerated from its tepid pace of slightly less than 1.0 percent over the first half of the year. Nowcasts of the current quarter generally indicate that growth is solidly above trend. Buoyed by robust growth in jobs and modest growth in wages, consumption has been the largest contributor to overall growth during the year and is expected to continue along that trend. Additionally, the economy has benefited from steady if unspectacular growth in housing. The stock market has risen steadily of late, financial volatility is low, and oil prices and the dollar appear to have stabilized. Brexit does not seem to be having any large effect on the U.S. economy, nor is it expected to. However, inflation as measured by year-over-year core personal consumption expenditures (PCE) inflation remains below target. And not all sectors of the economy are looking strong. Business fixed investment is exceptionally weak, and although manufacturing appears to be showing some signs of improvement, the ISM manufacturing index edged back into negative territory after expansionary readings in the previous four months.

Although the most recent retail sales report was unexpectedly weak, the retrenchment in the pace of consumption is not alarming, especially considering August's record heat. After growing more than 4.0 percent in the second quarter, consumption still appears to be growing above trend at around 3.0 percent in the current quarter. Fundamentals such as healthy personal income growth, a modest increase in equity prices, and continued steady growth in home prices will continue to support reasonably strong consumption growth over the remainder of the year. Additionally, consumers appear fairly confident, as measured by various indexes of consumer sentiment, and household balance sheets are in good shape.

Although the August employment report was a bit weaker than expected at 151,000 net new jobs, we still view it as a solid reading, especially on the heels of two exceptionally strong reports and factoring in the recent large upward revisions. Over the past three months, job growth has averaged 236,000 a month, an unsustainable pace given that the economy is near full employment. Despite the strong employment growth, the unemployment rate has held steady at 4.9 percent over the past three months. Additionally, average hourly earnings have been steadily growing at around 2.5 percent.

The July Job Openings and Labor Turnover Survey (JOLTS) continued to indicate dynamism in the labor market, with the job openings rate moving back to its historical high of 3.9 percent. Both the hiring and quits rates remained at healthy levels, and the layoffs rate was historically low. Contacts in our region continue to express difficulty finding workers with sufficient skills, and more firms say they are starting to increase salaries for skilled workers.

Residential real estate activity has been mixed. The housing sector has lost a bit of steam but should continue on a modest upward trajectory. Signs of continued strength include the robust 12.4 percent growth in new home sales in July, their highest reading in this recovery and the fifth straight month of growth. However, construction starts in August declined 5.8 percent. Single-family permits, on the other hand, increased 3.7 percent, indicating that starts may have bounced back in September. Additionally, house prices continue to rise at a moderate pace, and fundamentals remain healthy. Incomes are growing, and mortgage rates remain low. All told, the recent data indicate that residential investment is likely to make a somewhat smaller though still positive contribution to third quarter economic growth.

The latest ISM manufacturing index reading, at 49.4, indicates a slight contraction in this sector, but other indicators suggest manufacturing is improving. The previous four readings of the ISM index were all in expansion territory, and the latest factory orders data jumped noticeably, reversing the very weak numbers in June. Core orders came in at a solid 1.5 percent. Manufacturing industrial production, on the other hand, was relatively flat throughout the first two months of this quarter. Our regional contacts remain upbeat, but it is clear that manufacturing is not out of the woods yet.

On the inflation front, there are some glimmers of firming in August's CPI inflation index. The effects of the dollar's appreciation may be waning, and with gas and oil prices also stabilizing, there may be less drag on inflation going forward. Headline and core PCE price indexes were flat in July, and the 12-month change in core PCE inflation remained at 1.6 percent. But both the headline and core CPI price indexes rose 0.2 percent in August, and the 12-month change in the core index of 2.3 percent was its highest reading during the expansion. That said, inflation remains stubbornly below the 2.0 percent target of the Federal Open Market Committee (FOMC).

Meanwhile, inflation expectations as measured by the spread between nominal Treasury yields and Treasury Inflation-Protected Securities (TIPS) also remain below the 2 percent target, whereas survey measures on longer-run inflation expectations, such as those contained in the Survey of Professional Forecasters (SPF), remain consistent with the FOMC's long-run target. Given the accommodative stance of monetary policy and the stabilization of both energy prices and the dollar, 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, and employment growth remains solidly above the rate that would imply no change in the unemployment rate. Most forecasts, including those made by FOMC participants, continue to anticipate slightly above-trend economic growth and a gradual return of inflation to target.

That said, headline and core measures of PCE inflation remain stubbornly below the FOMC's target, and we admit to some uncertainty regarding whether inflation will move steadily higher.

The economic forecasts in September's Summary of Economic Projections (SEP) indicate that the majority of FOMC members expect the economy to grow at a roughly trend-like rate of 2.0 percent and for inflation to gradually return to target. Notably, there was a 50 basis point reduction in the appropriate path of tightening, with the funds rate reaching only 2.6 percent by the end of 2019. That would still leave the funds rate below the median projection of the long-run neutral funds rate of 2.9 percent, which is 0.1 percent below what was projected in June and down from the 3.5 percent projection of 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 second quarter of 2016. The forecast begins in the third quarter of 2016 and extends through the fourth quarter of 2019. 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 about 1.9 percent (Q4/Q4) in 2016, rising to 2.6 percent in 2017 and 2018, and 2.8 percent in 2019.
- Core PCE inflation reaches 1.9 percent (Q4/Q4) in 2016, rising to 2.1 percent in 2017 and to 2.3 percent in 2018 and 2019.

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 4.2 percent in the fourth quarter of 2017 and then edges up to 4.4 percent by the end of 2019.⁴
- The federal funds rate rises to 1.1 percent at the end of 2016 and reaches 2.2 percent at the end of 2017, 2.9 percent at the end of 2018, and 3.3 percent at the end of 2019.
- Compared with the June forecast, real GDP growth is about unchanged, inflation is slightly weaker, the unemployment rate declines a bit more, and the rise in the federal funds rate is slightly weaker over the forecast horizon (Figures 5 a, b).

The baseline forecast calls for output growth to accelerate from 1.1 percent in the second quarter of 2016 to 2.9 percent in the third quarter. Growth then hovers within a range of 2.5 percent to 2.7 percent over 2017 and 2018.⁵ A slight acceleration to 2.8 percent growth occurs in 2019. The unemployment rate continues to decline, reaching 4.2 percent and rising gradually to 4.4 percent at the end of 2019. Moderately strong growth and anchored long-run inflation expectations lead to an acceleration of core PCE inflation from 1.8 percent in the second quarter of 2016 to 2 percent by year-end. Inflation then edges up to 2.3 percent by the end of 2018 and through 2019. 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 rises to a bit over 1 percent at the end of 2016 and then increases on a modest path to 2.2 percent at the end of 2017 and 3.3 percent at the end of 2019.

The baseline forecast is somewhat stronger than the median projections from the third quarter 2016 SPF. In that survey, the respondents expected real output growth of 1.5 percent in 2016, 2.3 percent in 2017, and 2.2 percent in both 2018 and 2019. (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 4.6 percent in 2017 and 2018, rising to 4.7 percent in 2019.

The September 2016 SEP by FOMC participants shows the median projection for output growth at 1.8 percent in 2016, 2 percent in 2017 and 2018, and 1.8 percent in 2019. The median forecast of the unemployment rate is 4.8 percent in the fourth quarter of 2016, falling to 4.6 percent in the fourth quarter of 2017, edging down to 4.5 percent in the fourth quarter of 2018,

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.

and then moving up to 4.6 percent in the fourth quarter of 2019. Core PCE inflation is projected at 1.7 percent in 2016, rising to 1.8 percent in 2017 and to 2 percent in 2018 and 2019. Headline inflation is weaker in 2016 at 1.3 percent, but as energy prices stabilize, headline inflation is expected to run at a similar pace as core inflation over 2017–2019. The forecast model’s baseline forecast for the federal funds rate (Figure 4) is now well above the central tendency of the September 2016 SEP over the forecast horizon and remains well above market expectations for the funds rate, which are 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:

- 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 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 about 2.2 percent by the end of 2017, which is well above current market expectations of what the federal funds rate will be at that time.

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.

The alternative policy rules suggest different current levels of the appropriate federal funds rate. The baseline puts the funds rate at 0.7 percent in the third quarter of 2016, compared with 1.2 percent for the Taylor (1993) rule. The Taylor (1999) rule suggests a more accommodative policy, with the federal funds rate at 0 percent in the third quarter of 2016.⁷ 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 second quarter of 2016. The inertial Taylor rule suggests the funds rate at 0.4 percent in the third quarter of 2016, about the current actual setting. Looking ahead, all the rules indicate a further tightening of policy in the fourth quarter of 2016, when the funds rate stands at 1.4 percent for the Taylor (1993) rule, 0.9 percent for the Taylor (1999) rule, and 0.7 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 third 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 2.5 percent in the fourth 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 fourth quarter of 2016. Note, though, that the output growth forecasts largely converge by the third quarter 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 1.9 percent (Q4/Q4) in 2016 and shows little dispersion over the forecast horizon across the alternative policies. Core inflation is lower over the forecast horizon compared with the June projection largely due to the softer reading for core PCE that was realized in the second 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

⁷ We have not constrained the model to have a nonnegative interest rate in the estimation or simulation.

funds rate should be somewhat above 1 percent in the first quarter of 2017 and call for more aggressive policy normalization compared with financial market expectations.

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

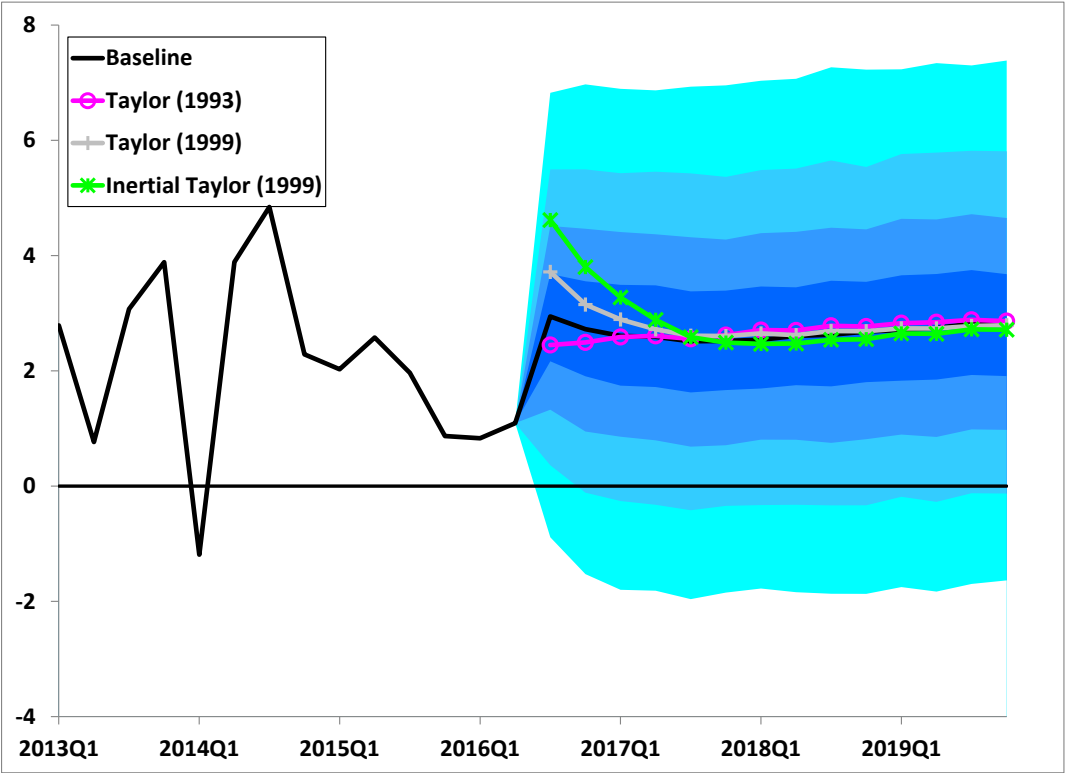


Figure 2: PCE Core Inflation

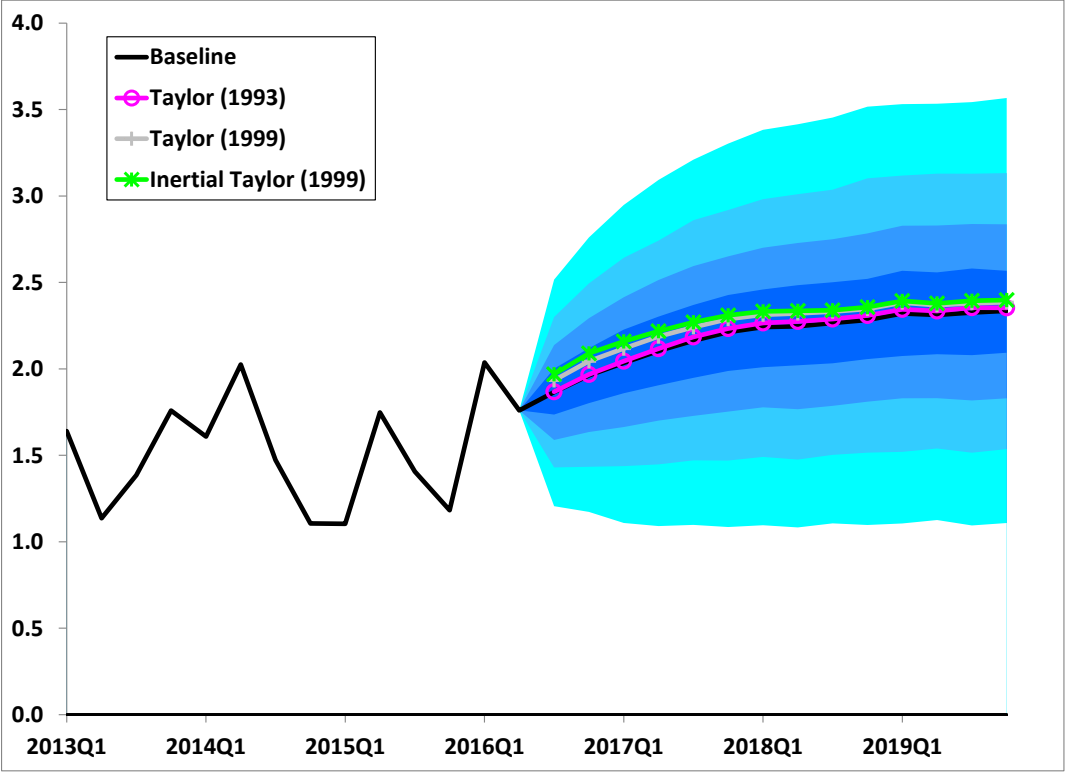


Figure 3: Unemployment Rate

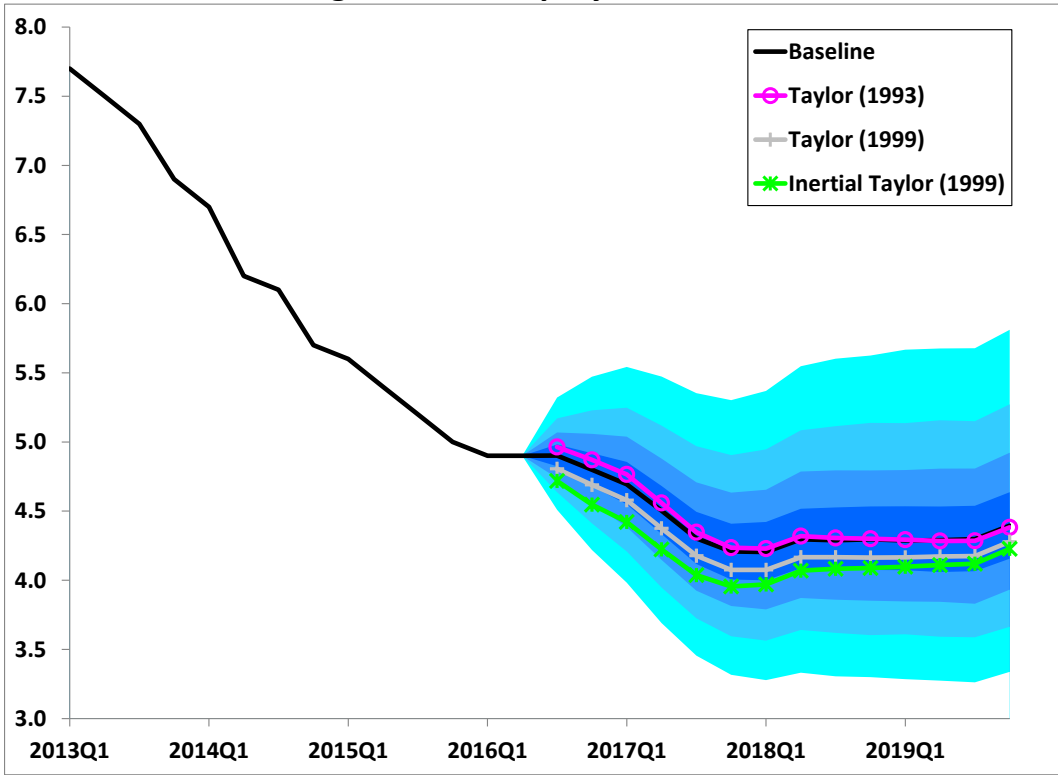


Figure 4: Federal Funds Rate

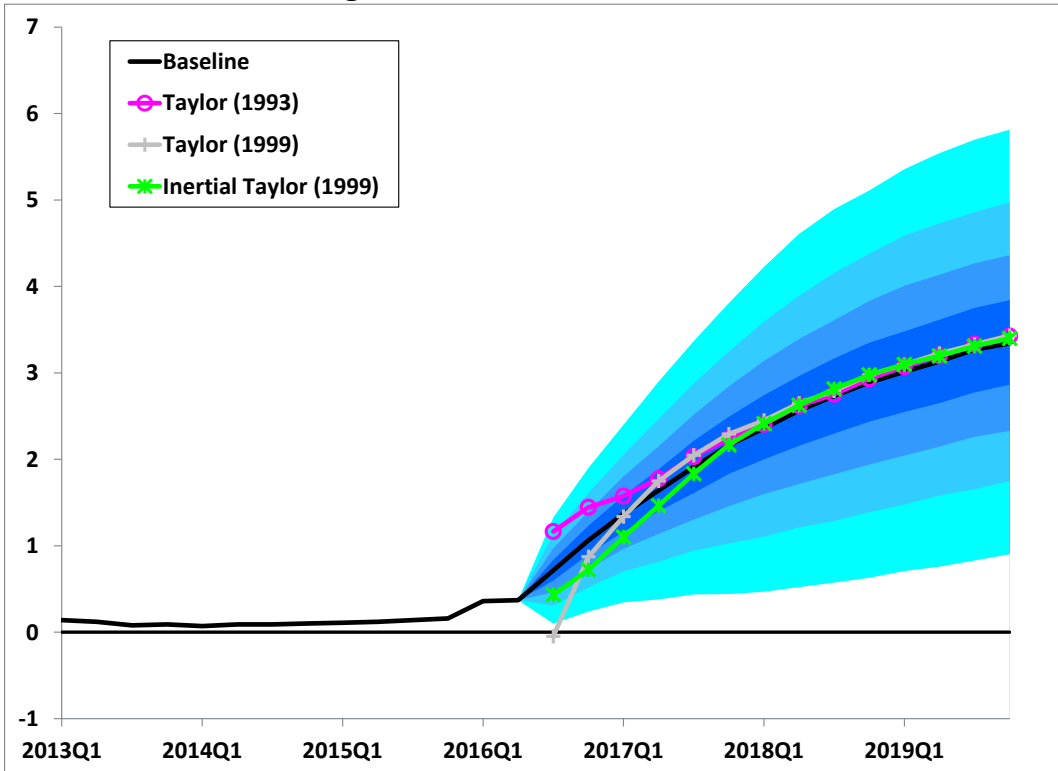


Figure 5: Baseline Forecast Comparisons

Figure 5a: Real GDP Growth

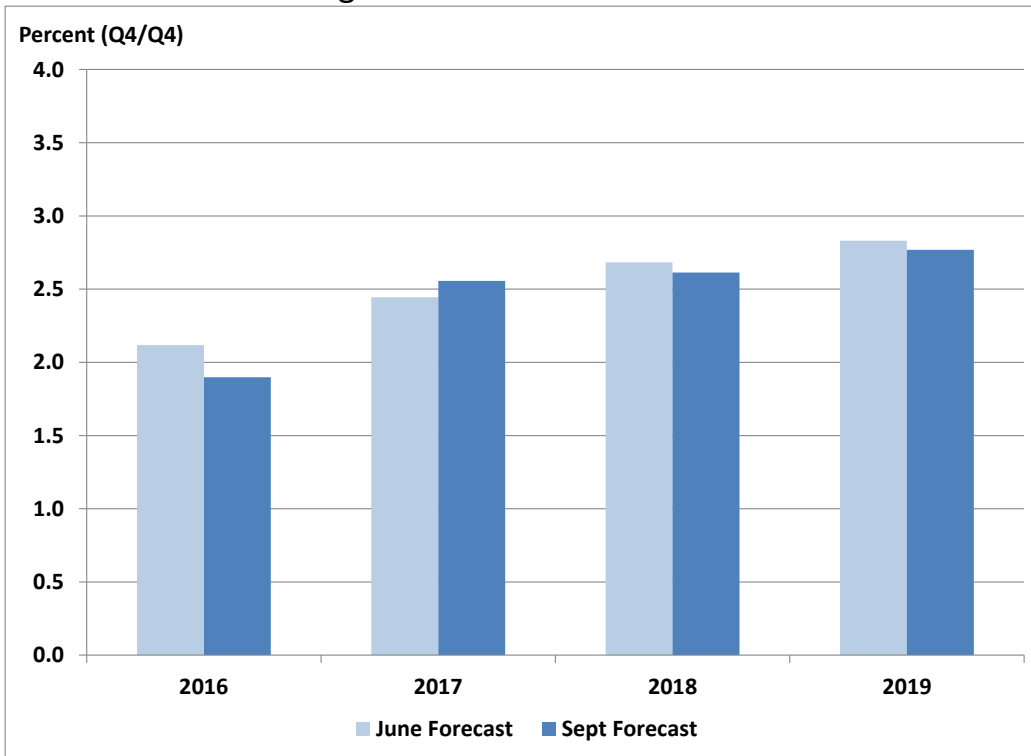


Figure 5b: PCE Inflation Growth

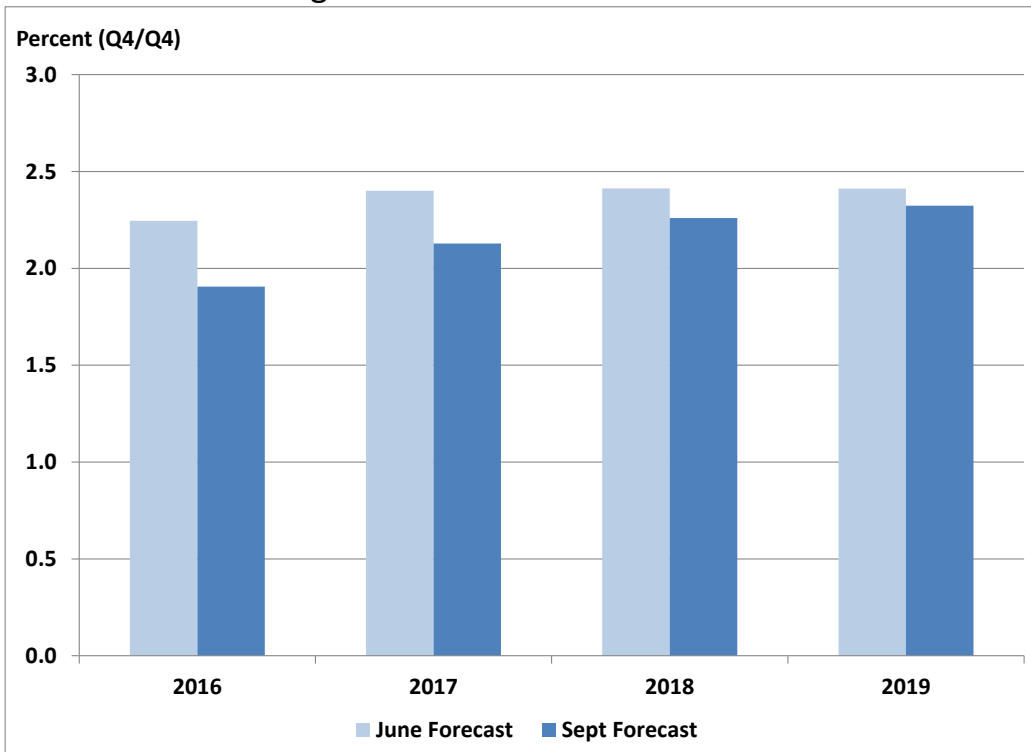


Figure 5c: Unemployment Rate

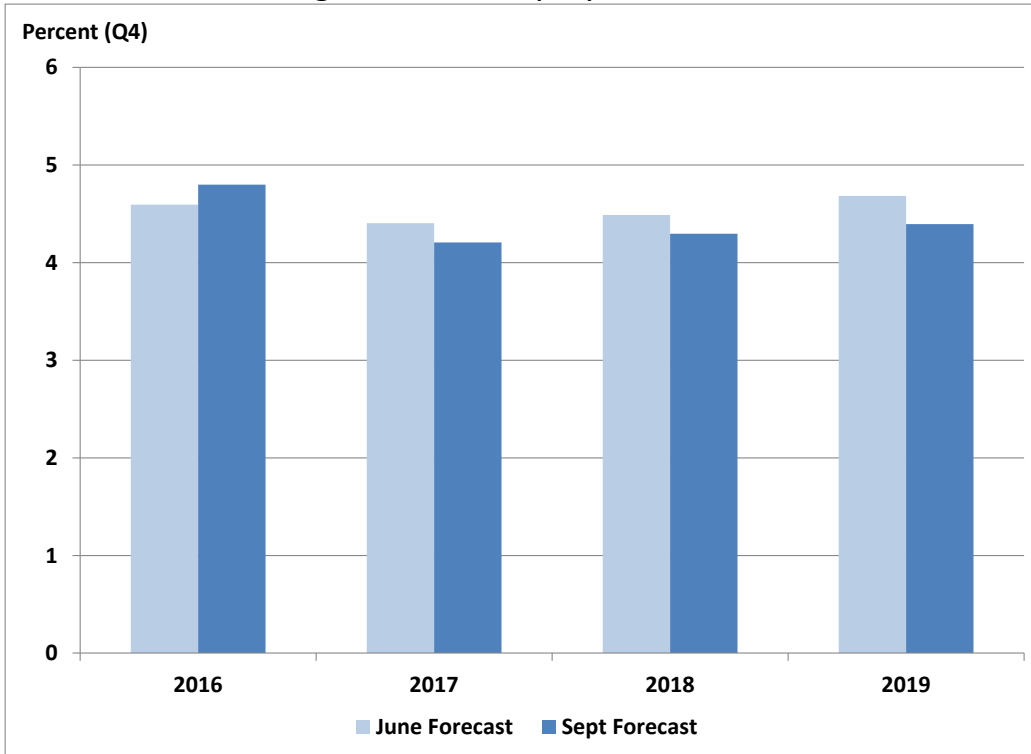


Figure 5d: Federal Funds Rate

