Monetary Policy Report:
Using Rules for Benchmarking

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Introduction

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

We begin with an overview of the economy and some heightened risks that could impede the economy going forward 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.

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[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.

Economic Overview

The labor market's performance moderated in September, with 142,000 net jobs added, and July and August's gains were revised downward by a total of 59,000. Employment gains now average about 167,000 a month for the third quarter and about 199,000 over the past six months, which is below the six-month average of 275,000 that had prevailed in February. September's weaker totals were broad based across industries. A broader measure of labor market slack, U6 — which includes marginally attached workers and those who report that they are working part time for economic reasons — fell to a still-elevated 10.0 percent in September. Also, wage growth remains modest. Nevertheless, job growth has been brisk enough to bring the unemployment rate down to 5.1 percent, where it remained in September. Thus, unemployment is below most estimates of the natural rate of unemployment. Additionally, the number of job openings soared in the latest report, to 5.75 million in July, achieving yet another record high, and the layoff rate returned to its record low of 1.1 percent. Overall, the labor market should continue to underpin moderate growth in consumer spending.

The continued moderate strength in consumer spending was reflected in the retail sales report for August. Over the past three months, core sales have grown at a fairly healthy 5.5 percent. Core sales came in unexpectedly strong in August, and July's numbers were revised substantially upward. Fairly robust growth in personal income should help keep consumer spending growing above trend, as reflected in August's robust pace of light vehicle sales — a 17.7 million-unit annual rate. Thus, consumption appears to be advancing in line with strong fundamentals, and consumer confidence remains high.

Manufacturing has remained rather sluggish, with a decline in manufacturing industrial production (IP) of 0.5 percent in August. Much of the decline was attributable to low vehicle assembly numbers. Overall IP is projected to grow at only a 2.3 percent annual rate this quarter. On a brighter note, we have seen a rebound in core orders of late, with a growth rate of 12.0 percent over the past three months. However, the August manufacturing survey from the Institute for Supply Management (ISM) fell to 51.1, its lowest reading since May 2013, and the new export orders index declined to 46.5, its lowest level since April 2009. On net, the manufacturing sector is not expected to add significant impetus to growth in the near term. In contrast, the service sector appears to be quite healthy, with the ISM nonmanufacturing index reading of 59.0 in August, placing it quite close to its historical peak.

The housing sector continues to improve. In July, private residential construction rose 1.1 percent, and sales of both existing and new homes increased. Housing starts remained relatively strong in August, and that strength has moved primarily to the single-family sector of the market, which compared with multifamily construction is less volatile and more supportive of consumer spending. Further, single-family permits rose significantly in August, indicating that the housing

sector will continue to grow. House prices continued to increase modestly, with the Federal Housing Finance Agency monthly index rising 5.4 percent year over year. Private nonresidential construction also increased in July, by 1.5 percent, and the construction sector appears to be rebounding strongly after surviving a weak winter.

On the inflation front, there is little sign of inflationary pressures. The headline consumer price index (CPI) declined 0.1 percent in August, and the 12-month change in the core CPI remained at 1.8 percent, although there has been some deceleration in the past three months. Oil prices remained low and volatile, and headline personal consumption expenditure (PCE) inflation has increased a mere 0.3 percent over the past 12 months. Core PCE inflation also remains muted at 1.2 percent, and inflation expectations as measured by the spread between nominal Treasury yields and Treasury Inflation-Protected Securities remain below the Federal Open Market Committee's (FOMC) 2 percent target.

Overall, economic growth has recovered since the first quarter of 2015, with a very strong second quarter gross domestic product reading of 3.9 percent and with most forecasts expecting slightly above-trend growth over the near term. Although inflation remains muted and employment has moderated, we continue to believe that the economy has returned to a fairly normal state of activity, and as we discuss here, our benchmarking indicates that monetary policy should follow suit.

However, a number of risks to the downside have materialized since our June report. China's growth seems to have slowed materially, and the uncertainty over the extent of the slowdown has led to both declining stock markets worldwide and a significant increase in volatility. Thus, the global outlook appears weaker and riskier. With the exception of exports, we have not seen any pronounced effects on the U.S. economy, but the weaker outlook and the moderation in job growth bear watching. U.S. stock prices have retrenched significantly from their peak, and the effect of that decline is uncertain. Keep in mind, however, that the stock market is a historically poor indicator of future economic activity. As Paul Samuelson famously observed, "Wall Street indexes predicted nine out of the last five recessions."[2]

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 Federal Reserve Board of Governors. This medium-scale model shares many features of standard New Keynesian Dynamic Stochastic General Equilibrium models that are at the forefront of macroeconomic modeling and forecasting. The EDO model features households

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[2] Paul Samuelson, as quoted in *Newsweek*, September 19, 1966. Also see the article by Leonard Mills in the September/October 1988 issue of the Federal Reserve Bank of Philadelphia *Business Review*.

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

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

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

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

Table 1

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

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

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 2015. The forecast begins in the third quarter of 2015 and extends through the fourth quarter of 2018. The forecasts under

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[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.

the baseline and the alternative policy rules are shown in Figures 1 through 4. The baseline forecast is represented by the dark solid line. The colored bands around the baseline forecast represent 10 percent confidence intervals of the predictive distribution around the median of the baseline forecast.[4]

The key features of the baseline forecast are as follows:

- Real output is forecast to grow at an average pace of about 2.9 percent in 2015, 2.8 percent in 2016, 2.6 percent in 2017, and 2.7 percent in 2018.

- PCE inflation averages 1.5 percent in 2015, rising to 1.8 percent in 2016 and 2.0 percent in 2017 and 2018.

- The unemployment rate falls gradually to about 4.9 percent in mid-2016 and then rises gradually to 5.1 percent in 2017 and 2018.[5]

- The federal funds rate begins rising immediately and reaches 0.8 percent in the fourth quarter of 2015, 2.0 percent in the fourth quarter of 2016, 2.6 percent in the fourth quarter of 2017, and 3.1 percent in the fourth quarter of 2018.

- Compared with the June forecast, we now anticipate stronger real GDP growth in 2015 and marginally weaker real GDP growth over 2016–2018. Inflation is a bit stronger in 2015 compared with the June report, while the unemployment rate and federal funds rate forecasts are about unchanged over the forecast horizon (Figure 5).

The baseline forecast calls for output growth to accelerate from 0.6 percent in the first quarter of 2015 to 3.3 percent in the fourth quarter of 2015. Output growth then edges down gradually to 2.6 percent by the start of 2017.[6] The unemployment rate continues to decline, reaching just below 5 percent in 2016 and then edging up to 5.1 percent by the start of 2017. Moderately strong growth and anchored long-run inflation expectations lead to an acceleration of core PCE inflation from 1.6 percent in the second half of 2015 to 2.0 percent at the end of 2017. Under the baseline policy parameterization, the output growth and inflation outcomes correspond to a gradually rising federal funds rate over the next three years. The model predicts that the funds rate lifts off from the zero bound immediately, reaching 0.5 percent in the third quarter of 2015. Thereafter, the funds rate rises at a gradual but steady pace to reach 3.1 percent by the end of 2018.

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[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.

The baseline forecast is broadly similar to the median projections from the third quarter 2015 *Survey of Professional Forecasters* (*SPF*). In that survey, the respondents expect real output growth of 2.4 percent in the second half of 2015, 2.8 percent in 2016, 2.6 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 1.5 percent (Q4/Q4) for 2015, 1.8 percent for 2016, and 1.9 percent for 2017. The *SPF* projection for the unemployment rate path continues to be a bit stronger than the baseline forecast: The median *SPF* forecast for the average unemployment rate is 5.0 percent for 2016, 4.8 percent for 2017, and 4.7 percent for 2018.

The September 2015 Summary of Economic Projections (SEP) by FOMC participants shows the central tendency for output growth in 2015 at 2.0 to 2.3 percent, rising to 2.2 to 2.6 percent in 2016, and then edging down to 2.0 to 2.4 percent in 2017 and 1.8 to 2.2 percent in 2018. The central tendency of the unemployment rate falls to a range of 4.7 to 4.9 percent for the fourth quarter of 2016 and then to 4.7 to 5.0 percent at the end of 2018. Core PCE inflation is projected to run between 1.3 and 1.4 percent in 2015, rising to about 1.8 to 2.0 percent in 2017 and 2018. The model's baseline forecast for the funds rate (Figure 4) is generally within the central tendency of the September 2015 SEP for the fourth quarter of 2016 and the fourth quarter of 2017 and toward the low end of the central tendency for the fourth quarter of 2018 (3.0 to 3.6 percent). The funds rate path remains well above market expectations for the fourth quarter of 2017, currently at about 1.1 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 lift off from the zero lower bound by the end of 2015.

- The more accommodative monetary policies are associated with more rapid output growth, lower unemployment, and higher inflation.

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[7] When generating the forecasts under the alternative policy rules, we assume that the state of the economy up to and including the second quarter of 2015 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 third quarter of 2015. 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.

- Most of the differences among the forecasts appear in output growth and not in inflation or unemployment. The model estimates somewhat persistent inflation measures that respond sluggishly to shocks.

- By mid-2016, the forecasts for output and inflation have largely converged across the policy alternatives. For the federal funds rate paths, convergence across rules is largely achieved by the end of 2016. The future path of the interest rate — more so than the current level of the federal funds rate — is key for the dynamics of the economy.

- The federal funds rate under all of the alternative rules nears 2.0 percent by the end of 2016, which is well above 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 third quarter of 2015. The Taylor (1993) rule calls for the most policy tightening, with a level of the funds rate at about 0.9 percent in the third quarter. At the other extreme, the Taylor (1999) rule shows the most accommodative near-term policy, with the funds rate in the third quarter of 2015 at -0.24 percent. (Note that we have not imposed a zero lower bound on interest rates in the model simulations.) The inertial Taylor rule is, on balance, the most accommodative of the policy rules, projecting a funds rate path that is below the baseline until the fourth quarter of 2016. Consequently, output growth is strongest, inflation is highest, and the unemployment rate is lowest under the inertial Taylor rule compared with forecasts under the other policy rules. Despite the near-term differences, all of the rules have the federal funds rate at about 2.0 percent by the end of 2016. So, even though the Taylor (1999) rule calls for current policy easing, the accommodation is relatively short lived. All of the rules continue to project a path for the federal funds rate that is well above market expectations derived from federal funds rate futures, which have the expected funds rate at 0.17 percent in the fourth quarter of 2015, 0.6 percent in the fourth quarter of 2016, and 1.1 percent in the fourth quarter of 2017.

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 3.1 percent in the third quarter of 2015. The inertial Taylor (1999) rule, which over the forecast horizon is the most accommodative policy, has real output growth at 5.2 percent in the third quarter of 2015. These forecasts are somewhat higher than private forecasts of growth in the third quarter that are conditioned on the most recent monthly data. Note, though, that the output growth forecasts largely converge by mid-2016 at about 3 percent. The alternative policy rules have little impact on the future path of inflation. Inflation adjusts gradually to shocks in the model and depends on the expected future path of the economy, which is similar across the policy rules in the medium and longer run. Core inflation runs at about 1.8 percent (Q4/Q4) in 2016 and shows little dispersion over the forecast horizon across the alternative policies. The inflation paths are all close to the baseline path and show relatively small differences across paths over the next three years.

Although all of the rules we examine in the EDO model have suggested for some time that it is appropriate to begin normalizing policy quickly, the FOMC is taking a deliberate approach and has not yet lifted policy off from the zero lower bound on interest rates. Why might this be? 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. It is important to keep in mind that 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.

Summary

The policy alternatives are now giving somewhat mixed signals about the appropriate current stance of monetary policy. The baseline rule and Taylor (1993) rule suggest that the federal funds rate should rise immediately. The inertial Taylor (1999) rule suggests that current policy is about appropriate. The Taylor (1999) rule suggests that policy should be more accommodative, similar to the June projection. However, the alternative policy rules agree that the funds rate should be somewhere in a range of 0.5 percent to 1.2 percent by the end of 2015 and so call for liftoff from the zero bound in 2015. Note that this prediction is somewhat higher than the central tendency for the fourth quarter of 2015 federal funds rate in the SEP for the September 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.
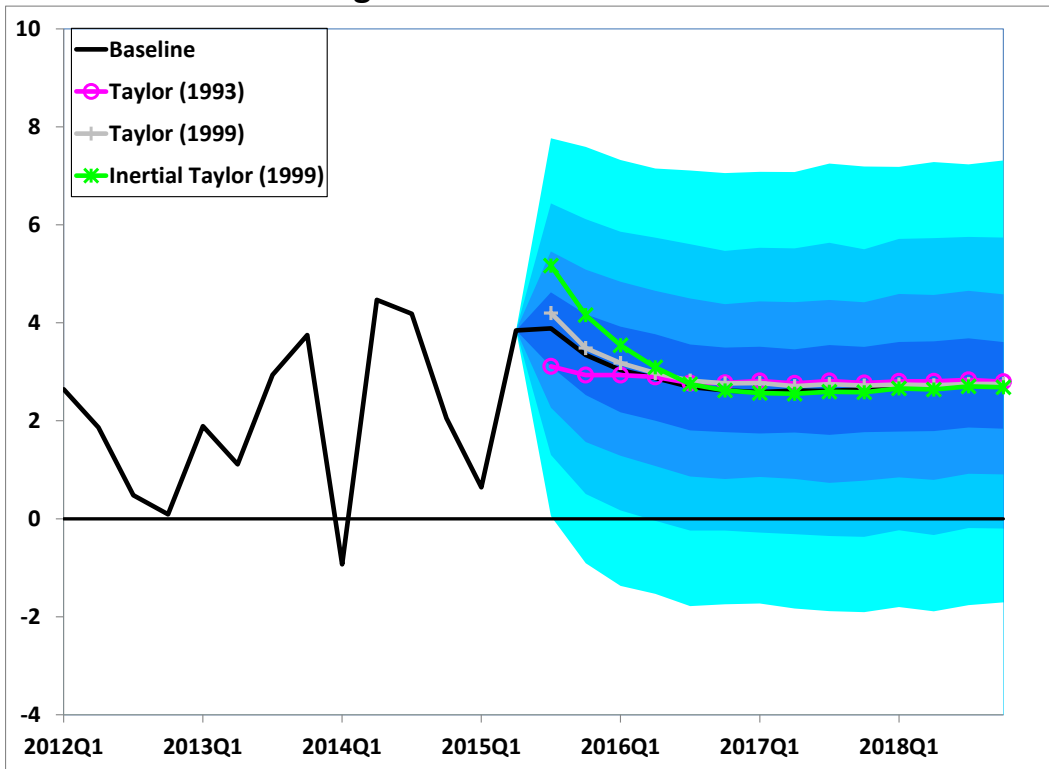
Figure 1: Real GDP Growth
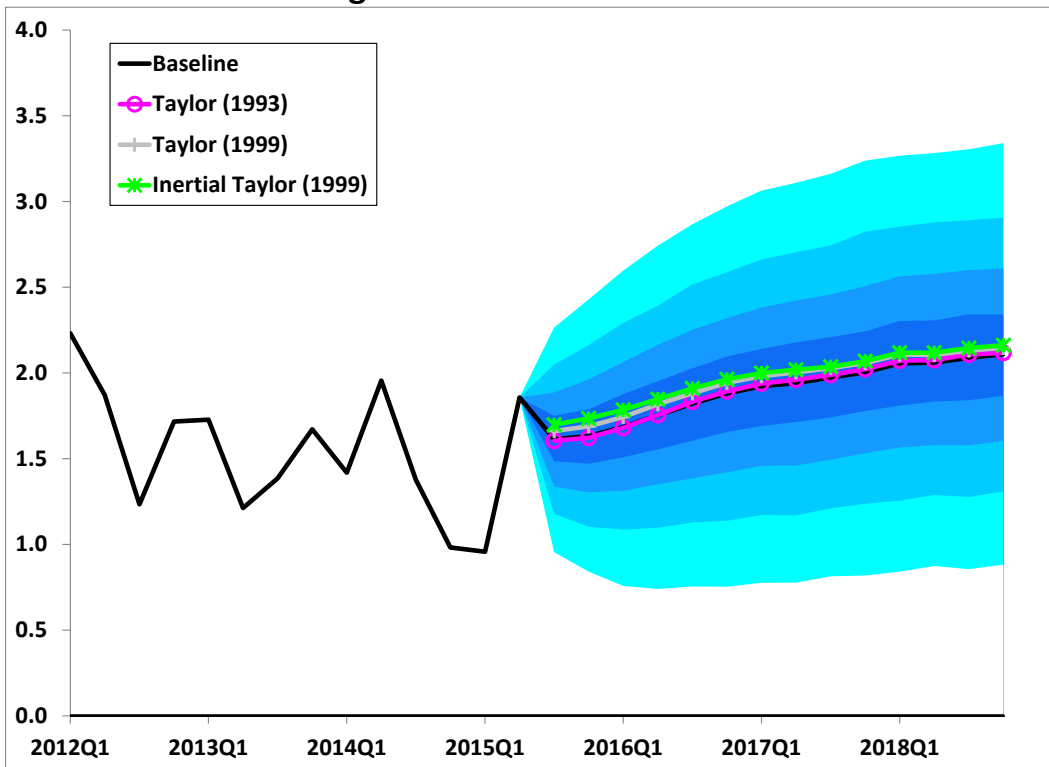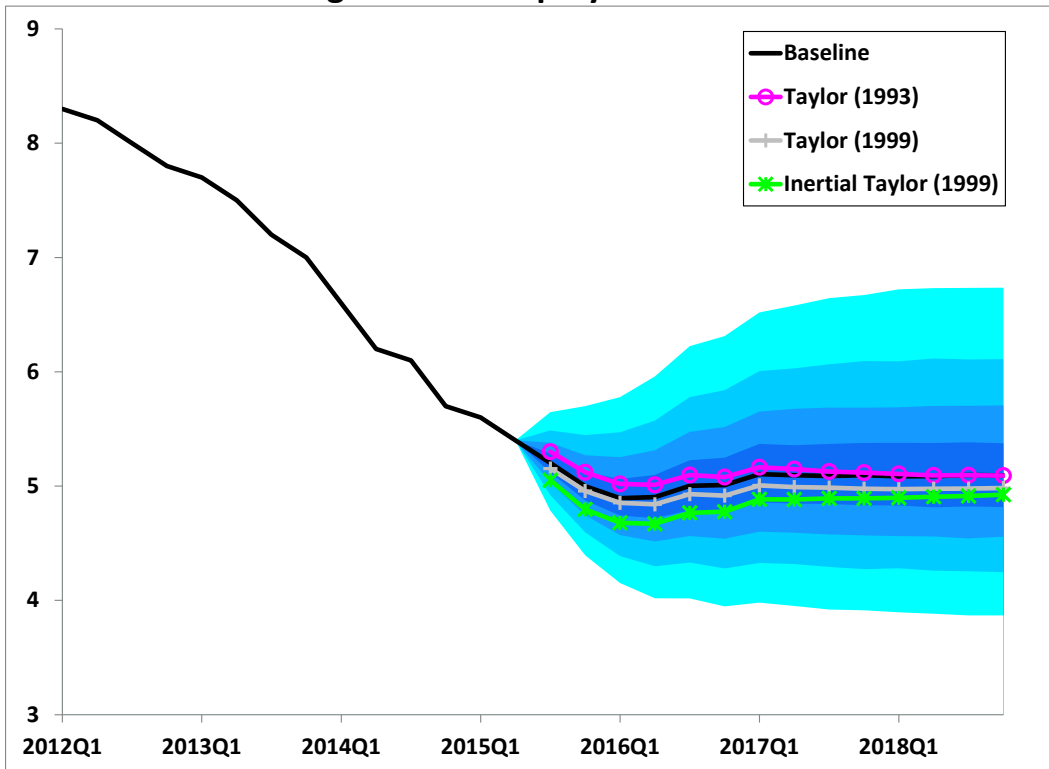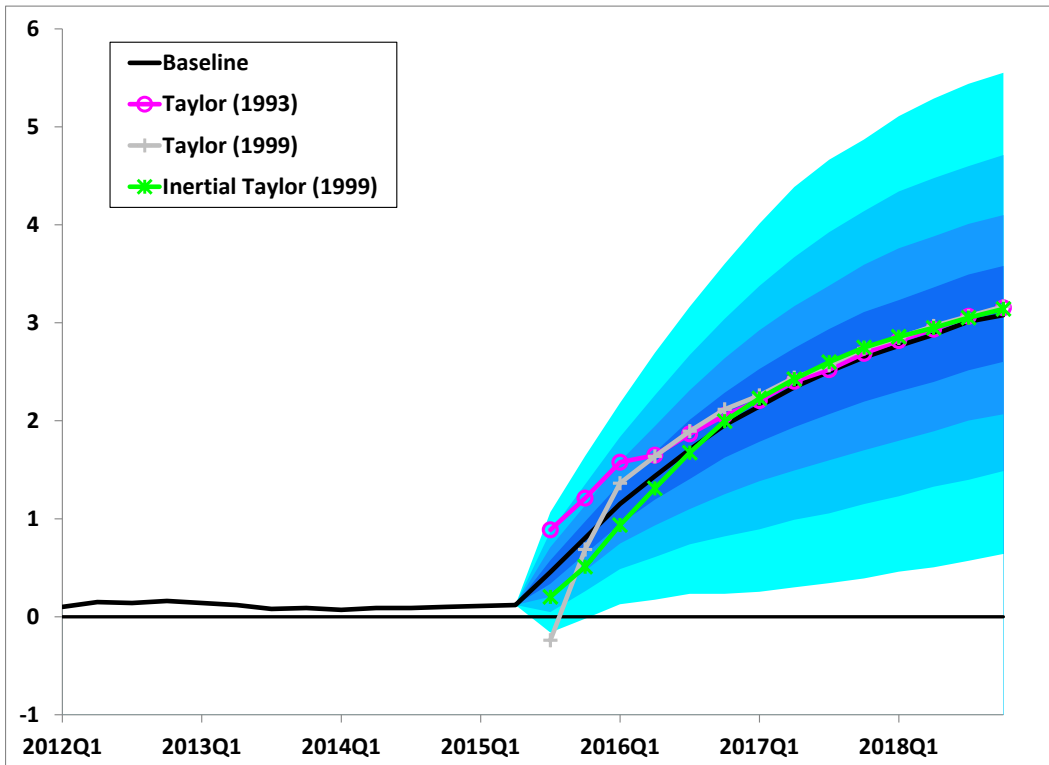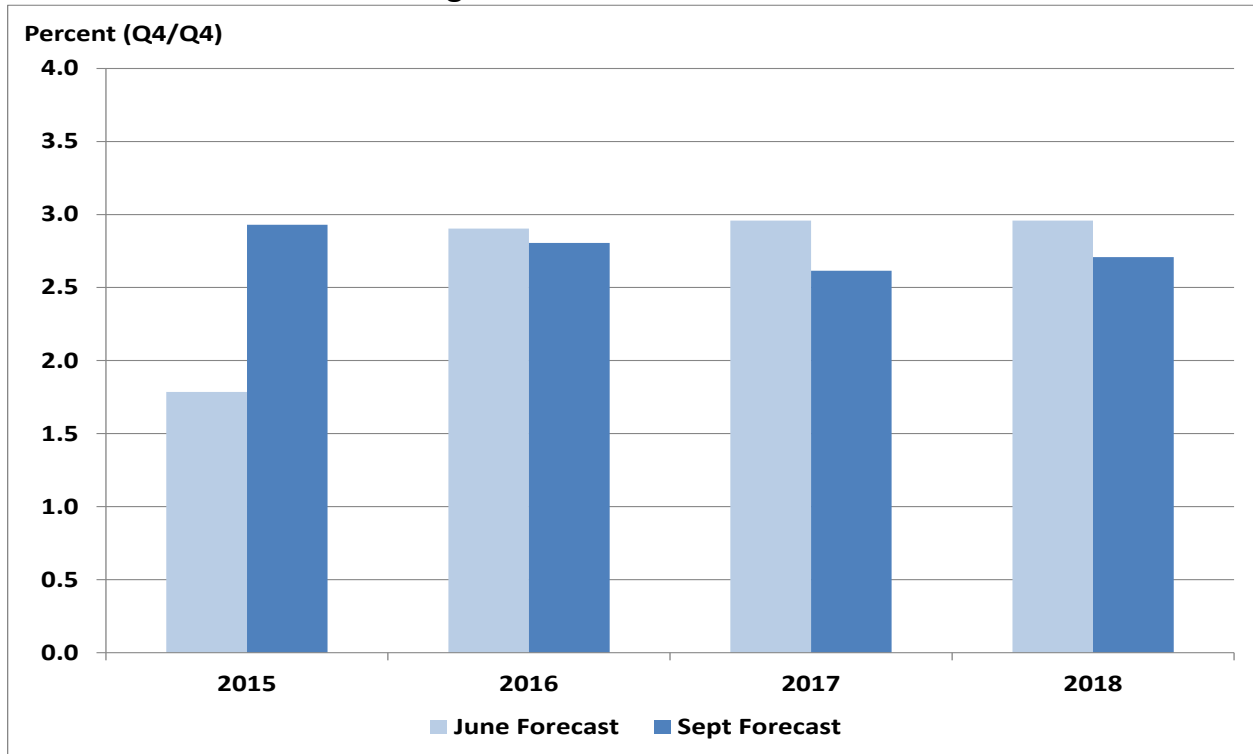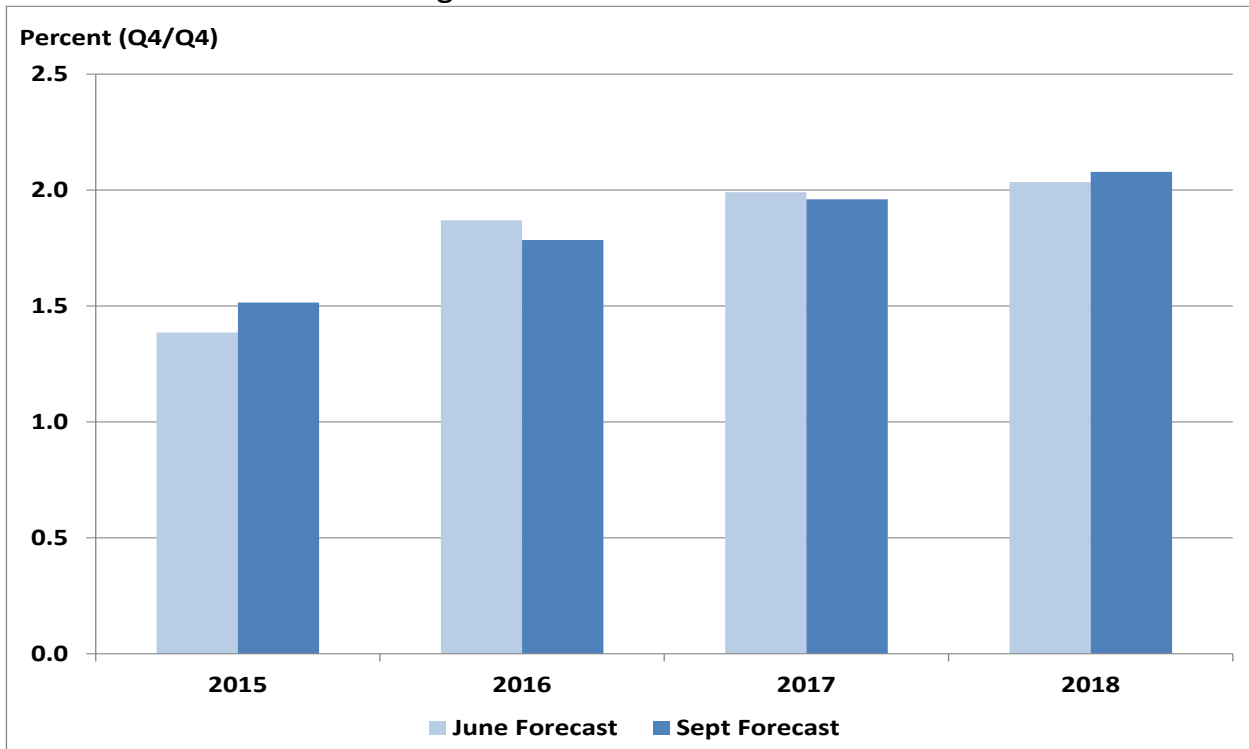

Figure 2: PCE Core Inflation

Figure 3: Unemployment Rate

Figure 4: Federal Funds Rate

Figure 5: Baseline Forecast Comparisons

Figure 5a: Real GDP Growth

Percent (Q4/Q4)

June Forecast ▪ *Sept Forecast*

Figure 5b: PCE Inflation Growth

Percent (Q4/Q4)

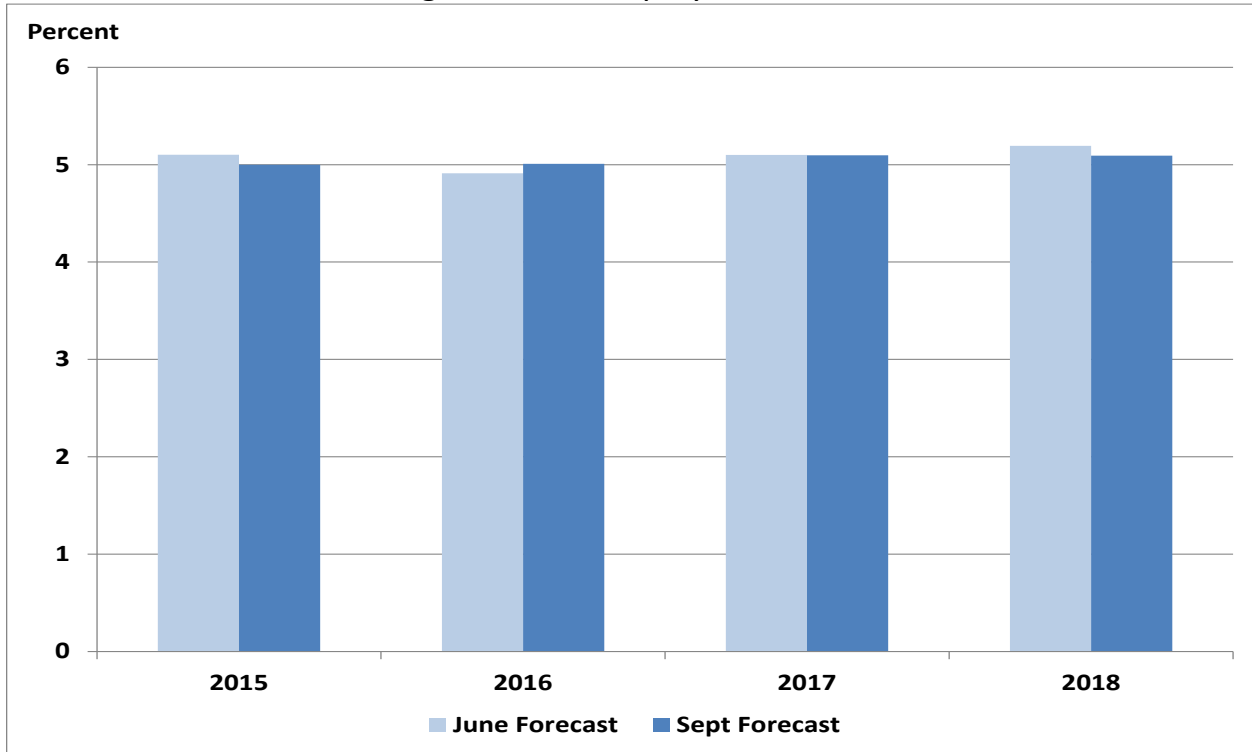*June Forecast* ▪ *Sept Forecast*

Figure 5c: Unemployment Rate

Percent

June Forecast Sept Forecast

Figure 5d: Federal Funds Rate

Percent

June Forecast Sept Forecast