SPECIAL REPORT
FEDERAL RESERVE BANK OF PHILADELPHIA

Monetary Policy Report: Using Rules for Benchmarking

Michael Dotsey
Executive Vice President and Director of Research

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

Federal Reserve Bank of Philadelphia

September 2019

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 structural forecasting model based on the New Keynesian dynamic stochastic general equilibrium methodology. 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.

Economic Overview

Economic activity in the second quarter of 2019 grew at a trend-like pace of 2.0 percent after growing at a healthy 3.1 percent in the previous quarter. Behind the headline number was considerable strength in final sales and consumption, which grew at 3.0 percent and 4.7 percent

[1] The views expressed in this report 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, Gillian Courtney, and Catherine O'Donnell for their assistance.

respectively. The third quarter is shaping up much like the second, with estimates of growth in the 1.5–2.5 percent range. The consumption-driven growth is supported by strong fundamentals, including solid job and income growth, accommodative financial conditions, and booming equity markets. Retail sales are exhibiting strong momentum, and motor vehicle sales remain at high levels, indicating that third-quarter consumption growth will likely exceed 3.0 percent. Overall, readings on consumer confidence remain elevated, and this is especially true of the Consumer Confidence index from the Conference Board.

Recent labor market data indicate that strength in the labor market is moderating, but overall conditions remain firm. Over the last three months job growth has averaged 156,000 net new jobs, which represents a decline from last year's 200,000-plus numbers. However, average hourly earnings continues to grow at greater than 3.0 percent annually, the unemployment rate remains near historical lows, and labor force participation has ticked up. Although job openings have retreated a bit, they still remain at very high rates, and the elevated quits rate implies that workers have confidence that jobs are plentiful. We continue to hear reports of supply constraints in the labor market, with firms reporting that they are using more and varied ways to attract and retain workers, including training and more flexible hours. We have also heard reports of mid-year salary increases initiated to help retain firms' existing work forces.

The most recent data on manufacturing surprised to the upside, with manufacturing output rising by 0.5 percent in August. August's rise more than reversed the decline in July. However, for the year as a whole activity is still down. Not all signs are positive. The ISM manufacturing index moved into negative territory for the first time since August 2016. Multiyear lows were reported in orders, production, and employment. Further, with the exception of the Philadelphia index, many of the regional indices are in recessionary territory. The trade war and a stronger dollar are no doubt contributing to the weakness in this sector. Economic uncertainty remains high, and firms are adjusting to reorganizations in their supply chains. Additionally, the strike at GM poses risks to economic growth, especially if the strike is prolonged. As well, investment remains weak and actually subtracted from second-quarter growth. Recent data on factory orders point to continuing weakness.

The housing sector may finally be turning the corner, with housing starts and permits hitting new highs for the expansion in August. Strength occurred in both the multifamily and single-family sectors of the market. The most recent data indicate that residential construction may be starting to rebound. Lower mortgage rates may finally be having a positive impact on housing. That said, activity is down for the year as a whole.

Inflation continues to run below the FOMC's 2.0 percent target, but recent data, especially with respect to Core CPI, has shown some upward momentum. Over the last three months to August, Core CPI inflation has accelerated to 3.4 percent, and the 12-month average rate now stands at 2.4

percent. This strength has not fully shown though to PCE inflation, which is what the FOMC targets, but it provides evidence that inflation is moving in the right direction. A bit more worrying than the actual numbers is the continued decline in market-based measures of longer-run inflation, which could be signaling the start of an unachoring of inflation expectations. However, evidence of that has yet to appear in survey measures of expected inflation. The recent behavior of inflation is certainly influencing the policy positions of a number of FOMC participants.

Economic risks have decidedly tilted to the downside. Besides the below-target inflation numbers there are a number of risks to real economic activity. The trade war with China and the uncertainty over its future course are likely influencing investment and weakening global growth, presenting a definite headwind for the U.S. economy. The recent attack on Saudi oil facilities also highlight vulnerabilities to future oil supplies. Counterbalancing those risks are some fundamental strengths in the U.S. economy, which as mentioned include a strong job market, rising equity prices, and accommodative financial conditions.

The Benchmark Model

To create our forecasts and to carry out our monetary policy benchmarking exercises, we use a structural forecasting model based on the New Keynesian dynamic stochastic general equilibrium (NKDSGE) methodology, which is at the forefront of macroeconomic modeling and forecasting. Our model features households and firms that are forward-looking and that make decisions while facing resource constraints. The model includes a labor market where firms and households engage in search-and-matching behavior—allowing us to model the unemployment rate in a meaningful way. The model features a rich menu of shocks as well as adjustment costs that make wages and prices less than fully flexible in responding to changes in economic conditions. Detailed documentation on the model structure is available from the authors upon request. We generate forecasts from the 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, $ygap_t$ is a measure of the output gap, and

ε_t^R is a monetary policy shock.[2] The parameters ρ, Ψ_π, and Ψ_y determine how monetary policy reacts to economic conditions. We run forecast simulations under four different versions of the basic rule shown here:

Table 1

Rule	$\boldsymbol{\rho}$	$\boldsymbol{\Psi_\pi}$	$\boldsymbol{\Psi_y}$
Baseline	0.85	2.62	0.53
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 NKDSGE 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 2019. The forecast begins in the third quarter of 2019 and extends through the fourth quarter of 2022. 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 a 2.3 percent annual rate over the next three years.
- Core PCE inflation reaches 2.3 percent by the end of 2019 and then rises to 2.6 percent (Q4/Q4) in mid-2021 before edging down to 2.2 percent at the end of 2022.

[2] The model calibration implies that the long-run equilibrium value of the federal funds rate is 3.5 percent. The output gap is calculated using the flexible-price version of the model. The gap is then measured as the log difference of realized output from its flexible-price counterpart. For the baseline rule, the output gap is a growth gap—the deviation of realized output growth from its longer-run trend.

[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 averages 3.6 percent in the fourth quarter of 2019, edging up to 4.2 percent at the end of 2020 and 5.0 percent at the end of 2022.
- The federal funds rate is at 2.3 percent at the end of 2019, 3.0 percent at the end of 2020, and 3.5 percent at the end of 2022.
- The comparison with our June forecast shows weaker GDP growth, somewhat higher inflation, and a more gradual rise in the federal funds rate over the forecast horizon (Figures 5a-d).

The baseline forecast calls for output growth of 2.2 percent in the fourth quarter, rising to a peak of 2.5 percent in the second quarter of 2022. The model forecast for the third quarter of 2019, at 2.5 percent, is a bit stronger than other nowcasts. The Federal Reserve Bank of Atlanta's GDPNow forecast for the third quarter of 2019 currently stands at 1.9 percent, while the Federal Reserve Bank of New York's Staff Nowcast is at 2.2 percent. As mentioned above, the NKDSGE model output forecast is made using quarterly data from the second quarter of 2019 and earlier. The incoming data since the end of June 2019 have generally been pointing to a pace of underlying growth for the third quarter that is on par with what we saw in the second quarter.

The baseline model shows output growth running at a pace near its longer-term trend over the forecast horizon.[4] The unemployment rate averages 3.6 percent in the fourth quarter of 2019 and then edges up gradually to 4.2 percent in fourth quarter of 2020. The unemployment rate continues to rise gradually over the remainder of the forecast horizon to reach 5.0 percent by the end of 2022.

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 2019 to 2.5 percent by the end of 2022. Under the baseline policy parameterization, the output growth and inflation outcomes correspond to a rising federal funds rate over the next three years. The model predicts that the federal funds rate rises to 2.3 percent at the end of 2019 and then moves up steadily to 3.5 percent by the end of 2022.

The baseline forecast is somewhat stronger than the median projections from the third-quarter 2019 Survey of Professional Forecasters (SPF) over the forecast horizon. The respondents expected real output growth of 2.3 percent in 2019, 1.9 percent in 2020, 2.0 percent in 2021, and 2.1 percent in 2022. (Note that the SPF reports GDP growth as annual average over annual average.) The SPF's core PCE inflation forecast is 1.7 percent (Q4/Q4) for 2019, rising to 2.0 percent in 2020 and falling back to 1.9 percent in 2021. The forecasters' path for the unemployment rate is

[4] The model estimates long-run real per capita output growth of about 1.6 percent. We then assume that population growth averages 0.8 percent per year over the forecast horizon.

somewhat lower than in the baseline model: The median SPF forecast for the unemployment rate averages 3.6 percent in 2020, rising to 3.9 percent in 2021 and 4.0 percent in 2022.

The September 2019 Summary of Economic Projections (SEP) by FOMC participants shows the median projection for output growth at 2.2 percent in 2019, 2.0 percent in 2020, 1.9 percent in 2021, and 1.8 percent in 2022. The median forecast of the unemployment rate is 3.7 percent at the end of 2019, edging up to 3.8 percent at the end of 2021 and 3.9 percent at the end of 2022. Core PCE inflation is projected at 1.8 percent in 2019, 1.9 percent in 2020, and 2.0 percent in 2021 and 2022. Headline inflation is projected to run at about the same pace as core inflation over the forecast horizon. The forecast model's baseline forecast for the federal funds rate (Figure 4) is largely above the central tendency of the September 2019 SEP over the forecast horizon. The baseline forecast remains above market expectations, which are at about 1.8 percent for the fourth quarter of 2019 and 1.2 percent for the fourth quarter of 2020. The model generally suggests a more rapid pace of policy normalization compared with market expectations. This normalization path keeps economic activity, inflation, 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.[5]

The key features of the forecasts under the alternative policy rules are as follows:

- The policy rules suggest that the federal funds rate should rise at a modest pace over the next three years—but more rapidly than suggested by financial markets.
- The more accommodative monetary policies are associated with more rapid output growth and higher inflation.
- The major differences among the forecasts is in the path for inflation and to a lesser extent in the near-term path for output growth (as well as in the near-term federal funds rate). The model generates very persistent inflation and interest rate outcomes.
- By mid-2020, the forecasts for output have largely converged. However, the outcomes for inflation show significant deviations from the baseline path through the forecast horizon. An important difference across the baseline and alternative rules is how the output gap is

[5] 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 2019 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 2019. 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.

measured. The baseline rule uses a growth gap—the deviation of output growth from its longer-run trend. The alternative Taylor rules use a level gap—the deviation of the level of output from the flexible-price alternative.

- The federal funds rate under the alternative policy rules is well above current market expectations of the path of the federal funds rate.

The primary reason that the alternative Taylor rules show higher near-term interest rates, lower near-term inflation, and lower near-term output growth is that as mentioned above the alternative rules use a different output gap compared with the baseline rule. As a general proposition, in NKDSGE models, the level of output depends on the future path of interest rates—hence, higher future interest rates are needed to bring the level of output down to the natural rate. This mechanism is somewhat attenuated in the inertial Taylor rule, since the lagged interest rate helps pin down the current interest rate. The Taylor 1993 and Taylor 1999 rules do not incorporate a lagged interest rate term and so are free to respond more strongly to changes in the output gap and inflation gap.

On balance, the alternative Taylor rules suggest a path for the funds rate that is not too different from that in the baseline rule. Over the near-term, the inertial Taylor rule and Taylor 1999 rule are somewhat stronger than the baseline rule, but by mid-2020 the rules are giving similar projections. Compared to last time, our interest rate projections are a bit different in that we now determine a longer-run equilibrium interest rate using data on longer-term Treasury rates rather than the model's implied steady state interest rate. Consequently, the path for interest rates are somewhat lower than in previous projections. All of the model-based rules generate paths for the federal funds rate that are significantly higher than implied by financial markets futures data.

The near-term path of output growth and the unemployment rate both show a somewhat weaker economy under the alternative rules, consistent with their higher predictions for the federal funds rate. The most dramatic difference across the forecasts is in the path for inflation. The Taylor 1999 and Taylor 1993 rules both generate significantly lower inflation paths over the medium term compared to the baseline and inertial Taylor rules. Under these rules, inflation would drop to a bit below 1.5 percent over the near term and then accelerate quickly to 2.5 percent by the end of the forecast horizon. Under the inertial Taylor rule, the economy stays stronger in the near term since the interest rate cannot adjust as quickly to eliminate the output gap. Consequently, the path for inflation is higher over the next two years compared with the other Taylor rules. By the end of 2021, inflation, unemployment, and interest rates have largely converged across the alternative rules—though at higher levels compared with the baseline rule. As time unfolds, the economy settles down to be the same across all the rules, but given the estimated persistence in the model, it takes a very long time for this to occur.

Summary

The baseline NKDSGE model uses historical correlations in the data to generate its forecasts and does not incorporate judgmental adjustment. The NKDSGE model also does not take account of data after the second quarter of 2019 and does not explicitly account for tax reform, trade policy, or recent movements in equity markets. The model continues to predict healthy output growth over the next three years and inflation rising modestly above the FOMC's 2 percent target. The unemployment rate is expected to remain steady this year and then begin edging up toward its longer-run natural-rate level. To keep inflation forces in check, the federal funds rate rises at a modest pace over the next three years—but significantly more strongly than anticipated by financial markets.

The alternative policy rules generally suggest similar outcomes to the baseline rule except for the future path of inflation. Generally, the alternative rules generate lower inflation outcomes over the near term compared to the baseline rule. However, all of the rules project that inflation will exceed the FOMC target of 2.0 percent over the medium term and have inflation running at about a 2.5 percent pace at the end of 2022. Both the estimated and alternative policy rules indicate that the federal funds rate will need to move up more rapidly than currently anticipated by financial markets as well as by FOMC participants as indicated in their SEP forecasts.

Figure 1: Real GDP Growth

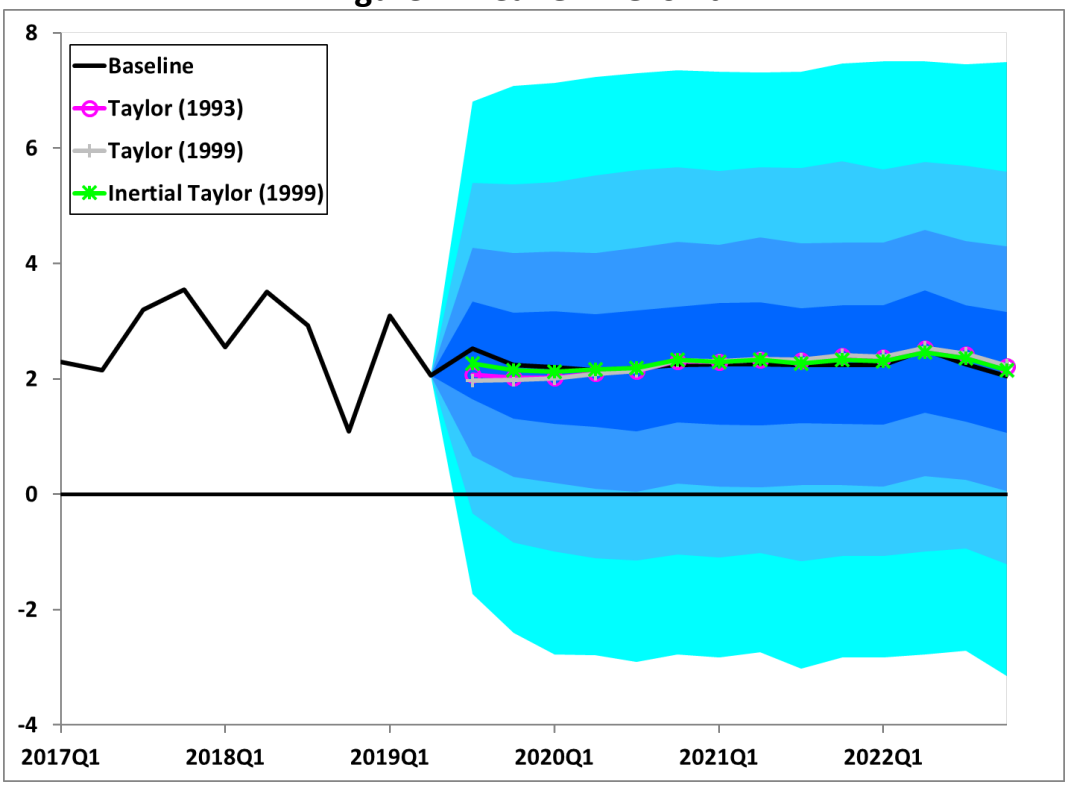


Figure 2: Core PCE Inflation

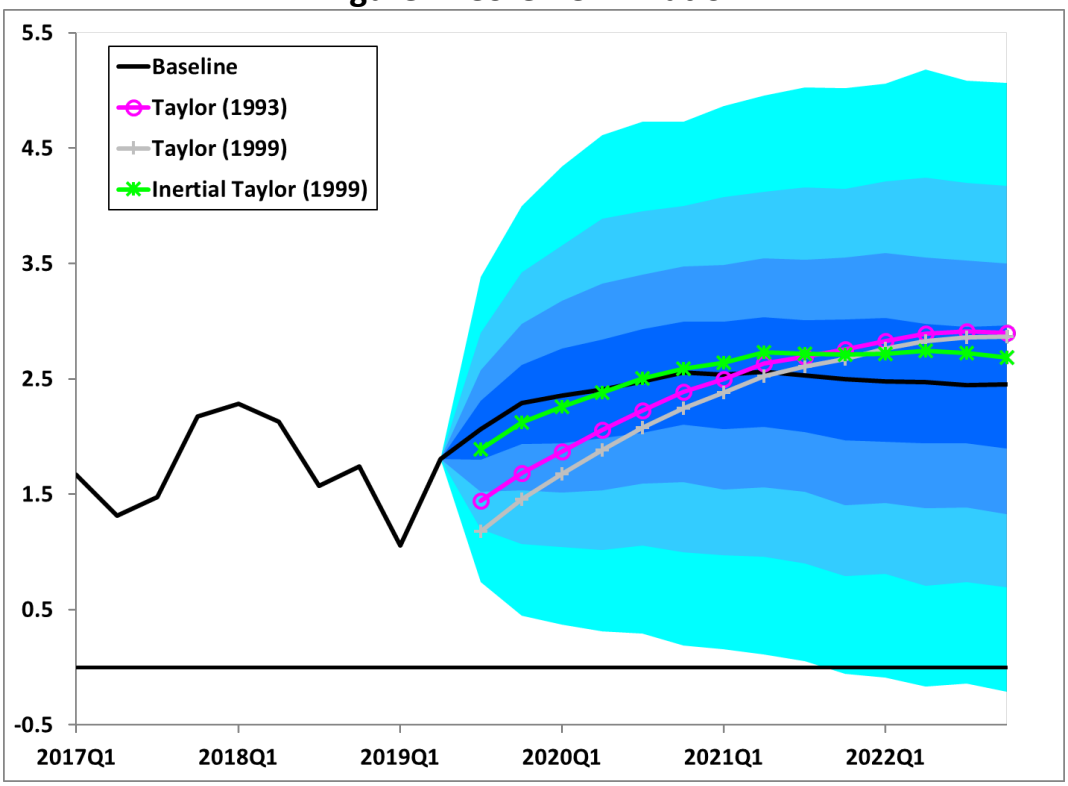


Figure 3: Unemployment Rate

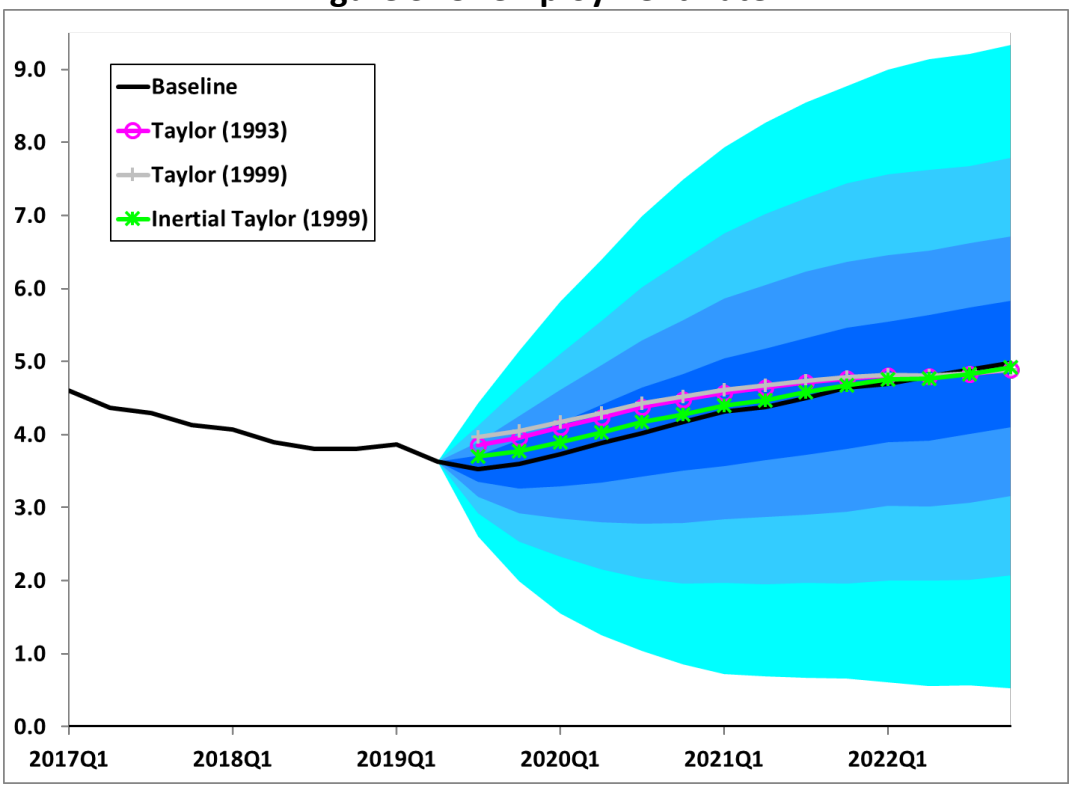


Figure 4: Federal Funds Rate

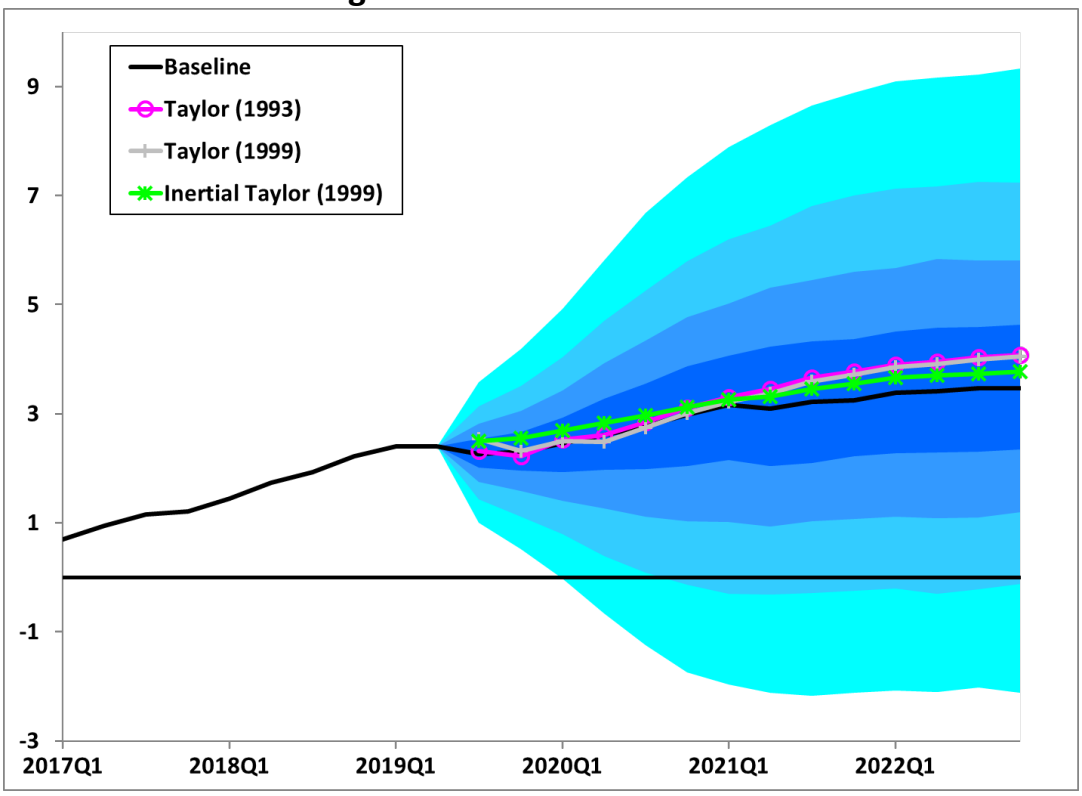


Figure 5: Baseline Forecast Comparisons

Figure 5a: Real GDP Growth

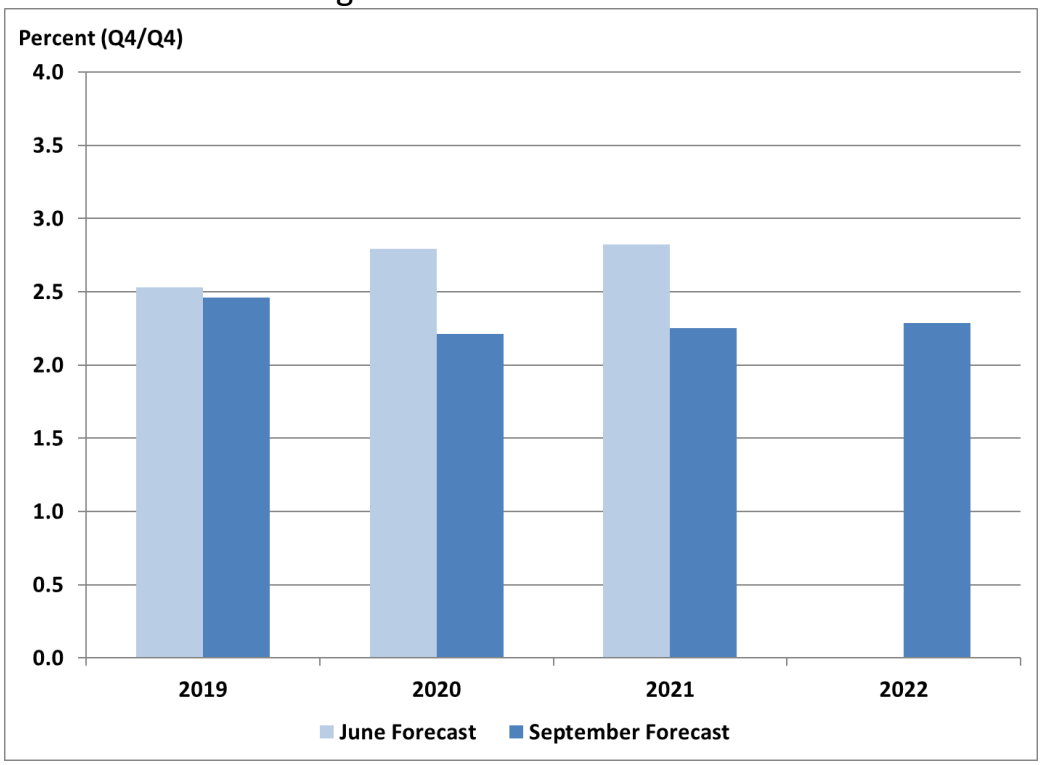


Figure 5b: Core PCE Inflation Growth

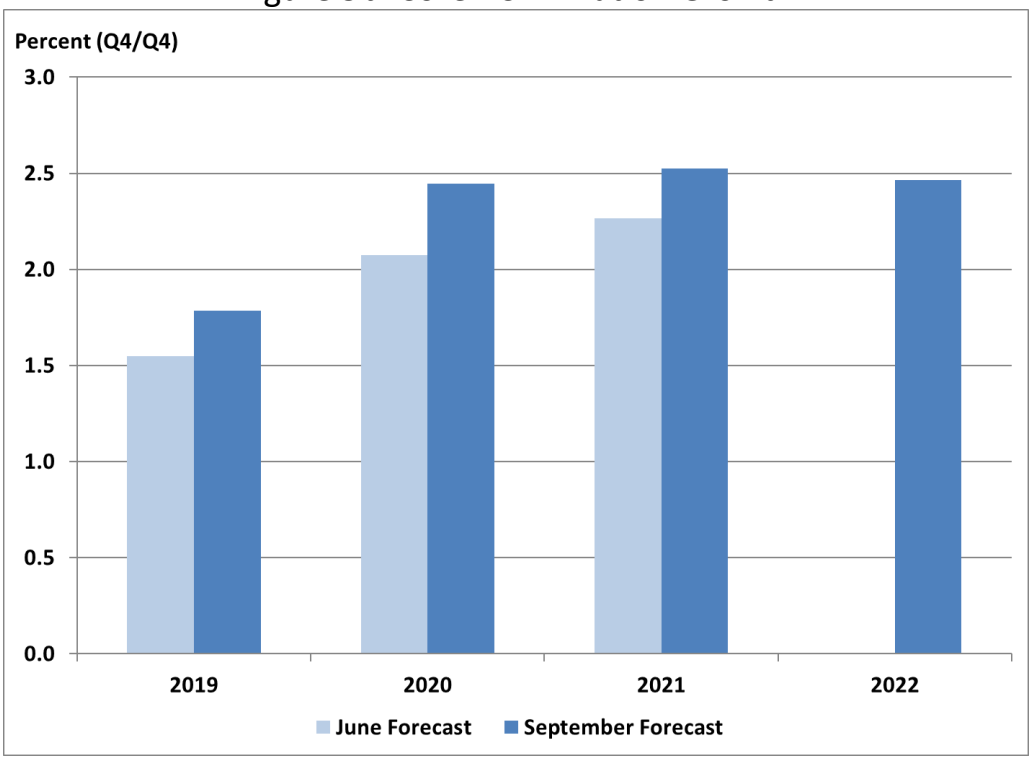


Figure 5c: Unemployment Rate

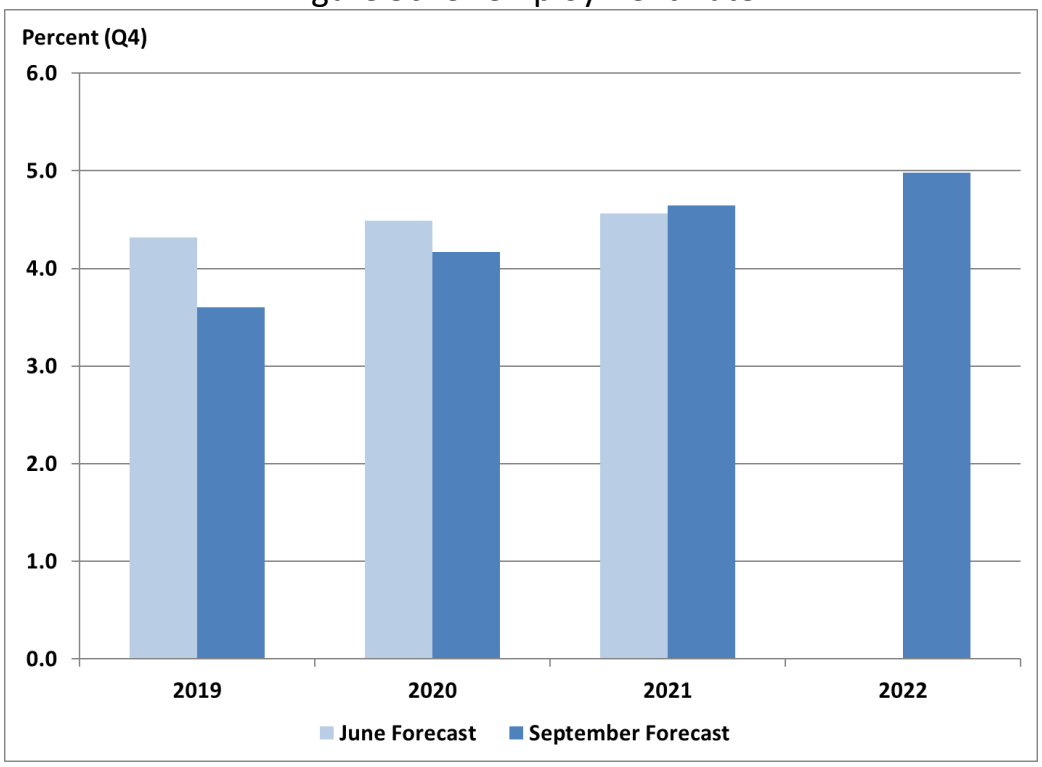
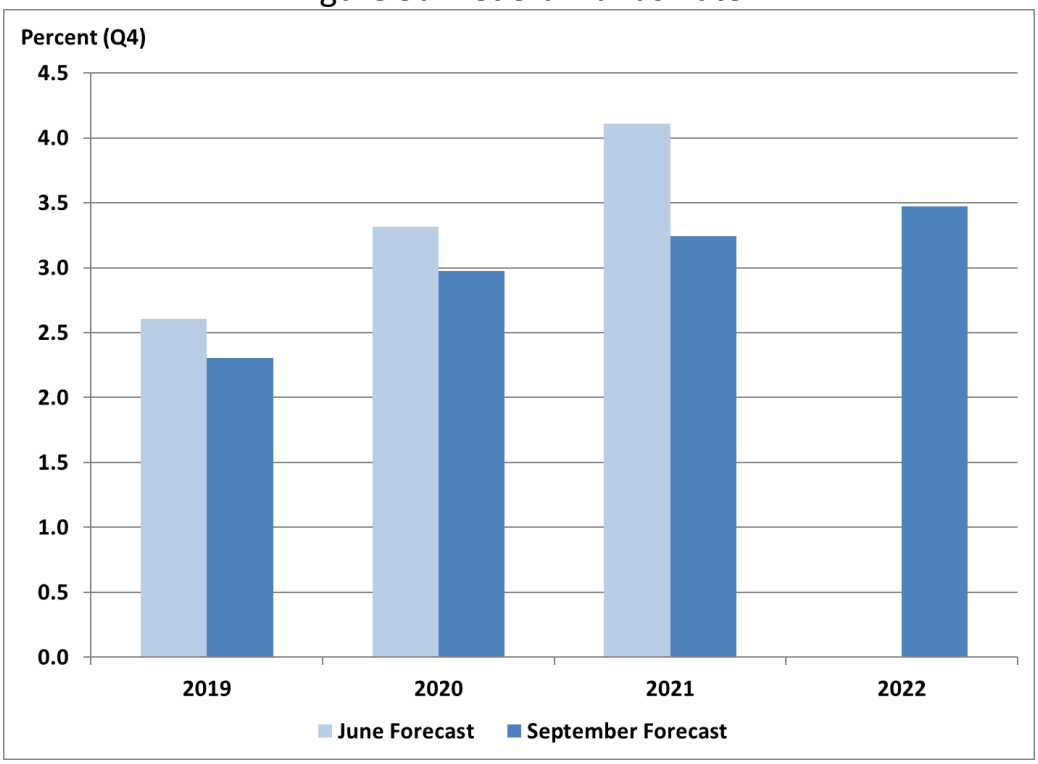


Figure 5d: Federal Funds Rate



Note: Historical data have been retrieved from Haver Analytics.