



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

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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 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 third quarter of 2019 grew at a trend-like pace of 2.1 percent after growing by 2.0 percent in the previous quarter. However, consumption growth at 2.9 percent retracted a bit after a strong second-quarter increase of 4.6 percent. Recent data on retail sales

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 Gillian Courtney and Catherine O'Donnell for their assistance.

have indicated a slowing in consumption growth, but light-vehicle sales are continuing to grow at a healthy pace. All-in-all the most recent data imply that growth in the fourth quarter may moderate further, but the greater-than-expected job growth and moderate growth in wages should support above-trend strength in consumption. Income is growing moderately, the stock market, although volatile, is at historic highs, and consumers remain optimistic. However, outside of a recent uptick in residential investment, no other factors appear likely to contribute to economic growth.

The most recent labor market data indicate that the labor market remains unexpectedly robust. November nonfarm payroll employment increased by 266,000, and October's reading was revised up to 156,000 net new jobs. Some of the strength was due to the return of striking GM workers, but over the last three months payroll growth has averaged 205,000 jobs. As well, the unemployment rate ticked down to 3.5 percent, and wage growth over the past 12 months, as measured by average hourly earnings, was a solid 3.1 percent. Thus, labor market performance should buttress consumption going forward. Anecdotally, we continue to hear of difficulties finding workers with the required skills, and surveys indicate that firms are increasingly hiring workers with lower skills and then training them. Also, more firms are looking to replace hard-to-find employees with machines.

However, it is hard to find much positive news outside of consumption. Investment was a drag on third-quarter activity, and manufacturing is not contributing positively either. However, the latest factory goods orders may indicate that fourth-quarter equipment spending could contribute to growth after subtracting from growth in the third quarter. Both core orders and shipments bounced back in October. Both series are quite noisy and have yet to show any strong upward trend. The latest data on industrial production indicated some modest increase in manufacturing activity. Although the aggregate numbers bounced back quite strongly in November, much of the jump was due to the end of the strike at GM. Survey data are generally still pointing to declining activity, although the Markit PMI remains in positive territory. Regarding the regional survey, the December Philadelphia Fed manufacturing survey was flat in December, although data on shipments and orders improved. In summary, the end of the GM strike was good news, but a strong dollar and a global slowdown will likely portend only tepid growth in this sector.

The housing sector may finally be turning the corner, with housing starts and permits moving higher over the last few months. Both single-family starts and permits are at their highest levels since the summer of 2007. Multi-family permits have also increased of late, and the news over the last few months indicates that residential investment will likely contribute modestly to fourth-quarter growth. Lower mortgage rates are finally having a positive impact on housing.

PCE Inflation continues to run below the FOMC's 2.0 percent target, and the most recent data give no signal that the target will be reached in the near-term. In October, the Core PCE declined by roughly 10 basis points on a 12-month average to 1.6 percent, while in November the Core CPI

remained at 2.3 percent. Most forecasters remain convinced that inflation will return to target over the next few years, and most FOMC members appear to share that view. Market-based measures are giving a different signal, with 10-year-ahead expectations of inflation reading 1.6 percent. However, survey measures, such as those provided in the Survey of Professional Forecasters, remain well anchored and consistent with the FOMC’s inflation objective. It is a bit too early to assess the effect of the last three rate cuts, and the FOMC has signaled that as long as data come in as expected, monetary policy will likely remain on hold.

Economic risks have moderated a bit, and most of our contacts seem a bit more upbeat about 2020 than they were a few months ago. There are still downside risks regarding weak global demand, but the risks associated with trade have ameliorated. Balancing these risks are the health of U.S. labor markets and high stock market and house price valuations.

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

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

reacts to economic conditions. We run forecast simulations under four different versions of the basic rule shown here:

Table 1

Rule	ρ	Ψ_{π}	Ψ_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 third quarter of 2019. The forecast begins in the fourth 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 2.4 percent annual rate over the next three years.
- Core PCE inflation runs at a 1.8 percent pace at the end of 2019 (Q4/Q4), rises to 2.3 percent in 2021, and then holds at that pace in 2022.
- The unemployment rate averages 3.7 percent in the fourth quarter of 2019, edging up to 4.3 percent in mid-2020, and then rising to 5 percent at the end of 2022.

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 federal funds rate is at 1.7 percent at the end of 2019, 2.2 percent at the end of 2020, and 3.2 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 1.5 percent in the fourth quarter, rising to a peak of 2.5 percent beginning in 2022. The model forecast for the fourth quarter of 2019 is within the range of other nowcasts. The Federal Reserve Bank of Atlanta's GDPNow forecast for the fourth quarter of 2019 currently stands at 2 percent, while the Federal Reserve Bank of New York's Staff Nowcast is at 0.6 percent. As mentioned above, the NKDSGE model output forecast is made using quarterly data from the third quarter of 2019 and earlier. The incoming data since the end of September 2019 have generally been pointing to a pace of underlying growth for the fourth quarter that is somewhat weaker than what we saw in the third 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 3.7 percent in the fourth quarter of 2019 and then edges up gradually to 4.3 percent in the fourth quarter of 2020. The unemployment rate continues to rise gradually over the remainder of the forecast horizon to reach 5 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 2.3 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 is at 1.7 percent at the end of 2019 and then moves up steadily to 3.2 percent by the end of 2022.

The baseline forecast is somewhat stronger than the median projections from the fourth-quarter 2019 Survey of Professional Forecasters (SPF) over the forecast horizon. The respondents expected real output growth of 2.3 percent in 2019, 1.8 percent in 2020, and 2.0 percent in 2021 and 2022. (Note that the SPF reports GDP growth as annual average over annual average.) The SPF's core PCE inflation forecast is 1.8 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 somewhat lower than in the baseline model: The median SPF forecast for the unemployment rate averages 3.7 percent in 2020 and 2021, rising to 3.9 percent in 2022.

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.

The December 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 3.6 percent at the end of 2019, edging down to 3.5 percent at the end of 2020, and then rising to 3.6 percent at the end of 2021 and 3.7 percent at the end of 2022. Core PCE inflation is projected at 1.6 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 above the central tendency of the December 2019 SEP over the forecast horizon. The baseline forecast remains above market expectations, which are at about 1.3 percent for the fourth quarter of 2020 and 2021. The model thus suggests a more rapid pace of policy normalization compared with market expectations. This normalization path keeps economic activity, inflation, and the 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.
- More accommodative monetary policy paths are associated with more rapid output growth and higher inflation. However, differences in output and unemployment rate paths across policies are now small.
- The major difference among the forecasts is in the path for inflation. The model generates very persistent inflation and interest rate outcomes.
- The forecasts for output growth and unemployment are quite similar across the policy rules in the current simulation. By mid-2021 the forecasts for inflation have largely converged. An important difference across the baseline and alternative rules is how the output gap is measured. The baseline rule uses a growth gap—the deviation of output

⁵ 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 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 fourth 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.

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 above that of the baseline rule. The alternative Taylors predict that the funds rate would be significantly higher in 2019Q4 compared to the baseline rule. The baseline is calibrated to match the effective funds rate as of December. The alternative Taylor rules predict that the funds rate should be near 2.5 percent in 2019Q4 based on economic data. Note though that the slopes of the monetary policy paths are similar across rules and when compared to the baseline. The primary difference is thus in the kick-off point for policy in 2019Q4. All of the model-based rules generate paths for the federal funds rate that are significantly higher than implied by financial markets futures data. Compared to last time, the baseline model predicts a more accommodative path for monetary policy over the next three years.

The most dramatic difference across the forecasts remains 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 about 1.6 percent over the near term and then accelerate quickly to 2.9 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 third 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 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 for the real side of the economy. 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 near 3 percent 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

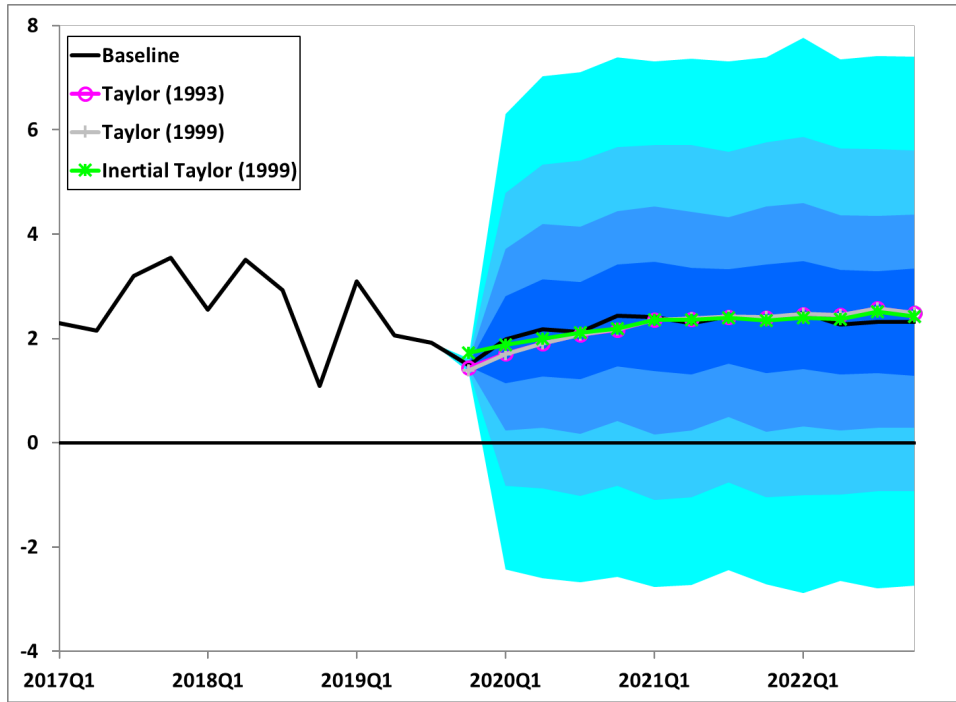


Figure 2: Core PCE Inflation

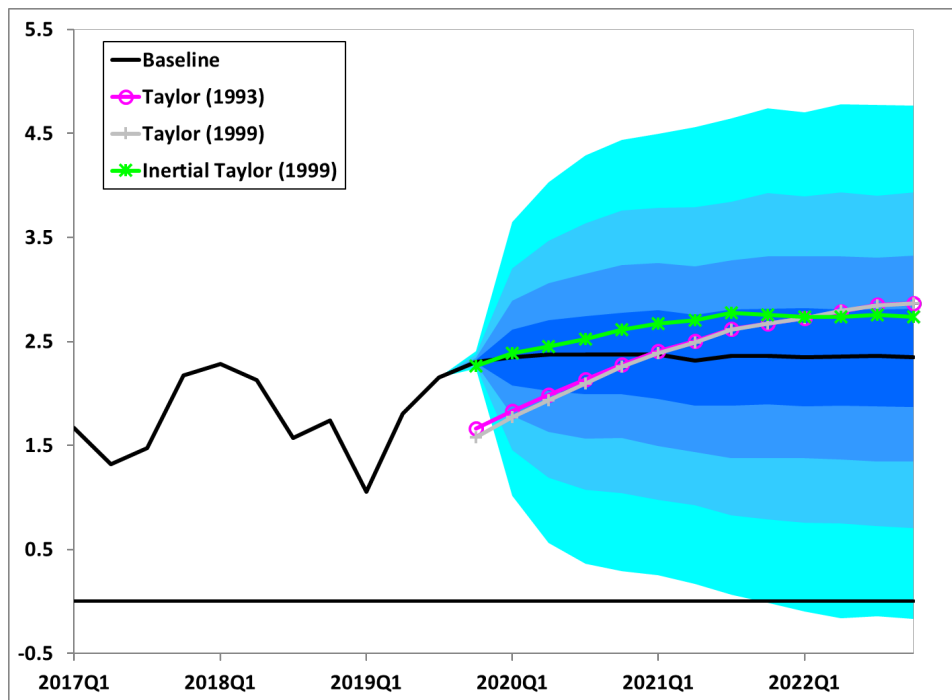


Figure 3: Unemployment Rate

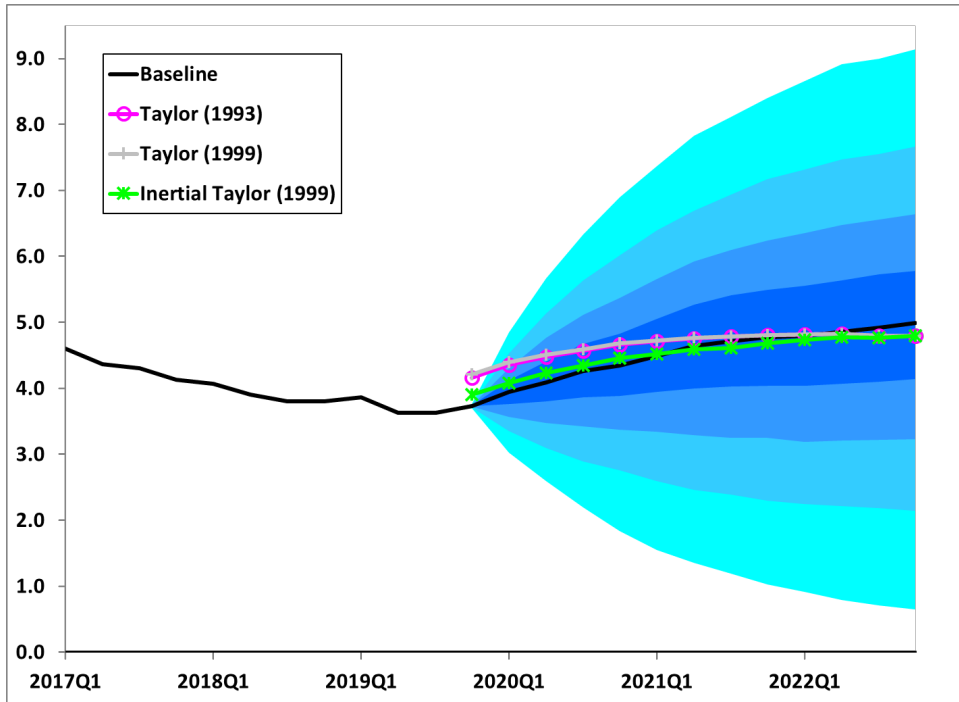


Figure 4: Federal Funds Rate

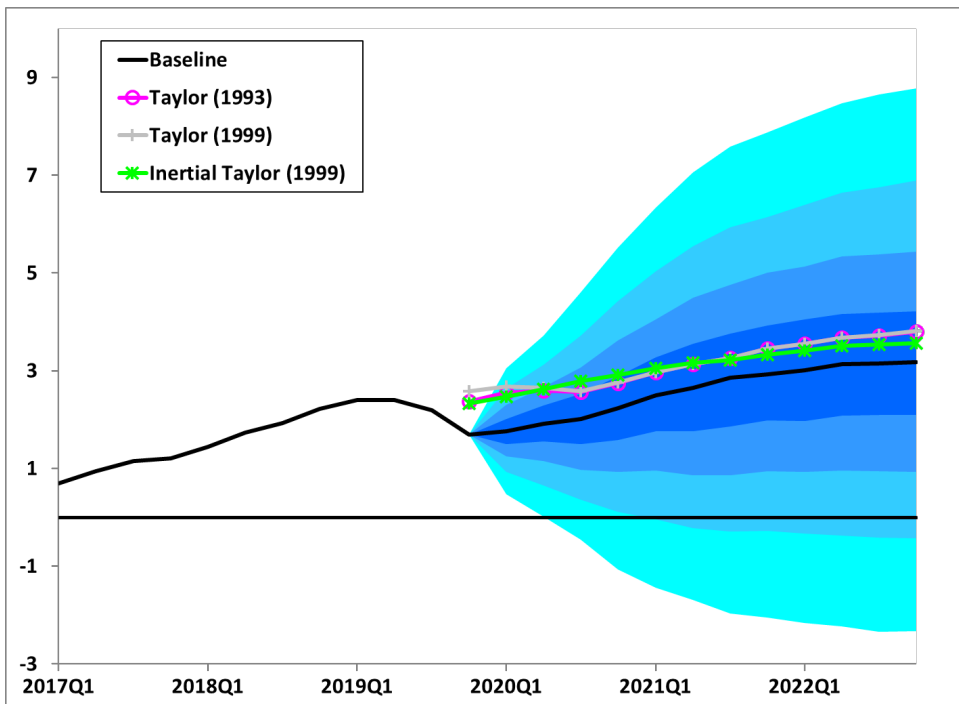


Figure 5: Baseline Forecast Comparisons

Figure 5a: Real GDP Growth

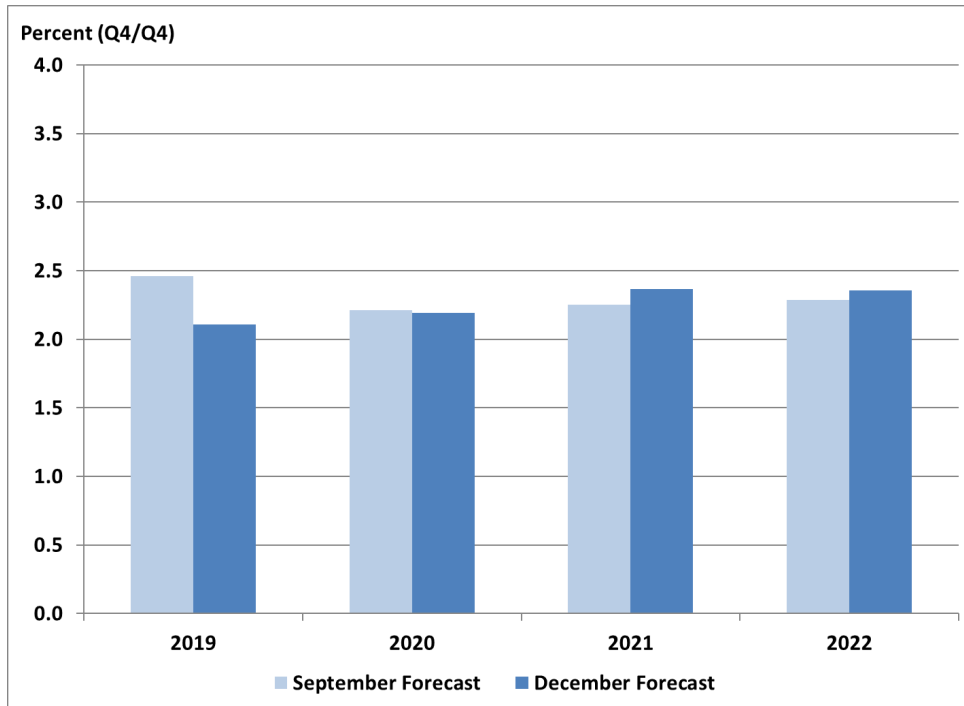


Figure 5b: Core PCE Inflation Growth

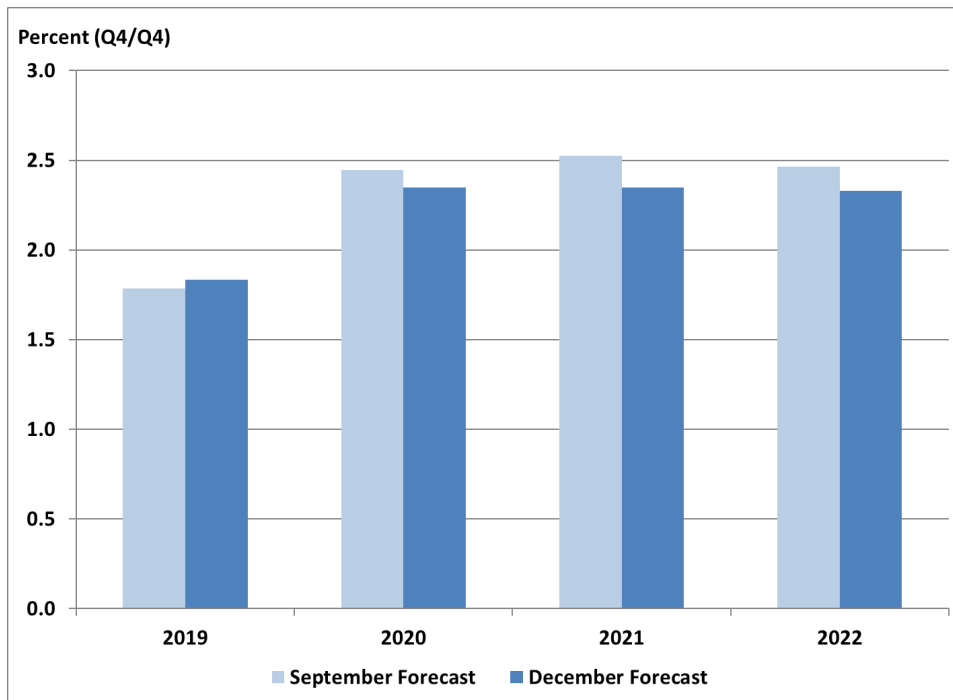


Figure 5c: Unemployment Rate

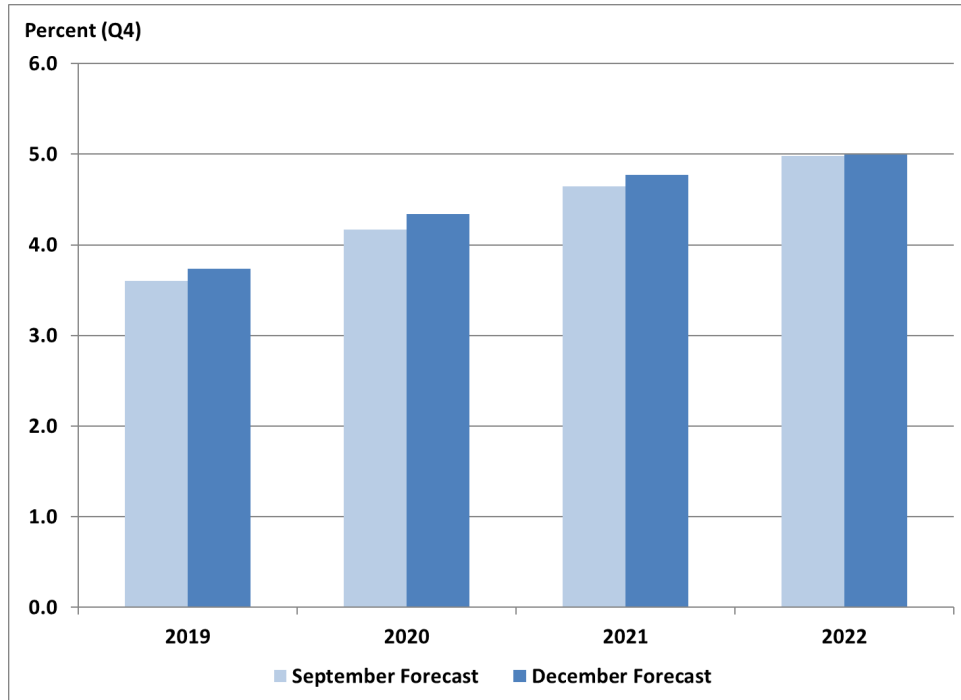
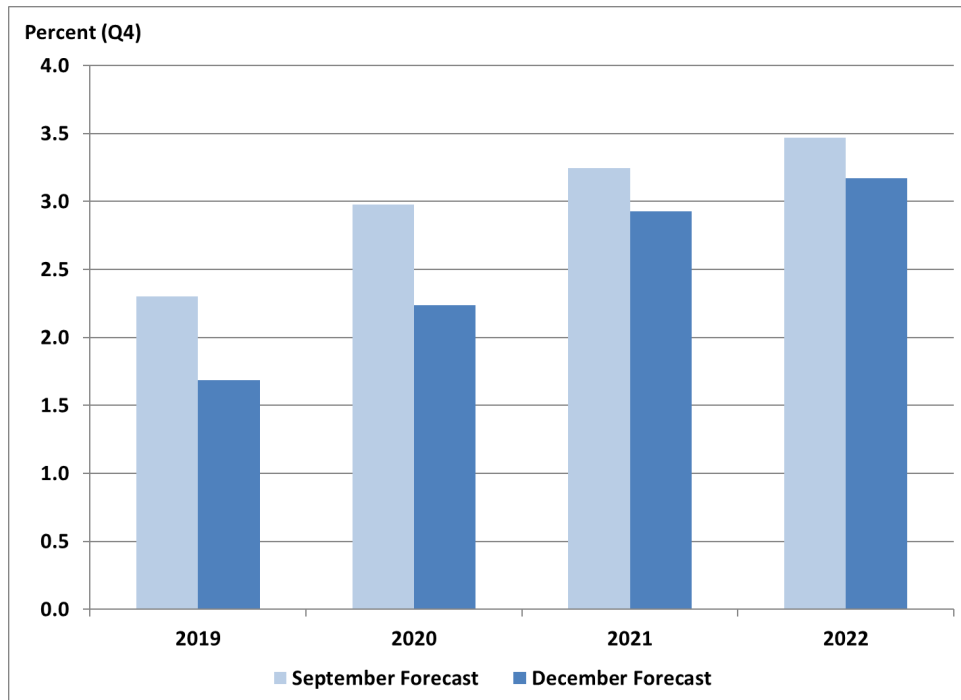


Figure 5d: Federal Funds Rate



Note: Historical data have been retrieved from Haver Analytics.