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Special Report
Research Department

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 this 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 the current stance of the federal funds rate, and they provide 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.

Economic Overview

Recent indicators point to modest growth in production and spending. While fourth-quarter 2022 real gross domestic product (GDP) growth is estimated to have been at a 2.7 percent pace, the incoming data suggest weaker growth in the current quarter. Indicators tied to economic production are coming in mixed. Industrial production was flat in January after

[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 Anna Benoit and Riley E. Thompson for their assistance.

declining in November and December. However, manufacturing output rose 1 percent in January (after falling 1.8 percent in December). Utilities output plunged due to unseasonably warm weather. The Institute of Supply Management (ISM) manufacturing index suggests that the sector contracted for the fourth consecutive month in February. The Philadelphia Fed Manufacturing Business Outlook Survey current activity index has been below its nonrecessionary average since March 2022. Although the ISM nonmanufacturing index declined in February, it continues to indicate growth in the services sector.

Growth in consumer spending jumped in January, with real personal consumption expenditures (PCE) rising 1.1 percent. However, when averaged over the last three months, the monthly increase is a much more modest 0.2 percent. Real disposable income rose at a healthy pace in January, but most of the increase was driven by a decline in personal taxes. Headline real income declined slightly in January. Total retail sales increased more than expected in January and more than offset December's contraction. Light-vehicle sales have been particularly strong, and sales at department stores posted outsized gains, as well. Consumer confidence measures are somewhat mixed, with the Conference Board index declining in both January and February and the Michigan sentiment index continuing to recover from its record low posted in June 2022. Housing activity is slowing further, with starts and permits continuing their downward trends over recent months. As well, existing home sales have now declined for 12 months in a row, and house prices continue to fall. The S&P CoreLogic Case-Shiller national house price index is down 3 percent from its January 2022 peak, while the Federal Housing Finance Agency (FHFA) house price index is now down 1 percent from its June 2022 peak.

Against the mixed readings on the production and consumption side of the economy, the labor market continues to show significant strength. Total nonfarm payroll employment increased by 311,000 jobs in February, and gains have averaged 351,000 over the last three months. Average hourly earnings increased modestly in February and are up 4.6 percent over the last year. The unemployment rate rose from 3.4 percent in January (its lowest reading since 1969) to 3.6 in February, in part due to an uptick in labor force participation. The Job Opening and Labor Turnover Survey (JOLTS) reported 10.8 million job openings on the last business day in January. While still at a very high level by historical standards, the job openings rate is now 0.9 percent lower than its peak in March 2022.

Inflation remains elevated. Headline and core PCE inflation both increased 0.6 percentage point in January. Over the last 12 months, headline PCE inflation rose 5.4 percent and core PCE inflation rose 4.7 percent. The 12-month change in the headline Consumer Price Index (CPI) was 6 percent in February, while the core CPI rose 5.5 percent. Core services inflation remains high and continues to be driven by the shelter component. However, removing

shelter from the core services component of the CPI still leads to elevated inflation of 6.1 percent over the last 12 months, so the story for services inflation is more than just food, energy, and shelter. Core goods prices rose slightly in February but had been falling over the previous three months and so appears contained. The Producer Price Index for final demand decreased 0.1 percent in February and was up 4.6 percent over the past 12 months. The index for final demand goods less food and energy was up 5.2 percent for the 12 months ended in January, so core measures remain elevated. For the most part, the most recent readings on inflation indicators surprised on the upside and are not yet evidencing a decisive break toward the Federal Open Market Committee's (FOMC's) 2 percent inflation target.

Recent financial market stresses and banking sector turmoil are likely to result in tighter credit conditions for households and businesses. Consequently, economic activity, employment, and inflation may be somewhat weaker in the months ahead as these headwinds dissipate. The extent and magnitude of these effects remain highly uncertain, though, and it will take some time to see how the stresses play out.

To conclude, the pace of economic activity appears to be slowing overall, and 2023 seems likely to experience very modest growth at best. There is evidence that supply bottlenecks are slowly unwinding, but supply chains have not returned to prepandemic efficiency. Past and prospective monetary tightening will weigh negatively on economic prospects, especially in interest-sensitive sectors. However, the labor market remains historically healthy, and the consumer has so far weathered economic headwinds. At present, risks remain to the upside for inflation and on the downside for growth. The view that future economic activity is likely to remain weak is reflected in FOMC members' projections of economic activity, which have been slightly downgraded since the December FOMC meeting. This year's median expected real GDP growth has been downgraded to 0.4 percent, while the forecasted unemployment rate at year's end came in at 4.5 percent. Expectations of inflation were raised to 3.3 percent for headline and 3.6 percent for core in 2023. The median participant sees the federal funds rate averaging 5.1 percent in the fourth quarter of 2023 and 4.3 percent in the fourth quarter of 2024. The brightest spot for the economy remains the labor market, with continued healthy gains in employment and a plentitude of job openings.

The Benchmark Model

To create our forecast, 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 in which 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. We have added additional shocks to the model to account for the pandemic—but we have not changed the model's structural equations in response to the pandemic. Implicit in this view is that the structure of the economy has returned to a prepandemic state now that the virus has been mitigated. While through the lens of our model some economic effects of the pandemic linger, this forecast is largely based on the economy's prepandemic structure. Detailed documentation on the model structure is available from the authors upon request.

The underlying baseline policy rule in the model is a response function 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	0.8	2.5	0.5
Taylor (1993)	0.0	1.5	0.5
Taylor (1999)	0.0	1.5	1.0
Inertial Taylor (1999)	0.85	1.5	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.

Model Forecasts Under the Baseline

The forecast is generated using observed data through the fourth quarter of 2022, together with an assumption of how output growth, inflation, the federal funds rate, and unemployment will fare in the first quarter of 2023. The forecast then begins in the second quarter of 2023

[2] The model calibration implies that the long-run equilibrium value of the federal funds rate is 1.95 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.

and extends through the fourth quarter of 2025. The forecast under the baseline is shown in Figures 1–4. 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 growth is forecast to be 0.9 percent in 2022, 0.6 percent in 2023, 1.6 percent in 2024, and 2.0 percent in 2025. This represents an upward revision in the forecast compared to December.
- Core PCE inflation runs at a 4.8 percent pace in 2022, falling to 3.2 percent in 2023, 2.6 percent in 2024, and 2.3 percent in 2025. The near-term path is revised down slightly compared to December.
- The unemployment rate stood at 3.6 percent at the end of 2022 and is expected to rise over the forecast horizon, reaching 4.5 percent at the end of 2023, 5.2 percent at the end of 2024, and 5.5 percent at the end of 2025. This represents a downward revision in the forecast compared to December.
- The federal funds rate averages 3.7 percent in the fourth quarter of 2023, falling to 2.8 percent in the fourth quarter of 2024 and 2.2 percent in the fourth quarter of 2025. This path is revised down slightly compared to December. Note that these forecasts were generated prior to the March FOMC meeting.

The forecast for output growth is slightly stronger compared to the December forecast as the economic data on output has shown less of a slowdown than expected. Our forecast was made prior to the most recent FOMC meeting; we no longer impose a path for the federal funds rate on the model but rather let monetary policy be completely data determined according to the model's policy reaction function. The model path for the federal funds rate is below the financial market expectation and the modal forecast from the March Summary of Economic Projections (SEP). There remains a great deal of uncertainty about how the economy will evolve over the near term. Although the pandemic has abated both domestically and abroad, war in Europe and increased financial uncertainty following the recent banking strains suggest that forecast uncertainty remains elevated. Longer-term interest rates have moved sideways since December and the labor market remains healthy, with job openings at high levels, a low unemployment rate, and monthly employment gains running at a healthy pace. Consumer confidence has stopped improving, though, and inflation remains well above the FOMC's target.

[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 model anticipates that output growth will be below 1 percent in 2023 and then increase slightly to about 1.6 percent in 2024 and 2 percent in 2025. The model's current-quarter forecast of -0.1 percent is slightly below the Survey of Professional Forecasters (SPF) median projection of 0.6 percent for the first quarter of 2023.

The baseline model shows output growth running at a pace that, on average, is about 1 percentage point below its long-run average over the next three years.[4] The unemployment rate rises gradually over the forecast horizon to reach 5.5 percent at the end of 2025. This is above the model's estimate of the natural rate of unemployment—i.e., the level of unemployment that the model returns to in the long run, which is 4.5 percent.

Recent data on inflation have been somewhat encouraging, though inflation remains at an uncomfortably high level. The model anticipates that core PCE inflation will run at a 3.2 percent pace in 2023, well below the 2022 rate of 4.8 percent. With tightening monetary policy and modest output growth, inflation then moves down, albeit slowly, over the forecast horizon to average 2.6 percent in 2024 and then decreasing further to 2.3 percent in 2025. Thus, the model anticipates that inflation will run above the FOMC target of 2 percent average inflation throughout the forecast horizon.

The baseline forecast is weaker on growth than the median projections from the first-quarter 2023 SPF over the forecast horizon. The median respondent expects real output growth of 0.7 percent in 2023. For the growth of the annual average, the SPF reports 1.4 percent in 2024 and 2.2 percent in 2025, slightly above the implied annual average growth of our baseline forecast of 1.3 percent in 2024 and 1.9 percent in 2025. The SPF's core PCE inflation forecast is 3.0 percent (Q4/Q4) for 2023, edging down to 2.3 percent in 2024 and 2.1 percent in 2025. Thus, the SPF is similar on inflation compared to the model baseline. The forecasters' path for the unemployment rate is lower over the forecast horizon compared to the baseline: The median SPF forecast for the unemployment rate is 3.8 percent in 2023, increasing to 4.2 percent in 2024 before edging down, which is where the unemployment rate is projected to remain in 2025.

The March 2023 SEP by FOMC participants shows the median projection for output growth at 0.4 percent in 2023, 1.2 percent in 2024, and 1.9 percent in 2025. The median forecast of the unemployment rate is 4.5 percent at the end of 2023 and 4.6 percent at the end of both 2024 and 2025. Core PCE inflation is projected at 3.6 percent in 2023, 2.6 percent in 2024, and 2.1 percent in 2025. The median Committee member forecast anticipates that the federal funds

[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.

rate will reach 5.1 percent at the end of 2023 and then move down to 4.3 percent at the end of 2024 and 3.1 percent at the end of 2025.

Alternative Policy Rules

With this edition of the Monetary Policy Report we continue to analyze alternative policy rules as prescriptions for the course of monetary policy over the next few years. As indicated in Table 1, the alternative rules are forms of the Taylor Rule that have differing weights on the inflation gap, the output gap, and the lagged interest rate. The alternative rules generally lead to lower core inflation, lower real output growth (indeed, negative output growth over the near term), and a higher unemployment rate over the forecast horizon. Thus, the alternative rules suggest policy should slow the real economy more than in the baseline in order to bring down inflation more quickly. This is indicated in Figure 4, where the federal funds rate paths, especially for the Taylor 1999 and Taylor 1993 rules, suggest sharp spikes in the federal funds rate in the near term in order to slow the economy. The inertial Taylor Rule, while having a federal funds rate path that is more similar to the baseline, is able to quash the output gap quickly, which is manifested in slower near-term output growth and a higher path for the unemployment rate. Consequently, inflation comes down more quickly under that specification. This works through the expectations channel as households act on the expectation that monetary policymakers will respond more aggressively to the output gap compared to the baseline. All else equal, the inertial Taylor Rule implies that interest rates would remain high even after inflation and the output gap have been brought down. Instead, forward-looking households and firms adjust their demand and prices immediately, lowering the output gap and inflation, allowing the monetary authority not to have to follow through on the threat of persistently higher rates.

Summary

The baseline NKDSGE model uses historical correlations in the data to generate its forecasts and does not incorporate significant judgmental adjustment. The NKDSGE model also does not explicitly account for any structural changes to the economy that may be induced by the pandemic or the war in Europe. The model projects feeble output growth in 2023 and only modest, below-average growth over the next two years. Inflation eases slowly and runs above the FOMC target of 2 percent on average over the next three years. Forecast uncertainty remains very high as the economy deals with war in Europe and the recent banking strains. These key factors are not incorporated into the model forecast, which is run solely off of existing quarterly data. On balance, as in the December projection, the forecast continues to call for below-trend growth and inflation above target over the next few years.

Figure 1: Real GDP Growth

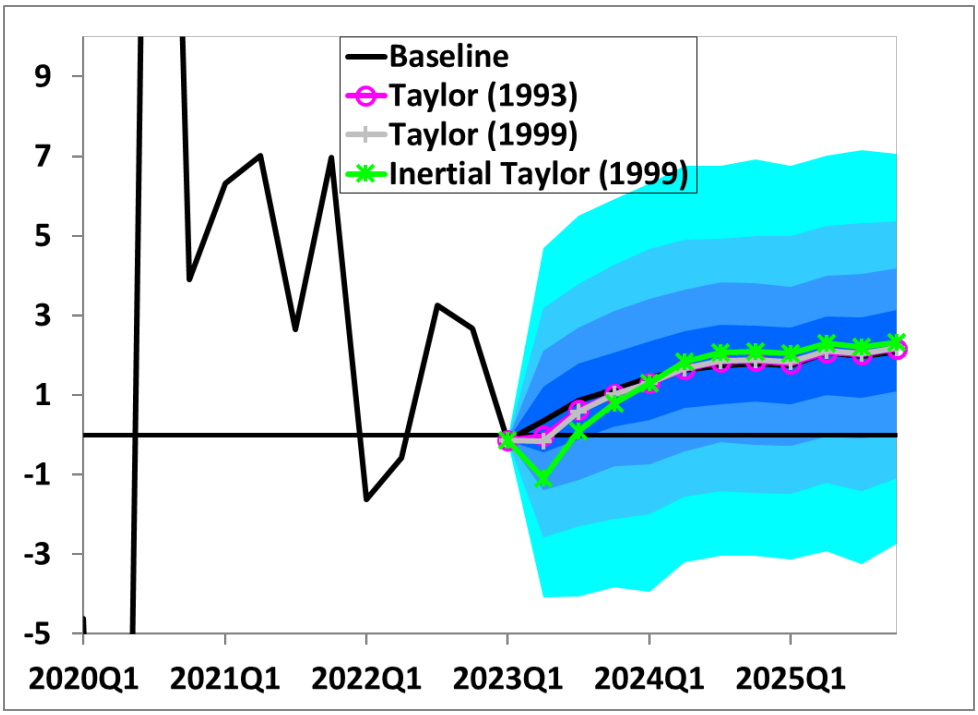


Figure 2: Core PCE Inflation

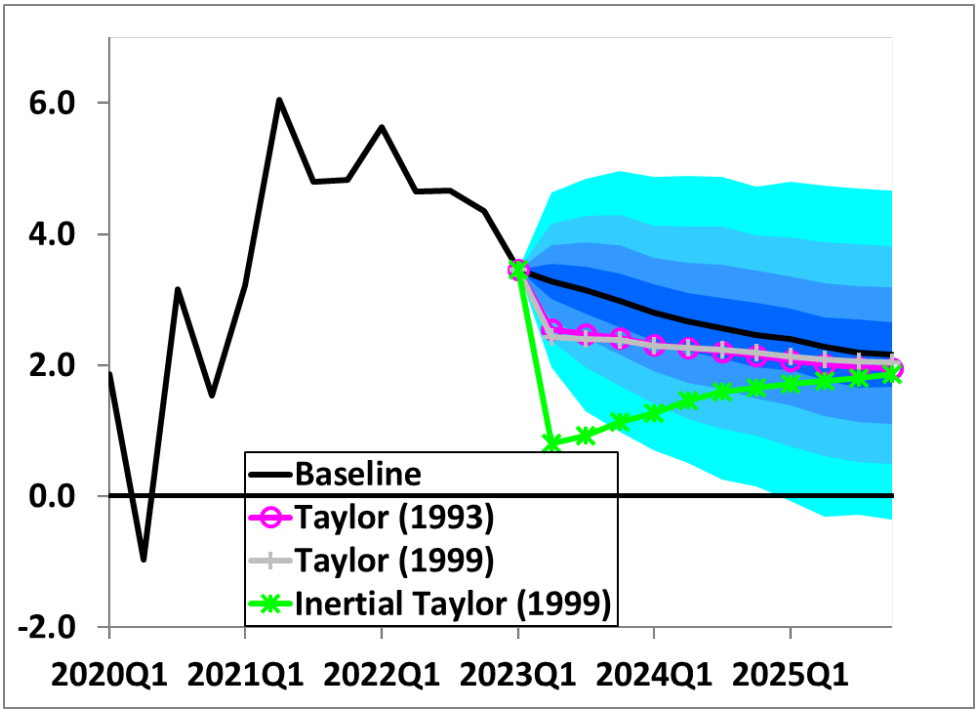


Figure 3: Unemployment Rate

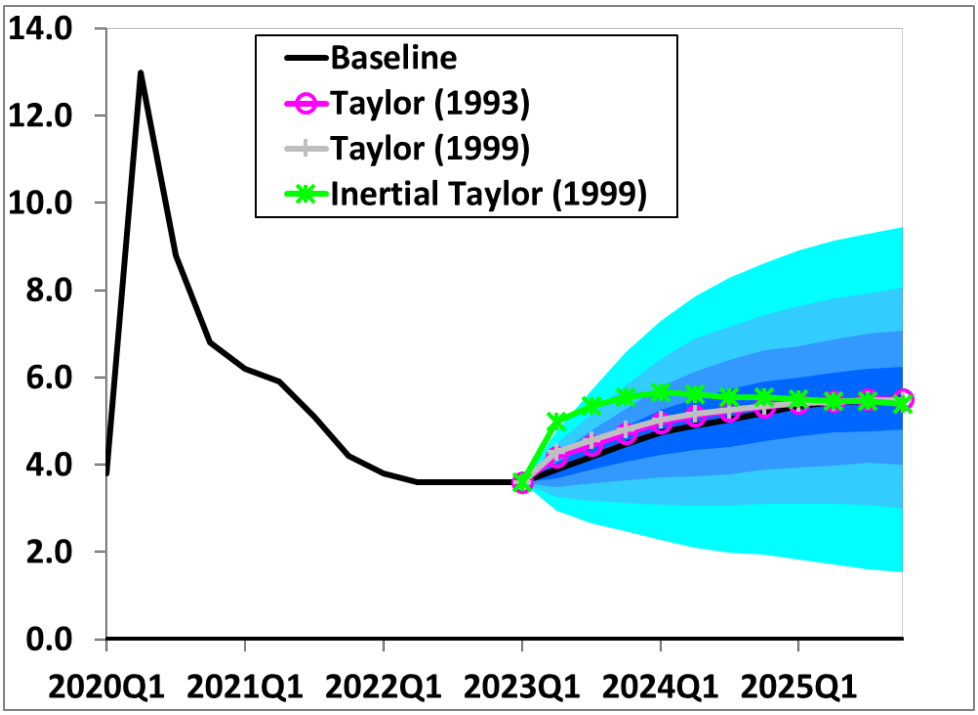


Figure 4: Federal Funds Rate

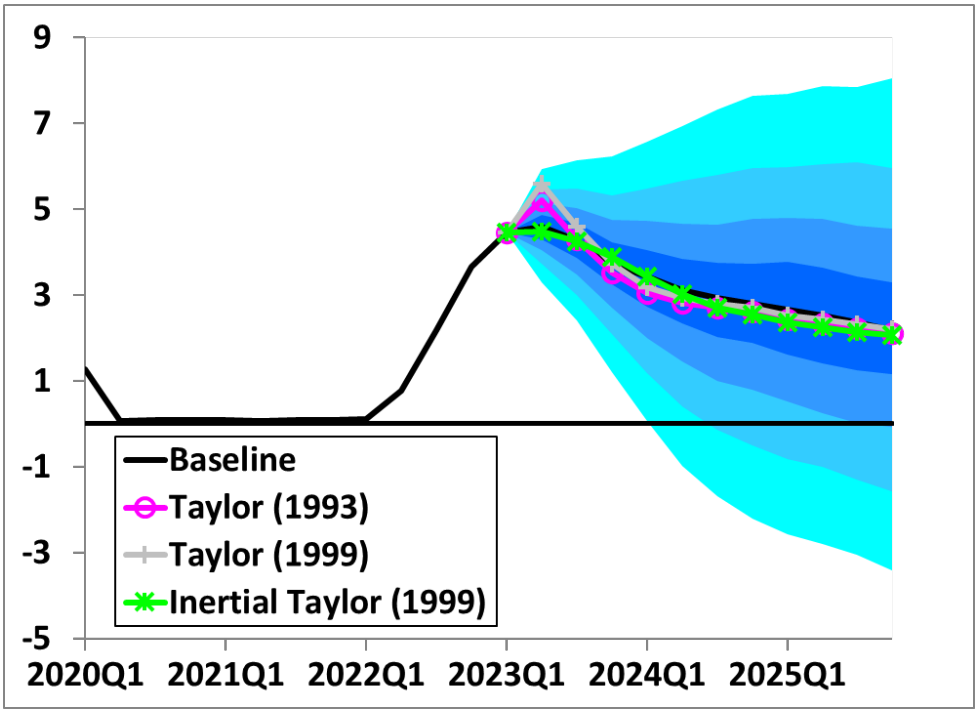


Figure 5: Baseline Forecast Comparisons

Figure 5a: Real GDP Growth

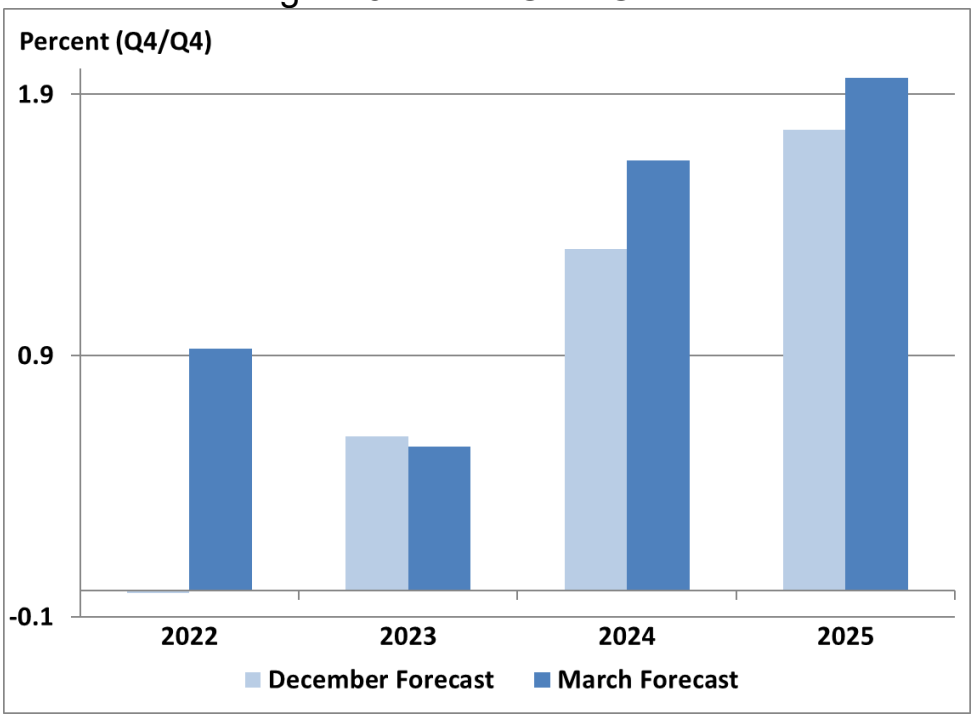


Figure 5b: Core PCE Inflation Growth

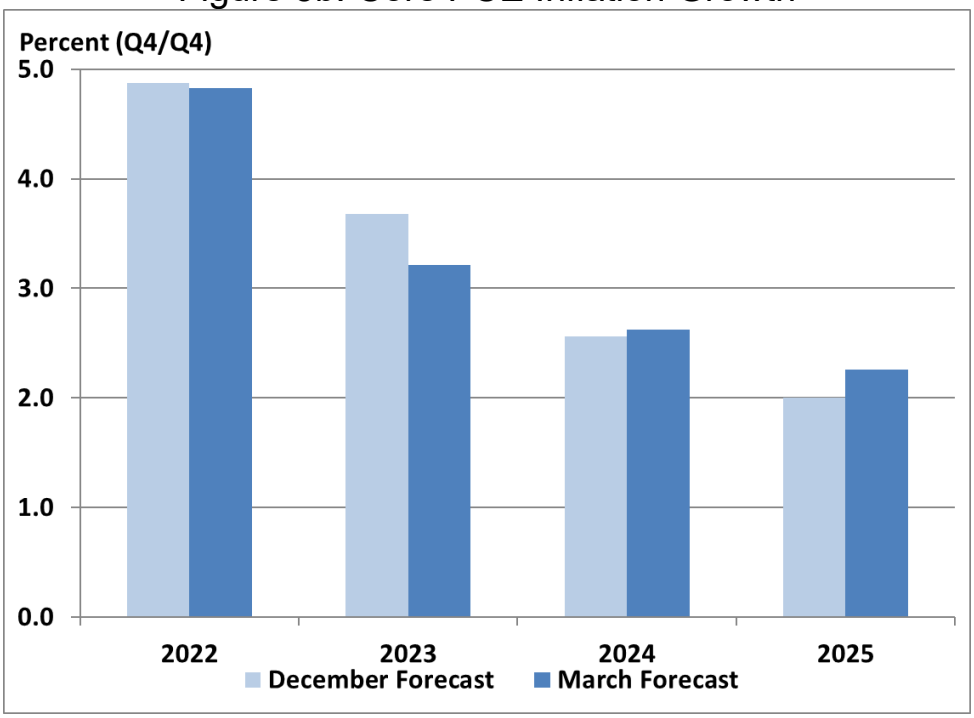


Figure 5c: Unemployment Rate

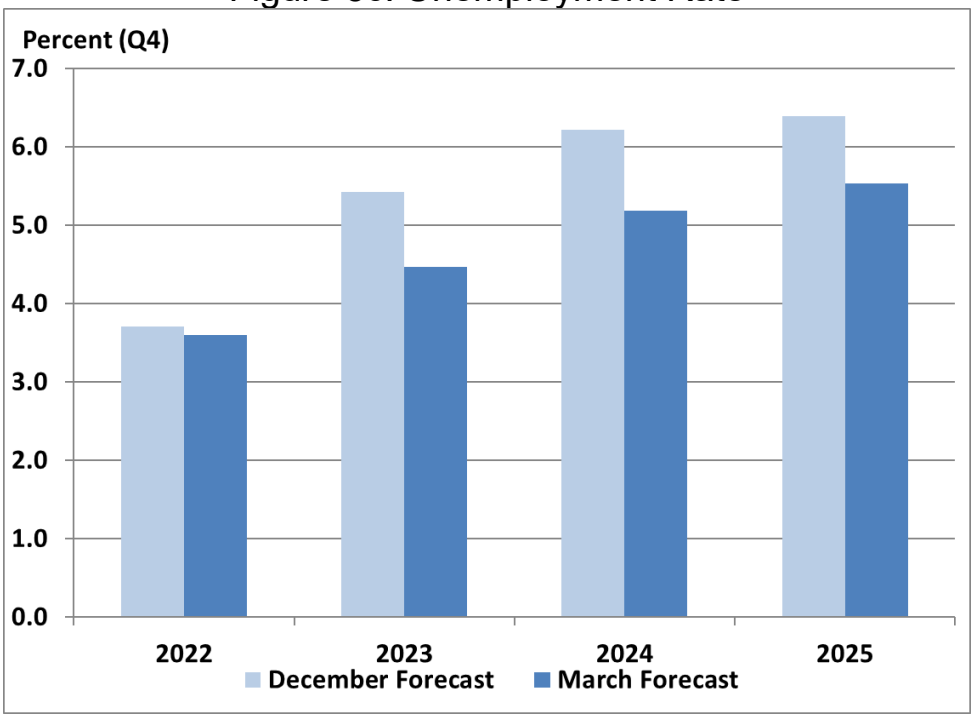
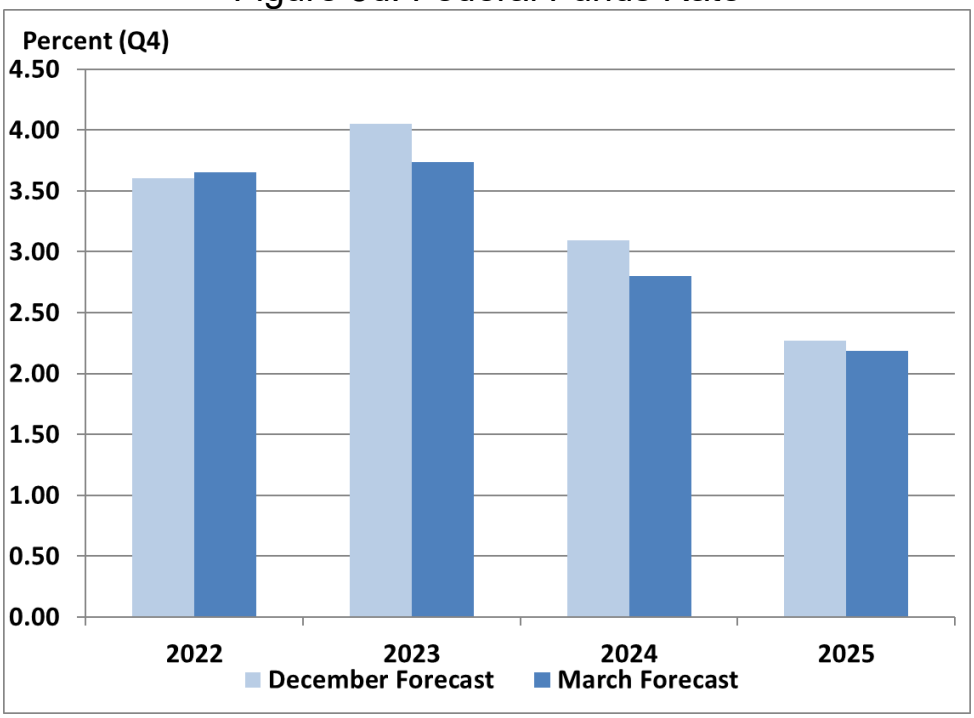


Figure 5d: Federal Funds Rate



Note: Historical data have been retrieved from Haver Analytics.