Finance and Economics Discussion Series

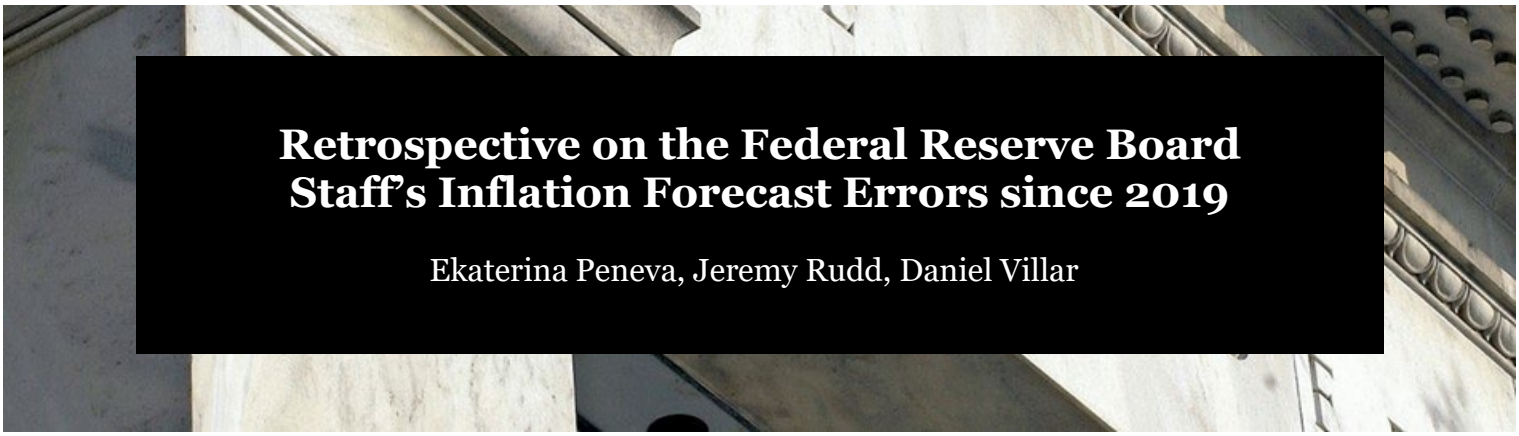
Federal Reserve Board, Washington, D.C.
ISSN 1936-2854 (Print)
ISSN 2767-3898 (Online)

Retrospective on the Federal Reserve Board Staff's Inflation Forecast Errors since 2019

Ekaterina Peneva, Jeremy Rudd, Daniel Villar

2025-069

Please cite this paper as:
Peneva, Ekaterina, Jeremy Rudd, and Daniel Villar (2025). "Retrospective on the Federal Reserve Board Staff's Inflation Forecast Errors since 2019," Finance and Economics Discussion Series 2025-069. Washington: Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2025.069.



Retrospective on the Federal Reserve Board Staff's Inflation Forecast Errors since 2019

Ekaterina Peneva, Jeremy Rudd, Daniel Villar

The analysis in this paper was presented to the Federal Open Market Committee as background for its discussion of the Federal Reserve's 2025 review of its monetary policy strategy, tools, and communications.

Abstract: This paper examines the Board staff's inflation forecast misses over the years following the COVID-19 outbreak, focusing on a timeline of what staff members knew when and lessons learned along the way. The staff significantly underestimated both the size and persistence of the inflationary surge that followed the reopening of the U.S. economy. As a result, staff members made various changes to their forecasting procedures, including using new types of data to inform their assessment of supply–demand imbalances in product and labor markets and to guide their judgmental forecast. Throughout, an important difficulty was the lack of similar historical episodes upon which to base a quantitative analysis. Over time, the innovations helped improve the staff's ability to understand and forecast inflation during this period. However, considerable uncertainty remains about the quantitative contributions of the various drivers of the pandemic-period inflation as well as the applicability of the lessons from this episode for forecasting.

JEL Classification: E31, E37.

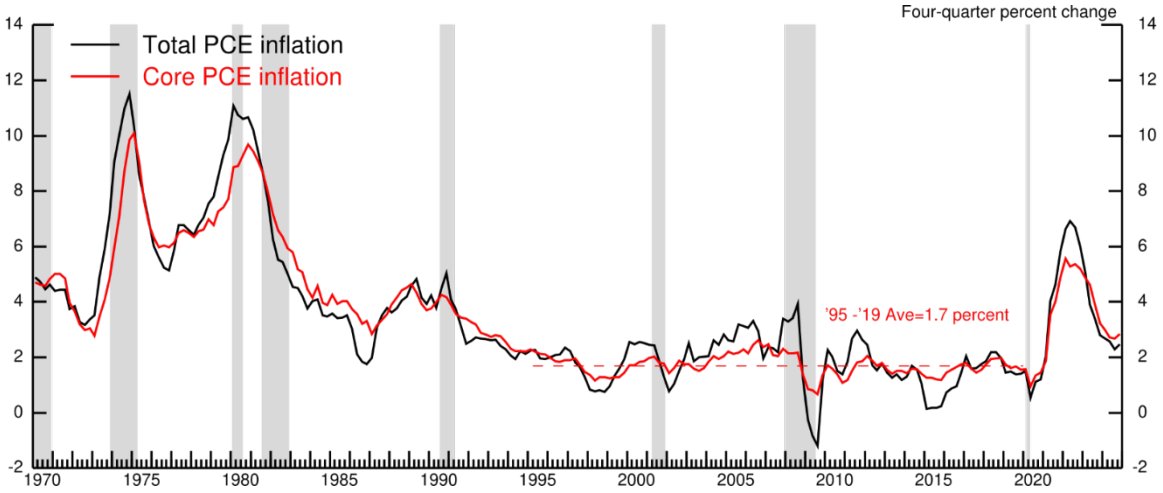
Keywords: Inflation forecasting, inflation dynamics, Phillips curve, COVID-19 pandemic.

Note: The views expressed in this paper do not necessarily reflect the views of the members of the Board of Governors of the Federal Reserve System or the Federal Open Market Committee. The authors are staff members of the Division of Research and Statistics at the Board of Governors of the Federal Reserve System; they prepared this paper drawing on forecast documents and other relevant materials prepared by Board staff. The authors are grateful to Spencer Bowdle, Hannah Landel, and Lucas Moyon for exceptional research assistance, including the timeline in appendix A, and to their colleagues for various comments on earlier drafts.

1. Introduction and overview

The surge in inflation in the U.S. and many other economies that followed the COVID-19 pandemic was unprecedented in recent history, with both headline and core inflation reaching levels not seen since the early 1980s (figure 1). Although early 2021 staff forecasts were already expecting an increase in inflation that year—based on anticipated supply bottlenecks and nonlinear responses of inflation as the economy reopened—the Board staff significantly underestimated both the size and persistence of this inflationary surge.

Figure 1: Headline and core PCE price inflation



Note: PCE is personal consumption expenditures. The gray shaded bars indicate a period of business recession as defined by the National Bureau of Economic Research.

Source: Bureau of Economic Analysis via Haver Analytics; National Bureau of Economic Research.

In response to these developments, staff members made various changes to their forecasting procedures. These changes included using new types of data to inform their assessment of supply–demand imbalances in product and labor markets and to guide their judgmental forecast, though the lack of similar historical episodes upon which to base their analysis made the task difficult. Staff members also adjusted their inflation models and developed new supplementary tools to assess inflation dynamics. At the same time, some elements of their projection—such as the assumption that inflation expectations would remain anchored around the Federal Open Market Committee's (FOMC) target—seem to have served them well. Overall, the innovations helped improve the Board staff's ability to understand and forecast inflation, but they still consistently underpredicted actual inflation until late 2022, after inflation had peaked.

The early months of the pandemic saw large and broad-based reductions in both supply and demand. In retrospect, shocks to supply were unexpectedly persistent (or recurring), while the recovery in demand was unexpectedly rapid and especially large in certain sectors. While there is undoubtedly still much to be learned about inflation dynamics from this episode in the years ahead, the staff's current take is that these supply–demand imbalances were the main cause of the inflation misses. To the extent that the economy faces a similar situation in the coming

years—for instance, shocks to supply chains and to labor supply—the staff will be better equipped with their set of recently developed indicators and tools, but as the shocks facing the economy change, so will the staff's methods. Still, a world with large shocks is one where inflation will be harder to forecast.

This paper starts by briefly reviewing the staff's basic pre-pandemic inflation framework and walks through the timeline of staff projections and forecast misses, focusing on what staff members knew in real time and how they interpreted that information. It then turns to the sources of the staff's forecast misses and what they got right and asks to what extent current research carries useful lessons. This paper finishes with a retrospective assessment of what happened to inflation over the past five years.

2. The pre-pandemic inflation framework

On the eve of the pandemic, the staff's view was that core inflation could be described in terms of transitory and relatively small fluctuations around a long-run trend, as summarized by the Phillips curve for core inflation (π_t) shown below. These fluctuations were attributable to changes in resource utilization ($U_t - U_t^*$), changes in relative import and energy prices ("supply shocks," Z_t), and temporary innovations ϵ_t, including idiosyncratic relative price movements—for example, a change in personal consumption expenditures (PCE) medical services prices following a change in Medicare reimbursement rates or unusual swings in core nonmarket prices.

$$\pi_t = \alpha\pi_{t-1} + \beta(U_t - U_t^*) + Z_t + (1-\alpha)\pi_{t-1}^* + \epsilon_t, \quad (0 \leq \alpha \leq 1). \tag{1}$$

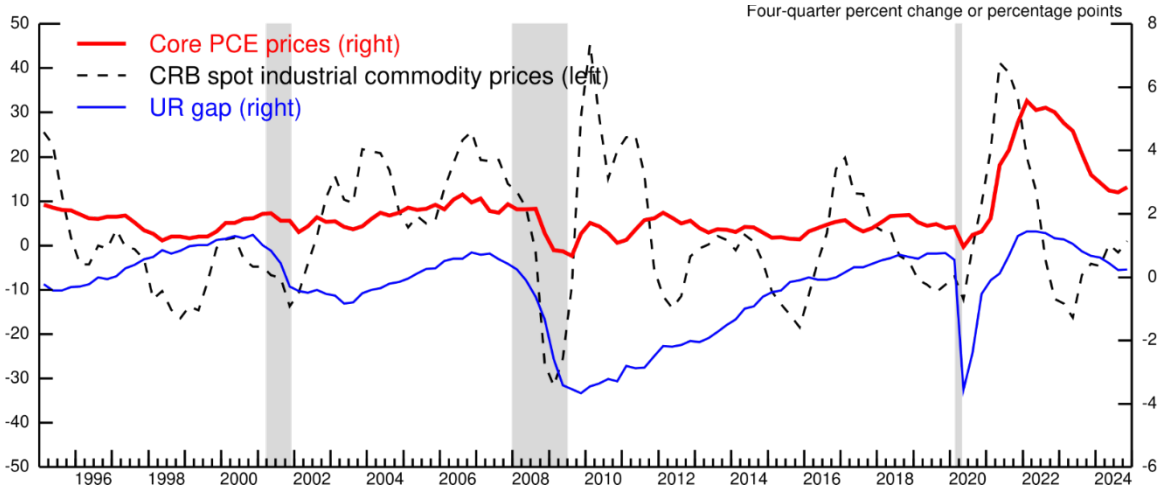
Trend inflation (which the Board staff refer to as "underlying" inflation, or ULI) is denoted by π_t^*. The presence of the lagged inflation term—which, in practice, usually involves multiple lags—is intended to capture the idea that prices do not immediately adjust to shocks; the size of the coefficients on the lagged inflation terms determines the speed with which the effect of a transitory shock to inflation dies out. (The persistence of the shock itself will also be a factor in how quickly its effects on inflation go away.) Finally, the coefficients on lagged and trend inflation sum to one, so that a change in ULI eventually passes through one-to-one into actual inflation.[1]

Three features of this framework helped it explain inflation behavior since the mid-1990s, which saw core inflation remaining within a relatively narrow range despite large swings in commodity prices and economic activity (figure 2). First, ULI was assumed to be *stable* in the sense of being invariant to actual economic conditions, including past inflation. (Because ULI is viewed as being ultimately determined by long-run inflation expectations, the relative stability of

[1] The term "underlying inflation" is sometimes used to refer to inflation calculated using a core, median, or trimmed mean index (the idea being that such measures better reveal the direction and momentum of overall inflation). The Board staff use this term to denote inflation's long-run trend—that is, the rate of inflation that would eventually prevail in the absence of any slack, supply shocks, or idiosyncratic relative price changes.

long-run inflation expectation measures provided further support for this assumption.) Second, the price Phillips curve was flat by historical standards (β was small in absolute terms), implying that an extremely tight or extremely slack economy would make a relatively modest contribution to inflation. Third, the effects of supply shocks on core inflation during this period were small, with import prices being an important exception. Although shocks to food and energy prices appeared to have significant effects during the 1970s and early 1980s, after the 1980s it became harder to find empirical evidence that they passed through to core inflation. In addition, other supply-side shocks—notably, the disruption caused by the 2011 Tōhoku earthquake and tsunami—had a relatively small and short-lived effect on U.S. inflation.

Figure 2: Core inflation, commodity prices, and the unemployment gap



Note: PCE is personal consumption expenditures; UR is unemployment rate. The gray shaded bars indicate a period of business recession as defined by the National Bureau of Economic Research.

Source: Bureau of Economic Analysis via Haver Analytics; National Bureau of Economic Research; Commodity Research Bureau (CRB) via Haver Analytics; FRB staff calculations.

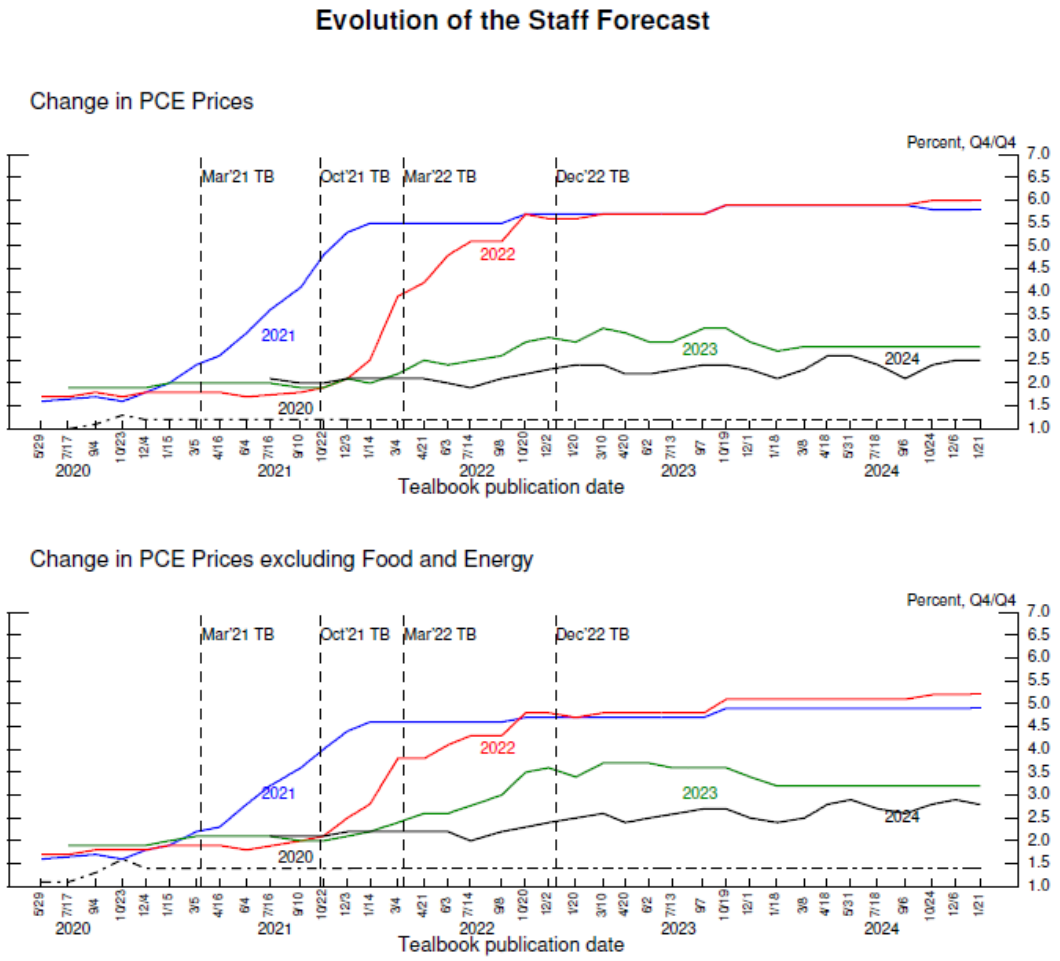
Although a Phillips curve with an anchored trend and a weak connection between inflation and resource utilization appeared to characterize post-1995 inflation behavior well, staff members were always aware that these features might not be present under different economic circumstances. Because they did not fully understand why inflation's long-run trend had become invariant to economic conditions and why the Phillips curve had become so flat, it was difficult to assess in real time whether and to what degree these features would continue to describe the inflation process as the pandemic-related disruptions began to make themselves felt.

3. Evolution of the Tealbook inflation projections

The Board staff's inflation forecasts persistently underpredicted actual inflation by a considerable amount from the spring of 2021 through the fall of 2022, as the staff kept expecting the drivers of high inflation to wane over the following year (figure 3). Eventually, in late 2022 and in subsequent forecasts, staff expectations of a gradual cooling in inflation were realized. This section describes in more detail the staff's interpretation of the data and their forecasts at

key points during this period. (The multipage figure in appendix A provides a timeline of major events related to inflation, the spread of COVID-19, fiscal policy, FOMC statements, and other relevant developments.)

Figure 3: Tealbook forecast evolution, 2020–24



Note: PCE is personal consumption expenditures. Colored lines give the Q4/Q4 projection for the year indicated from each Tealbook vintage.

Source: Bureau of Economic Analysis via Haver Analytics; FRB staff calculations.

3.1 Core inflation in 2020

When the pandemic broke out in the U.S. and most of the rest of the world in early 2020, inflation dipped as the economy entered a recession, with the decline most pronounced in sectors related to travel where demand was most restricted by the pandemic. For the year as a whole, on a Q4-over-Q4 basis, core inflation came in at 1.4 percent. (Headline inflation was only 1.2 percent, reflecting a large decline in energy prices.) This level of core inflation was lower than the staff could explain using the pre-pandemic relationship between inflation and its typical drivers; they attributed the difference to downward demand pressures from social distancing that

were perhaps not being fully captured by labor market variables and that were outweighing the effects of production disruptions.

3.2 March 2021 Tealbook

At the time of the March 2021 Tealbook, the 12-month change in core PCE prices that the Board staff had in hand—1.5 percent through January—was still subdued. At the same time, vaccinations were progressing at a rapid pace, monetary policy was supporting activity, and substantial fiscal support was in train from the recently enacted Coronavirus Response and Relief Supplemental Appropriations Act and the anticipated American Rescue Plan.[2] The staff therefore expected very strong gross domestic product (GDP) growth from both a pickup in aggregate demand and improvements in aggregate supply.[3] Given the progress on vaccinations and return to in-person schooling, the staff also expected that the labor force participation rate (LFPR) would pick up rapidly in the fall of 2021 and would return to its pre-pandemic level by the end of 2022 as the strong labor market drew in people who had previously been out of the labor force. Even with such a rise in the LFPR, staff members anticipated that unusually strong output growth would cause the unemployment rate to fall to very low levels, moving below 3 percent by the end of 2022 and to 2.7 percent in 2023.[4]

With these forecasts for the overall economy and the labor market, the staff built into the March 2021 inflation projection two related but distinct channels of influence on inflation—***transitory supply bottlenecks*** (due to businesses having trouble expanding production rapidly enough to keep up with surging demand) and ***nonlinear effects*** (the idea that the Phillips curve would steepen once the unemployment rate reached historically low levels). All told, the staff expected the unwinding of the 2020 net negative effect on prices from social distancing and the emerging bottlenecks in the provision of goods and services to both boost core inflation in 2021, while the nonlinear Phillips curve effects were projected to boost inflation in 2022 and 2023. Still, with very limited historical experience of an economy as tight as projected, an expectation that a greater-than-usual portion of domestic demand would be met by imports, and an expectation that supply disruptions would be temporary and limited, the projected contribution to inflation from these sources was relatively modest. The staff also judged that longer-term inflation expectations would remain well anchored. In all, and as illustrated by the vertical line labeled "Mar.'21 TB" in the bottom panel of figure 3, the staff projected core PCE inflation to pick up from 1.4 percent in 2020 (the dashed black line) to 2.2 percent in 2021 (the blue line)

[2] While new COVID-19 cases, hospitalizations, and deaths were still high, the pace of vaccinations had been increasing, reaching 2 million per day in early March 2021, up from 1 million per day in mid-January.

[3] The Board staff's forecast called for 6.5 percent GDP growth in 2021 and 3.9 percent growth in 2022. These were even stronger than the current estimates of 5.7 percent for 2021 and 1.3 percent for 2022.

[4] In the Domestic Economic Developments and Outlook section of the April 2021 Tealbook A, the box "How Low Can the Unemployment Rate Fall?" highlighted the unusually low unemployment rate staff members were forecasting by exploring just how low it could go.

and then to remain a little above its underlying pace of 1¾ percent, hovering around 2 percent through the end of 2023 as resource utilization remained high.

3.3 July 2021 Tealbook

The March reading for core PCE inflation (received in April) surprised the Board staff to the upside, driven by an enormous single-price increase in the PCE price index for financial services charges associated with checking accounts and other bank services as well as notable increases in the prices for lodging away from home, car rentals, furniture, and major household appliances. Staff members did not take signal from the financial services surprise, but in response to the other surprises, they raised their projection for the next few months by a touch. Even so, the data for April through June came in way above staff expectations.

By the time of the July 2021 Tealbook, the staff estimated that the 12-month change in core PCE inflation was 3.5 percent in June, up sharply from the start of the year. At a higher frequency, the three-month changes had skyrocketed from an annual rate of 3.1 percent through March to nearly 6.7 percent in June. However, both the high readings in April through June and the surprises were concentrated in a handful of categories—most notably, used and new motor vehicles as well as travel-related services, which jointly accounted for more than 70 percent of the acceleration in prices from March through June. Staff members viewed the sharp acceleration in motor vehicle prices as stemming from a global semiconductor shortage that was restricting new motor vehicle production by more than they had anticipated, combined with ongoing strong demand for vehicles. For travel-related services prices, the staff attributed the sharp increase to a rebound from the pandemic-induced declines. There was also a surge in goods input costs reflecting the effect of the February Texas freeze on petrochemicals and plastics production. Staff members viewed all these effects as transitory and took limited signal from the upside surprises; they therefore expected the monthly core inflation readings to ease down over the rest of the year and the 12-month change to end the year at 3.1 percent.

3.4 October 2021 Tealbook

By the October 2021 Tealbook, inflation had moderated noticeably in the real-time data, with monthly core inflation rates falling from an average pace of about 0.55 percent over April through June to an average of 0.25 percent over July through September.[5] The Board staff thought that the July through September readings—which included net *declines* in used motor vehicle prices and airfares—were generally good news and provided support for the staff's forecast for a slowdown in monthly readings. But staff members also attributed part of the decline in inflation to the reduction in economic activity that followed the spread of the Delta

[5] These values include the Board staff's translation of the source data that were available at the time, including any implied revisions to previous months, and so will not necessarily correspond to the first release or the current vintage of the series.

variant.[6] Indeed, despite an increase in the share of the population that was fully vaccinated, the more transmissible Delta variant resulted in a steep increase in COVID-19 cases and hospitalizations between June and early September, and the economic recovery had slowed considerably.

The labor market news was mixed: Real-time payroll gains through September had slowed noticeably (a slowdown that was later revised away considerably). However, the participation rate had not recovered as the staff had expected, indicating labor supply constraints, and quits had been increasing. The unemployment rate, at 4.8 percent in September, had moved below the staff's estimate of its natural rate, and the vacancy–unemployment (V/U) ratio had moved slightly above its pre-pandemic level in August (the latest reading that was available in October 2021), but neither measure was yet indicating a hot labor market.

Board staff members' October 2021 assessment of news on production and distribution difficulties, including surging freight prices and congestion at U.S. ports, led them to think that bottlenecks in the various markets were more severe than they had thought and that the bottlenecks' unwinding would be more gradual than they had anticipated.[7] All told, the details of the incoming price data (including an acceleration in housing services prices), news about bottlenecks in the goods-producing sectors, and evidence of ongoing labor shortages as the labor supply failed to recover led staff members to raise their 2021 core PCE inflation forecast nearly ½ percentage point to 4.0 percent (on a Q4-over-Q4 basis), a large revision in normal times.

Still, with COVID case counts receding after their early September peak and indications that some supply constraints might be starting to resolve, the staff thought the worst inflation was behind them. Staff members did not expect that supply constraints would boost inflation beyond the first half of 2022; in fact, they anticipated that the resolution of bottlenecks would put a modest amount of *downward* pressure on inflation in both 2022 and 2023.

3.5 January 2022 Tealbook

The release of the high October consumer price index (CPI) in mid-November was an unwelcome surprise. By the time of the January Tealbook, it was clear that monthly core inflation rates had unexpectedly stepped back up to an estimated average pace of about 0.45 percent in the last three months of 2021. In addition, high inflation readings had become more broad based.[8] The price acceleration from October through December left Q4-over-Q4

[6] Although the Board staff had put considerable effort into understanding the dynamics of the COVID spread, there was still much uncertainty about how a new strain would affect a partially vaccinated population.

[7] In the Domestic Economic Developments and Outlook section of the October 2021 Tealbook A, the box "Semiconductor Chip Shortages in the Motor Vehicle Sector" flagged production shortfalls in chips and motor vehicles, following up on the box "Supply Chain Bottlenecks in U.S. Manufacturing" in the June 2021 Tealbook that also mentioned steel and lumber.

[8] A staff briefing at the December 2021 FOMC meeting (with the November CPI in hand) had flagged that the share of CPI categories with 12-month changes greater than 3 percent had surged in the fall. The briefing described inflation as "high, broad, and stubborn."

core PCE inflation at 4.6 percent and the 12-month change through December at 4.8 percent. Smoothing through the volatile monthly readings and taking stock of 2021 as a whole, the Board staff noted that while prices accelerated across goods, housing services, and services excluding housing, the contribution from the sharp pickup in goods price inflation in 2021 was the largest. The staff attributed 2021's high inflation readings to several factors, with the most important factor being the emergence of large supply–demand imbalances. These imbalances mainly affected core goods and were exacerbated by a longer-lived shift in consumption away from services. That said, the staff also thought that capacity constraints and wage pressures were boosting services price inflation.

The forecast of inflation for 2022 importantly reflected the staff's understanding and projection of supply disruptions and the labor market. At the start of 2022, the highly transmissible Omicron variant was causing new cases of COVID-19 to rise sharply again; the increase in cases reduced activity at ports in China and the U.S. and exacerbated supply chain bottlenecks. U.S. businesses were struggling to obtain materials, and the distribution of goods was brought to a standstill by port congestion and a shortage of truck drivers. In January, staff members expected that supply constraints and bottlenecks would now persist into the first half of 2022, but they remained optimistic that there would be some improvement in bottlenecks later in the year, hints of which were showing up in the data: Motor vehicle production had moved up as substantial increases in semiconductor production passed through the supply chain and assembly plants came back on line; in addition, the unusually high inventory of containers waiting at ports for transit had fallen.

In the labor market, the unemployment rate had dropped sharply (from a slightly revised 4.7 percent in September to 3.9 percent in December), while the participation rate had improved only slightly since the middle of 2021. Across a broad range of industries, businesses reported hiring difficulties and employee absences were widespread. The V/U ratio was well above its pre-COVID levels and continuing to increase. Wages were rising rapidly. Although staff members expected labor supply to recover some as Omicron passed, they still expected a very tight labor market, with the unemployment rate projected to fall further to 3.3 percent by year's end.

All told, the staff still expected the pace of monthly price increases to slow as supply constraints eased but not as noticeably as before in light of the stubbornly slow progress on bottleneck resolutions. The staff raised the projection for core PCE inflation in 2022 to 2.8 percent (on a Q4-over-Q4 basis), with a very high inflation reading expected for the first quarter before gradual easing thereafter.

3.6 March 2022 Tealbook

In early 2022, inflation continued to come in high (and higher than the Board staff projected in the January Tealbook). In addition to another very high reading for monthly core PCE inflation in January, both food and energy prices rose rapidly and core import prices soared

in January. Furthermore, oil prices surged in late February and early March on the news of Russia's invasion of Ukraine, and nonfuel commodity prices, including corn and wheat, also increased steeply. At the same time, rental rates in housing markets were still rising at rapid rates, and, in the March 2022 Tealbook, the staff began putting more weight on a new model that used them. As a result, staff members revised up the forecast for 2022 core PCE inflation by a full percentage point relative to their January projection; this revision—which was very large by historical standards—pushed the 2022 Q4-over-Q4 change in core PCE prices to 3.8 percent.

At the March 2022 meeting, the FOMC lifted off from the effective lower bound, though policy-sensitive rates had started rising in the fall of 2021 in anticipation of this move. By the time of the March meeting, the two-year Treasury rate was up about 150 basis points from its September level.

3.7 December 2022 Tealbook

Between the March 2022 and December 2022 Tealbooks, inflation continued to surprise to the upside. That said, many measures of supply chain bottlenecks were improving over the year, and Board staff members were starting to see some disinflation; goods price inflation in particular appeared to have turned a corner. The unwinding of pandemic-related fiscal support had already started to exert a drag on real GDP growth in 2021, the historically tight labor market appeared to be moderating, and interest-sensitive sectors were being weighed on by the increase in rates from the monetary policy tightening in train.

3.8 Core inflation in 2023 and 2024

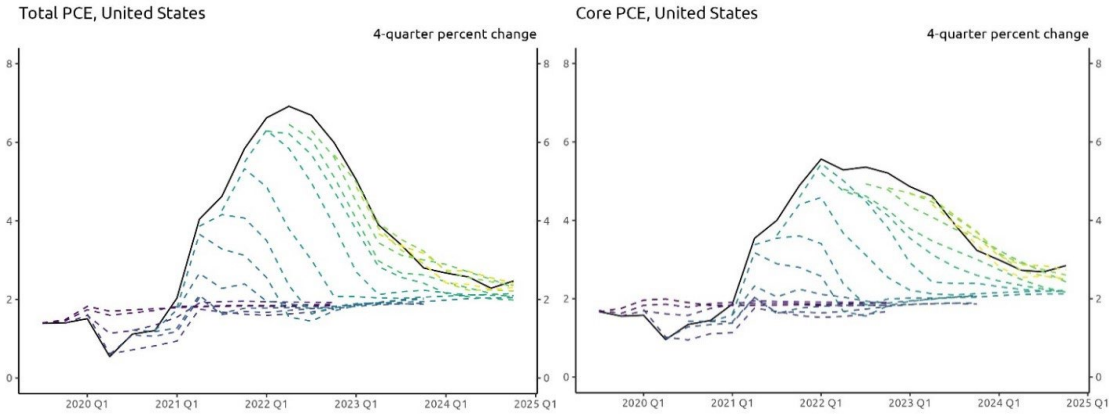
Over the next two years, both core and total PCE inflation rates slowed materially as supply–demand imbalances in the product and labor markets eased, and the Board staff's forecast errors were relatively smaller and offsetting in 2023 and 2024. Although some measures of longer-term inflation expectations had moved up modestly from 2020 to 2022, they generally remained within the range seen over the previous two decades during the inflation surge. The overall stability of long-term inflation expectations informed the view that inflation expectations remained well anchored, which the staff took as evidence that the public expected the FOMC to achieve its longer-run policy goal.

4. Sources of forecast errors and changes made to staff forecasting procedures

As can be seen in figure 4, Board staff forecasts for 2021 and 2022 consistently underpredicted both total and core inflation. Within core inflation, the staff saw upside surprises in all three major categories of PCE prices—goods, housing, and services excluding housing.[9]

[9] Appendix B includes charts of the staff forecasts for each of these three categories.

Figure 4: Tealbook inflation forecast at SEP dates: Headline and core PCE prices



Note: SEP is Summary of Economic Projections; PCE is personal consumption expenditures. The dashed lines show the Tealbook projection of a variable as of the closest SEP date; the solid line gives the current-vintage estimate of the actual series.

Source: Bureau of Economic Analysis via Haver Analytics; FRB staff calculations.

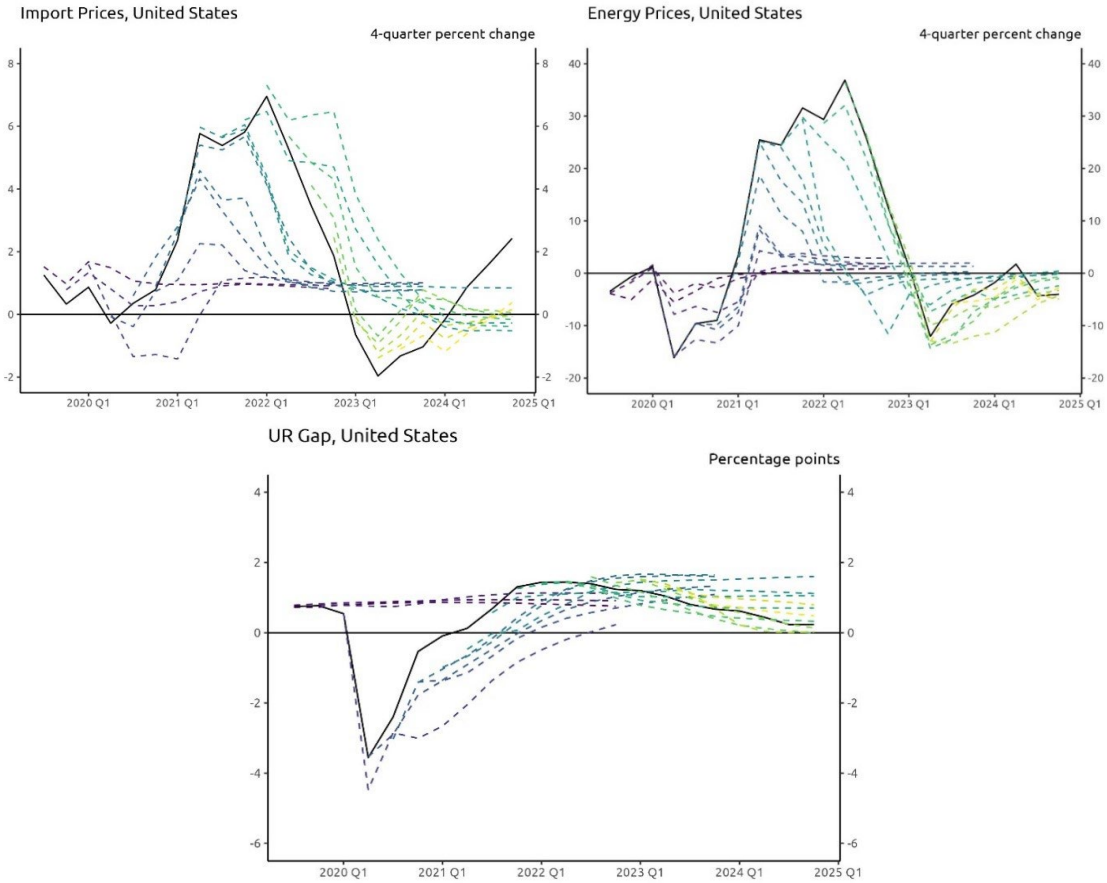
While the staff's inflation forecast is ultimately judgmental, the medium-term projection is importantly informed by a linear Phillips curve like the one described in section 1.[10] A natural way to decompose the staff's forecast errors, therefore, is to break them into two parts: first, errors that reflect poor real-time staff forecasts of conventional driving variables, and second, "specification errors" that can reflect deviations from the historical relationship of these variables with inflation as well as omitted or badly captured driving factors, including shocks arising from supply disruptions or large and rapid changes in the mix of goods and services consumed.

Errors in forecasts of conventional driving variables

Figure 5 indicates that the Board staff consistently underestimated how high import and energy price inflation would be. Although staff members correctly anticipated the rapid drop in the unemployment rate in 2021 and 2022—in part because they accurately predicted fiscal policy developments—they did not correctly anticipate the sluggish response of the labor force and the labor market churn from re-allocation. As a result, the staff projected that the natural rate of unemployment would rise more slowly than it now appears to have done; correspondingly, the unemployment gap closed more quickly than the staff had anticipated.

[10] Board staff members actually refer to a suite of models to inform the inflation projection; for the quantitative results shown here, we use a specific model that closely matches their judgmental framework and that conditions on their judgmental ULI assumption. The relationship between inflation and driving variables like resource utilization, import price inflation, and changes in energy prices is obtained from the historical relationship between core inflation and these variables (as staff members measure them).

Figure 5: Evolution of inflation driving variables

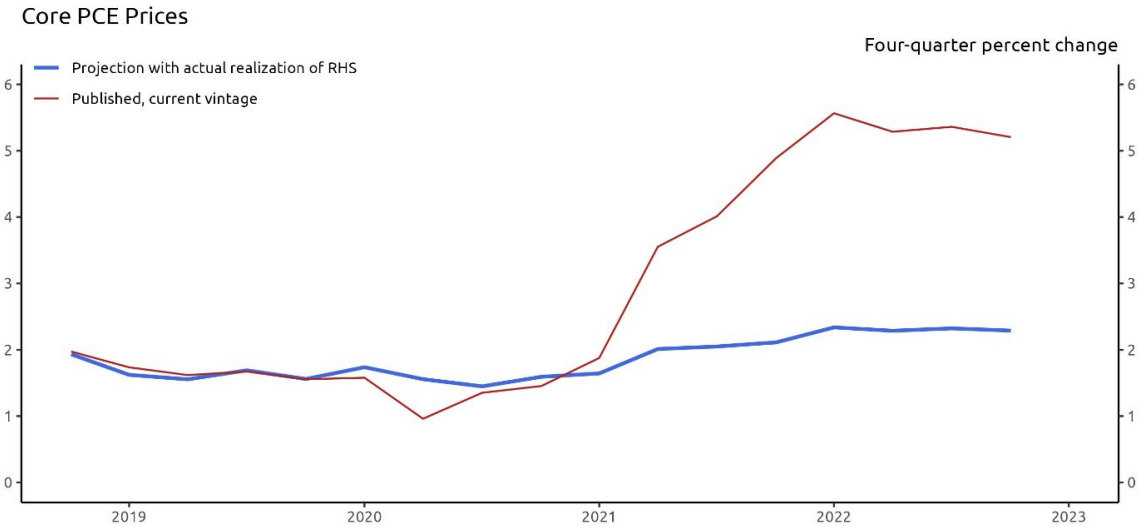


Note: UR is unemployment rate. The dashed lines show the Tealbook projection of a variable as of the closest Summary of Economic Projections date; the solid line gives the current-vintage estimate of the actual series.

Source: Bureau of Economic Analysis via Haver Analytics; FRB staff calculations.

However, figure 6 shows that even with the ex post paths of these variables, a Phillips curve model like equation (1) estimated with data through the first quarter of 2020 would have predicted only a small portion of the increase in inflation that actually happened in 2021 and 2022. Hence, most of the forecast misses appear attributable to specification errors (broadly construed).

Figure 6: Model forecast for core inflation using realized values of driving variables



Note: The blue line is a projection from a Phillips curve model based on the staff's underlying inflation assumption, estimated 1988–2019 and simulated starting in 2020:Q1 conditioning on the realized paths of the unemployment rate gap (defined as the actual unemployment rate minus the staff's estimate of the natural rate of unemployment), relative import price inflation, and energy prices. (In the legend, "RHS" refers to the model's right-hand-side variables.) PCE is personal consumption expenditures.

Source: Bureau of Economic Analysis via Haver Analytics; FRB staff calculations.

Omitted or poorly captured driving variables

A likely contributor to the Board staff's forecast errors is that the unemployment gap (the staff's usual proxy for overall resource utilization in the economy) underestimated how tight labor and product markets actually were. Alternative indicators such as the V/U ratio and the quits rate could have provided a more accurate picture of labor market tightness: When the labor market is already extremely tight, a further tightening might tend to raise vacancies more than it lowers unemployment, while quits could rise as employers use higher wages to lure workers from other firms.[11] In the staff's inflation framework, relevant shifts in the Beveridge curve would influence inflation through their effect on the staff's estimate of the natural rate of unemployment, which staff members boosted in 2021—but, in hindsight, not as quickly as they should have.

In addition, capacity and other constraints, which were not normally captured by the staff's Phillips curve framework, may have led to large and rapid increases in markups over labor

[11] These effects are difficult to pin down because the V/U ratio and the quits rate are strongly correlated with the unemployment gap before the pandemic. In the model used for figure 6, replacing the unemployment gap with the V/U ratio implies 0.15 percentage point higher inflation in 2021 and 0.45 percentage point higher inflation in 2022.

costs for some products, such as motor vehicles.[12] As it became clear that such imbalances were playing an important role and were likely to continue to do so in the future, staff members tried to identify, measure, and forecast these imbalances as well as they could. For example, for goods price inflation, they followed news on staffing issues (for example, in U.S. meat processing plants) and factory closures (including in China); they also tracked retailers' margins for evidence of excess demand for goods and as an indicator of potential price declines once supply–demand imbalances eased.[13] The staff also looked at evidence of supply chain bottlenecks or disruptions, such as high shipping costs, ships waiting at ports, supplier delivery times, the prevalence of reported shortages in the Quarterly Survey of Plant Capacity Utilization, and lists of items in short supply at manufacturers. Staff members used the evolution of these indicators, occasional anecdotal evidence (for example, from Beige Books and corporate earnings calls), and their judgment to forecast how supply–demand imbalances across the economy would evolve.

The Board staff also used the portion of inflation unexplained by model fundamentals to gauge the ***persistence of the effects from these supply–demand imbalances***. In 2021 and especially 2022, in response to their persistent misses, staff members undertook a major rethink of how quickly the effects of these imbalances on inflation would dissipate. Specifically, the staff markedly increased their projection for these effects and stopped assuming that the increase and reduction of the imbalances would eventually be neutral for the price level. This rethink led staff members to make a significant upward revision such that their projection had inflation remaining above what their model predicted (given the forecasts for the variables in the model) over a large portion of the projection period.

At the end of 2021, staff members also started boosting the price forecast to reflect the portion of wage growth that was not being captured by their usual wage-forecasting models—that is, ***wage–price pass-through effects***. Before the pandemic, fundamentals did a reasonable job of explaining wage growth, and any residual or unexplained portion tended not to persist. However, given the size and persistence of the unexplained portion of wage growth during the pandemic period, the staff allowed it to have a separate effect on price inflation as a way of systematically incorporating the effects of labor shortages and unusually high labor costs into their price projection. These effects were based on an estimated relationship between

[12] For example, light motor vehicle production remained below pre-COVID levels for an extended period, and Board staff members persistently overpredicted light motor vehicle production as bottleneck effects waned more slowly than they expected. These factors are not captured by the unemployment gap in the staff's Phillips curve framework.

[13] This latter task is difficult because these measures are *margins*—that is, the difference between the price of goods sold and the cost of acquiring them—rather than *markups* over marginal costs: With a constant markup, a margin will rise if the cost of acquiring the goods increases. Margins can also increase if retailers face higher labor and other costs in addition to the cost of acquiring goods. Hence, while elevated markups might be expected to normalize once supply–demand imbalances eased, margins could still remain higher than the level seen before these imbalances occurred.

employment cost index (ECI) growth and market-based core PCE price inflation. Similar to their assumptions regarding inflation residuals, staff members assumed that unexplained wage inflation would fade only gradually over time.

Finally, another important component of the staff's forecasting framework had been the assumption of a constant rate of ULI. The staff changed this assumption starting in December 2021 by implementing an ***updating rule for underlying inflation*** that allowed ULI to increase endogenously in response to high realized inflation, which in turn implied that higher inflation would persist longer over the projection period. At its peak, this change added about ½ percentage point to projected inflation. At the end of 2023, staff members moved back to assuming a constant rate of ULI, but at a higher level than their pre-pandemic assumption.[14]

Changes in slope

Another possibility is that the relationship between slack and inflation changed as the degree of tightness in labor and product markets pushed the economy to a steeper portion of a nonlinear Phillips curve. The Board staff's pre-pandemic framework, outlined in section 1, assumed a linear relation between slack and inflation. In early 2021, however, the staff's projection called for fiscal stimulus to boost spending and activity such that the unemployment rate would move well below their estimate of its natural rate. With some pre-pandemic evidence, mainly based on metro-level data analysis, that the Phillips curve steepens at extremely high rates of resource utilization, the staff began adjusting the inflation projection in March 2021 to reflect possible ***Phillips curve nonlinearities***. These nonlinear effects pushed up the staff's inflation forecast in 2022 and 2023. However, because the historical data suggested relatively moderate amounts of nonlinearity, the staff assumed that the contribution of these nonlinear effects to inflation would be relatively small. While it is possible that staff estimates understated the true slope even with these adjustments, it is also difficult to distinguish between changes in the slope and shifts in the Phillips curve such as those induced by supply disturbances.

Relatedly, an additional way in which a nonlinearity between slack and inflation could have occurred is if the pass-through of production costs became larger, faster, or both. Producers and sellers likely came to view the pandemic-related cost shocks as persistent or permanent and also realized that their customers were willing and able to pay higher prices. Likewise, multiple, large, and one-sided shocks to production costs might have induced firms to reset prices more often.[15]

[14] In December 2023, the staff simply assumed that ULI had moved up from 1.7 percent pre-pandemic to 2.0 percent by the end of 2022. At present, it is hard to actually know whether there has been a permanent change to ULI, and it will take a number of years before statistical filters provide useable estimates of inflation's long-run trend.

[15] Montag and Villar (2023) document that the surge in inflation during the pandemic recovery was characterized by a large increase in the frequency of price increases and, to a lesser extent, an increase in their average size.

In addition, it is possible that speed effects—inflation pressures resulting from the *change* in resource utilization—were at work. Anecdotal evidence through 2021 suggests that producers—for example, of steel and motor vehicles—were caught flat-footed by the rapid *increase* in demand, and supply could not keep up. (Such effects might have been present before the pandemic but were less evident because the swings in demand in earlier periods were relatively small.)

Determining exactly which of these various specification errors were present, and to what degree, is challenging to do with only one episode. It seems clear that errors in forecasting the variables in the staff's baseline model (import and energy prices and the unemployment gap) contributed somewhat but were not very important quantitatively. By contrast, errors related to limited ability to measure and forecast supply constraints, use of imperfect measures of labor and product market slack, and failure to fully capture possible nonlinear or speed effects played a much larger role. Even after the fact, however, the staff do not yet see a clear way to disentangle the quantitative relevance of these various sources of forecast errors.

Building up from sector-specific forecasts

Before the pandemic, the Board staff's near-term price forecast was heavily informed by the recent behavior of inflation in specific categories and any news or indicators relevant to those categories. The medium-term projection, by contrast, was top down and mostly based on fundamentals, the rationale being that idiosyncratic relative price changes were unlikely to persist and would tend to cancel each other out over time. That approach became less useful during the pandemic, as these relative price changes proved to be large and persistent.

As a result, staff members began to ***build up their medium-term aggregate inflation forecast*** from the separately forecast components of goods, housing, and core services excluding housing. Doing so allowed the staff to use indicators of supply–demand imbalances, such as semiconductor shortages or congestion at ports, to inform the forecast for core goods inflation. Another important example was the staff's introduction of a market rents model to inform their housing services forecast: Given the lag with which growth in market rents feeds into PCE housing services inflation, it was clear that these data could inform the staff forecast beyond the near term. The staff also allowed relative price changes like these to show through to overall inflation over the medium term, rather than assuming that they would be offset by other relative price changes.

5. Useable lessons from other empirical research

The large literature on pandemic-era inflation dynamics faces the same challenges described above. As with the Board staff's analysis, much of the literature has focused on evaluating alternative measures of slack like the V/U ratio, modeling Phillips curve nonlinearities, and developing measures of supply disruptions.[16] But the fact that researchers are

[16] See the framework review paper by Hajdini and others (2025) for a more comprehensive discussion.

trying to explain a single outlier event makes it hard to be confident that any findings are robust, and trying to explain pandemic-era inflation developments with a particular factor will likely overstate its contribution unless researchers also account for other salient influences on inflation.

Alternative measures of slack

Search-and-matching models of the labor market suggest that the V/U ratio provides a better measure of labor market tightness than the unemployment rate alone. The extraordinary increase in the V/U ratio over the pandemic period makes it an attractive candidate for explaining a portion of the inflation seen during that time, and this series has been used for this purpose by Ball, Leigh, and Mishra (2022), Bernanke and Blanchard (2023), and Barnichon and Shapiro (2024a, 2024b), among others. In a similar vein, Heise, Pearce, and Weber (2024) argue that the quits rate represents an even better measure of labor market tightness than the V/U ratio. However, as described in a framework review paper, measures of V/U are not problem-free.[17] Moreover, the research finds widely differing estimates of the share of inflation that the V/U ratio can explain during the pandemic.[18]

Phillips curve nonlinearities

The idea that the Phillips curve becomes steeper at high rates of utilization (a nonlinear Phillips curve) is a very old one and has reemerged as an explanation for pandemic-period inflation swings.[19] Because a large shift in the Phillips curve at relatively low rates of unemployment will look like a nonlinearity in a simple unemployment–inflation scatterplot, controlling for any shifts (such as those induced by supply shocks) is critical for assessing whether a nonlinear relation is a structural feature of the inflation process. Comprehensively controlling for these shifts is difficult to do, however, and, as a result, it is difficult to determine whether and to what degree Phillips curve nonlinearities contributed to inflation in the pandemic period.[20] Indeed, there is a wide range of estimates of how steep the Phillips curve becomes at high rates of utilization and considerable uncertainty regarding what level of utilization might cause nonlinear effects to emerge.

---

[17] See the framework review paper by Foote and others (2025).

[18] Compare, for instance, the relatively small estimates of Bernanke and Blanchard (2023) and Barnichon and Shapiro (2024a) with the larger effects found in Benigno and Eggertsson (2024).

[19] See Benigno and Eggertsson (2024), Schmitt-Grohé and Uribe (2022), and Ball, Leigh, and Mishra (2022) for examples.

[20] Benigno and Eggertsson (2024) use relative import prices and the relative contributions of food and energy prices as controls for supply shocks; it seems likely, however, that other supply-side disturbances were at work during the pandemic. Ball, Leigh, and Mishra (2022) include a measure of supply disruptions and allow for nonlinear effects; however, the nonlinear terms in their specification make no contribution to their model's ability to fit inflation. Schmitt-Grohé and Uribe (2022) focus on the labor market but make no allowance for supply shocks in product markets; moreover, the fit of their calibrated model is not especially good, with extremely large prediction errors at low levels of unemployment.

Measures of supply disruptions

Another extension involves trying to measure a "shift" term in a Phillips curve that captures the effect of supply-related factors on inflation, which is an ongoing area of research.[21] The main shortcoming from an inflation-forecasting point of view is that these indicators would themselves need to be projected; in addition, in some cases, the measures' estimated effects on inflation rely on the pandemic period for identification, which might reduce the usefulness of these indicators in other situations.[22]

6. Robust elements of the staff's framework

Although the Board staff made large forecast errors over this period, three features of the inflation framework turned out to be reliable guides for their projection. First, the staff's inflation forecast was predicated on an assumption that long-term inflation expectations—and so ULI—would remain relatively well anchored at a level consistent with the FOMC's 2 percent goal (and that this outcome would be ensured by monetary policy commitment and actions).[23] More broadly, the staff assumed that most of the observed rise in inflation reflected *shifts* in the Phillips curve induced by persistent pandemic-related shocks, as opposed to a fundamental change in the inflation process—for example, a rise in the intrinsic persistence of inflation or a return to an accelerationist regime.

Second, a key feature of the staff's forecast was that lower inflation would occur without a large increase in the unemployment rate: In the July 2022 Tealbook, staff members projected

---

[21] Two often-cited examples are Ball, Leigh, and Mishra (2022) and Bernanke and Blanchard (2023). An alternative way of estimating the effects on inflation of supply-side disruptions is to use the input–output tables to map out production networks. This procedure is intended to capture the various ways in which the rise in an input price will feed through to the costs of producers, including producers who use the input indirectly by purchasing the output of other firms that use the input. Earlier attempts to apply this approach to the pandemic period (Baqaee and Farhi, 2022; di Giovanni and others, 2022) assumed, rather than estimated, the relevant elasticities of aggregate supply and demand, limiting the usefulness of their estimates. However, this literature is an area of active research and might be useful as it develops further. In addition, Braun, Flaaen, and Hoke (2024) describe a methodology that uses sign-restricted vector autoregression models to decompose changes in manufacturing producer price indexes into supply- and demand-related components; this approach might also be able to inform interpretations of observed PCE price changes at some point.

[22] For example, 95 percent of the variability of the Ball, Leigh, and Mishra (2022) measure is attributable to energy and used car prices, neither of which is especially easy to forecast or likely to capture supply disruptions generally. The Bernanke–Blanchard proxy for supply disruptions is a Google search term for "shortages," which only shows meaningful variation during the pandemic period (and even then the sum of the coefficients on current and lagged shortages is not statistically significant). Bernanke and Blanchard (2023) also use relative food and energy price changes as a measure of supply shocks; these, along with the shortages term, are taken as given when the model's headline CPI tracking performance is evaluated.

[23] As described in section 4, in the December 2021 projection, the Board staff did start to use an updating rule for ULI in order to hedge against the risk that some of the rise in actual inflation would persist. However, this rule took only limited signal from actual inflation and was anchored in the long run at 2 percent; at its peak, therefore, projected ULI was just 2.3 percent.

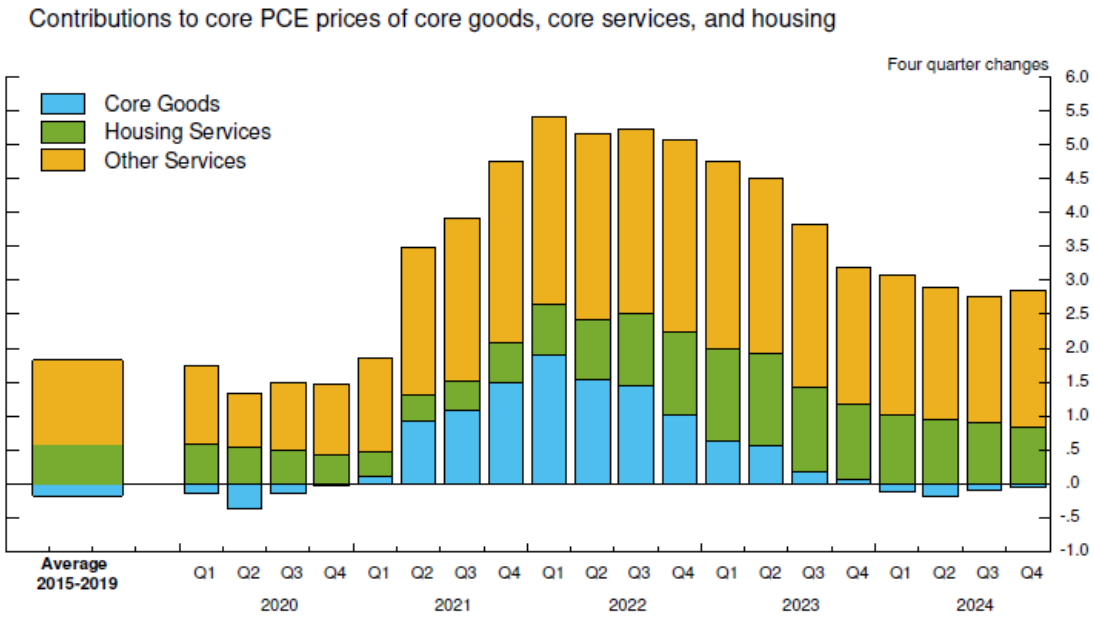
that total PCE price inflation would peak in June 2022 and decline 4.9 percentage points by the end of 2024 with an unemployment rate increase of 0.8 percentage point. This forecast reflected their interpretation that pandemic-related disruptions to labor and product markets together with shocks to energy and food prices were responsible for a large portion of the rise in inflation, as well as their assumption that ULI would remain relatively stable. As a result, inflation was expected to ease as supply recovered (and in the absence of further shocks). In the event, this prediction was borne out, though the recovery in supply was more delayed than the staff had expected: Total PCE price inflation fell about 4½ percentage points from its June 2022 peak, while the unemployment rate rose 0.5 percentage point.

Third, staff members highlighted early and regularly that there were upside risks to their inflation projection. In December 2020, the Tealbook noted that the pandemic had caused an "unprecedented" mix of supply and demand pressures and included an alternative scenario to explore the possibility that these pressures would be larger than expected. In March 2021, the staff highlighted an alternative scenario with significantly greater inflationary pressures and unanchored inflation expectations. And, by July 2021, the staff's assessment was that the risks to the inflation projection were skewed to the upside. In retrospect, though, staff members were insufficiently aggressive in the design of their alternative scenarios. For example, in the March 2021 scenario, total PCE inflation was 2.4 percent by the end of 2022 (in the event, it was 6 percent).

7. The staff's best explanation for inflation over this period

With the benefit of hindsight, the Board staff think that the pandemic led to large and persistent reductions in supply across broad swaths of the economy, which, combined with the surge in demand generated by the rapid reopening of the economy amid large fiscal and monetary support, resulted in excess demand in a number of sectors; inflation then gradually subsided as these supply–demand imbalances unwound. The staff view inflation dynamics over this period primarily in terms of an upward shift of the Phillips curve, accompanied by a rapid tightening in the labor market that likely led to the emergence of nonlinear and speed effects. This process played out somewhat differently across the three main categories of prices (figure 7).

Figure 7: Core inflation contributions, by major category



Note: PCE is personal consumption expenditures.
Source: Bureau of Economic Analysis via Haver Analytics; FRB staff calculations.

- First, pandemic-related developments, including remote work, remote schooling, and a greater need for personal transportation, led to a large and persistent shift in consumer demand away from services and toward goods, which then ran up against a limited, slow-to-respond, and often disrupted global supply. This strong demand was supported by large fiscal policy transfers, which likely also had the effect of making buyers less price sensitive. The resulting surge in goods prices over the 2021–22 period was then followed by a marked deceleration in 2023 as the resolution of supply chain issues and a shift in demand back toward services caused supply–demand imbalances in the goods market to ease significantly.
- The pandemic and the increase in remote work also led to increased demand for housing that was focused on larger units and single-family houses outside of urban centers. Because housing supply is inelastic in the short run, and labor and material shortages during the pandemic made supply even more inelastic than usual, greater demand led to a sharp acceleration in market rents for single-family units that started in early 2021 and reached a peak in early 2022. These rapid increases in market rents slowly passed through to measured PCE housing services; as a result, PCE housing services inflation did not reach its peak until early 2023 and has been coming down slowly (but consistently) since then.
- For core services excluding housing, in early 2021 wage growth in lower-wage and high-contact industries started to increase, leading to high inflation for categories like food away from home. By the fall of 2021, the labor market was beginning to tighten

as many people stayed out of the labor market, likely prompted by renewed health scares and schools that were still in a remote posture and enabled by fiscal transfers. At the same time, re-allocation across sectors roiled labor markets, all while labor demand continued to recover. As the labor market became increasingly tight and the cost of living rose, strong wage growth became widespread across sectors; these increases in labor costs were passed through to higher prices, particularly in the services sector, where labor's share of costs tends to be higher.

- Finally, the need for firms and workers to adjust prices and wages to the series of large supply and demand shocks resulted in a long-lived boost to inflation that has been unwinding only slowly and unevenly.

In coming to this assessment, the Board staff have been informed both by external research and by numerous internal discussions and analyses that led them to make the adjustments to the forecast framework described in section 4. There is broad-based agreement that both supply and demand shocks contributed to inflation during the pandemic even if there is no agreement about the exact extent to which shocks to labor supply, fiscal policy, monetary policy, the shift toward goods consumption, global supply chains, and other factors played a role in the inflation swings. Thus, there remains great uncertainty about an exact accounting of the various contributors to the pandemic-period inflation, and analysis that either attributes all or most of the inflation to any single factor or that expresses great confidence in quantitative estimates of their contributions seems too bold.

Still, while the Great Recession episode taught the Board staff that inflation can remain relatively stable despite large swings in commodity prices and economic activity, the pandemic episode showed that this stability need not always be the case. With inflation for goods and some components of services having come down, and with more deceleration in housing services in train, there is not strong evidence that the inflation process has fundamentally changed. Rather, the staff generally believe that the various effects of the large and persistent shocks to inflation, singly and in combination, are finally fading out.[24] As a result, the staff's basic inflation framework should still be useful going forward, but staff members will also stand ready to deviate from it if the new set of indicators they are now watching closely (or any others) start to suggest significant risks to the forecast.

[24] Indeed, the new tool developed in Smith and Wolman (2024), which uses the entire distribution of price changes to monitor whether inflation is behaving in a manner consistent with the low and stable pre-COVID inflation regime, shows that since May 2023, the behavior of prices has been largely consistent with the 1995–2020 period.

References

Ball, Laurence, Daniel Leigh, and Prachi Mishra (2022). "Understanding US Inflation during the COVID-19 Era," *Brookings Papers on Economic Activity,* Fall, pp. 1–54, https://www.brookings.edu/articles/understanding-u-s-inflation-during-the-covid-era.

Baqaee, David, and Emmanuel Farhi (2022). "Supply and Demand in Disaggregated Keynesian Economies with an Application to the COVID-19 Crisis," *American Economic Review*, vol. 112 (May), pp. 1397–436.

Barnichon, Régis, and Adam Hale Shapiro (2024a). "How Much Has the Cooling Economy Reduced Inflation?" FRBSF Economic Letter 2024-30. San Francisco: Federal Reserve Bank of San Francisco, November 18, https://www.frbsf.org/wp-content/uploads/el2024-30.pdf.

Barnichon, Régis, and Adam Hale Shapiro (2024b). "Phillips Meets Beveridge," *Journal of Monetary Economics*, vol. 148, Supplement (November), 103660, https://doi.org/10.1016/j.jmoneco.2024.103660.

Benigno, Pierpaolo, and Gauti B. Eggertsson (2024). "Revisiting the Phillips and Beveridge Curves: Insights from the 2020s Inflation Surge," NBER Working Paper Series 33095. Cambridge, Mass.: National Bureau of Economic Research, October, https://doi.org/10.3386/w33095.

Blanchard, Olivier J., and Ben S. Bernanke (2023). "What Caused the US Pandemic-Era Inflation?" NBER Working Paper Series 31417. Cambridge, Mass.: National Bureau of Economic Research, June, https://doi.org/10.3386/w31417.

Braun, Robin, Aaron Flaaen, and Sinem Hacıoğlu Hoke (2024). "Supply vs Demand Factors Influencing Prices of Manufactured Goods," FEDS Notes. Washington: Board of Governors of the Federal Reserve System, February 23, https://doi.org/10.17016/2380-7172.3465.

Foote, Christopher, Shigeru Fujita, Amanda Michaud, and Joshua Montes (2025). "Assessing Maximum Employment," Finance and Economics Discussion Series 2025-067. Washington: Board of Governors of the Federal Reserve System, August, https://doi.org/10.17016/FEDS.2025.067.

di Giovanni, Julian, Şebnem Kalemli-Özcan, Alvaro Silva, and Muhammed A. Yildirim (2022). "Global Supply Chain Pressures, International Trade, and Inflation," NBER Working Paper Series 30240. Cambridge, Mass.: National Bureau of Economic Research, July, https://doi.org/10.3386/w30240.

Hajdini, Ina, Adam Shapiro, A. Lee Smith, and Daniel Villar (2025). "Inflation since the Pandemic: Lessons and Challenges," Finance and Economics Discussion Series 2025-070. Washington: Board of Governors of the Federal Reserve System, August, https://doi.org/10.17016/FEDS.2025.070.

Heise, Sebastian, Jeremy Pearce, and Jacob P. Weber (2024). "Wage Growth and Labor Market Tightness," Federal Reserve Bank of New York Staff Reports 1128. New York: Federal Reserve Bank of New York, October (revised March 2025), https://doi.org/10.59576/sr.1128.

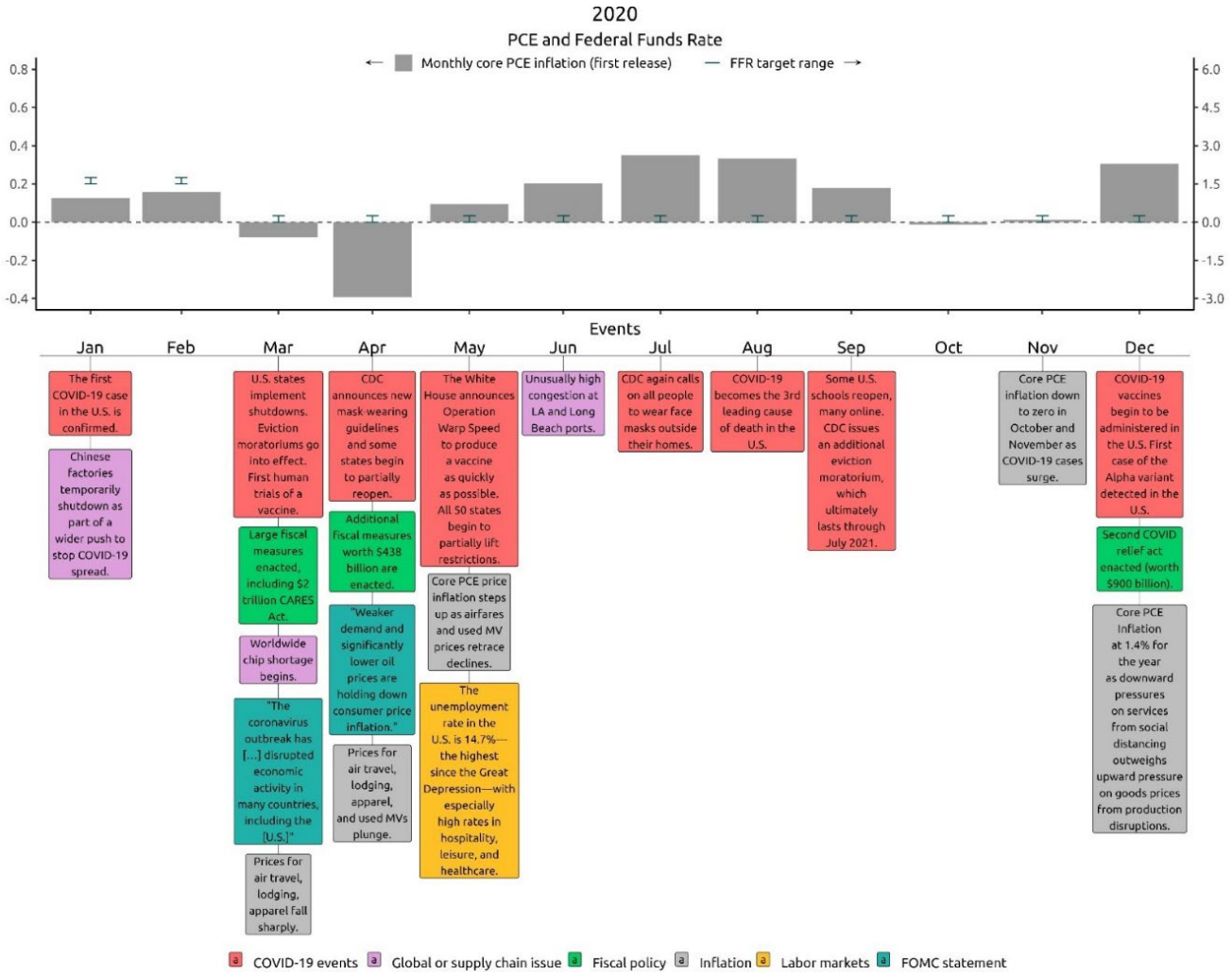
Montag, Hugh, and Daniel Villar (2023). "Price-Setting during the Covid Era," FEDS Notes. Washington: Board of Governors of the Federal Reserve System, August 29, https://doi.org/10.17016/2380-7172.3298.

Smith, Simon C., and Alexander L. Wolman (2024). "New Tools to Monitor Inflation in Real Time," FEDS Notes. Washington: Board of Governors of the Federal Reserve System, December 20, https://doi.org/10.17016/2380-7172.3617.

Schmitt-Grohé, Stephanie, and Martín Uribe (2022). "Heterogeneous Downward Nominal Wage Rigidity: Foundations of a Nonlinear Phillips Curve," NBER Working Paper Series 30774. Cambridge, Mass.: National Bureau of Economic Research, December (revised October 2023), https://doi.org/10.3386/w30774.

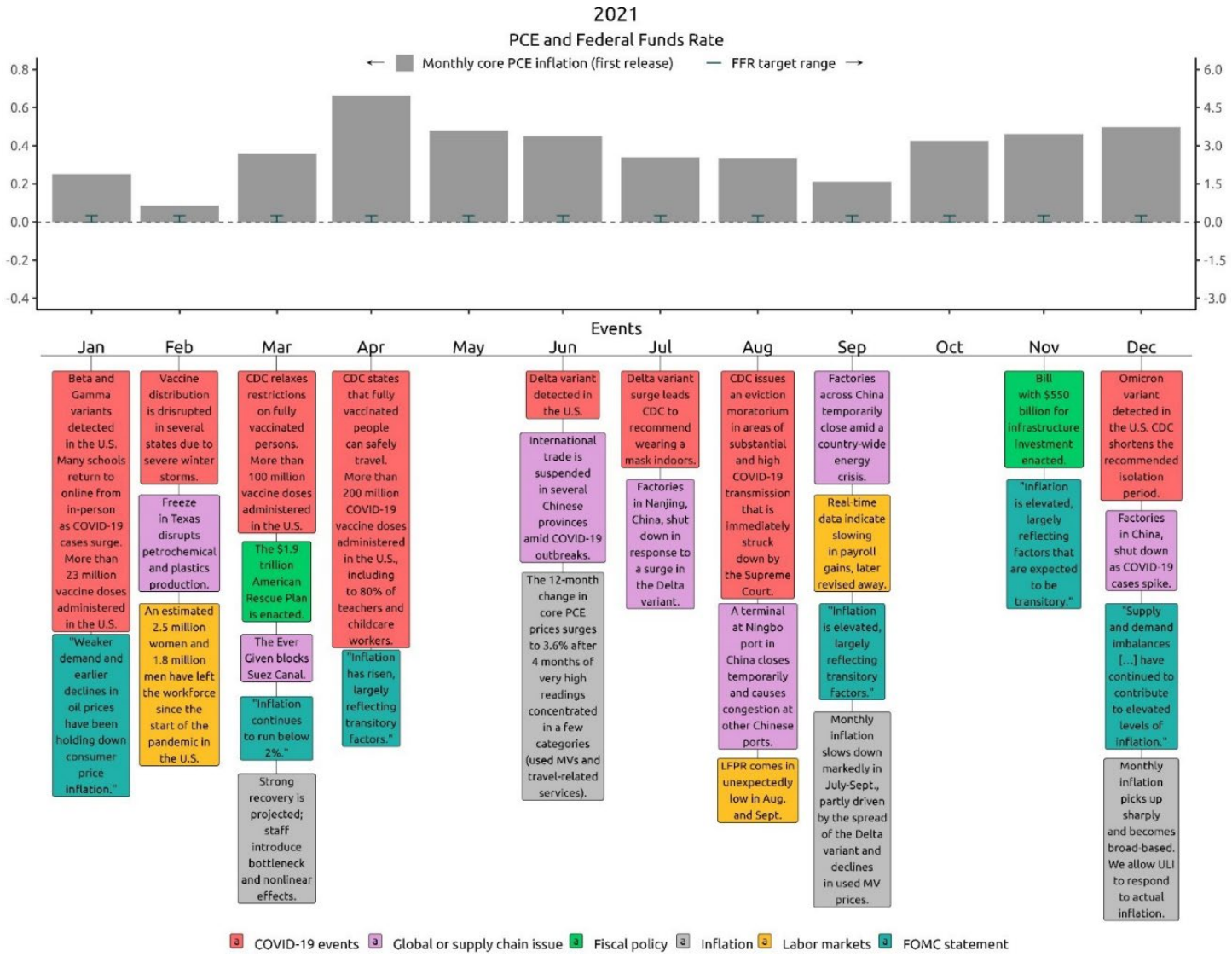
Appendixes

Appendix A: Timeline of Key Inflation-Related Developments

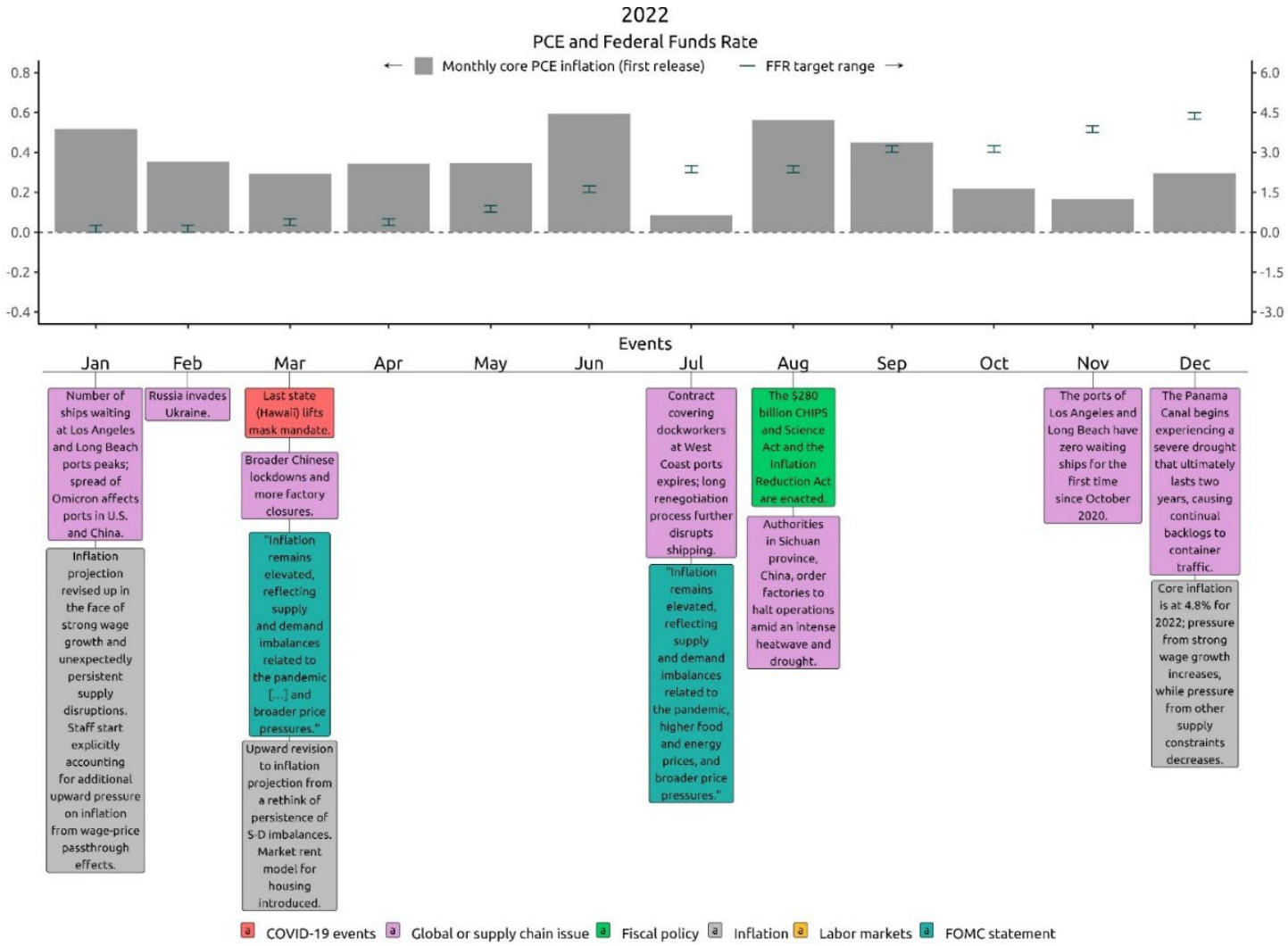


Note: PCE is personal consumption expenditures; FFR is federal funds rate; CARES is Coronavirus Aid, Relief, and Economic Security; CDC is Centers for Disease Control and Prevention; MV is motor vehicle. Units of the axes are percent.

Source: Bureau of Economic Analysis via Haver Analytics; FRB staff calculations.

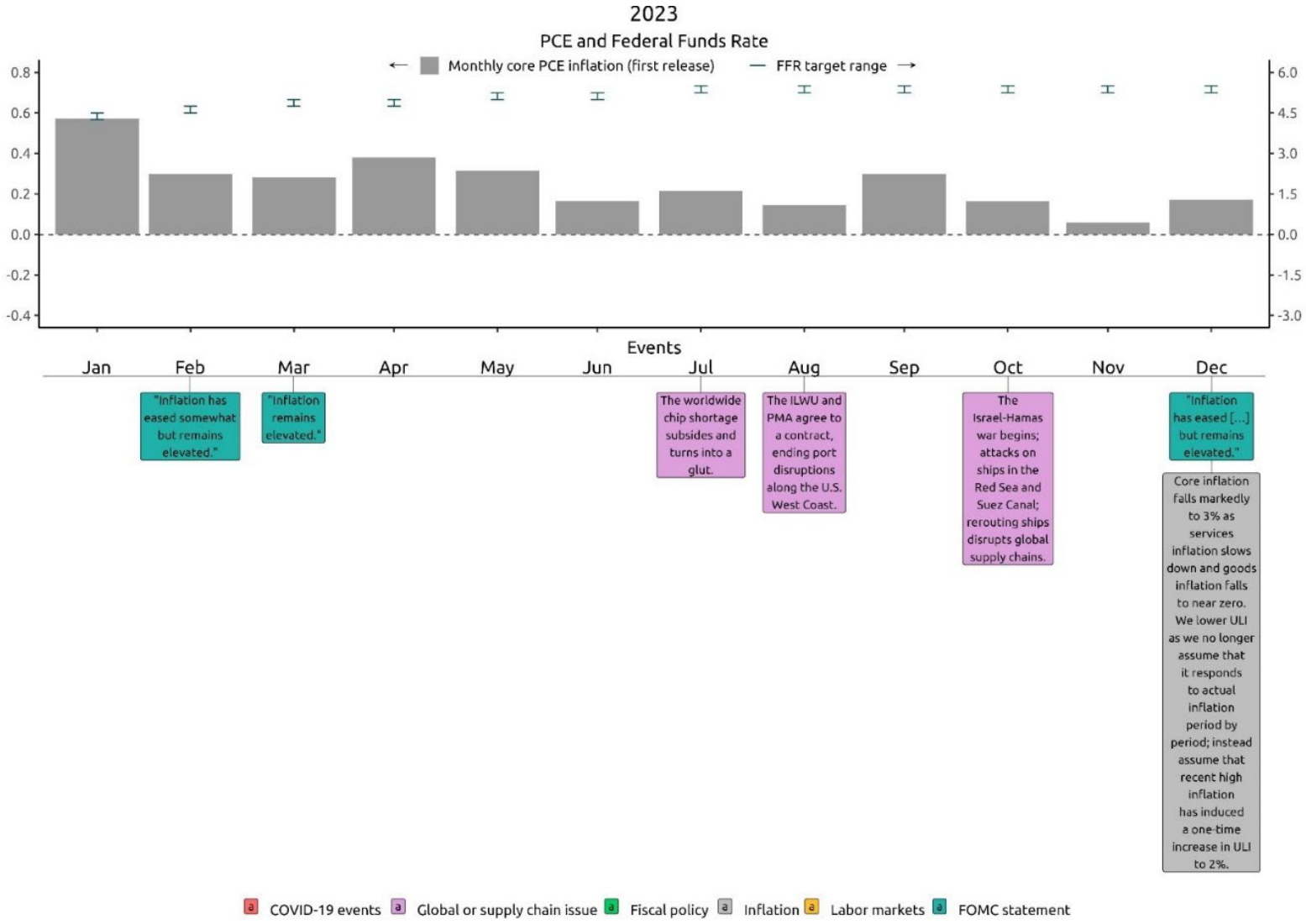


Note: PCE is personal consumption expenditures; FFR is federal funds rate; CDC is Centers for Disease Control and Prevention; MV is motor vehicle; LFPR is labor force participation rate; ULI is underlying inflation. Units of the axes are percent.
Source: Bureau of Economic Analysis via Haver Analytics; FRB staff calculations.



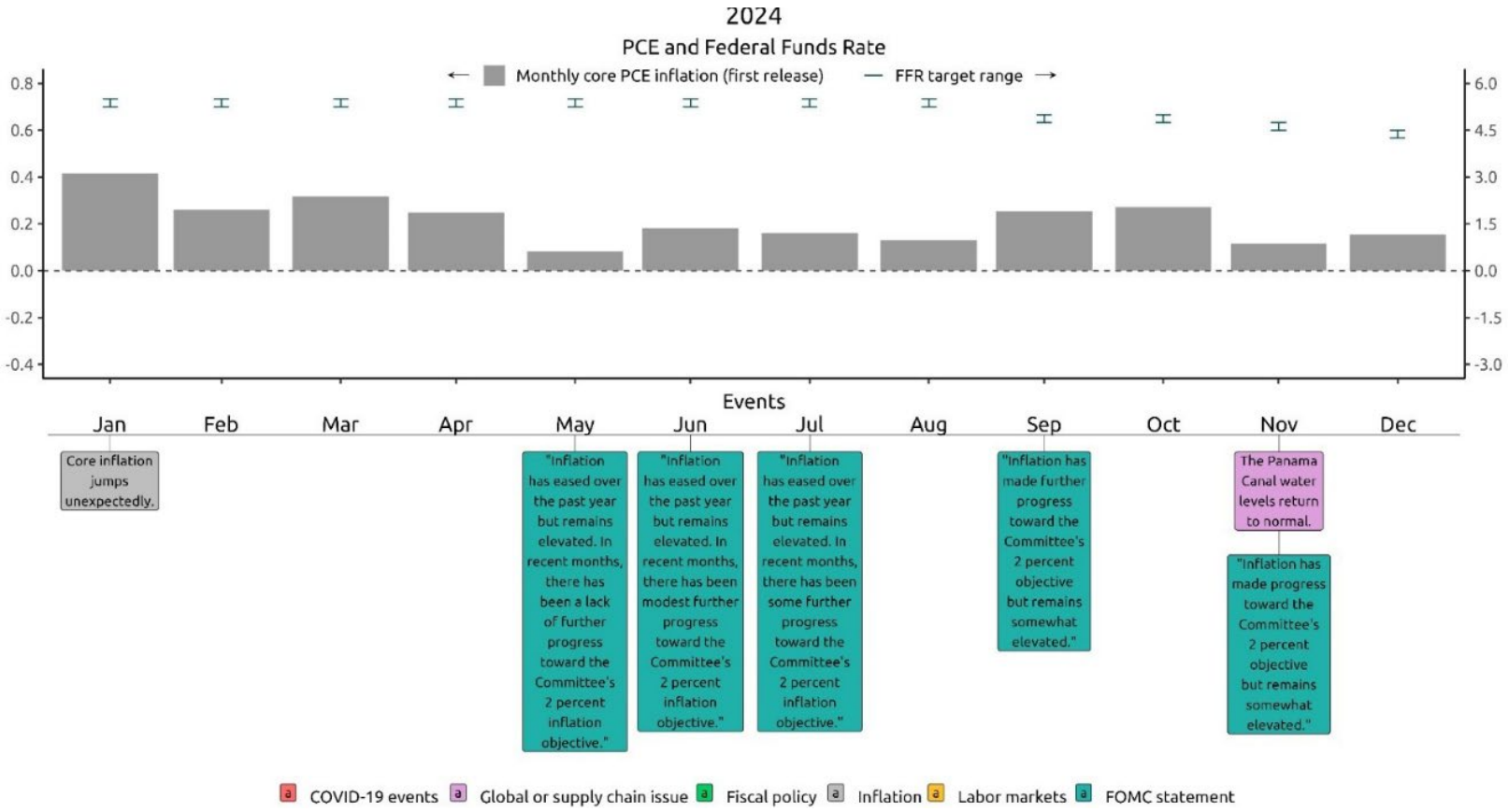
Note: PCE is personal consumption expenditures; FFR is federal funds rate; S-D is supply–demand; CHIPS is Creating Helpful Incentives to Produce Semiconductors. Units of the axes are percent.

Source: Bureau of Economic Analysis via Haver Analytics; FRB staff calculations.



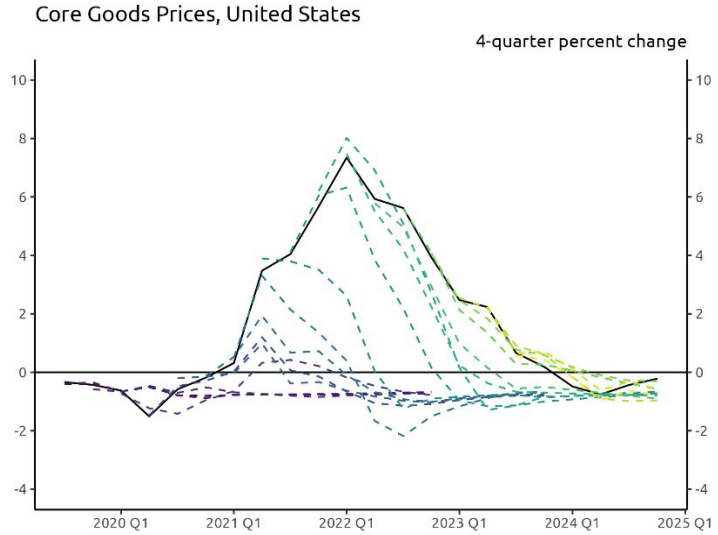
Note: PCE is personal consumption expenditures; FFR is federal funds rate; ILWU is International Longshore and Warehouse Union; PMA is Pacific Maritime Association; ULI is underlying inflation. Units of the axes are percent.

Source: Bureau of Economic Analysis via Haver Analytics, FRB staff calculations.

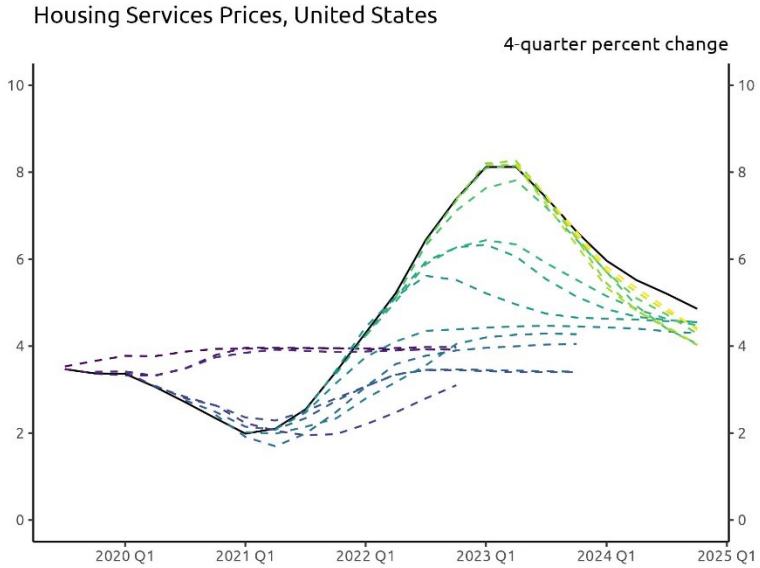


Note: PCE is personal consumption expenditures; FFR is federal funds rate. Units of the axes are percent.
Source: Bureau of Economic Analysis via Haver Analytics, FRB staff calculations.

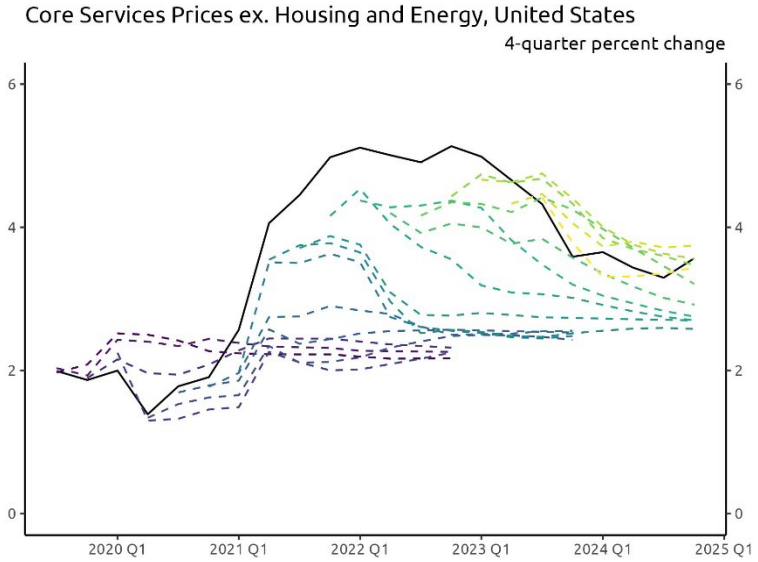
Appendix B: Tealbook Inflation Forecasts at Summary of Economic Projections Dates for Core Goods, Housing Services, and Core Services excluding Housing



Source: Bureau of Economic Analysis via Haver Analytics; FRB staff calculations. The dashed lines show the Tealbook projection of a variable as of the closest SEP date; the solid line gives the current-vintage estimate of the actual series.



Source: Bureau of Economic Analysis via Haver Analytics; FRB staff calculations. The dashed lines show the Tealbook projection of a variable as of the closest SEP date; the solid line gives the current-vintage estimate of the actual series.



Source: Bureau of Economic Analysis via Haver Analytics; FRB staff calculations. The dashed lines show the Tealbook projection of a variable as of the closest SEP date; the solid line gives the current-vintage estimate of the actual series.