Monitoring economic conditions:
The policy process at the New York Fed

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ECB Conference on

Macroeconomic Modeling Frontiers for Research and Policy in Central Banks

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*The views expressed here are my own and do not necessarily reflect those of the Federal Reserve Bank of New York or the Federal Reserve System.

Use of models in central banks

- Why central banks use models
  - For organizing and processing data releases in real time
  - For making projections to guide monetary policy strategy and actions
- Why quantitative models
  - To be able to replicate results
  - To quantify uncertainty and assess risks
- Over time models are enriched and adapted to handle new situations
  - Occurrence of new shocks (financial crisis, secular stagnation, pandemic)
  - Introduction of new policy regimes (inflation targeting, strategy reviews, ..)
- New models are also introduced to reflect frontier research innovations
  - Modeling various forms of heterogeneity, handling different assumptions on expectations
  - Handling climate issues, effects of inequality, the advent of artificial intelligence
  - Handling new and richer data sources

Models in practice

- Role of models in policy preparations
  - Prepare forecasts of variables of interest into near- and medium-term future
  - Assess uncertainty and risks around those projections
  - Conduct policy exercises: e.g., analyzing impact of alternative policy strategies or actions

- Most central banks use a variety of models to inform their policy
  - Large-scale models (augmented with judgment): typically used to produce ‘staff’ forecasts
  - Structural models: smaller, derived from micro-foundations, built on optimizing behavior
  - Time series models: describe co-movements of variables with limited constraints from theory
  - Support models: provide more detailed analysis of particular elements of the large model

- To illustrate how the several types of models are used in practice, I will discuss their role in the policy process at my institution

The policy process at the NY Fed

- FOMC cycles: eight per year
- Cycle preparation peaks up two weeks before the FOMC meeting
  - Week -2
    - Staff meet to review inter-meeting development and discuss preliminary outlook
      - Evidence from the DSGE model and time series models is also reviewed
    - Policy recommendations are discussed
  - Week -1
    - The Board's Tealbook is discussed and outlooks compared
    - Staff review survey evidence, market expectations and finalize outlook and policy recommendation
    - Staff meet with the President for an academic-type discussion of a policy relevant topic
    - Staff discuss outlook and risks with the Presidents and assist to finalize the projections, if SEP due
  - Week 0
    - Attendee to the FOMC meeting briefs the staff; discuss issues for the following cycle

Staff outlook

Main model: large, bottom-up model reflecting the NIPA structure, augmented with judgment

- Expenditure components:
  - Consumption, Investment (residential, non-res, equipment, IPP, inventories), Government, Net-exports
    - Uses higher frequency data releases to track current quarter's expenditures
- Inflation PCE components: energy prices, food and beverages, and core
  - Uses weekly data to track energy and food prices; uses translation from CPI to PCE;
  - Phillips curves for core goods and services; include longer-term inflation expectations
- Productivity and costs : block to obtain path of unemployment implied by the GDP forecast
  - given estimates of long-run growth of nonfarm productivity, LFP, Pop growth and weekly hours
- Financial variables - 10-y Treasury rate, corporate bond rates and term spreads affect rate sensitive expenditures
- Most of the blocks are estimated equation by equation

Uncertainty and risks

- Challenge in evaluating uncertainty of the judgmental forecast
- Our approach is to construct a forecast distribution from weighting the forecasted paths obtained from alternative scenarios
  - A scenario is a path for the observables that can be created with an appropriate combination of shocks
  - The scenarios reflect the current concerns of policymakers
  - Scenarios are constructed from the DSGE model or the BVAR model
  - Combination of scenarios obtained with judgmental weights
- The distributions are centered at the judgmental forecast's point forecast

A complementary view: GDP growth Nowcast

- Dynamic factor model, tracks current and next quarter GDP growth
  - Automated platform to process data releases in real time
    - First published in 2016, reintroduced in 2023 after brief suspension
  - Data include a total of 35 time series, most of them monthly and a few quarterly
  - Updated weekly: reflects the impact of surprises (realizations – forecast) from data releases

- Adapting the model to better handle post-pandemic volatility
  - Richer dynamics of the latent factors: stochastic volatility and outlier adjustment
  - An added "COVID" factor (only active from March to September of 2020) captures correlated variation in several series impacted by the pandemic

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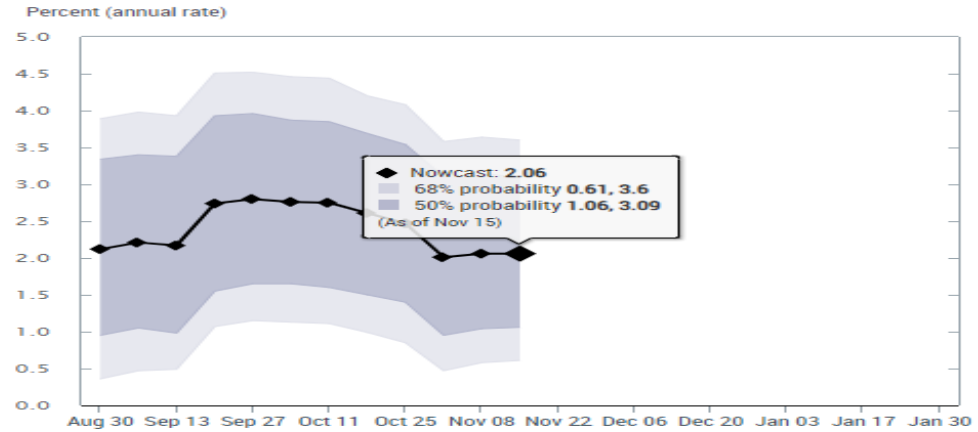
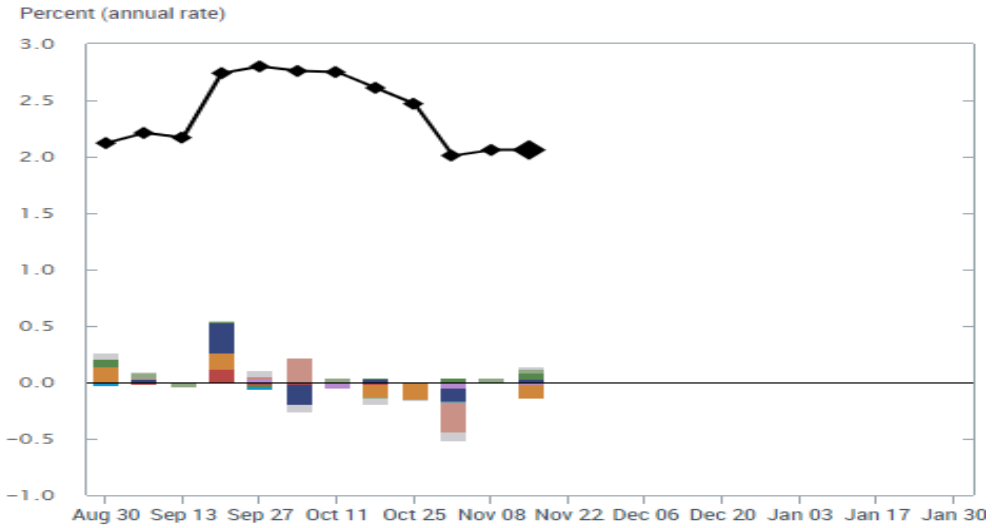
*https://www.newyorkfed.org/research/policy/nowcast#/overview

The New York Fed Staff Nowcast

2024:Q4





Impact of Data Releases

Data Flow (Nov 15, 2024)

Model Update	Release Date	Data Series	Actual	Impact	Nowcast GDP Growth
Nov 15					2.06
	8:30AM Nov 15	Empire State Mfg. Survey: General business conditions	31.20	0.03	
	8:35AM Nov 13	CPI-U: All items less food and energy	0.28	0.00	
	8:35AM Nov 13	CPI-U: All items	0.24	-0.01	
	8:31AM Nov 15	Export price index	0.82	0.02	
	8:31AM Nov 15	Import price index	0.28	0.01	
	8:32AM Nov 15	Retail sales and food services	0.40	0.06	
	9:16AM Nov 15	Industrial production index	-0.26	-0.12	
		Data revisions	0.00	0.02	
		Parameter revisions	0.00	0.01	
Nov 08					2.06

What data matter most and when?

TABLE 4. Share of Total Staff Nowcast Impact by Category

Category	2014 - 2016	2017 - 2019	2021- 2022	2014 - 2022
Income	3.4%	3.1%	1.0%	1.0%
International Trade	7.2%	6.3%	4.4%	2.6%
Housing & Construction	8.0%	8.3%	5.0%	3.4%
Labor	14.6%	13.7%	18.5%	41.5%
Manufacturing	11.5%	10.8%	8.6%	5.0%
Surveys	19.5%	21.3%	22.7%	16.2%
Retail & Consumption	10.1%	11.1%	10.4%	6.1%
Prices	8.0%	9.7%	5.0%	3.0%
Data Revisions	11.0%	9.4%	4.8%	4.0%
Parameter Revisions	6.8%	6.3%	19.0%	16.2%
Mean Quarterly Impact	6.6	4.8	26.5	25.5

Parameter Revisions category also reflects updates of the outlier matrices s_{et} and s_{ft}.

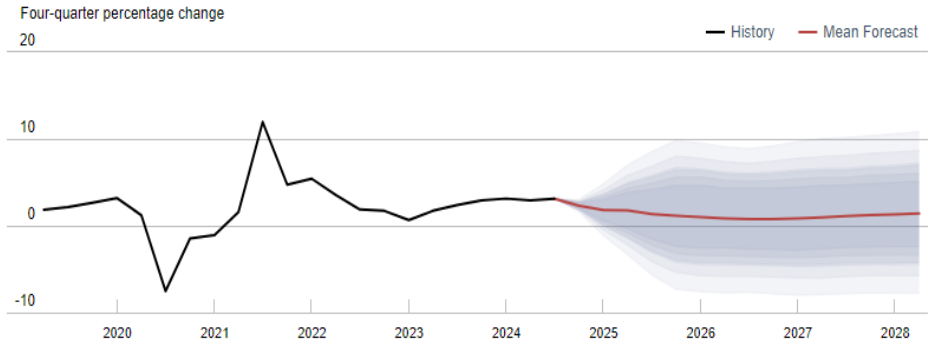
The DSGE model forecasts

- The NY Fed DSGE model provides another input to the Research forecasting process*
  - Quarterly projections for output growth, core PCE inflation and the real natural interest rate
  - Published on the NY Fed website (since 2014) and commented in LS blog posts.
- The DSGE model provides a consistent framework of analysis
  - Interprets economic fluctuations as determined by different types of shocks
  - Besides forecasts it lends itself to policy analysis, counterfactual scenarios
- Current version of the model is medium-scale, closed economy, representative agent, rational expectations
  - Builds on seminal work by Smets and Wouters (2007) and Christiano et al (2005) including financial frictions
  - Modified in 2020 to reflect the new policy strategy of flexible average inflation targeting
  - Extended to incorporate a new set of temporary shocks to capture the pandemic period
- The model is estimated using Bayesian methods
  - Estimated on quarterly data since 1960Q1, on growth rate of output (GDP and GDI), consumption, investment, real wage, hours worked, inflation (both core PCE and GDP deflator), long-run inflation expectations, the Federal funds rate, the 10-year Treasury yield, TFP growth, Baa/10y Treasury bond yield spread.

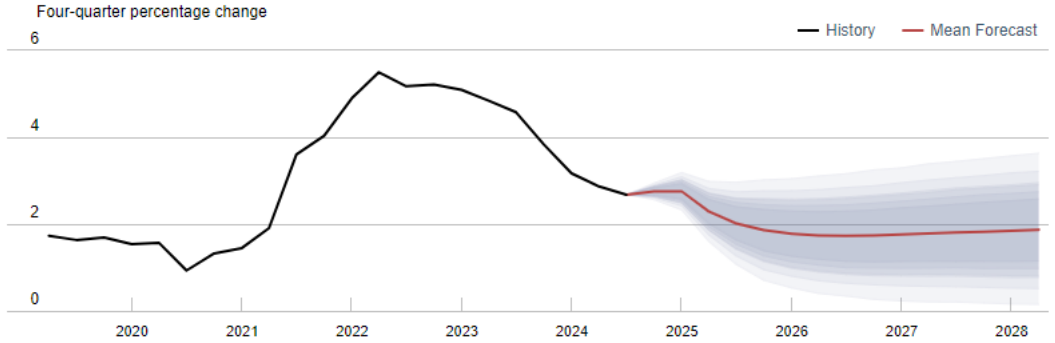
* The New York Fed DSGE Model Forecast - FEDERAL RESERVE BANK of NEW YORK

September DSGE forecasts

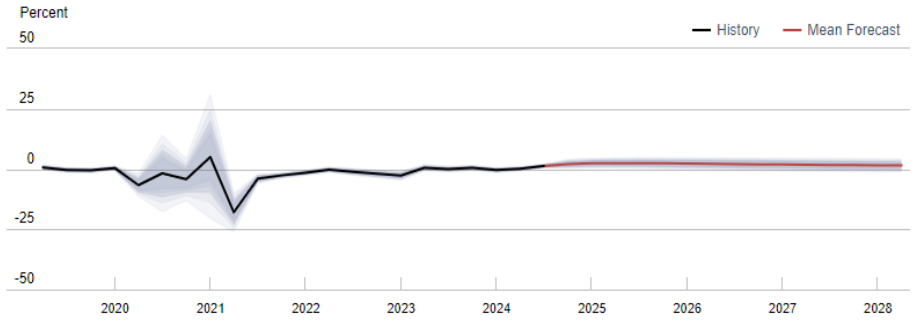
Forecasts of Output Growth



Forecasts of Core PCE Inflation



Real Natural Rate of Interest



Source: Authors' calculations.

Notes: The black line shows the model's mean estimate of the real natural rate of interest; the red line shows the model forecast of the real natural rate. The shaded area marks the uncertainty associated with the forecasts at 50, 60, 70, 80, and 90 percent probability intervals.

Latest Release 9:00 a.m. EST September 20, 2024

Forecast period	2024	2025	2026	2027
GDP growth (Q4/Q4)	**1.8** (0.1, 3.6)	**1.0** (-4.2, 6.3)	**0.8** (-4.4, 6.2)	**1.3** (-4.2, 6.7)
Core PCE inflation (Q4/Q4)	**2.8** (2.5, 3.0)	**1.8** (1.0, 2.5)	**1.8** (0.8, 2.7)	**1.8** (0.8, 2.9)
Real natural rate of interest (Q4)	**2.4** (1.2, 3.6)	**2.3** (0.9, 3.7)	**1.9** (0.3, 3.4)	**1.6** (-0.1, 3.2)

Source: Authors' calculations.

Notes: This table lists the forecasts of output growth, core PCE inflation, and the real natural rate of interest from the September 2024 forecasts. The numbers outside parentheses are the mean forecasts. and the numbers in parentheses are the mean forecasts. and the numbers in parentheses are the 68 percent bands.

DSGE model's forecasts through the pandemic

Recent research* addresses the accuracy of the DSGE model's forecasts

- Compares actual real-time predictions from the NY Fed DSGE to professional forecasters projections
    - Blue Chip Economic Indicators (BCEI) consensus
    - Median forecasts from the Survey of Professional Forecasters (SPF)
- Comparison covers the period 2011:Q1 to 2023:Q2
- Real-time: RMSE are computed from the forecasts reported to the FOMC *at the time*
- Key take-aways
    - The economy has become much harder to forecast after the pandemic
    - This is true for both GDP growth and inflation
    - DSGE forecast accuracy similar to the average of private forecasters, except at very short horizons (esp. 1qrt)
    - Much less accurate in the period after COVID

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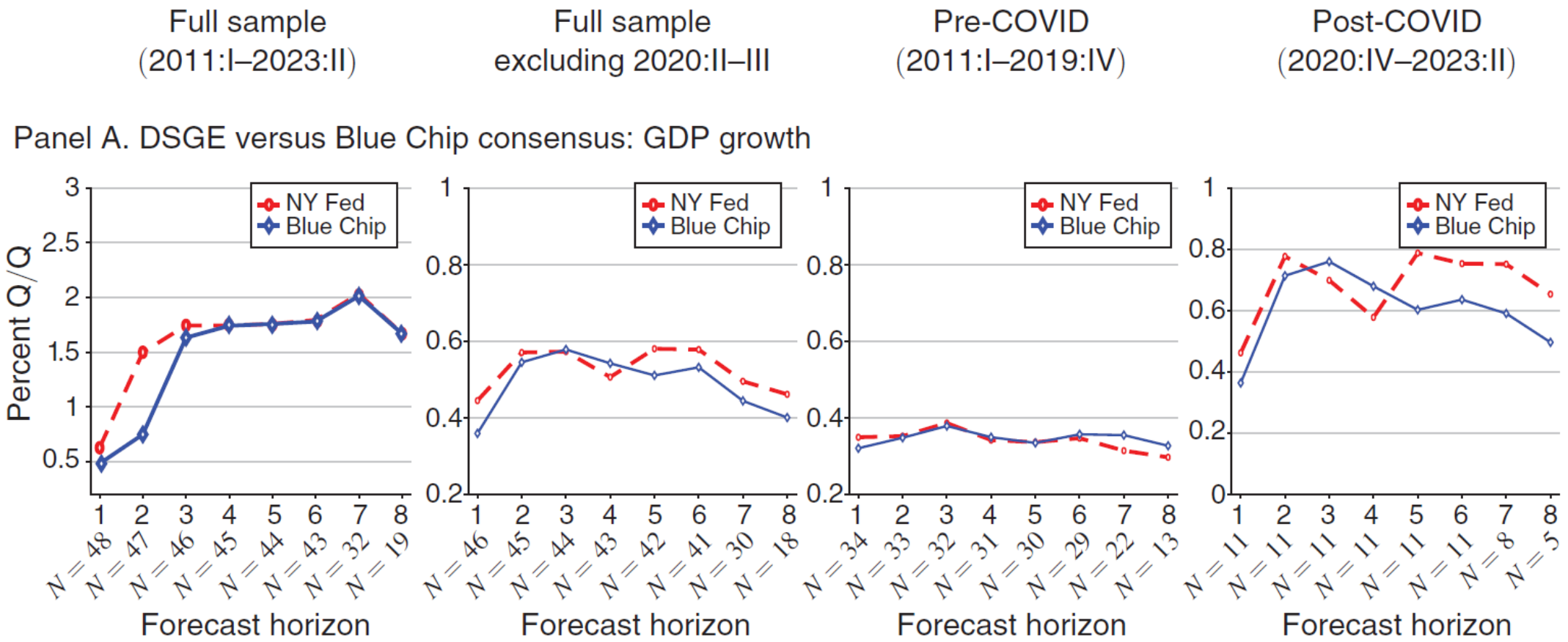
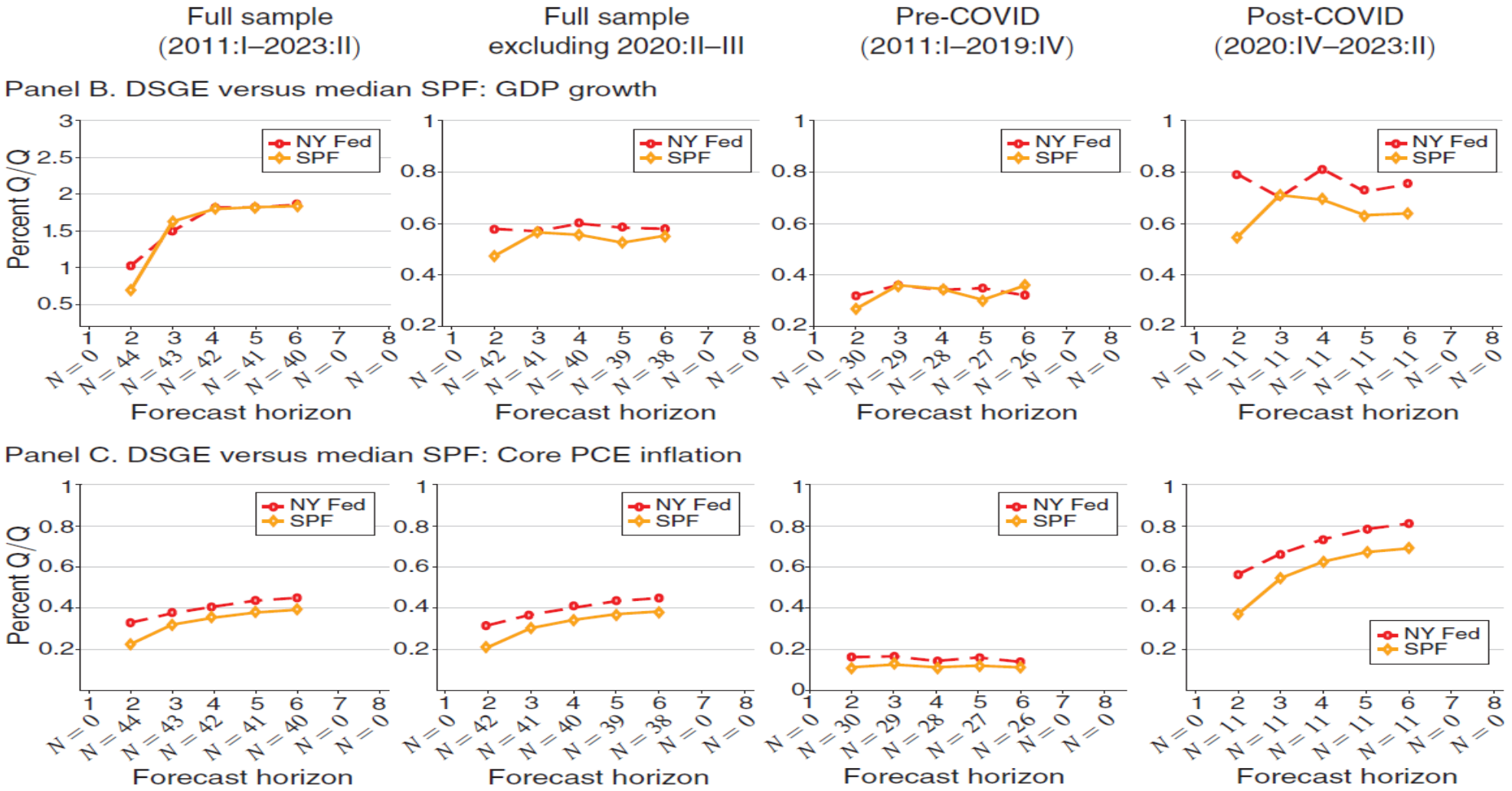
* Del Negro et al., 2024. "The NY Fed DSGE Model: A Post-COVID Assessment," AEA P&P.

Forecasting performance vs Blue Chip

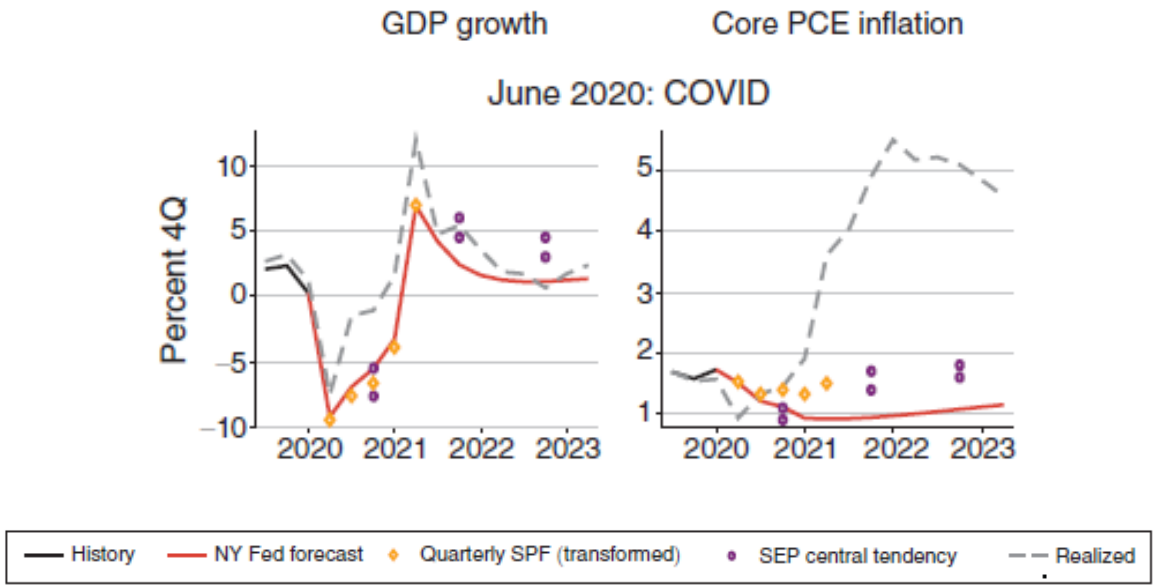


Forecasting performance vs SPF



DSGE modeling of the pandemic

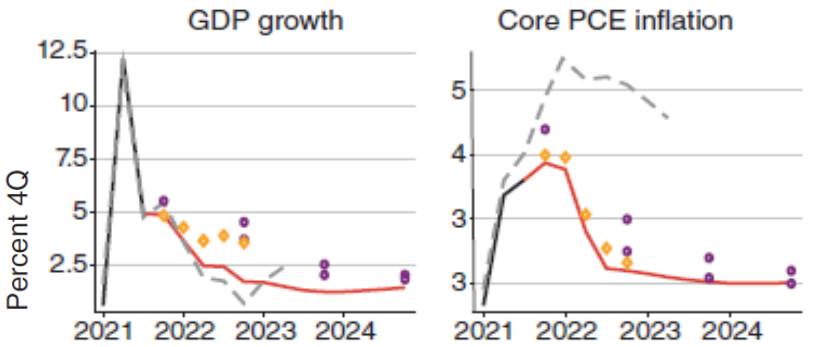
- Introduced a new set of temporary shocks, reflecting a priori uncertainty on nature of covid shock
- Constructed three scenarios to incorporate the uncertainty about the persistence of the economic effects of the pandemic, computed mean GDP growth and inflation
- Compared those to actual realizations, SPF projections and SEP central tendency at 3 points in time



1 - June 2020

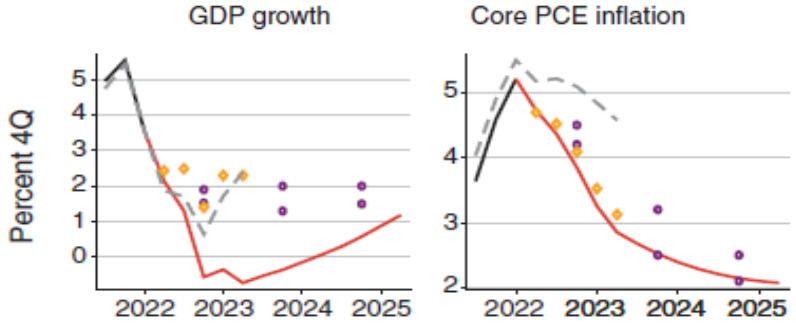
- Model underestimated the speed of the recovery in early 2021, but so did SPF and SEP
- Missed the inflation surge, to a slightly greater extent than SPF and SEP

Cont.



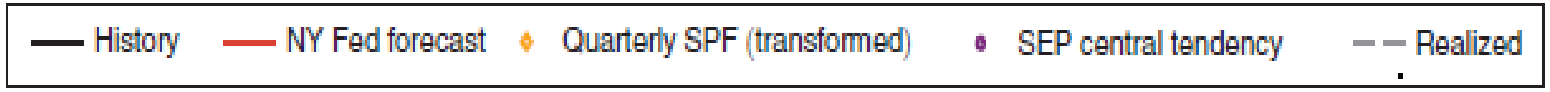
2 - December 2021

- Both SPF and SEP expected high growth in 2022; the model expected a waning effect of expansionary policy
- All forecasts underestimated inflation persistence



3 - June 2022

- Model doesn't predict a soft landing, unlike SPF and SEP
- Inflation trajectory of the model is similar to SPF and SEP, but more pessimistic



Assessing economic risks

Outlook-at-Risk

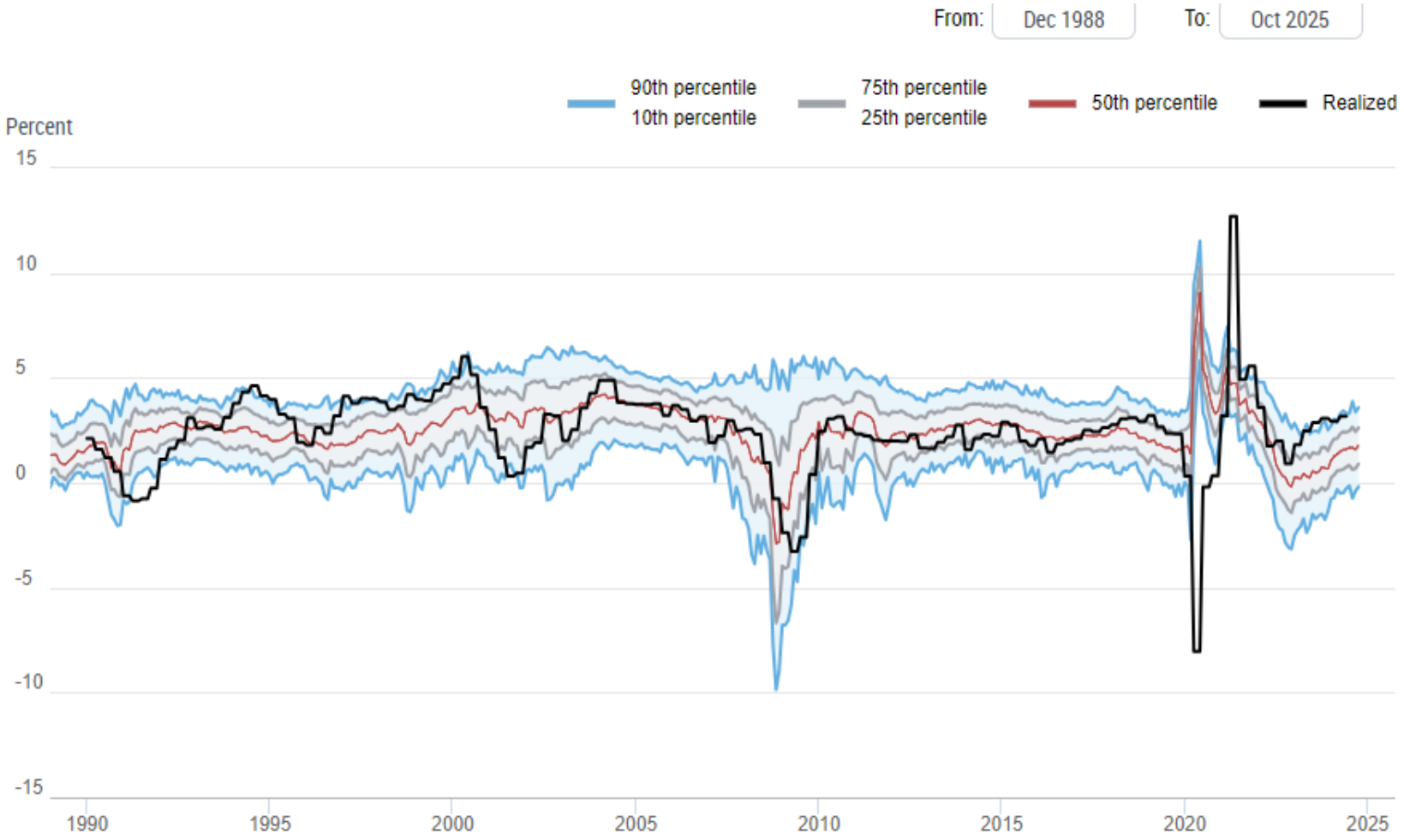
- Model based on the observation that there is a negative relationship between real activity and financial conditions and that is strongest when the economy is "at risk" (Adrian et al. 2019)
  - Quantifies the risks around future real GDP growth, the unemployment rate, and inflation by capturing how *such risks evolve* as economy-wide financial conditions ease or tighten.

Data & method

- Monthly near-term forecasts (1q to 4q ahead) for real GDP growth, the unemployment rate, and CPI inflation from BCEI
- Overall U.S. financial conditions are measured by the Composite Indicator of Systemic Stress (CISS), produced by the ECB.
- The model estimates the conditional (to financial conditions) distributions using quantile regressions
  - Percentiles in the *left tail* of the conditional distribution of GDP growth provide hint at future recessions
  - Percentiles in the *right tail* of the conditional distribution of unemployment inform about potential labor market slowdown
  - Selected estimated percentiles allow to evaluate features of the outlook (e.g. uncertainty 90^{th} to 10^{th} percentile)

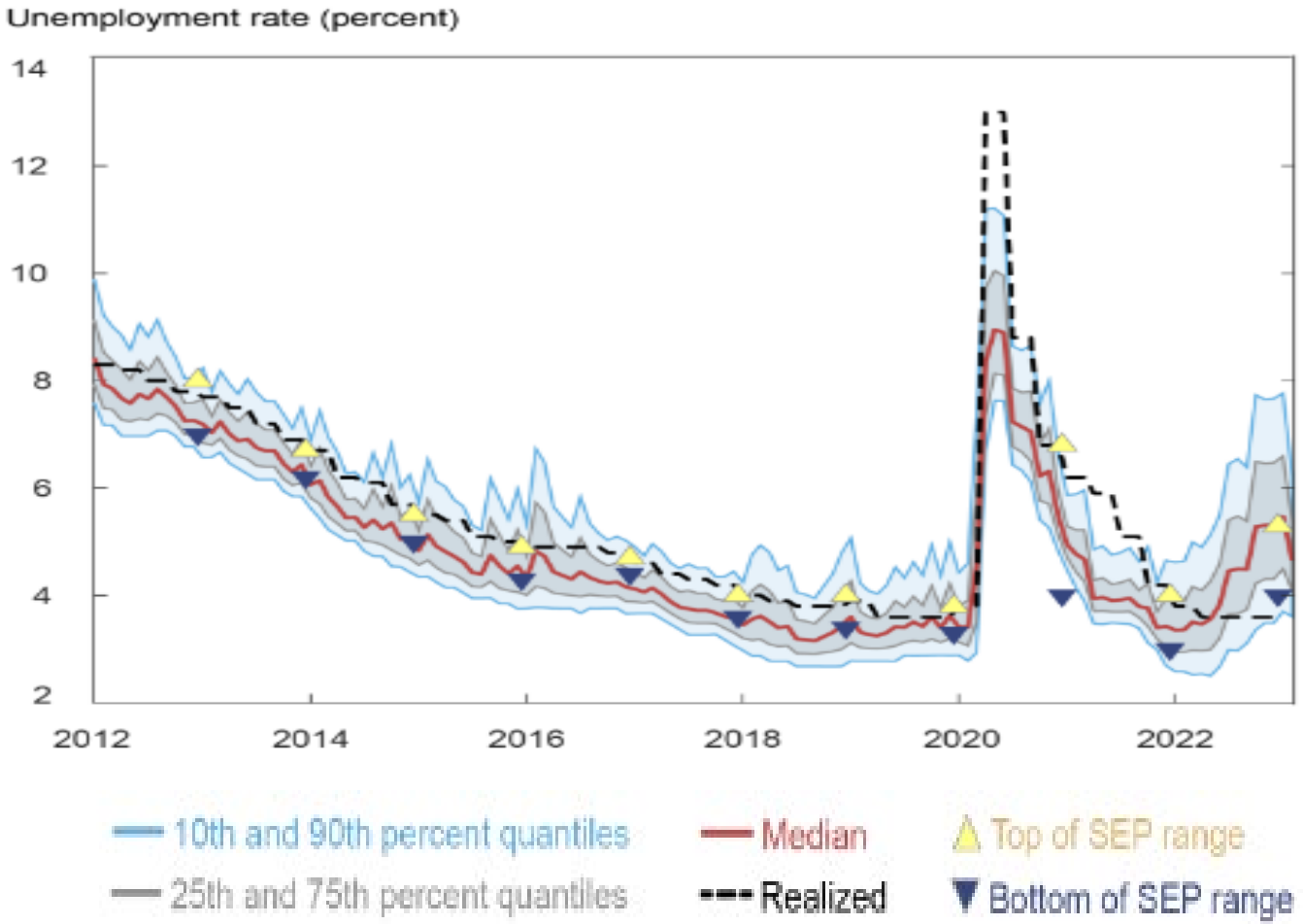
Outlook-at-Risk: Real GDP Growth, Unemployment, and Inflation - FEDERAL RESERVE BANK of NEW YORK

Growth-at-risk



Selected quantiles (10, 25, 75, 90) of the four-quarter average predicted distribution of GDP growth at each forecast date, together with the median forecast (red) and the realized four quarter average real GDP growth (black)

Model uncertainty and SEP disagreement



Snapshot of September 2023

- Selected quantiles (10, 25, 70, 90) of the predicted distribution of avg u rate in four quarters' time at each forecast date.
- Disagreement among FOMC participants (SEP range) is smaller than actual uncertainty implied by the model

Sectoral analyses: inflation and the labor market

Transitory or persistent? A sectoral lens on inflation

- Model to separate *trend* from *noise* in inflation
- Dynamic factor model with time-varying parameters (Stock-Watson, 2016)
  - Built on the 17 major sectors of the PCE price index
- Monthly rate of inflation in sector *i* during month *t* is

$$\pi_{it} = \underbrace{\alpha_{\tau,it}\tau_{ct} + \tau_{it}}_{\text{persistent component}} + \underbrace{\alpha_{\varepsilon,it}\varepsilon_{ct} + \varepsilon_{it}}_{\text{transitory component}}$$

- Persistent and transitory components have common ("c") and sector-specific subcomponents ("i")
  - τ_{ct}, τ_{it} are random walks and $\varepsilon_{ct}, \varepsilon_{it}$ are low-order MAs
- Loadings $\alpha_{\tau,it}, \alpha_{\varepsilon,it}$ and persistent and transitory components' volatilities are time-varying
- Estimation is by Bayesian methods

A measure of persistence

- With the model's estimates, a measure of persistence is defined as
- Multivariate Core Trend inflation (MCT)*

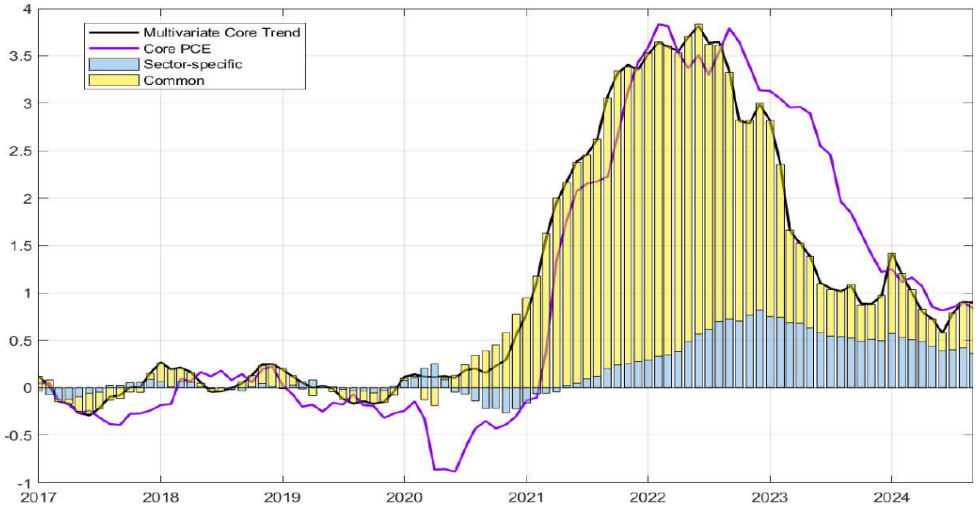
$$\text{MCT}_t = \sum_{i=1}^{N} w_{it} \times \left(\alpha_{\tau,it}\tau_{ct} + \tau_{it}\right)$$

- Where N is the number of sectors in the core PCE and w_{it} is the core PCE share of sector *i*
- Advantage of a sectoral approach
  - Can measure the contribution of *common vs idiosyncratic trend* movements to overall trend inflation
  - As well as the contribution of *different sectors* to persistence: core goods, services ex-housing, and housing
- Based on the ability to forecasting future inflation in real time, MCT slightly outperform other measures of core for the PCE price index (trimmed mean, median)
  - That indicates value in weighting the data as a function of their signal-to-noise ratio

* Multivariate Core Trend Inflation - FEDERAL RESERVE BANK of NEW YORK

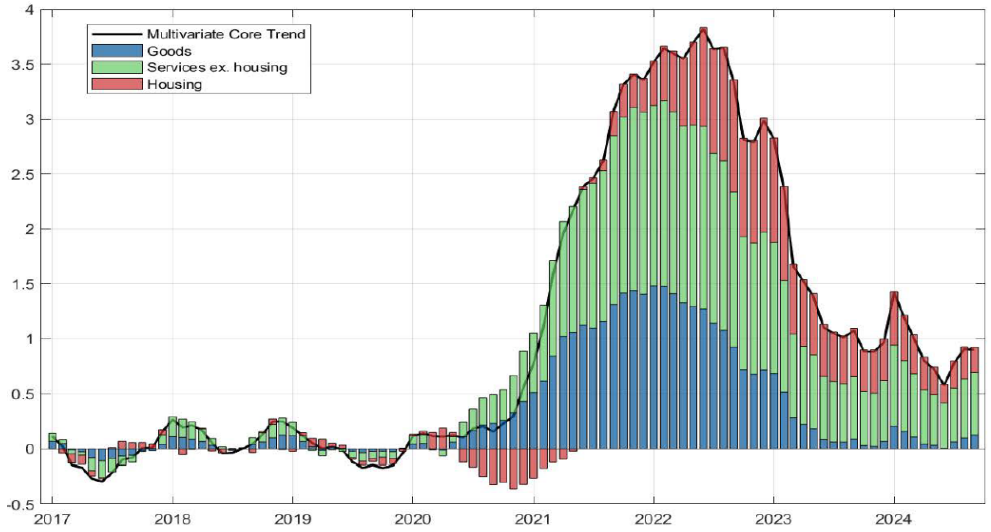
MCT decompositions

Common vs sector-specific persistence



- MCT measured relative to the average 2017-2019
- Earlier pick up in 2021
- Faster decline than core from mid-2022 peak
- Common component contribution much reduced

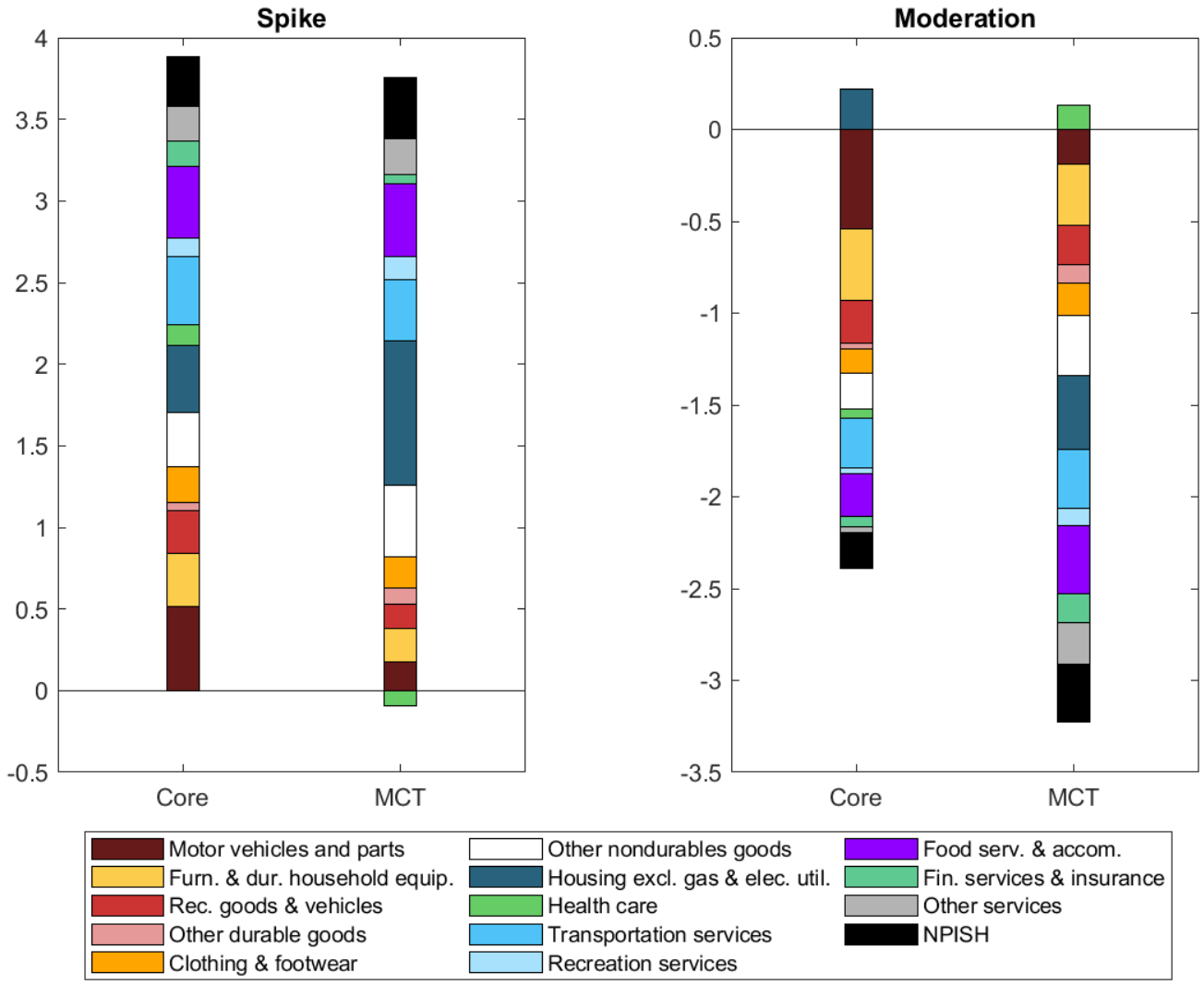
Persistence in Core Goods, Services ex-housing, and Housing



- Larger initial contribution from goods
- Persistence largely driven by services ex-housing inflation (its sector-specific component – not shown)

Inflation surge and moderation

- MCT takes more signal from sectors with less transitory fluctuations.
- It helps interpreting the sources of the surge and then moderation of inflation.



Spike: Dec. 2019- May 2022; **Moderation**: June 2022-Nov 2023

Inflation: a global view

- Is persistence a global phenomenon?
- We used the MCT framework to analyze inflation co-movement across 16 OECD countries*
  - Decomposed each country CPI inflation (both headline and core) into the sum of a persistent and a transitory component
  - Persistent and transitory are decomposed in *common* and *country-specific* subcomponents
    - to determine whether movements in the global trend come from shocks that affect individual countries (e.g., domestic policy or demand changes) or all countries at the same time (e.g., changes in the international price of oil or other commodities)
- Global trend inflation is the aggregate of the persistent (both common and country-specific) components, weighted by their expenditure shares

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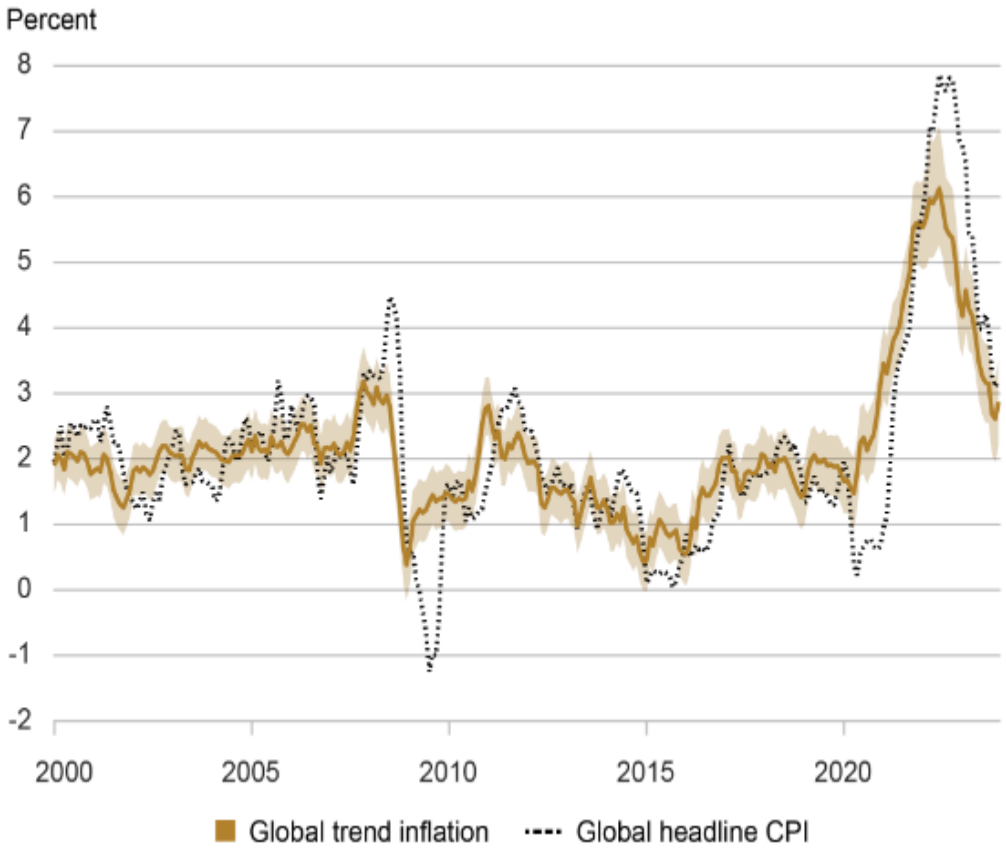
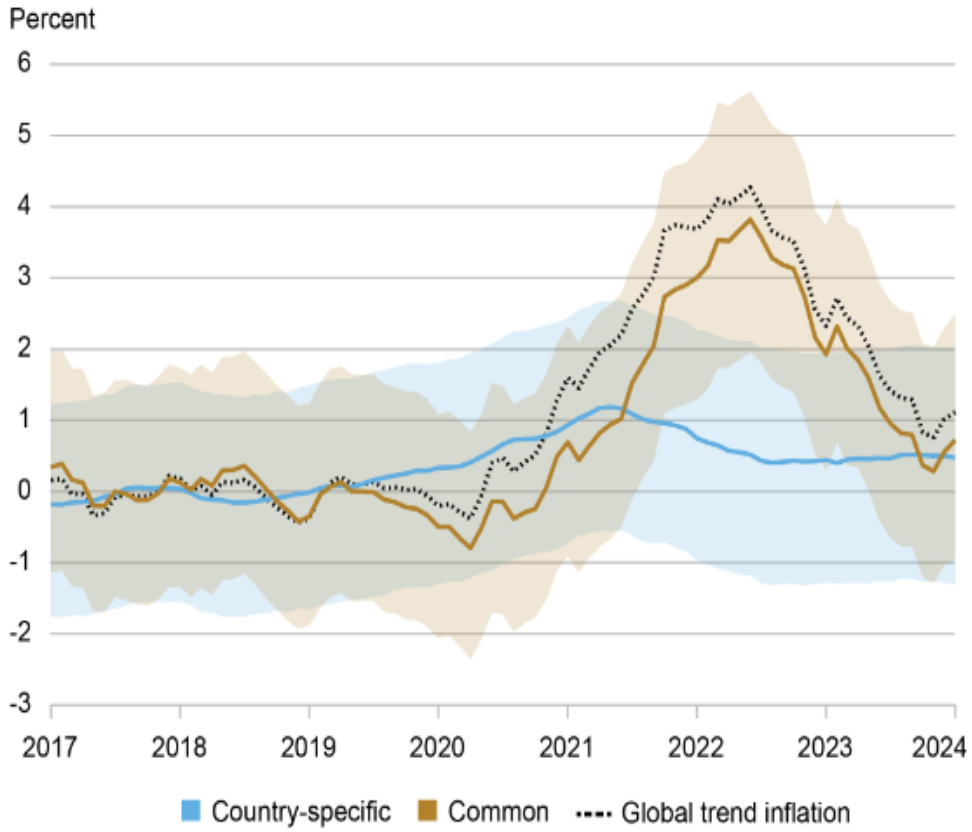
* Is the Recent Inflationary Spike a Global Phenomenon? - Liberty Street Economics

Global inflation trend – headline CPI

Global trend inflation in headline CPI

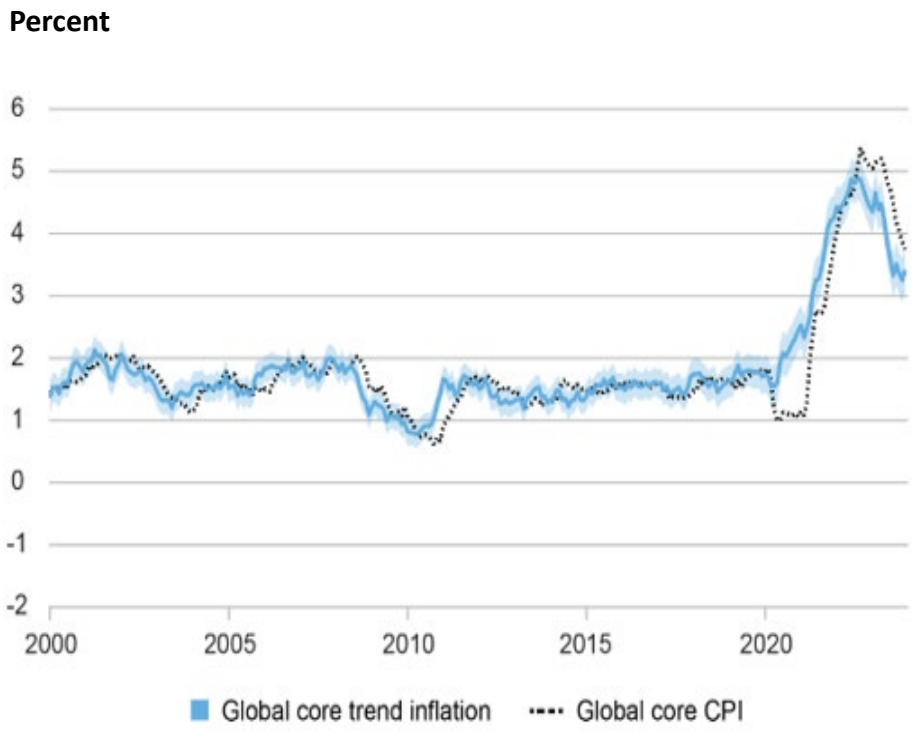


Post-pandemic trend surge is largely common

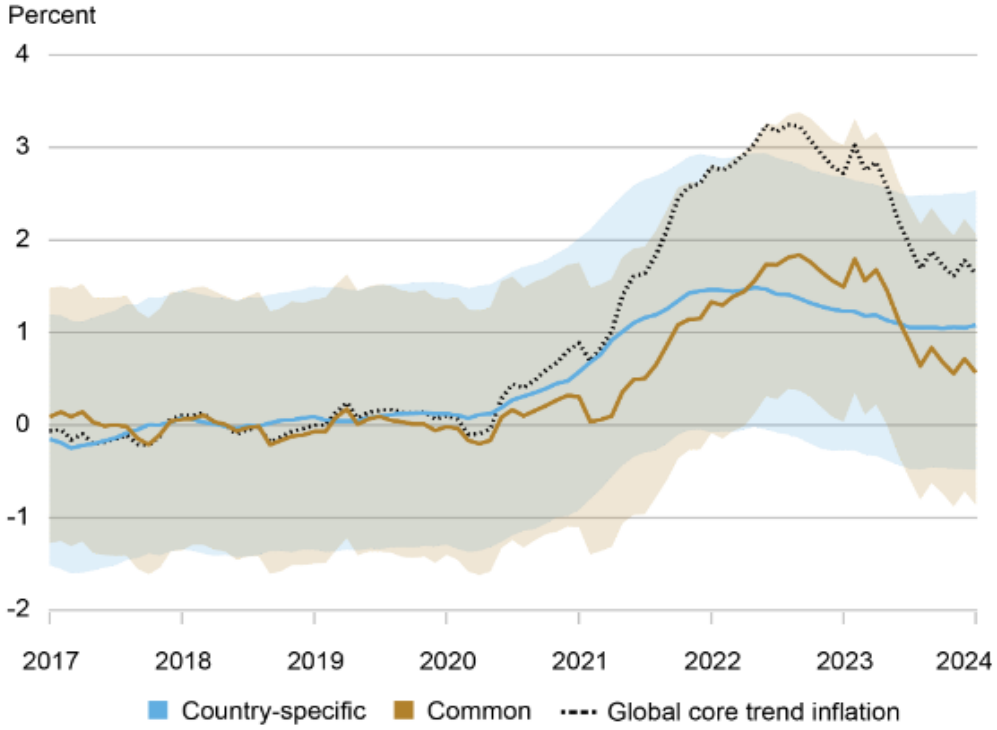


Global trend – core CPI

Global trend inflation in core CPI



Country-specific factors matter in global trend



- Estimates of inflation persistence on measures including food and energy prices show broad-based movements
- Using core measures shows about half of the increase in persistence originates in country-specific movements

Persistence in wage inflation

- Substantial reallocation of workers across different sectors of the economy triggered by the pandemic likely to have affected aggregate wage growth
- Look at industry level wage growth
  - Combine worker-level data on nominal wage growth with time series filtering techniques.
- Trend wage inflation model (TWIn)*
  - Wage is measured by median growth in the hourly wage of individuals observed twelve months apart (CPS)
  - Wage growth in *seven broad industry groups* is decomposed in a persistent component and a noise term capturing transitory movements and measurement errors
  - The trend is then further decomposed in a common and industry-specific components: $\bar{\tau}_{it} = \alpha_{\tau,it}\tau_{ct} + \tau_{it}$
  - The aggregate wage growth trend is then obtained aggregating the sectoral trends weighted by the industry shares.

$$\bar{\tau}_t = \sum_{i=1}^{n} s_{it}\bar{\tau}_{it}$$

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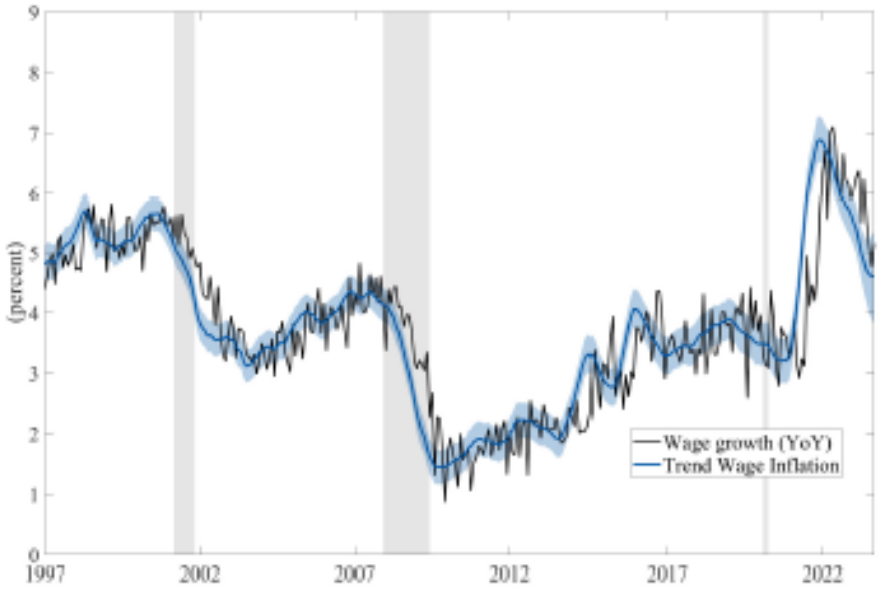
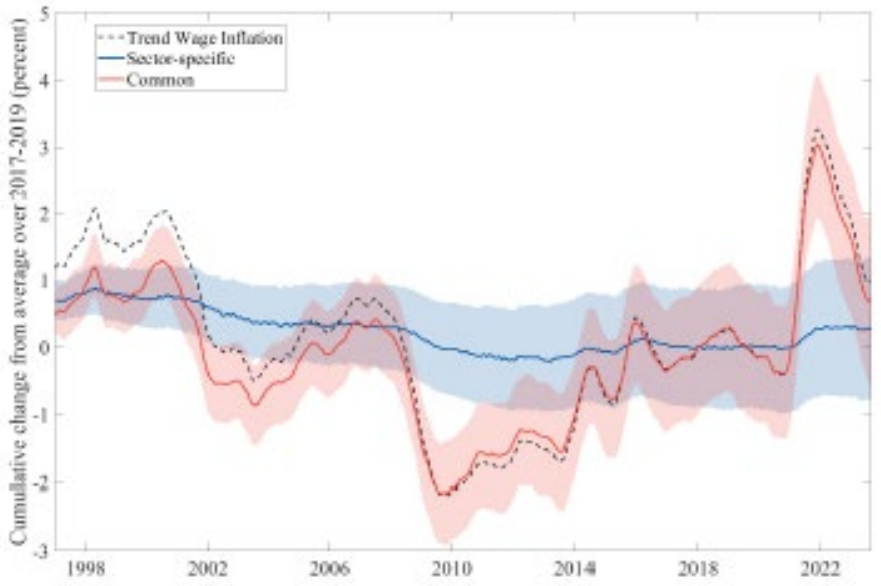
* M. Almuzara, R. Audoly and D. Melcangi, 2024. "A Measure of Trend Wage Inflation", Fed. Res. Bank of New York, Staff Report 1067

Trend wage inflation



(a) Estimates of Trend Wage Inflation



(b) Common and Sector-Specific Components of Trend Wage Inflation

- Most of the variation in Trend Wage Inflation explained by the common persistent component of wage growth
- The estimated sector-specific trend component of the model captures lower frequency movements

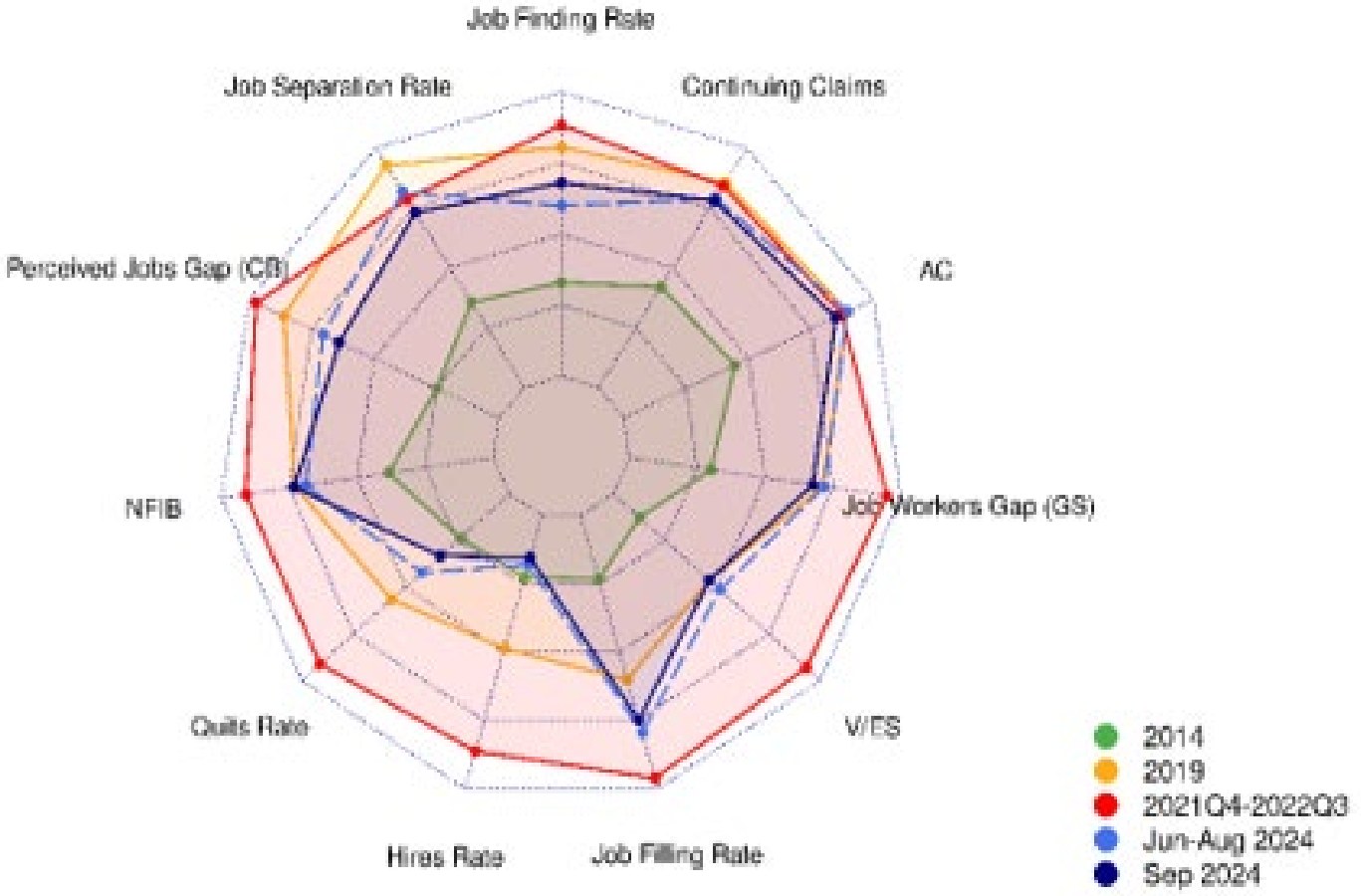
Labor market tightness

"Signs of elevated labor market tightness emerged suddenly in mid-2021. The unemployment rate at the time was much higher than the 3.5 percent that had prevailed without major signs of tightness before the pandemic. Employment was still millions below its level on the eve of the pandemic. Looking back, we can see that a significant and persistent labor supply shortfall opened up during the pandemic—a shortfall that appears unlikely to fully close anytime soon.."

Chair Jerome H. Powell, *Inflation and the Labor Market, November 30*, 2022

Labor market tightness: a visualization

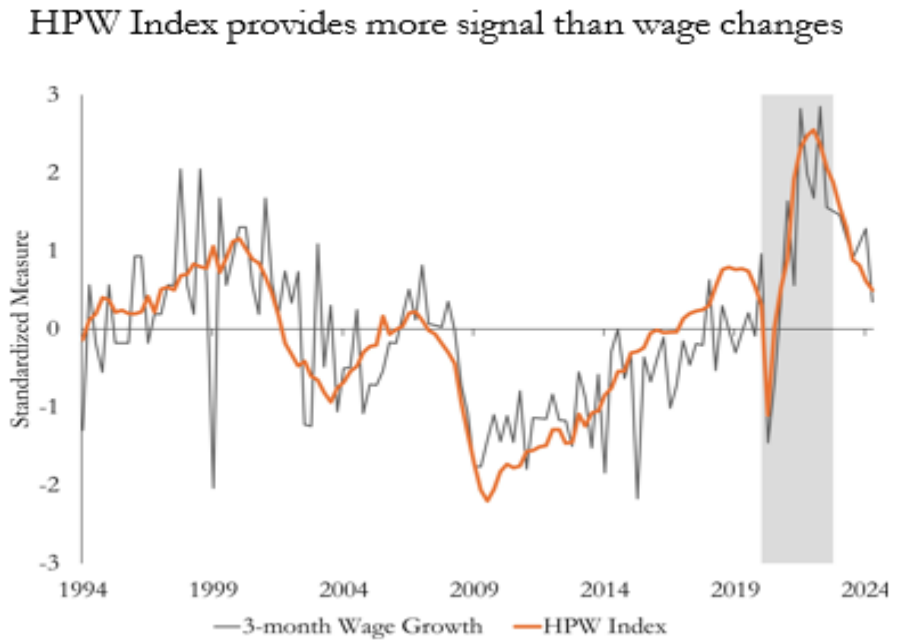
- A **spider web** visualize the movement of several indicators
- Tightness is measured relative to three “benchmarks”
  - 2014: slack labor market (green)
  - 2019: tight labor market (yellow)
  - 2021Q4-2022Q3: extremely tight labor market (red)
- Recent research* suggests that **Quits** and **V/ES** are strong indicators*



*Sebastian Heise, Jeremy Pearce and Jacob Weber, Wage Growth and Labor Market Tightness, Staff Report 1127

Tightness measures and wage growth

- Quits rate provides a measure of opportunities at other firms: high quits → tight labor market
- Ratio of vacancies to "effective searchers" V/ES more informative than V/U
  - Because firms also poach already-employed workers by offering a higher wage
  - "searchers" should include both unemployed and on-the-job searchers.



- HPW: A measure combining quits rate and V/ES
  - Searchers are a weighted avg of short- and long-term unemployed, and employed, with weights based on estimated search intensity
  - Measure co-moves most with nominal wage growth (3mo growth in the ECI)

Policy analysis: BVAR and conditional forecasts

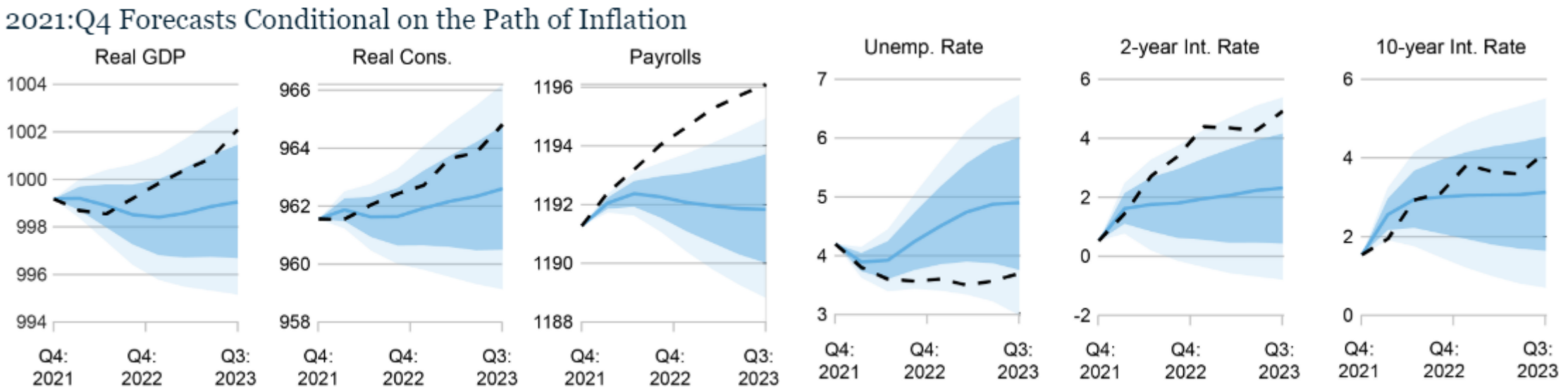
- Large BVAR model with macro and financial time series, estimated on quarterly data 1973Q2 to 2019Q4
- Used to compute 'conditional' forecasts
  - Obtained projecting future value of the variables of interest under knowledge of the future value of one (or a set of) other variables

Example*

- At the end of 2023 - strong growth and cooling inflation despite restrictive policy stance
- Is the resilience of the economy due to policy being less effective or to policy lags (so effect not yet seen)?
- Three conditional forecasts:
  a. Feed the model all historical data through 2021Q4 and the path of inflation for 2022 and through 2023Q3
  b. Feed the model the future path of the 2-year interest rate
  c. Current forecast (all information)
- Compare conditional forecasts of the other variables with realizations

* A Bayesian VAR Model Perspective on the Lagged Effect of Monetary Policy - Liberty Street Economics

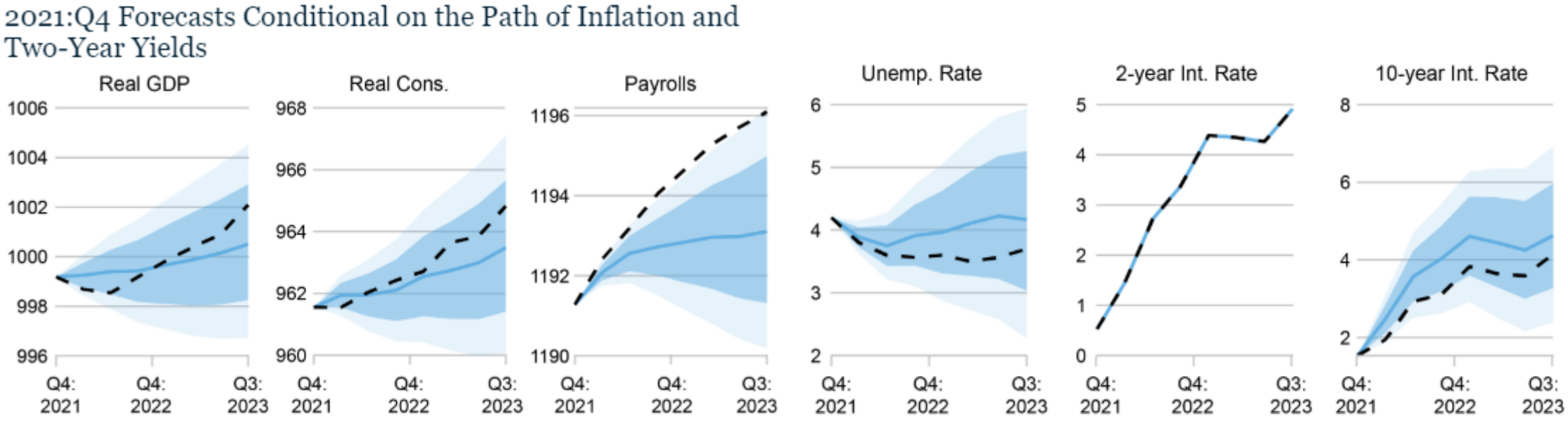
a. Conditioning on the path of inflation



Notes: The chart shows the conditional forecast (blue line) and shaded regions denoting the associated pointwise posterior coverage intervals (dark shading 68 percent and light shading 90 percent). Dashed lines represent the path of the realized data.

- Knowing only the future path of inflation for 2022 -2023:Q3, the model would have anticipated a small interest rate increase: a mild decline in the level of GDP and unemployment rate reaching about 5 percent
- Interest rate would have risen only modestly

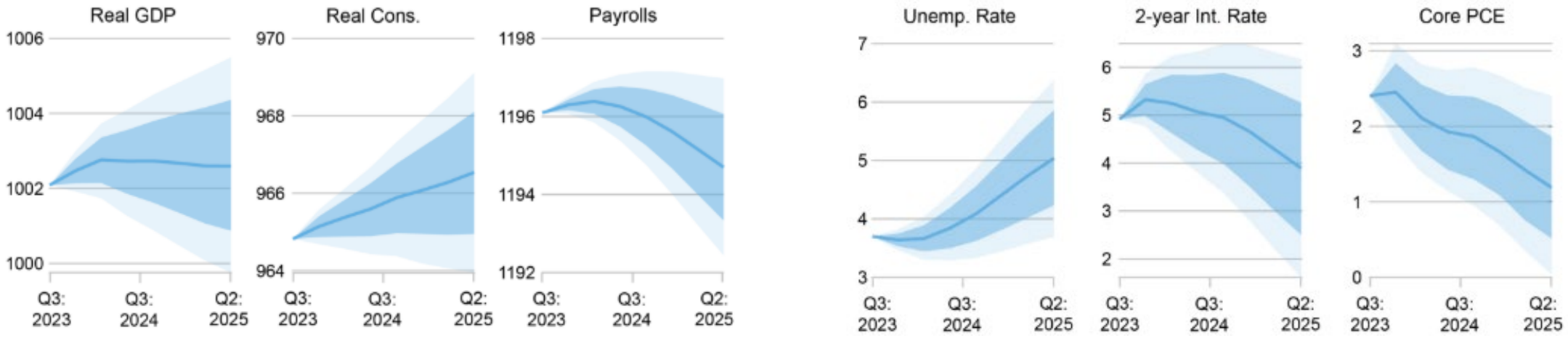
b. Conditioning on inflation and interest rate path



Notes: The chart shows the conditional forecast (blue line) and shaded regions denoting the associated pointwise posterior coverage intervals (dark shading 68 percent and light shading 90 percent). Dashed lines represent the path of the realized data.

- Knowing also the future path of the 2-year nominal interest rate – a rapid tightening, the model now forecasts weak growth, but not a recession; consumption and payrolls would have been stronger, but still lower than realized
- Implication: even conditional on higher inflation and steep tightening, the model would have predicted lower activity at the end of 2023.

c. Current (2023:Q3) forecast

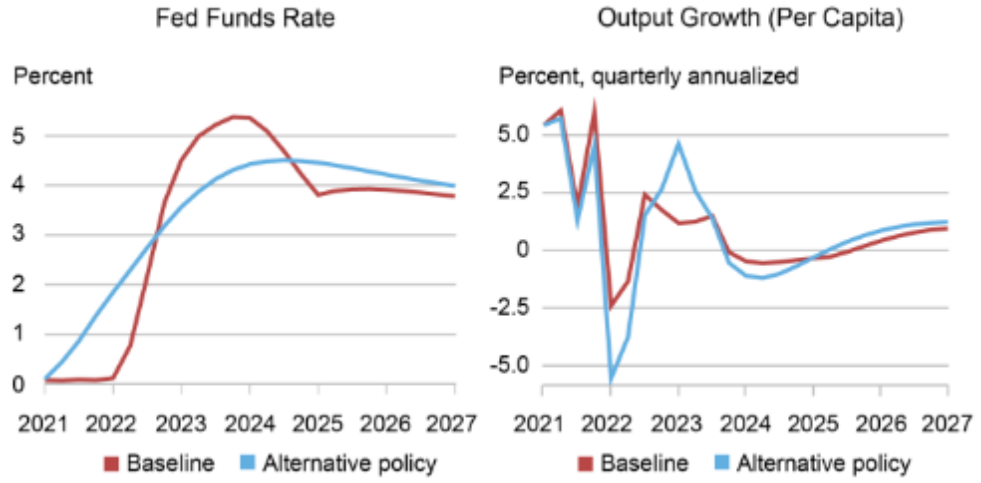


Notes: The chart shows the forecast (blue line) and shaded regions denoting the associated pointwise posterior coverage intervals (dark shading 68 percent and light shading 90 percent).

- With all information up to 2023Q3 the model forecasts a decline of the interest rate over 2024 -25, but GDP steadily declines from early 2024, unemployment rate increases and employment declines.
  - Economic activity in 2022-23 was stronger than expected conditional on the path of interest rates and inflation.
  - The lagged effects of monetary tightening were counteracted by positive demand shocks in 2023-24, but the model was still expecting a slowdown in 2024-25.

Policy analysis: DSGE counterfactuals

- The Fed changed policy strategy to average inflation targeting (AIT) in 2020
  - AIT rule : the policy rate responds to the inflation gap, constructed by cumulating past shortfalls from target, and an output gap, similarly constructed by cumulating past shortfalls of output growth from trend.
- In 2021Q2 inflation began to rise, but the Fed kept the federal fund rate at the ZLB
  - Started tightening only in March 2022, rising the policy rate aggressively after that.
- Had the FOMC deviated from the ZLB pledge in 2021Q2, would the outcome of the macroeconomy have been different?*

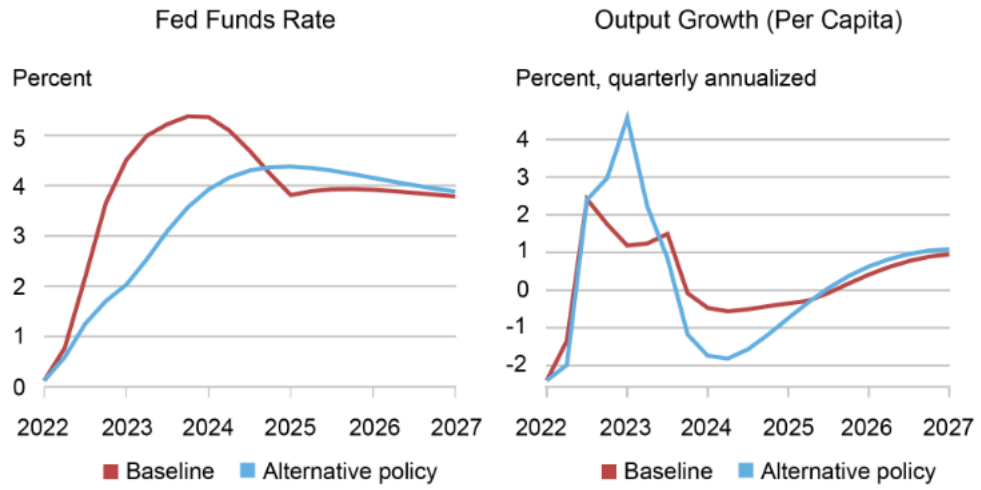


- Actual path and current *baseline* forecast of the fed funds rate (FFR) after 2023:Q2 (red) versus the *counterfactual* path had the FOMC followed the AIT rule starting in 2021:Q2 (blue).
- Had the FOMC pursued this policy, per capita output growth would have been lower in 2022 (due to tightening in 2021), and stronger in 2023 (due to the less aggressive pace of tightening in 2022 and 2023.)

*The New York Fed DSGE Model Perspective on the Lagged Effect of Monetary Policy - Liberty Street Economics

DSGE counterfactual: 2022 -2023

- Isolating the effect of the aggressive tightening in 2022 and 2023: start the model simulation in 2022:Q2
- The model allows for both *contemporaneous* shocks (deviations from the AIT reaction function in the quarter) as well as *anticipated* policy shocks (identified with FFR expectations from the SPD). Most of the deviation from the AIT rule are due to contemporaneous shocks.



- The baseline path is now well above the counterfactual AIT path: the pace of tightening in 2022 and early 2023 (red) is steeper than implied by the AIT rule (blue).
- Per capita output growth is lower under the baseline in mid-2022 to mid 2023, but higher in 2024, with a cumulative loss in the level of output (peaking in mid-2023 with the level of output about 1.25 percent below the AIT counterfactual.)

Refining models is a continuing process

- This discussion shows that, beyond forecasting, DSGE models are particularly valuable for counterfactual exercises and for estimating latent variables such as natural rate of interest, or r*
- Many DSGE analyses complement BVAR estimates by providing a structural interpretation
- The set of structural models is expanding, as the staff continues to develop frameworks suitable for forecasting and policy analyses
  - Open economy DSGE models to study the effects of policy abroad on the US economy and spillover from US policies.
  - A multi-sector structural model, applied to study the effect of the green transition on inflation.
  - A New Keynesian model with heterogeneous agents (HANK), applied to analyse both the benefits of price stability as well as the implications of disinflationary policies across the wealth and income distributions.
  - A banking model where financial stress arises endogenously, to investigate the relationship between financial frictions and monetary policy, as well as the interaction between the natural rate of interest (r*) and the financial instability interest rate (r**).

Refining models is a continuing process

- No expectation that there should be a single model, even a single DSGE model
  - Different models involve different degrees of detail, and serve different purposes

End