Monetary Policy, Perceptions, and Financial Markets

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Chicago Harris, NBER, and CEPR

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Monetary policy $\leftrightarrow$ financial markets

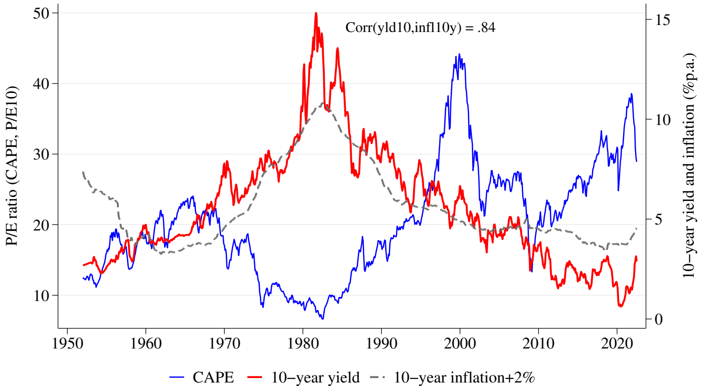
- Transparent framework matters for macroeconomic transmission (Blinder et al. (2008), Bernanke (2010))
- Monetary policy acts through long-term asset prices
    - Woodford (2005): "The effectiveness of changes in central-bank targets for overnight rates... is wholly dependent upon the impact of such actions upon other financial-market prices."
- Monetary policy matters for asset prices
    - Expected path of short rates is a key determinant of term structure
    - Monetary policy shapes macro dynamics that determine risk and risk premia in Treasury bonds
- Asset prices are forward looking $\implies$ linked to beliefs about how the Fed *will respond* to incoming data

Overview

- Bonds and stocks linked to inflation and economy
- But financial markets also subject to time-varying risk premia (e.g. Shiller (1981), Campbell and Shiller (1991), Bernanke and Kuttner (2005))
- How do perceptions about monetary framework vary and drive long-term asset prices (Bauer, Pflueger, and Sunderam (2024))?
- Can FOMC responses be reconciled with standard model of monetary policy (Pflueger and Rinaldi (2022))?
- Does monetary policy framework or supply shocks make Treasury bonds risky (Campbell, Pflueger and Viceira (2020), Pflueger(2024))?

EMPIRICAL FACTS (AROUND FOMC ANNOUNCEMENTS)

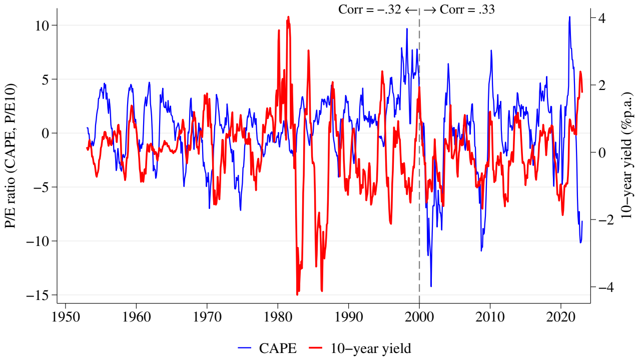
Historical link between inflation, stocks, and bonds



Cieslak and Pflueger (2023), Figure 1, data from Robert Shiller

- **Nominal bond yields clearly linked to long-term inflation**

Changing bond-stock comovement



Cieslak and Pflueger (2023), Figure 1, data from Robert Shiller

- **Inflation was bad for stocks in 1980s, but good in 2000s**

Markets and the Fed

U.S. MARKETS

Stocks Fall After Powell Comments, Latest Fed Rate Hike

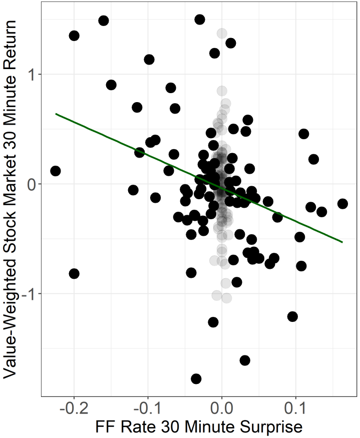
After a quiet morning, U.S. indexes were volatile following Federal Reserve move

By Akane Otani Follow

May 3, 2023 4:12 pm ET

U.S. stocks dropped Wednesday, giving up their initial gains, after the Federal Reserve approved raising interest rates to their highest level in 16 years.

Stock response to Fed surprises



Pflueger and Rinaldi (2022), updated from Bernanke and Kuttner (2005)

Evidence that Fed moves economy? Risk premia? Over-reaction?

Cross-section and FOMC surprises

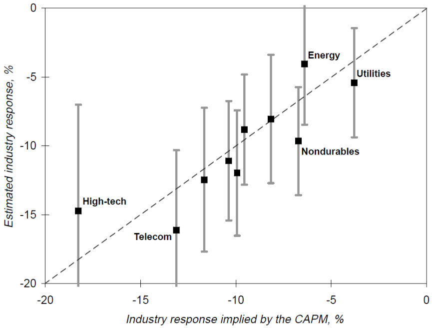


Figure 5. Estimated industry responses and CAPM implications. The figure depicts the 1-month responses of the Fama-French industry portfolios to a one percentage point Federal funds rate surprise. The values on the horizontal axis are the industry stock return responses implied by the CAPM. The vertical axis values are the estimated industry return responses reported in Table IX. The vertical lines represent the 80% confidence intervals associated with the estimated industry responses.

Figure 5, Bernanke and Kuttner (2005)

High-frequency responses line up with low-frequency betas

Large bond yield response to FOMC surprises

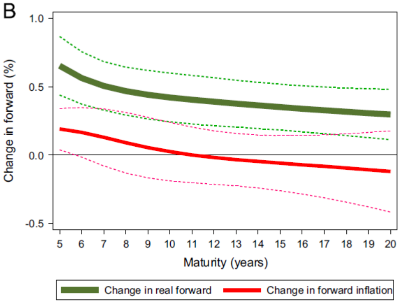


Figure 1, Hanson and Stein (2015)

Puzzlingly large response of real long-term yields, given that monetary policy tends to mean-revert within a few years

Fed information effect

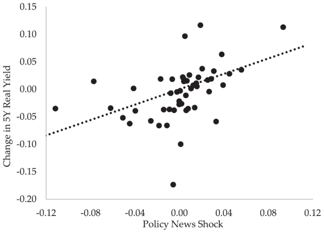


Figure I

Binned Scatter Plot for Five-Year Real-Yield Regression

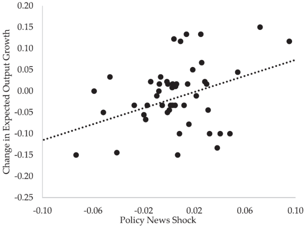


Figure II

Binned Scatter Plot for Expected Output Growth Regression

Figures 1&2, Nakamura and Steinsson (2018)

- mps_t is first principal component of 30-minute change in fed funds futures and eurodollar rates with maturity up to 1 year
- Fed information effect (Romer and Romer (2000), Nakamura and Steinsson (2018)): mps_t contains news about long-term growth
- But public may have underestimated Fed's response to economy (Bauer and Swanson (2023))

Average bond and stock returns around FOMC dates

- Somewhat separate set of facts regarding the average returns on stocks and bonds on FOMC dates
- Average level of equity returns is typically higher prior to FOMC dates (Lucca and Moench (2015); Cieslak, Morse, and Vissing-Jorgensen (2019); Cieslak and Pang (2021))
- 3-Day window around FOMC dates explains most of the decline in long-term bond yields (Hillenbrand (2023))
- Complementary evidence from stock returns around non-farm payroll and other macroeconomic news surprises (Boyd, Hu and Jagannathan (2005), Elenev, Law, Song, and Yaron (2023))

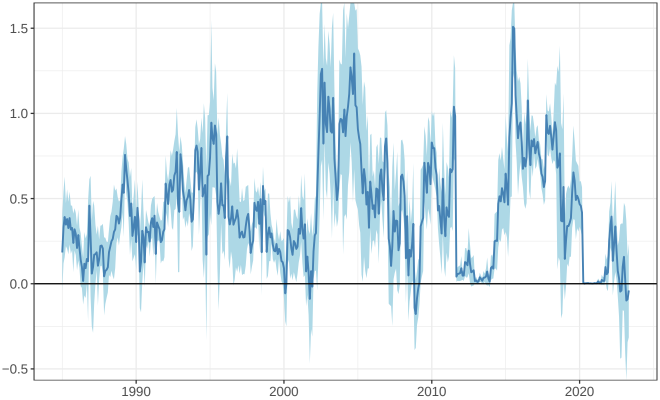
PERCEPTIONS ABOUT MONETARY POLICY

Bauer, Pflueger, and Sunderam (2024)

This paper: Approach

- Estimate perceived policy rule with *time-varying parameters*
  - Blue Chip Financial Forecasts for federal funds rate, inflation, real GDP growth
  - Each monthly survey is forecaster $\times$ horizon panel of forecasts for each variable

$$E_t^{(j)} i_{t+h} = \alpha_t^{(j)} + \hat{\beta}_t E_t^{(j)} \pi_{t+h} + \hat{\gamma}_t E_t^{(j)} x_{t+h} + e_{th}^{(j)}$$



This paper: Results

- Substantial *cyclical variation* in perceived responsiveness to real activity, $\hat{\gamma}_t$
- Perceptions update in response to monetary policy shocks
- Perceived rule matters for transmission to financial markets
  - Sensitivity of asset prices to macro news
  - Statistical and subjective bond risk premia
  - Response of stock market to monetary policy
- Rationalize these results in a simple model

Literature

- **Monetary policy with limited information and rationality:** Orphanides and Williams (2007), Primiceri (2006), Cogley and Sargent (2015), Coibion and Gorodnichenko (2015), Gabaix (2020), Angeletos and Lian (2022), Bauer and Swanson (2023)

- **Financial market impacts of monetary policy:** Piazzesi (2001), Cochrane and Piazzesi (2002), Hanson and Stein (2015), Stein and Sunderam (2018), Nakamura and Steinsson (2018), Bianchi, Lettau, and Ludvigson (2022), Pflueger and Rinaldi (2023), Pflueger (2023), Nagel and Xu (2024)

- **Estimating monetary policy rule:** Taylor (1993), Clarida, Gali, and Gertler (2000), Hamilton, Pruitt and Borger (2011), Andrade, Crump, Eusepi and Moench (2016), Haddad, Moreira, and Muir (2021), Cieslak and McMahon (2023)

Data and estimation

Blue Chip Financial Forecasts (BCFF)

- Provide GDP growth and inflation *assumptions* used to form interest rate forecasts.
    - 30-50 forecasters each month, 1985-2023
    - Forecasts for current quarter to 5 quarters ahead
- Observation unit (forecaster j, month t, forecast horizon h in quarters)
    - $E^{(j)} i_{t+h} =$ federal funds rate forecast
    - $E^{(j)} \pi_{t+h} =$ four-quarter average CPI inflation forecast
    - $E^{(j)} x_{t+h} =$ output gap forecast = cumulate GDP growth forecast minus CBO projected potential (real-time)

Month-by-Month Panel Regressions: Baseline Rule

- Perceived time-varying monetary policy rate response:

$$E_t^{(j)} i_{t+h} = \alpha_t^{(j)} + \hat{\beta}_t E_t^{(j)} \pi_{t+h} + \hat{\gamma}_t E_t^{(j)} x_{t+h} + e_{th}^{(j)}$$

  - Forecaster fixed effect $\alpha_t^{(j)}$ captures disagreement over natural rate at t

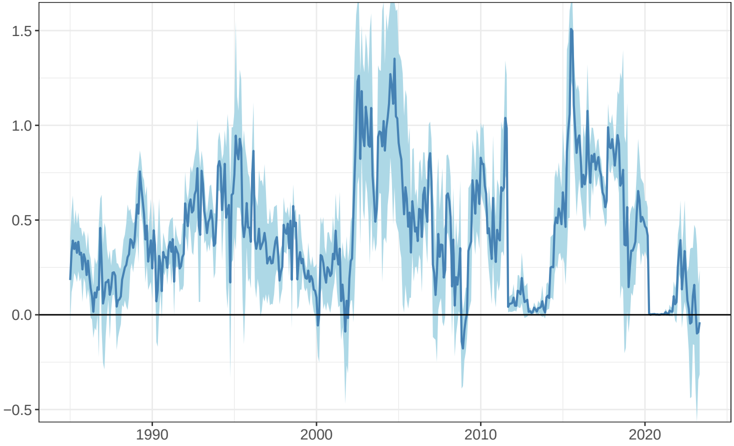
- Assumption #1: Disagreement over economic fundamentals

- Assumption #2: Economic forecasts determined independently of expected future monetary policy shock

- Assumption #3: Correctly capturing policy rule specification
  - Other variables do not enter policy rule
  - Coefficients $\hat{\beta}_t$ and $\hat{\gamma}_t$ shared across forecasters

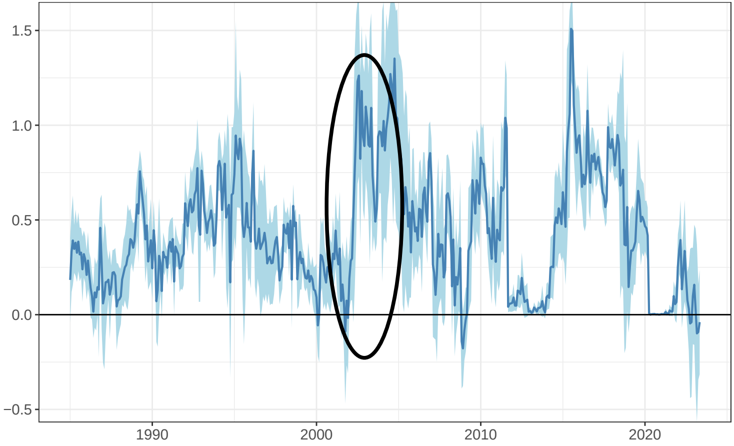
- Good description of data: Average regression R^2 33% (no FE) and 70% (FE)

Perceived Output Gap Coefficient $\hat{\gamma}_t$ from Baseline Rule



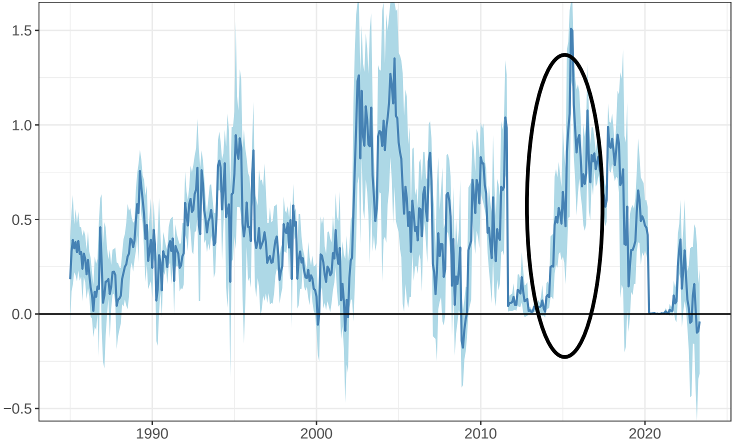
- Perceived output gap response $\hat{\gamma}_t$ is high when policy is more "data-dependent".

Perceived Output Gap Coefficient $\hat{\gamma}_t$ from Baseline Rule



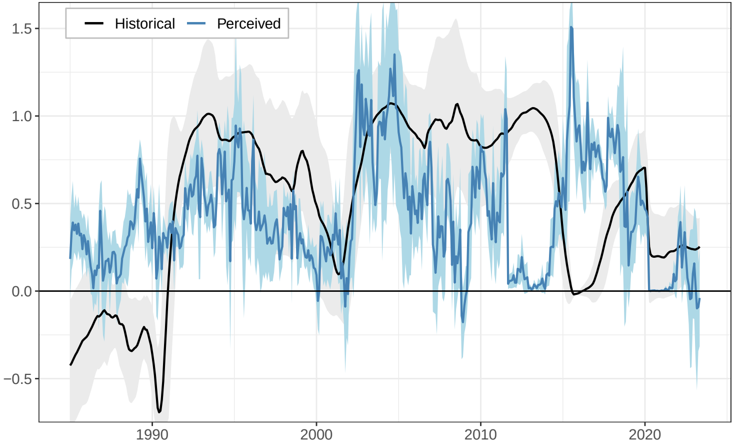
- Bernanke (2004): “FOMC’s communication strategy, which has linked future rate changes to the levels of inflation and resource utilization”

Perceived Output Gap Coefficient $\hat{\gamma}_t$ from Baseline Rule



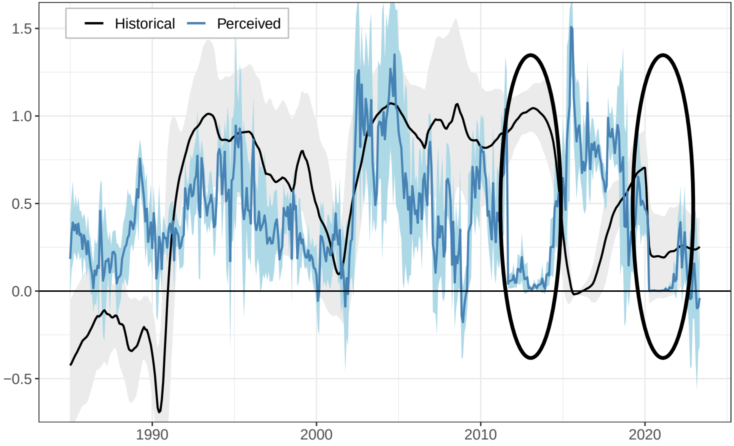
- Yellen (2015): "all agreed that the timing of a rate increase would depend on what the incoming data tell us..."

Perceived Output Gap Coefficient $\hat{\gamma}_t$ from Baseline Rule



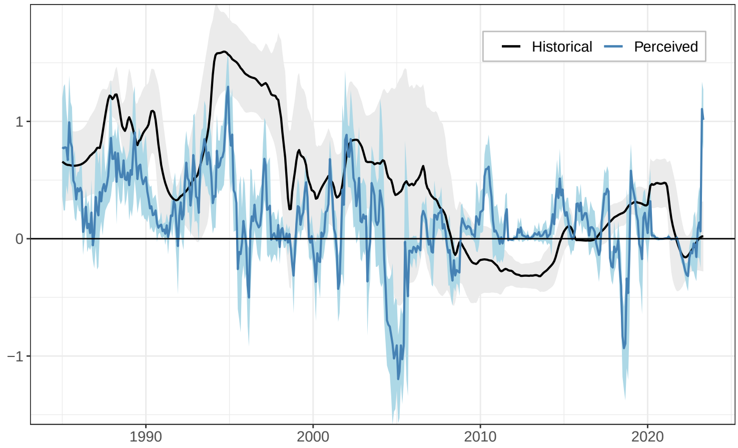
- Rolling historical rule and perceived rule generally line up...

Perceived Output Gap Coefficient $\hat{\gamma}_t$ from Baseline Rule



- Except when forward-looking perceived response clearly right.

Perceived Inflation Coefficient $\hat{\beta}_t$ from Baseline Rule



- Sample dominated by demand shocks...except the end

Robustness: Alternative specifications

- Inertial rule
- Heterogeneity of beliefs
  - Average of rules perceived by each individual forecaster
  - Multidimensional panel: interacted forecaster fixed effects
  - Split forecasters into groups based on inflation forecasts
- Fed's response to financial conditions
  - Include credit spread forecasts in rule
- Bias adjustment using simple NK model
  - Bias depends on perceived variance of policy shocks vs. output gap, which can be estimated in the forecast data

Alternative estimates highly correlated with baseline estimate

Correlations | Bias-adjustment | Two-year yield | Equal-weighted | Credit Spreads | Hawks vs Doves

Cyclical shifts in perceived policy rule

	Slope (12m lag)	Tightening dummy	Unemployment rate	ZLB dummy	VIX
Panel A: Baseline $\hat{\gamma}$					
Cofficient	0.12***	0.14*	-0.02	-0.12	-0.01***
	(0.03)	(0.08)	(0.02)	(0.11)	(0.00)
Intercept	0.20***	0.37***	0.54***	0.46***	0.72***
	(0.06)	(0.04)	(0.14)	(0.05)	(0.09)
R^2	0.18	0.04	0.01	0.03	0.12
Panel B: Inertial $\hat{\gamma}$					
Cofficient	0.04**	0.05	-0.01	-0.10***	-0.01***
	(0.01)	(0.04)	(0.01)	(0.03)	(0.00)
Intercept	0.10***	0.16***	0.20***	0.20***	0.32***
	(0.03)	(0.02)	(0.05)	(0.02)	(0.05)
R^2	0.07	0.02	0.00	0.08	0.14
N	460	460	460	460	448

Timing matters

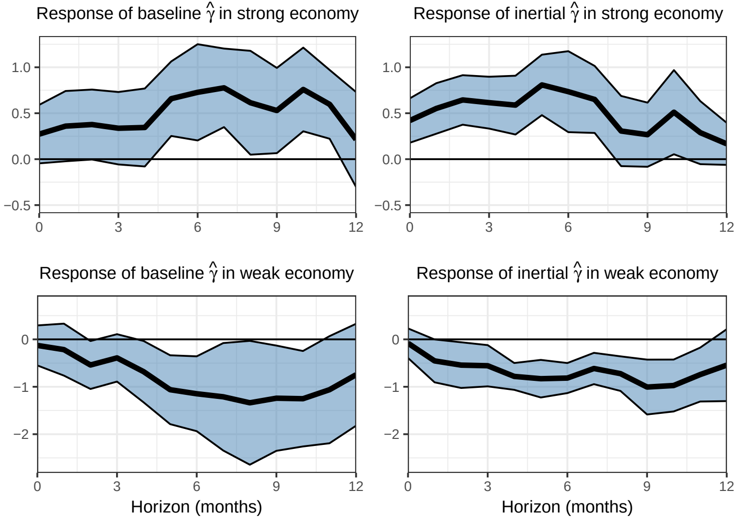
Quick, surprising rate cuts but gradual, predictable tightening

- Fed cuts quickly at beginning of easing cycles (low γ)
  - No further action anticipated for a while and $\hat{\gamma}$ falls
  - "*Front-loaded easing policy*" (FOMC minutes, January 29-30, 2001)
  - "*Investors and analysts do not expect the Fed to be as fast in cutting rates in the months ahead.*" (NYTimes, January 31, 2001)
- As economy starts to recover, Fed aims to gradually, predictably tighten according to incoming data (high γ)
  - "Data-dependent" (Bernanke, FOMC press conference, December 2013)
  - "policy will depend on [...] incoming data" (Yellen, speech December 2, 2015)
  - "Data-dependent" (Powell, speech October 8, 2019)

How do forecasters update their beliefs about the policy rule?

- **Prediction 1:** Surprise tightening in strong economy $\rightarrow \hat{\gamma}$ increases
  - *"Fed prevents economy from overheating"*
- **Prediction 2:** Surprise tightening in weak economy $\rightarrow \hat{\gamma}$ decreases.
  - *"Fed fails to support a struggling economy"*
- Romer and Romer (1989) identified dates with shifting Fed preferences as monetary policy shocks
- In our model, state-contingent responses rule out that
  - Fed response fully known and
  - Monetary policy surprises convey only pure monetary policy shocks

Local projection estimates of state-dependent impulse responses



- State-contingent updating supports monetary policy rule partly unknown (Bauer and Swanson (2023))
- *Moreover*: Forecasters learn about rule from interest rate decisions
- Sizeable response: 10 bps surprise in strong economy $\rightarrow$ 0.3 stdev increase in baseline $\hat{\gamma}$

$$\hat{\gamma}_{t+h} = a^{(h)} + b_1^{(h)} mps_t \times (1 - weak_t) + b_2^{(h)} mps_t \times weak_t + c^{(h)} weak_t + d^{(h)} \hat{\gamma}_{t-1} + \varepsilon_{t+h}$$

Shifts in the sensitivity of interest rates to macro news

- Large macro-finance literature estimates impact of macroeconomic news on financial markets using high-frequency event studies:

$$\Delta y_t = b_0 + b_1 Z_t + \varepsilon_t$$

  - Δy_t high-frequency interest rate change around macro data release
  - Z_t surprise component of macro data release, e.g., non-farm payroll employment relative to consensus expectation prior to announcement

- Interest rate sensitivity determined by perceived Fed responsiveness?

$$\Delta y_t = b_0 + b_1 Z_t + b_2 \hat{\gamma}_t + b_3 \hat{\gamma}_t Z_t + \varepsilon_t$$

- Prediction: $b_3 > 0$
- Identifying assumption: News in announcement window primarily about macroeconomy, not policy rule

Rates more sensitive to news when $\hat{\gamma}_t$ is high

	Nonfarm payrolls				All announcements			
	3m FF	6m FF	2y Tsy	10y Tsy	3m FF	6m FF	2y Tsy	10y Tsy
Baseline $\hat{\gamma}$	0.00	0.00*	0.00	-0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Z	0.00	0.00	0.00	0.00***	0.84***	0.83***	0.75***	0.79***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.21)	(0.17)	(0.13)	(0.14)
$\hat{\gamma} \times Z$	0.21***	0.35***	0.45***	0.33***	0.46	0.49	0.70***	0.58**
	(0.03)	(0.04)	(0.05)	(0.05)	(0.39)	(0.32)	(0.25)	(0.27)

- Perceived policy rule transmits to interest rates outside of FOMC dates
- Markets “do the central bank’s work for it” (Woodford, 2005)

Conclusion: Perceptions about monetary policy

- *Perceived* monetary policy rule varies a lot over time
    - Systematic relationship with the monetary policy cycle
- Shifts in rule capture monetary policy surprises (learning updates) and forward guidance
- Consistent with simple learning framework about unobserved monetary policy rule
- Empirical evidence that perceived rule
    1. Changes transmission of monetary policy surprises to stock market
    2. Moves term premia in long-term bonds

NEW KEYNESIAN MODEL AND ASSET PRICES

Campbell, Pflueger, and Viceira (2020), Pflueger and Rinaldi (2022), Cieslak and Pflueger (2023), Pflueger (2024)

Work-horse New Keynesian model

$$\begin{aligned}
\textbf{Euler Equation:} \quad & x_t = (1-\rho^x)E_t x_{t+1} + \rho^x x_{t-1} - \psi(i_t - E_t \pi_{t+1}) + v_{x,t}, \\
\textbf{Phillips Curve:} \quad & \pi_t = \kappa x_t + (1-\rho^\pi)\, E_t \pi_{t+1} + \rho^\pi \pi_{t-1} + v_{\pi,t}, \\
\textbf{Monetary Policy Rule:} \quad & i_t = \rho^i i_{t-1} + (1-\rho^i)\left(\gamma^x x_t + \gamma^\pi \pi_t\right) + v_{i,t}
\end{aligned}$$

x_t = output gap, π_t = inflation, i_t = nominal policy rate, up to constant

Work-horse New Keynesian model

$$
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\end{aligned}
$$

$x_t =$ output gap, $\pi_t =$ inflation, $i_t =$ nominal policy rate, up to constant

- **Euler Equation** represents consumers' first-order condition for risk-free bond
  - Consumption today versus consumption tomorrow
  - Textbook macro model (e.g. Clarida, Gali, and Gertler (1999), Woodford (2005), Gali (2008)) has constant risk premia $\Rightarrow$ hard to talk about asset prices
  - Demand shock $v_{x,t}$ represents shift to consumption at given risk-free rate, such as demand for safe assets (Cieslak, Li, and Pflueger (2023)), or growth expectations

Work-horse New Keynesian model

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\textbf{Euler Equation:} \quad & x_t = (1-\rho^x) E_t x_{t+1} + \rho^x x_{t-1} - \psi(i_t - E_t \pi_{t+1}) + v_{x,t}, \\
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\end{aligned}$$

$x_t =$ output gap, $\pi_t =$ inflation, $i_t =$ nominal policy rate, up to constant

- **Phillips Curve** follows from firms' optimal price-setting and production decisions when opportunities to revise prices are infrequent (Calvo 1983)
    - Backward-looking term may represent the dependence of inflation expectations on past realized inflation, or price indexation to past inflation
    - Supply (or cost-push) shock $v_{\pi,t}$ captures disturbance between the output gap and marginal costs of production, such as increases in wage bargaining power or changing optimal markups

Work-horse New Keynesian model

$$\begin{aligned}
\textbf{Euler Equation:} \quad & x_t = (1-\rho^x)E_t x_{t+1} + \rho^x x_{t-1} - \psi(i_t - E_t \pi_{t+1}) + v_{x,t}, \\
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\end{aligned}$$

$x_t =$ output gap, $\pi_t =$ inflation, $i_t =$ nominal policy rate, up to constant

- **Monetary policy framework**

Work-horse New Keynesian model

$$\begin{aligned}
\textbf{Euler Equation:} \quad & x_t = (1-\rho^x)E_t x_{t+1} + \rho^x x_{t-1} - \psi(i_t - E_t \pi_{t+1}) + v_{x,t}, \\
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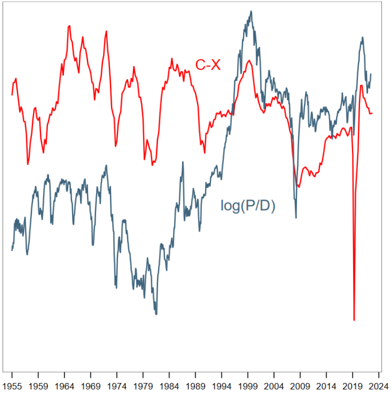
\end{aligned}$$

$x_t =$ output gap, $\pi_t =$ inflation, $i_t =$ nominal policy rate, up to constant

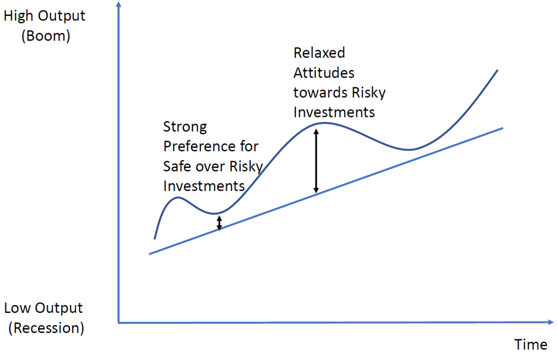
- **Monetary policy framework**
  - Long-term output gap and inflation weights γ^x and γ^π
  - Inertia or gradualism parameter ρ^i determines speed of policy response
  - Monetary policy shock $v_{i,t}$ captures deviation from rule, mean-reverts at rate ρ^i

Stock prices and de-trended consumption highly correlated in data



Updated from Cochrane (2017)

Integrate with work-horse finance model: Higher risk aversion in bad times



- Volatile, high, predictable stock returns (Campbell and Cochrane (1999))
- $\Rightarrow$ **"Flight-to-safety" to Treasury bonds is endogenous and arises only if inflation dynamics make Treasury bonds safe**
- $\Rightarrow$ **Explains large stock response to monetary surprises in the data**

WHY DOES THE FED MOVE MARKETS SO MUCH?

Pflueger and Rinaldi (2022)

Model explains large stock response to MP shocks

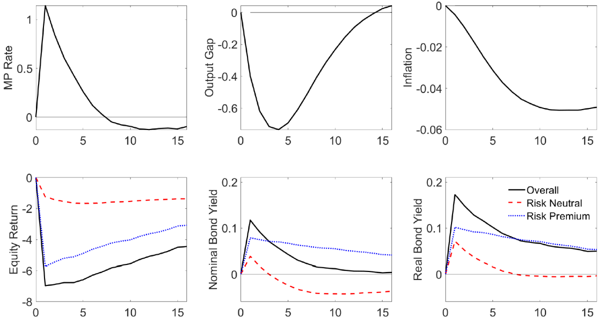
Table 4 Stock Market onto High-Frequency Monetary Policy Shocks

	Data			Model					
				Overall		Risk Neutral		Risk Premium	
FF Shock	-3.02***	-2.73*	-6.14***	-6.37	-6.31	-1.23	-1.22	-5.13	-5.08
	(0.99)	(1.53)	(1.16)						
FF Shock $\times$ (FF Shock>0)		0.54			-0.07		-0.02		-0.06
		(2.14)							
Timing			-5.67***						
			(1.52)						

Endogenously time-varying risk premia important

Model asset price impulse responses

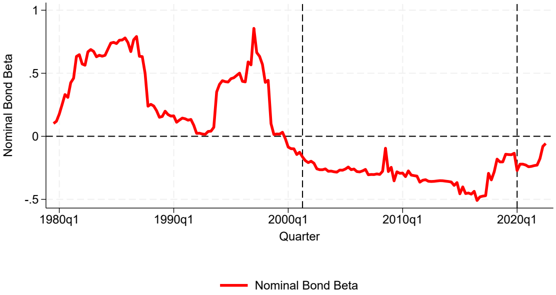
Fig. 3 Model Impulse Responses to Monetary Policy Shock



- MP hike is bad news for surplus consumption ⇒ risk aversion rises ⇒ stock market falls more than discounted expected present value of dividends
- New Keynesian model with asset pricing habits matches large stock response to MP shocks ⇒ large stock response on FOMC dates reduced to equity volatility puzzle (Shiller 1981)

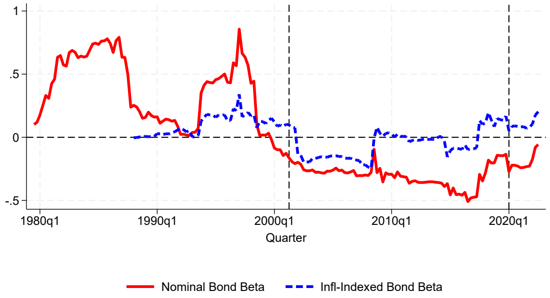
BACK TO THE 1980s OR NOT?

Changing bond-stock comovement



$xr_{n,t+1} = \alpha + \beta xr^{eq}_{t+1} + \varepsilon_{t+1}$, quarterly returns, 5-year rolling windows
Pflueger (2024) Figure 1

Changing bond-stock comovement: Inflation



$xr_{n,t+1} = \alpha + \beta xr^{eq}_{t+1} + \varepsilon_{t+1}$, quarterly returns, 5-year rolling windows
Pflueger (2024) Figure 1

- **1980s nominal bond-stock betas priced "stagflation" risk and generated endogenous "flight-from-safety" from bonds. Low inflation recessions and endogenous "flight to safety" in 2000s.** (Campbell, Pflueger, Viceira (2020, JPE))

Supply shocks vs. monetary policy?

DE Shaw &Co (2021)

> In short, the safe haven status of Treasury securities was put to a major test, and it passed. (...) As argued in that paper, we believe that the stock-bond correlation depends critically on the type of shocks hitting the economic system.

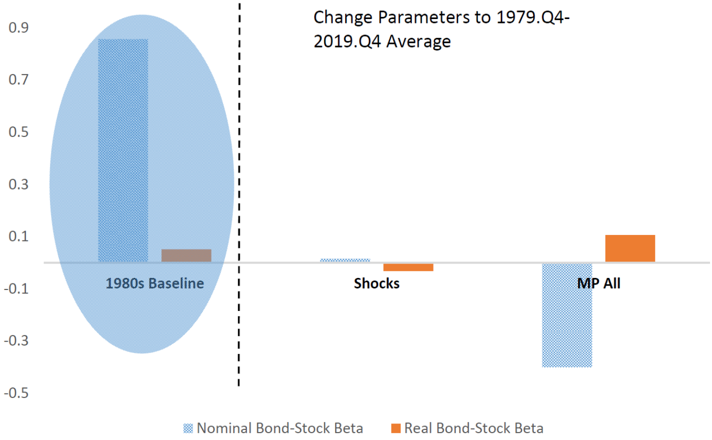
WSJ

5/22/2022

> That hedge has evaporated this year. Investors have dumped both stocks and bonds as the Federal Reserve has embarked on a campaign to raise interest rates to combat inflation, which is at a 40-year high. Even the

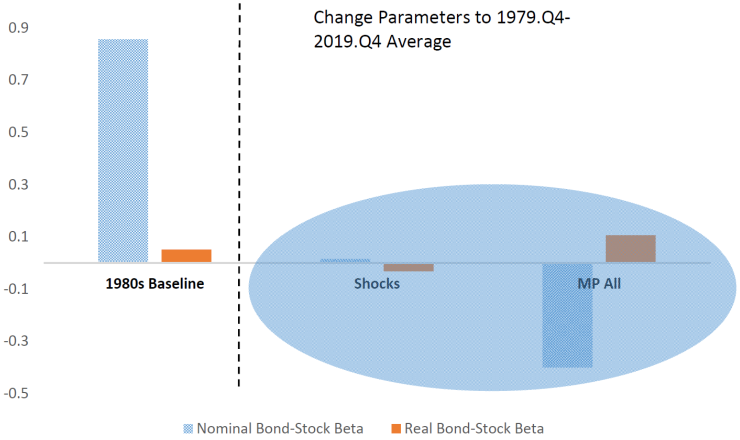
Pflueger (2024)

1980s calibration: Positive nominal bond-stock betas...



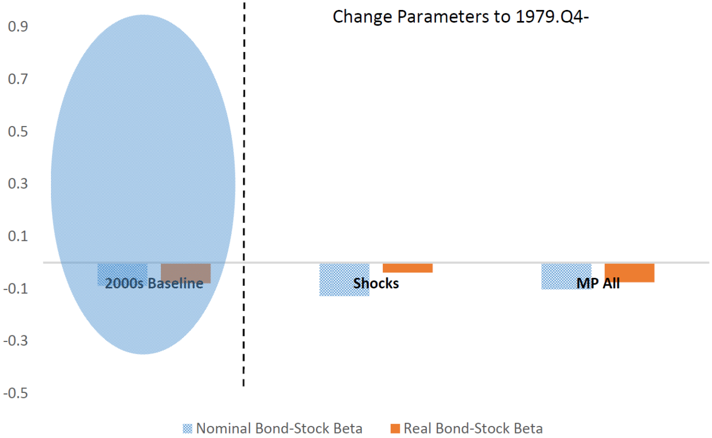
Pflueger(2024)

...change with shocks or monetary policy



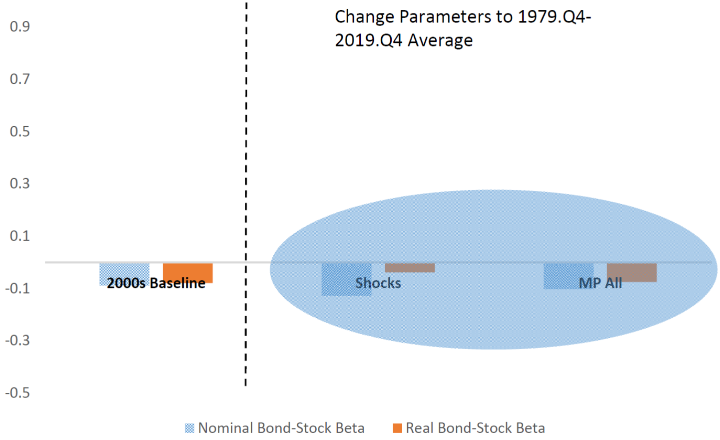
Pflueger(2024)

2000s calibration: Negative nominal bond-stock betas...



Pflueger(2024)

...do not change

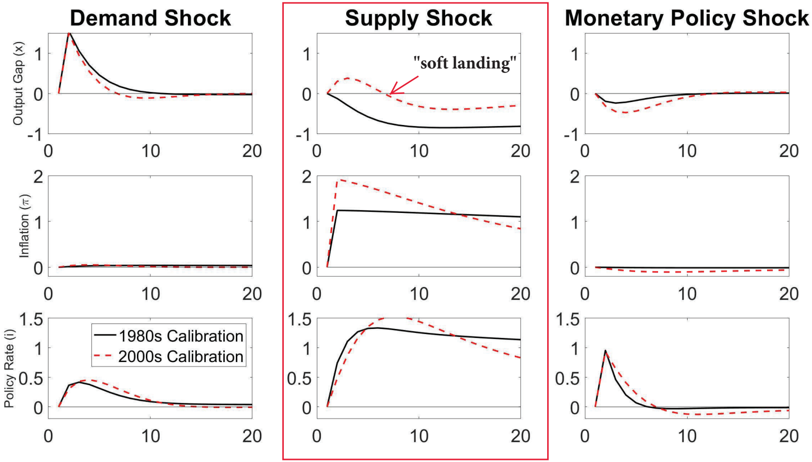


Pflueger(2024)

- Positive bond-stock betas harder to generate than one might think
- Positive bond betas (risky bonds): Interaction supply shocks and hawkish monetary policy rule

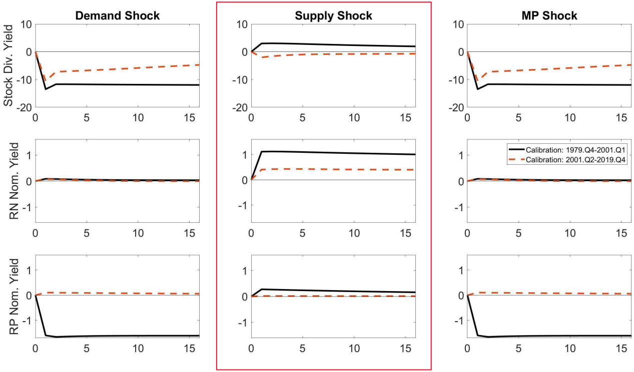
MECHANISM

Different Macro Impulse Responses to Supply Shock...



1 pp surprises ▸ 1 Std Shocks

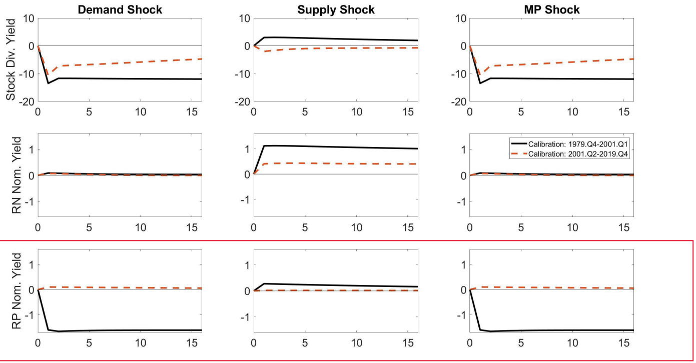
Translate into Different Bond-Stock Comovement



1 pp surprises
Bond prices fall with bond yield, stock prices fall with dividend yield

- **1980s Calibration: Positive bond-stock comovement**
- **2000s Calibration: Negative bond-stock comovement**

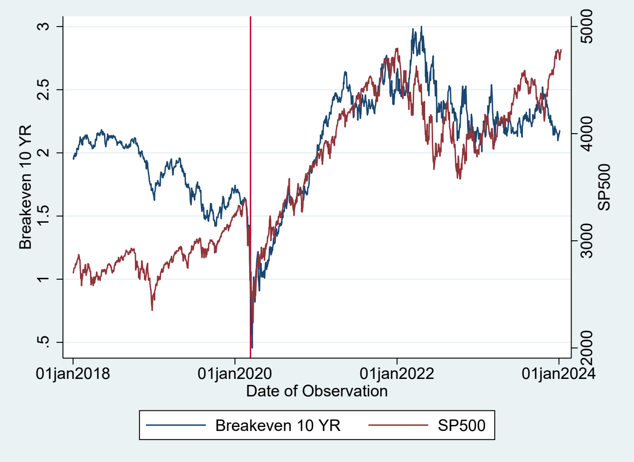
.... and Important Risk Premia



1 pp surprises

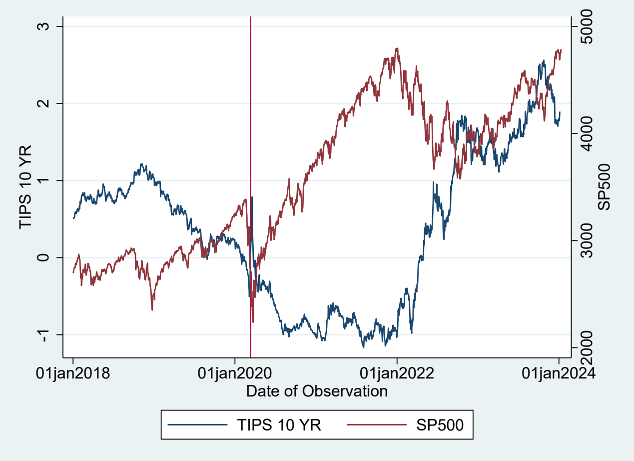
- 1980s calibration: All three impulses lead to $corr(bond, stock) > 0$
- 2000s calibration: All three impulses lead to $corr(bond, stock) < 0$
- **Expected composition of shocks matters: Flip risk premium in nominal bonds**

Recent: Breakeven Moves with Stock Market



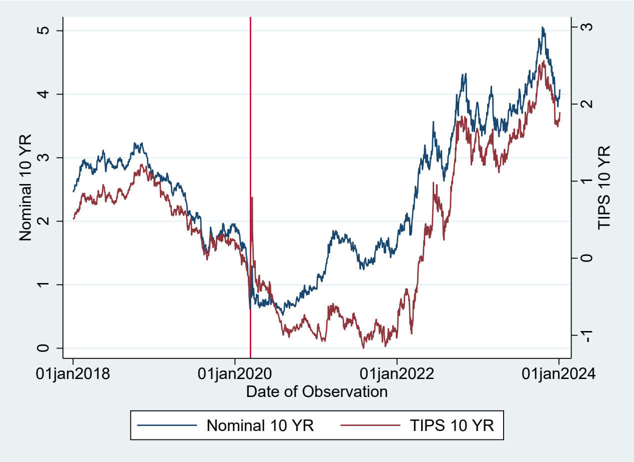
Pushes nominal bond-stock return beta negative

Recent: Real Yields Move Against Stock Market

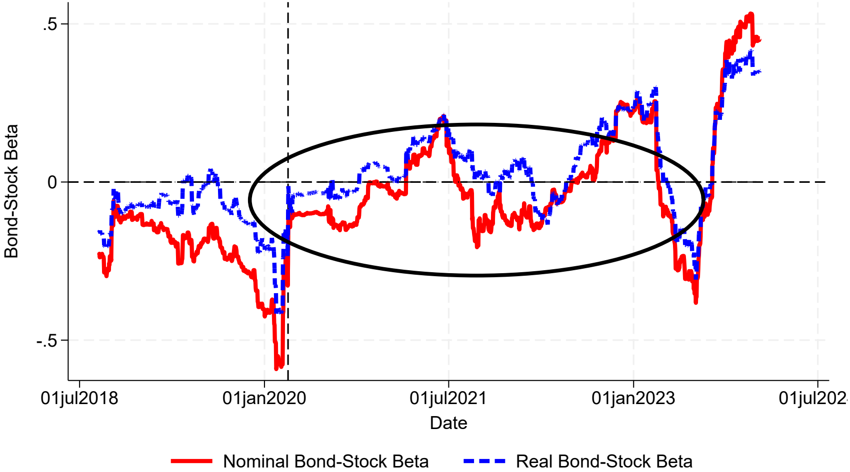


Positive real bond-stock return beta

Recent: De- and re-coupling of Nominal and Real Yields

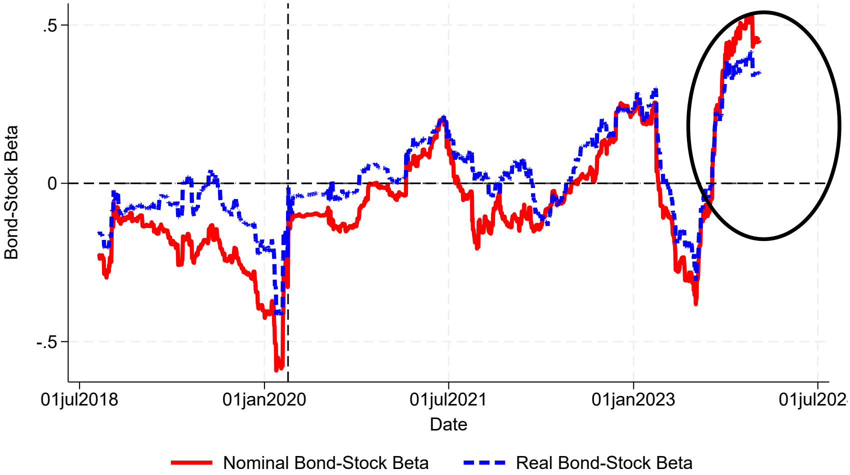


Recent Treasury bond-stock betas (US, daily) priced “soft landing”



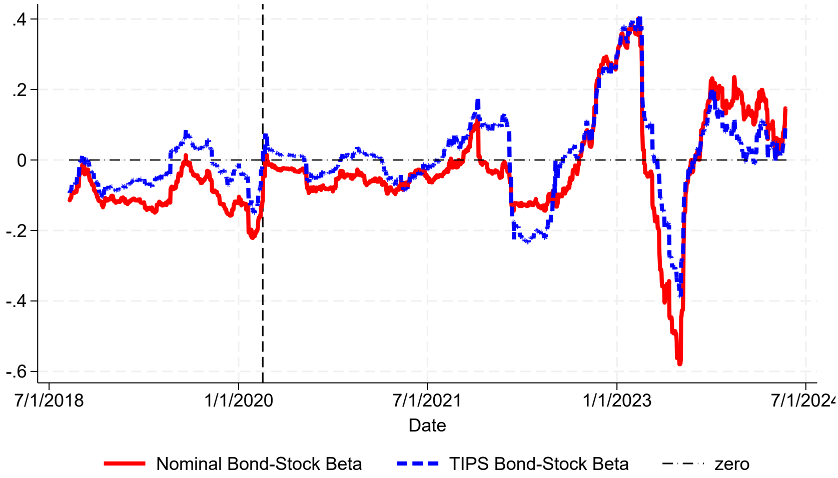
Model wants supply shocks but more inertial, less hawkish monetary policy.

2023.Q3: More like 1980s



Model wants supply shocks and hawkish monetary policy. Time-varying risk premia drive wedge between realized and priced shocks in sample...

Germany: Bond-stock betas



Conclusion

- Monetary policy and asset prices clearly linked
- Perceptions of monetary policy reaction functions vary substantially, respond to interest rate decisions, and feed to long-term asset prices (Bauer, Pflueger, and Sunderam (2024))
- Combining standard New Keynesian framework with standard finance habit can go long way to understanding
    - Strong stock response to identified monetary policy surprises (Pflueger and Rinaldi (2022))
    - Change in nominal Treasury bonds from risky in 1980s to safe in 2000s (Campbell, Pflueger, and Viceira (2020))
    - Increasingly risky nominal Treasury bonds price anticipation of inflation-responsive monetary policy and supply shocks, not realized shocks/policy (Pflueger (2024))