Back to the 1980s or Not? The Drivers of Inflation and Real Risks in Treasury Bonds *

Carolin Pflueger
University of Chicago, Harris School of Public Policy, NBER, and CEPR

Abstract

This paper shows that supply shock uncertainty interacts with the monetary policy rule to drive bond risks in a New Keynesian asset pricing model. In my model, positive nominal bond-stock betas emerge as the result of volatile supply shocks but only if the monetary policy rule features a high inflation weight. Habit formation preferences generate endogenously time-varying risk premia, explaining the volatility and predictability of bond and stock excess returns in the data, and implying that bond-stock betas price the expected equilibrium mix of shocks rather than realized shocks. The model explains the change from positive nominal and real bond-stock betas in the 1980s to negative nominal and real bond-stock betas in the 2000s with a shift from dominant supply shocks and an inflation-focused monetary policy rule, to demand shocks in the 2000s. Post-pandemic nominal and real bond-stock betas are explained with dominant supply shocks and a late increase in the monetary policy inflation coefficient.

Keywords: Bond betas, stagflation, soft landing, supply shocks, demand shocks, monetary policy, New Keynesian, time-varying risk premia
JEL Classifications: E43, E52, E58

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1. Introduction

What do nominal and real Treasury bond risks tell us about supply shocks and stagflation or, conversely, the Fed's ability to engineer a "soft landing"? Nominal and inflation-indexed bonds have different inflation exposures, so nominal bond-stock betas are intuitively infor-

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mative about inflation dynamics, whereas inflation-indexed bond-stock betas are informative about the dynamics of real rates. Figure 1 shows that during the 1980s nominal bond betas were positive and significantly larger than inflation-indexed bond betas, as one would expect if inflation expectations rise during recessions and investors worry about stagflation.[1] Nominal bond betas changed sign and the gap between nominal and inflation-indexed bond betas narrowed during the 2000s, as one would expect if inflation is less volatile and tends to rise in expansions. Maybe surprisingly, Figure 1 newly shows that nominal bond-stock betas remained negative for much of the post-pandemic period. This raises the question why – different from the 1980s – nominal bond-stock betas did not rise during the recent spike in inflation, despite perceived macroeconomic similarities.

Calibrating a New Keynesian equilibrium model for asset prices separately to the 1980s and the 2000s, I find that over the past 30 years monetary policy and the real side of the economy have changed sufficiently that reverting either set of parameters is insufficient to revert bond risks to their levels in the 1980s. Instead, a "perfect storm" consisting of a change towards more volatile supply shocks and a more hawkish monetary policy rule is needed to generate a reversion back to the risky bond markets of the 1980s. The model hence explains the different bond-stock betas during the recent period with substantial supply shock uncertainty and an initially low but increasing monetary policy inflation coefficient.

Despite the substantial literature studying historical bond-stock comovements (e.g. David and Veronesi (2013), Song (2017), Campbell, Sunderam and Viceira (2017), Campbell, Pflueger and Viceira (2020, CPV)), the link to monetary policy and macroeconomic shocks within a general equilibrium asset pricing framework has still been elusive. The habit formation preferences in this paper build on CPV and Pflueger and Rinaldi (2022, PR), giving rise to countercyclical risk premia, volatile and predictable stock returns, and a log-linear macroeconomic Euler equation linking output, consumption, and the monetary policy rate. However, the model in this paper contains several innovations over CPV and PR, in particular demand and supply shocks and adaptive inflation expectations. These innovations give it a unique ability to conduct counterfactual exercises to assess the impact of changes in the macroeconomic shock volatilities and Taylor rule coefficients on bond-stock betas. Different from CPV and PR, a bond preference shock gives rise to a negative demand shock, lowering real consumption at a given policy rate, similar to the safety shock that has been increasingly

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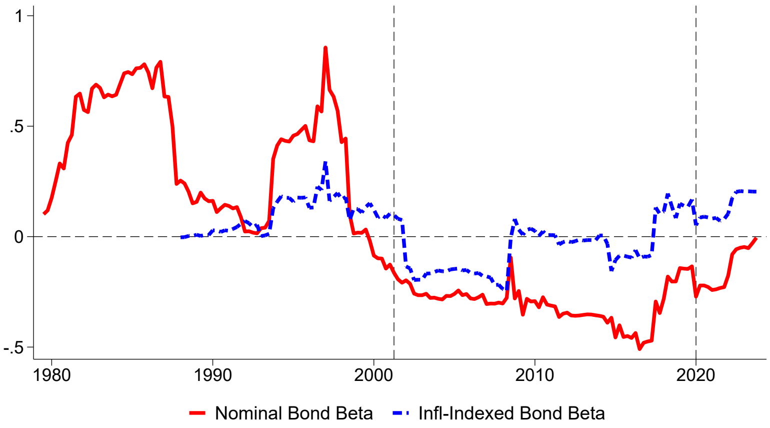
[1] Figure 1 depicts five-year rolling nominal and inflation-indexed bond-stock return betas from 1979.Q4 through 2022. I use UK inflation-linked bond yields prior to 1999 and yields on US Treasury Inflation-Protected Securities (TIPS) after 1999, when TIPS data becomes available. Campbell, Shiller and Viceira (2009) find similar changes in US and UK nominal and inflation-indexed bond-stock betas.

Figure 1: Rolling Nominal and Real Bond-Stock Betas



Note: This figure shows betas from regressing quarterly ten-year Treasury bond excess returns onto quarterly US equity excess returns over five-year rolling windows for the period 1979.Q4-2023.Q4. Quarterly excess returns are in excess of three-month T-bills. Prior to 1999, I replace US Treasury Inflation-Protected (TIPS) returns with UK ten-year linker returns. Bond excess returns are computed from changes in yields. Zero-coupon yield curves are from Gürkaynak, Sack and Wright (2007, 2010) and the Bank of England. Vertical lines indicate 2001.Q2 and the start of the pandemic 2020.Q1.

successful in international finance.[2] The supply side of the model features adaptive wage-setter inflation expectations and sticky wages in the manner of Rotemberg (1982). Wage markup shocks give rise to supply shocks to the wage Phillips curve. Monetary policy is modeled as a Taylor (1993)-type rule, whereby the nominal monetary policy rate increases with inflation and the output gap and has an inertial weight on the lagged policy rate. Stocks in the model represent a levered claim to firm profits, and investors are assumed to have rational inflation expectations. Demand, supply, and monetary policy shocks are assumed to be uncorrelated, as is standard for structural shocks.

I calibrate the model separately to macroeconomic data from the 1980s and 2000s, thereby using the well-understood changes in the macroeconomy over these decades as a laboratory for my model of bond-stock betas. The model matches the changing bond-stock betas from the 1980s to the 2000s with a change from a supply-shock driven economy in the 1980s to a demand-shock driven one in the 2000s, and a change from a quick-acting and inflation-focused monetary policy rule in the 1980s to an inertial and more output-focused monetary policy rule in the 2000s. The volatilities of shocks and monetary policy parameters for each subperiod target inflation-output gap, fed funds rate-output gap, and inflation-fed funds rate relationships, as well as the volatilities of consumption growth, long-term

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[2] E.g. Bianchi and Lorenzoni (2021), Kekre and Lenel (2021), Jiang, Krishnamurthy and Lustig (2021).

inflation expectations, and the fed funds rate. I set the adaptiveness of wage-setters' inflation expectations to match the well-known predictability of bond excess returns of Campbell and Shiller (1991). I use a break date of 2001.Q2, when the correlation between inflation and the output gap turned from negative (i.e. stagflations) to positive (Campbell et al. (2020)), and Goodfriend (2007) argues monetary policy changed to a "new consensus".

The calibrated changes in the monetary policy rule and the nature of macroeconomic shocks are consistent with anecdotal evidence. For example, in recent decades central bankers have tended to move in incremental policy steps, and have shown substantial concern for output.[3] Since it has been argued that monetary policy opened up the economy to self-fulfilling sunspots or "inflation scares" during the 1970s (Clarida, Gali and Gertler (2000), Goodfriend (2007)), I refrain from calibrating my model for the 1970s and instead focus on the 1980s and 1990s as an example of a supply-shock dominated economy. Examples of supply-type shocks during my first calibration period include the sudden drop in oil prices in 1986 (Gately, 1986) and the "New Economy" of the 1990s.[4]

I next use the calibrated model for a series of counterfactual analyses. The first counterfactual shows that combining 1980s-style shocks with a 2000s-style monetary policy rule implies negative nominal bond betas but positive real bond-stock betas, thereby explaining the empirical pattern of nominal and real bond-stock betas during 2021 and 2022. Intuitively, when the systematic component of monetary policy allows the real rate to fall in response to an inflationary supply shock, the recession is mitigated and a "soft landing" ensues. Nominal bond prices fall with higher inflation expectations, while stocks do not fall due to the accommodative monetary policy response, implying a slightly negative nominal bond-stock beta. The drop in the real rate boosts real bond prices, as well as the economy and stock prices, and a positive real bond-stock beta ensues. Nominal bond-stock betas in the model do not depend strongly on the adaptiveness of wage-setters' inflation expectations, but the predictability of nominal bond excess returns does.

The second counterfactual shows that prevalent shocks – or the expected mix of shocks going forward – are priced in bond-stock betas, whereas realized shocks matter little. I show that model nominal bond-stock betas remain positive as long as the 1980s calibration is

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[3] See Cieslak and Vissing-Jorgensen (2021), Bauer and Swanson (2023), and Bauer, Pflueger and Sunderam (2024a) for direct empirical evidence of the Fed's output concern after the mid-1990s.

[4] In my model the volatility of shocks matters for bond-stock betas, but not the sign of the realized shocks. Different from the 1970s, the supply shocks of the 1980s and 1990s were often positive rather than negative. Greg Mankiw noted these supply shocks during the 1980s and 1990s in a *Fortune* article arguing: "Greenspan has been more fortunate. Shortly before he was appointed Fed chairman in 1987, world oil prices plummeted, improving the inflation-unemployment tradeoff. Over the past two years, the foreign-exchange market has provided a similar benefit (...)" N. Gregory Mankiw, "Alan Greenspan's Tradeoff", Fortune, December 8, 1997.

priced in equilibrium, even if the realized shocks are drawn from the 2000s distribution. The mechanism relies on habit formation preferences, which generate endogenous time-varying risk premia. Intuitively, in the 1980s equilibrium nominal bonds are priced as risky assets because they are expected to pay out in low marginal utility states. An increase in risk aversion—whether caused by realizations of demand, supply, or monetary policy shocks—causes investors to have a lower willingness to pay for risky nominal bonds and stocks, driving down nominal bond and stock prices simultaneously. Bond betas in the model should hence be interpreted as forward-looking indicators.

The third counterfactual computes the changes in parameters necessary to replicate 1980s bond-stock betas starting from the 2000s calibration. I find that a high volatility of supply shocks is necessary to reverse-engineer the bond-stock betas observed during the first subperiod. Consistent with the notion that a "perfect storm" is needed to make bonds risky again, a high supply shock volatility is necessary but not sufficient to replicate the high nominal bond-stock betas of the 1980s. A high monetary policy inflation coefficient and low monetary policy inertia are also needed. This counterfactual hence further supports a high supply shock volatility for the first calibration period.

Finally, I show that the model gives an intuitive account of the recent period, which was characterized by high inflation not seen since the 1980s. For this, I turn to bond-stock betas from daily returns to measure the risks of Treasury bonds at higher frequency. The model can explain negative nominal bond-stock betas and slightly positive real bond-stock betas from daily returns during the early post-pandemic (until 2023.Q2), and positive nominal, real, and breakeven (i.e. nominal-minus-real) bond betas from daily returns during the later post-pandemic (2023.Q3-Q4). It does so by selecting a low monetary policy inflation coefficient for the early post-pandemic and a high monetary policy inflation coefficient for the later post-pandemic, as well as 1980s-style shocks for the entire post-pandemic period. The late model-implied change towards a more inflation-focused monetary policy rule is consistent with the timeline of events, as inflation rose already in 2021, well before the Fed started lifting interest rates. The delayed change in the model-implied monetary policy rule is also consistent with evidence from rich survey data (Bauer, Pflueger and Sunderam (2024b)). Taken together, the framework in this paper is a useful tool for understanding the monetary policy stance and macroeconomic shocks priced by nominal and real bond-stock betas during the recent inflationary spike.

This paper contains distinct contributions over the literature studying changing bond-stock comovements. Various channels have been proposed in the literature to explain the changes in bond-stock betas over the past four decades, including changing inflation risks (Piazzesi and Schneider (2006), David and Veronesi (2013), Song (2017), Campbell, Sunderam and Viceira (2017), Campbell, Sunderam and Viceira (2017), Gourio and Ngo (2020), and Fang, Liu and Roussanov (2022)); liquidity, flight-to-safety, and time-varying risk aversion (Baele, Bekaert and Inghelbrecht (2010), Kozak and Santosh (2020), and Laarits (2022)); permanent-transitory compositional changes of consumption growth (Chernov, Lochstoer and Song (2021)); and changes in the monetary-fiscal mix regimes (Li, Zha, Zhang and Zhou (2022)). The model in this paper incorporates these channels in a relatively parsimonious setup, where inflation risk and the permanent-transitory decomposition arise endogenously from the nature of macroeconomic shocks and monetary policy, and habit formation preferences give rise to time-varying risk aversion and hence endogenous "flight-to-safety".

Compared to CPV, PR, and Song (2017), the ability to perform counterfactual exercises assessing how changes in Taylor rule coefficients *and* macroeconomic volatilities impact bond-stock betas within a general equilibrium model sets this paper apart. In contrast to this paper, in CPV the monetary policy rule is not specified. CPV's reduced-form equation for interest rate dynamics cannot be interpreted as a structural monetary policy rule because its innovations are correlated with inflation innovations, and it has a negative coefficient on lagged inflation. The model in Pflueger and Rinaldi (2022) is more similar to the one in this paper, containing a structural Phillips curve and Taylor-type monetary policy rule. The calibration of the model for two distinct subperiods sets the current paper apart from PR. The model in this paper also contains innovations that are crucial to reach its conclusion, such as demand and supply shocks (PR has neither), and adaptive inflation expectations. Another closely related paper is Song (2017), which however considers an endowment economy.

The model in this paper is also distinct from prior work that models the impact of changes to the volatilities of macroeconomic shocks or to monetary policy separately, whereas it is central to the conclusion in this paper to model these changes jointly. Different from the current paper, the production-based models of Fang, Liu and Roussanov (2022), and Kozak (2022) do not incorporate changes in monetary policy. Conversely, Gourio and Ngo (2020) and Li, Zha, Zhang and Zhou (2022) model changes in monetary policy but do not incorporate changes in the composition of macroeconomic shocks. Finally, Gourio and Ngo (2022) consider a model where the only macroeconomic shocks, technology shocks, have constant volatility and bond-stock comovements are closely linked to the level of inflation. Because of the close link between the level of inflation and bond-stock comovements, their model is not suited to understanding the key empirical finding in this paper that bond-stock betas remained negative even as inflation surged during 2021-2022. Hence, none of those previous papers are sufficient to reach the key conclusion that a "perfect storm" is needed to revert bond risks to the levels of the 1980s.

The paper is also complementary to a long-standing macroeconomics literature on DSGE models with regime switches in policy and/or the volatility of shocks, such as Liu, Waggoner and Zha (2011) and Bianchi and Ilut (2017). Using samples that start and end substantially earlier than mine, these two papers detect a change from a high-volatility to a low-volatility regime around 1980, i.e. the start of my sample period. The more reduced form approach to regime switches of Sims and Zha (2006) and the macro-asset pricing approach of Bianchi, Lettau and Ludvigson (2022a) also detect breaks around 2000, consistent with the start of my second subperiod. Consistent with the recent macroeconomics and inflation literature, I find that bond-stock betas support a combination supply shocks with initially easy monetary policy during the post-pandemic period (e.g. Gagliardone and Gertler (2023), Rubbo (2022), Hazell and Hobler (2024), Bocola et al. (2024), Cieslak et al. (2024)).

Finally, this paper more broadly contributes to the literatures jointly modeling term premia within New Keynesian models (Kung (2015), Rudebusch and Swanson (2012), Kekre, Lenel and Mainardi (2024)), stock and credit risk premia within New Keynesian models (Kekre and Lenel (2022), Swanson (2021), Bianchi, Lettau and Ludvigson (2022a), Bianchi, Ludvigson and Ma (2022c)), and optimal monetary policy with time-varying risk premia (e.g. Gilchrist and Leahy (2002), Caballero and Simsek (2022)). Complementary to this paper, Bauer, Pflueger and Sunderam (2024a,b) cannot speak to the role of supply shocks and contain no general equilibrium asset pricing model, so they are insufficient to reach the key conclusion of the present paper that a "perfect storm" is needed to turn bonds risky. Bond-stock betas studied here are informative about monetary policy and economic shocks over the lifetime of the assets, and matter separately, for example for portfolio allocation and Treasury debt issuance.

2. Model

I use lower-case letters to denote logs throughout, π_t to denote log price inflation, and π_t^w to denote log wage inflation. I refer to price inflation and inflation interchangeably.

2.1. Preferences

A representative agent derives utility from real consumption C_t relative to a slowly moving habit level H_t:

$$U_t = \frac{(C_t - H_t)^{1-\gamma} - 1}{1-\gamma}. \tag{1}$$

Habits are external, meaning that they are shaped by aggregate consumption and households do not internalize how habits might respond to their personal consumption choices. The parameter γ is a curvature parameter. Relative risk aversion equals $-U_{CC}C/U_C = \gamma/S_t$, where surplus consumption is the share of consumption available to generate utility:

$$S_t = \frac{C_t - H_t}{C_t}. \tag{2}$$

Risk aversion therefore increases when consumption has fallen close to habit. As equation (2) makes clear, a model for market habit implies a model for surplus consumption and vice versa. As in Campbell, Pflueger and Viceira (2020), I model market consumption habit implicitly by assuming that log surplus consumption, s_t, satisfies:

$$\begin{aligned} s_{t+1} &= (1-\theta_0)\bar{s} + \theta_0 s_t + \theta_1 x_t + \theta_2 x_{t-1} + \lambda(s_t)\varepsilon_{c,t+1}, & (3) \\ \varepsilon_{c,t+1} &= c_{t+1} - \mathrm{E}_t c_{t+1}. & (4) \end{aligned}$$

Here, x_t equals the log output gap, defined as log real output minus log potential real output at perfectly flexible prices and wages. In Section 2.4, potential depends on a moving average of past output and there is no real investment, yielding a useful expression linking the output gap and consumption (up to a constant):

$$x_t = c_t - (1-\phi)\sum_{j=0}^{\infty}\phi^j c_{t-1-j}. \tag{5}$$

Here, ϕ is a smoothing parameter. Expression (5) implies that log consumption growth is stationary – as is standard in asset pricing – but the output gap is stationary in levels – as is standard in macroeconomics. It is also consistent with the smoothing embedded in typical empirical proxies of potential. Provided that the parameter ϕ is close to one, asset price dynamics are relatively insensitive to its precise value.

The sensitivity function $\lambda(s_t)$ takes the form as in Campbell and Cochrane (1999)

$$\begin{aligned} \lambda(s_t) &= \begin{cases} \frac{1}{\bar{S}}\sqrt{1-2(s_t-\bar{s})} - 1 & s_t \le s_{max} \\ 0 & s_t > s_{max} \end{cases}, & (6) \\ \bar{S} &= \sigma_c\sqrt{\frac{\gamma}{1-\theta_0}}, \ \ \bar{s} = \log(\bar{S}), \ \ s_{max} = \bar{s} + 0.5(1-\bar{S}^2). & (7) \end{aligned}$$

This function is decreasing in log surplus consumption, so marginal utility becomes more sensitive to consumption surprises when surplus consumption is already low, as would be the case after a sequence of bad shocks. Here, σ_c denotes the standard deviation of the consumption surprise $\varepsilon_{c,t+1}$, and $\bar{s}$ is the steady-state value for log surplus consumption. Both consumption and the output gap are equilibrium objects that depend on fundamental shocks, and in equilibrium they are conditionally homoskedastic and lognormal. As shown in Campbell, Pflueger and Viceira (2020), implied log habit follows approximately a weighted average of lagged consumption and lagged consumption expectations. The asset pricing habit formation preferences used here are known to capture a wide range of asset pricing moments, including the high volatility of stock returns, their high Sharpe ratio, the predictability of stock excess returns (Campbell and Cochrane (1999)), and the risk premium effect of high-frequency monetary policy surprises (Bernanke and Kuttner (2005), Pflueger and Rinaldi (2022)). However, the mechanism more broadly relies on countercyclical risk premia, whether they are generated from the price of risk as here, the quantity of risk as in Jurado, Ludvigson and Ng (2015), or heterogeneous agents with different risk aversion (Chan and Kogan (2002), Kekre and Lenel (2022), Caballero and Simsek (2020), Drechsler, Savov and Schnabl (2018)).

2.2. Asset Pricing Equations and Bond Preference Shock

The stochastic discount factor (SDF) M_{t+1} is derived from (1):

$$M_{t+1} = \beta \frac{\frac{\partial U_{t+1}}{\partial C}}{\frac{\partial U_t}{\partial C}} = \beta \exp\left(-\gamma(\Delta s_{t+1} + \Delta c_{t+1})\right). \tag{8}$$

I model stocks as a levered claim on consumption or equivalently firm profits, while preserving the cointegration of consumption and dividends. The asset pricing recursion for a claim paying consumption at time $t+n$ and zero otherwise takes the following form

$$\frac{P^c_{n,t}}{C_t} = E_t\left[M_{t+1}\frac{C_{t+1}}{C_t}\frac{P^c_{n-1,t+1}}{C_{t+1}}\right]. \tag{9}$$

The price-consumption ratio for a claim to all future consumption then equals

$$\frac{P^c_t}{C_t} = \sum_{n=1}^{\infty}\frac{P_{n,t}}{C_t}. \tag{10}$$

At time t the aggregate levered firm buys P^c_t and sells equity worth δP^c_t, with the remainder of the firm's position financed by one-period risk-free debt worth $(1-\delta)P^c_t$, so the price of the levered equity claim equals $P^\delta_t = \delta P^c_t$. Log zero coupon yields are defined by $y_{n,t} = -\log P_{n,t}$ and $y^\$_{n,t} = -\log P^\$_{n,t}$, and log excess returns in excess of the corresponding 1-quarter rate from t to $t+h$ are denoted by $xr^\$_{n,t\rightarrow t+h}$ and $xr_{n,t\rightarrow t+h}$.

The bond asset pricing recursions are subject to a bond preference shock ξ_t. The Euler equation for the one-period risk-free rate is given by:

$$1 = E_t\left[M_{t+1} exp\left(r_t - \xi_t\right)\right], \tag{11}$$

and one-period real and nominal interest rates are linked via the Fisher equation

$$i_t = E_t\pi_{t+1} + r_t. \tag{12}$$

Equation (12) is an approximation, effectively assuming that the inflation risk premium in one-period nominal bonds is zero. Longer-term bond prices do not use this approximation and are given by the recursions:

$$P^{\$}_{1,t} = exp(-i_t), \;\; P_{1,t} = exp(-r_t), \tag{13}$$

$$P^{\$}_{n,t} = exp(-\xi_t)E_t\left[M_{t+1}exp(-\pi_{t+1})P^{\$}_{n-1,t+1}\right], \;\; P_{n,t} = exp(-\xi_t)E_t\left[M_{t+1}P_{n-1,t+1}\right], \tag{14}$$

where all expectations are rational. Because all bonds are priced with the preference shock ξ_t, the expectations hypothesis holds when investors are risk-neutral.

Fundamentally, the shock ξ_t corresponds to a disconnect between the bond and the stock markets, as for example documented empirically during March 2020 by He, Nagel and Song (2022). A positive shock ξ_t acts like a decline in Treasury bond convenience, analogous to the time-varying intermediation capacity that has been successful at reconciling several empirical puzzles in international finance, and may reflect that households do not have direct access to the government bond market.[5] Alternatively, the shock ξ_t can be microfounded as an optimism or growth shock, similar to expectations-based demand shocks in Beaudry and Portier (2006), Bordalo, Gennaioli, LaPorta and Shleifer (2022) and Caballero and Simsek (2022)'s "traditional financial forces" shock. For microfoundations see Appendix D.

2.3. Macroeconomic Euler Equation from Preferences

I next show that the bond preference shock enters equilibrium macroeconomic dynamics just like a demand shock in the Euler equation. Starting from the asset pricing equation for a one-period risk-free bond (11), and substituting for the SDF and surplus consumption dynamics gives (up to a constant):

$$r_t = \gamma \mathrm{E}_t\Delta c_{t+1} + \gamma \mathrm{E}_t \Delta s_{t+1} - \frac{\gamma^2}{2}\left(1+\lambda(s_t)\right)^2\sigma_c^2 + \xi_t, \tag{15}$$

$$= \gamma \mathrm{E}_t\Delta c_{t+1} + \gamma\theta_1 x_t + \gamma\theta_2 x_{t-1} + \underbrace{\gamma(\theta_0-1)s_t - \frac{\gamma^2}{2}\left(1+\lambda(s_t)\right)^2\sigma_c^2}_{=0} + \xi_t. \tag{16}$$

The sensitivity function (6) through (7) has the advantageous property that the two bracketed terms drop out, and the real risk-free rate has the familiar log-linear form, and much lower volatility than the stock market. Substituting (5) then gives the exactly log-linear

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[5] See e.g. Krishnamurthy and Vissing-Jorgensen (2012), Du, Im and Schreger (2018), Bernanke and Gertler (2001), Bianchi and Lorenzoni (2021), Gabaix and Maggiori (2015), Jiang, Krishnamurthy and Lustig (2021), Itskhoki and Mukhin (2021). Pflueger, Siriwardane and Sunderam (2020) provide US evidence that preference for safety not immediately driven by aggregate risk aversion can forecast business cycle variables.

macroeconomic **Euler equation**:

$$x_t = f^x E_t x_{t+1} + \rho^x x_{t-1} - \psi r_t + v_{x,t}. \tag{17}$$

Imposing the restriction that the forward- and backward-looking terms in the Euler equation add up to one, the Euler equation parameters are given by

$$\rho^x \quad = \quad \frac{\theta_2}{\phi - \theta_1}, f^x = \frac{1}{\phi - \theta_1}, \psi = \frac{1}{\gamma(\phi - \theta_1)}, \theta_2 = \phi - 1 - \theta_1. \tag{18}$$

Non-zero values for the habit parameters, θ_1 and θ_2, are therefore needed to generate the standard New Keynesian block with forward- and backward-looking coefficients. The demand shock in the Euler equation equals

$$v_{x,t} \quad = \quad \psi \xi_t. \tag{19}$$

Because consumption is endogenous, a decrease in the preference for government bonds ($\xi_t \uparrow$) tends to raise both consumption and the real rate through (17). Higher consumption, in turn, raises dividends and lowers risk aversion. The preference shock ξ_t hence raises stock prices, even though it does not appear directly in the Euler equation for consumption claims. The demand shock $v_{x,t}$ is conditionally homoskedastic, serially uncorrelated, and uncorrelated with supply and monetary policy shocks because ξ_t is. Its standard deviation is denoted by σ_x.[6]

2.4. Supply Side

I keep the supply side as simple as possible to generate a standard log-linearized Phillips curve, and the link between consumption and the output gap. Details are relegated to the Appendix. There is no real investment, and the aggregate resource constraint simply states that aggregate consumption equals aggregate output, i.e. $C_t = Y_t$. Following Lucas (1988) I assume that productivity depends on past economic activity. Potential output is defined as the level of real output that would obtain with flexible prices and wages taking current productivity as given. The log output gap is the difference between log real output and log potential real output and in equilibrium satisfies (5).

Wage unions charge sticky wages but firms' product prices are flexible. Specifically, I assume that wage-setters face a quadratic cost as in Rotemberg (1982) if they raise wages faster

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[6] While a shock to the discount factor shared by bonds and stocks (Albuquerque, Eichenbaum, Luo and Rebelo (2016)) also generates a demand shock in the Euler equation, a joint discount rate shock tends to move bonds and stocks in the same direction unless the endogenous cash flow effect is very strong. Different from a bond preference shock, a joint discount rate shock hence cannot explain the negative real bond-stock beta observed during the pre-pandemic 2000s.

than past inflation. The indexing to past inflation is analogous to the indexing assumption in Smets and Wouters (2007) and Christiano, Eichenbaum and Evans (2005). I assume that households experience disutility of working outside the home due to the opportunity cost of home production as in Greenwood, Hercowitz and Huffman (1988), with external home production habit defined so that home production drops out of the intertemporal consumption decision and the asset pricing stochastic discount factor. Log-linearizing the intratemporal first-order condition of wage-setting unions gives the **Phillips curve**:

$$\pi_t^w = f^\pi E_t \pi_{t+1}^w + \rho^\pi \pi_{t-1}^w + \kappa x_t + v_{\pi,t}, \tag{20}$$

for constants ρ^π, f^π, and κ. The parameter κ is a wage-flexibility parameter. The supply or Phillips curve shock $v_{\pi,t}$ is assumed to be conditionally homoskedastic with standard deviation $\sigma_{\pi,t}$, serially uncorrelated, and uncorrelated with other shocks. This supply shock can arise from a variety of sources, such as variation in optimal wage markups charged by unions or shocks to the marginal utility of leisure.[7]

Following Fuhrer (1997) wage-setters have partially adaptive subjective inflation expectations

$$\tilde{E}_t \pi_{t+1}^w = (1-\zeta) E_t \pi_{t+1}^w + \zeta \pi_{t-1}^w, \tag{21}$$

where E_t denotes the rational expectation conditional on state variables at the end of period t. Hence, while financial assets are priced with rational inflation expectations, wage-setters' expectations are more sluggish, capturing the idea that markets are more sophisticated and attentive to macroeconomic dynamics than individual wage-setters. A similar assumption has been used by Bianchi, Lettau and Ludvigson (2022a). A long-standing Phillips curve literature has found that adaptive inflation expectations and a strongly backward-looking Phillips curve are needed to capture the empirical persistence of inflation (Fuhrer and Moore (1995), Fuhrer (1997)).[8] If $\rho^{\pi,0}$ is the backward-looking component under rational inflation expectations ($\zeta = 0$), the backward- and forward-looking Phillips curve parameters equal:

$$\rho^\pi = \rho^{\pi,0} + \zeta - \rho^{\pi,0}\zeta, \;\; f^\pi = 1 - \rho^\pi. \tag{22}$$

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[7] While I do not model fiscal sources of inflation, under certain conditions a shock to inflation expectations due to fiscal policy can act similarly to a shift to the Phillips curve (Hazell, Herreno, Nakamura and Steinsson (2022), Bianchi, Faccini and Melosi (2023)). Up to the distinction between wage and price inflation, supply shocks are also isomorphic to shifts to potential output unrecognized by the central bank, in which case x_t is the output gap perceived by consumers and the central bank, and the actual output gap is $x_t + \frac{1}{\kappa} v_{\pi,t}$.

[8] Consistent with this older literature, a quickly growing literature has documented deviations from rationality (Coibion and Gorodnichenko (2015), Bianchi, Ludvigson and Ma (2022b)) and excess dependence of expectations on lagged inflation (Malmendier and Nagel (2016)).

Ten-year survey inflation expectations are modeled similarly as a weighted average of a moving average of inflation over the past ten years and the rational forecast, with the weight on past inflation given by ζ.

Equilibrium price inflation equals wage inflation minus productivity growth, which depends on the output gap:

$$\pi_t = \pi_t^w - (1-\phi)x_{t-1}. \tag{23}$$

In the calibrated model, ϕ is close to one, and price and wage inflation are very similar.[9] The reason to assume sticky wages rather than sticky prices is simply that with these assumptions a consumption claim (Abel (1990)) is identical to a claim to firm profits.[10]

2.5. Monetary Policy

Let i_t denote the log nominal risk-free rate available from time t to $t+1$. Monetary policy is described by the following rule (ignoring constants):

$$i_t = \rho^i i_{t-1} + \left(1-\rho^i\right)\left(\gamma^x x_t + \gamma^\pi \pi_t\right) + v_{i,t}, \tag{24}$$

$$v_t \sim N\left(0, \sigma_i^2\right). \tag{25}$$

While there is an active debate to what extent monetary policy can be described by rules versus discretion, rules such as (24) are often found to provide a good description of historical policy rates (Taylor (1993), Clarida, Gali and Gertler (2000)). The monetary policy shock in (24) can be interpreted to represent the discretionary component of monetary policy.[11] The term $\gamma^x x_t + \gamma^\pi \pi_t$ denotes the central bank's interest rate target, to which it adjusts slowly. The parameters γ^x and γ^π represent monetary policy's long-term output gap and inflation weights. The monetary policy shock, $v_{i,t}$, is assumed to be uncorrelated with supply and demand shocks, serially uncorrelated, and conditionally homoskedastic. A positive monetary

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[9] In reality, the link between price and wage inflation is arguably less close than in the model. Appendix G solves a model extension with an additional shock to the price-wage dynamics (23), showing that the results are unchanged even when the volatility of this shock is set to a high value. For parsimony, I hence abstract from shocks to wage-price dynamics in the baseline version of the model.

[10] It is also in line with Christiano, Eichenbaum and Evans (1999) who find that sticky wages are more important for aggregate inflation dynamics than sticky prices. See also Favilukis and Lin (2016) who find that wage-setting frictions are important to ensure that a claim to firm profits behaves similarly to a claim to consumption in an asset pricing sense. Appendix E.4 shows that model implications are robust to setting wage and price inflation equal through $\phi = 1$.

[11] I do not model the zero lower bound, because I am interested in longer-term regimes, and a substantial portion of the zero lower bound period appears to have been governed by expectations of a swift return to normal (Swanson and Williams (2014)). The zero-lower-bound may however be important for more cyclical changes in bond-stock betas, as emphasized by Gourio and Ngo (2020), and I leave this to future research.

policy shock represents a surprise tightening of the short-term nominal policy rate, which mean-reverts at rate ρ^i.

2.6. Model Solution

The solution proceeds in two steps. Different from Campbell et al. (2020), I need x_{t-1} as an additional state variable because it enters the surplus consumption ratio dynamics (3), and the new demand shock means that it is no longer spanned by the other state variables. First, I solve for log-linear macroeconomic dynamics. Second, I use numerical methods to solve for highly non-linear asset prices. This is aided by the particular tractability of the surplus consumption dynamics, implying that the surplus consumption ratio is a state variable for asset prices but not for macroeconomic dynamics. I solve for the dynamics of the log-linear state vector

$$Y_t = [x_t, \pi_t^w, i_t]'. \tag{26}$$

The dynamics of these equilibrium objects are driven by the vector of exogenous shocks

$$v_t = [v_{x,t}, v_{\pi,t}, v_{i,t}], \tag{27}$$

according to the consumption Euler equation (17), the Phillips curve (20), the monetary policy rule (24), and the wage-price inflation link (23). I solve for a minimum state variable equilibrium of the form

$$Y_t = BY_{t-1} + \Sigma v_t, \tag{28}$$

where B and Σ are $[3 \times 3]$ and $[3 \times 3]$ matrices, and v_t is the vector of structural shocks. I solve for the matrix B using Uhlig (1999)'s formulation of the Blanchard and Kahn (1980) method. In both calibrations, there exists a unique equilibrium of the form (28) with non-explosive eigenvalues. I acknowledge that, as in most New Keynesian models, there may be further equilibria with additional state variables or sunspots (Cochrane (2011)), but resolving these issues is beyond the scope of this paper. Note that equation (28) implies that macroeconomic dynamics are conditionally lognormal. The output gap-consumption link (5) therefore implies that equilibrium consumption surprises $\varepsilon_{c,t+1}$ are conditionally lognormal, as previously conjectured.

The key properties of endogenously time-varying risk premia can be illustrated with a simple analytic expression. Consider a one-period claim with log real payoff αc_t. For illustrative purposes consider α to be an exogenous constant, though in the full model it depends on the macroeconomic equilibrium. Denoting the log return on the one-period claim by $r_{1,t+1}^{c,\alpha}$, the risk premium—adjusted for a standard Jensen's inequality term—equals the conditional covariance between the negative log SDF and the log real asset payoff:

$$E_t\left[r^{c,\alpha}_{1,t+1}-r_t\right]+\frac{1}{2}Var\left(r^{c,\alpha}_{1,t+1}\right)=\mathrm{Cov}_t\left(-m_{t+1},x_{t+1}\right)=\alpha\gamma\left(1+\lambda\left(s_t\right)\right)\sigma_c^2. \tag{29}$$

This expression shows that assets with risky real cash flows ($\alpha > 0$) require positive risk premia. Since $\lambda(s_t)$ is downward-sloping, risk premia on risky assets increase further after a series of bad consumption surprises. Conversely, assets with safe real cash flows ($\alpha < 0$) require negative risk premia that decrease after a series of bad consumption surprises. Because real cash flows on nominal bonds are inversely related to inflation, nominal bonds resemble a risky asset ($\alpha > 0$) if inflation is countercyclical (i.e. stagflations) but a safe asset ($\alpha < 0$) if inflation falls in bad times.

Because full asset prices are not one-period claims, I use numerical value function iteration to solve the recursions (13) through (10) while accounting for the new demand shock and the link between wage and price inflation (23). Asset prices have five state variables: three state variables in Y_t, the lagged output gap x_{t-1}, and the surplus consumption ratio s_t.

3. Empirical Analysis and Calibration Strategy

Table 1 lists the parameters for the calibrations and how they vary across subperiods.

3.1. Calibration Strategy

I calibrate the model separately for two subperiods, where I choose the 2001.Q2 break date from Campbell, Pflueger and Viceira (2020). This date was chosen by testing for a break in the inflation-output gap relationship and did not use asset prices. I start the sample in 1979.Q4, when Paul Volcker was appointed as Fed chairman. I end the sample in 2019.Q4 prior to the pandemic, leaving the analysis of how shocks changed during the pandemic period for a separate discussion. I do not account for the possibility that agents might have anticipated a change in regime.[12] The model is calibrated to macroeconomic moments, with only the inflation expectations parameter set to match Campbell and Shiller (1991)-type bond excess return predictability. The calibration does not match bond-stock betas directly but uses them as additional moments, because the solution for macroeconomic dynamics is much faster than the solution for asset prices. Section 4.4 provides a simple reverse-engineering exercise showing that a high supply shock volatility is needed to explain the bond-stock betas in the first subperiod starting from the calibration for the second subperiod.

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[12] Cogley and Sargent (2008) show that an approximation with constant transition probabilities often provides a good approximation of fully Bayesian decision rules.

Table 1: Calibration Parameters

Panel A: Period-Specific Parameters		1979.Q4-2001.Q1	2001.Q2-2019.Q4
MP Inflation Coefficient	γ^π	1.35	1.10
		(0.53)	(0.05)
MP Output Coefficient	γ^x	0.50	1.00
		(0.74)	(0.28)
MP Persistence	ρ^i	0.54	0.80
		(0.18)	(0.04)
Vol. Demand Shock	σ_x	0.01	0.54
		(0.32)	(0.02)
Vol. PC Shock	σ_π	0.58	0.06
		(0.04)	(0.00)
Vol. MP Shock	σ_i	0.55	0.06
		(0.14)	(0.05)
Adaptive Inflation Expectations	ζ	0.6	0.0
		(0.51)	(9.69)
Leverage	δ	0.50	0.66

Panel B: Invariant Parameters		
Consumption Growth	g	1.89
Utility Curvature	γ	2
Risk-Free Rate	$\bar{r}$	0.94
Persistence Surplus Cons.	θ_0	0.87
Backward-Looking Habit	θ_1	-0.84
PC slope	κ	0.0062
Consumption-output gap	ϕ	0.99

Consumption growth and the real risk-free rate are in annualized percent. The standard deviation σ_x is in percent, and the standard deviations σ_π and σ_i are in annualized percent. The Phillips curve slope κ and the monetary policy parameters γ^π, γ^x and ρ^i are in units corresponding to the output gap in percent, and inflation and interest rates in annualized percent. Standard errors are computed using the delta method with details given in Appendix F.

3.2. Invariant Parameters

The calibration proceeds in three steps. First, I set some parameters to invariant values following the literature, shown in Panel B of Table 1. The expected consumption growth rate, utility curvature, the risk-free rate, and the persistence of the surplus consumption ratio (θ_0) are from Campbell and Cochrane (1999), who found that a utility curvature of $\gamma = 2$ gives an empirically reasonable equity Sharpe ratio and set θ_0 to match the quarterly persistence of the equity price-dividend ratio in the data. The output gap-consumption link parameter $\phi = 0.99$ is chosen to maximize the empirical correlation between stochastically detrended real GDP and the output gap from the Bureau of Economic Analysis. I choose a slightly higher value because the correlation between the output gap and stochastically detrended real GDP is flat over a range of values ($corr = 76\%$ at $\phi = 0.93$ vs. $corr = 73\%$ at $\phi = 0.99$), and higher ϕ minimizes the gap between price and wage inflation and hence simplifies the model. I calibrate $\theta_1 - \phi$ and hence the Euler equation exactly as in Pflueger and Rinaldi (2022), where the habit parameters θ_1 and θ_2 were chosen to replicate the hump-shaped response of output to an identified monetary policy shock in the data. The second habit parameter, θ_2 is implied and set to ensure that the backward- and forward-looking components in the Euler equation sum up to one. Because the model impulse responses to a monetary policy shock are invariant to the shock volatilities and vary little with monetary policy and Phillips curve parameters, I effectively match habit preferences to the output response to an identified monetary policy shock. I set the slope of the Phillips curve to $\kappa = 0.0062$ based on Hazell, Herreno, Nakamura and Steinsson (2022), who also find it to be stable over time. Appendix Table A4 shows that asset pricing implications are robust to choosing a different utility curvature γ, consumption-output gap link ϕ, and Phillips curve slope κ.

3.3. Period-Specific Shock Volatilities and Monetary Policy

The second step chooses period-specific monetary policy parameters and shock volatilities through Simulated Methods of Moments. Let $\hat{\Psi}$ denote the vector of twelve (13 for the second subperiod) empirical target moments, and $\Psi(\sigma_x, \sigma_\pi, \sigma_i, \gamma^x, \gamma^\pi, \rho^i; \zeta)$ the vector of model moments computed analogously on model-simulated data. I choose subperiod-specific monetary policy parameters γ^x, γ^π, and ρ^i and shock volatilities σ_x, σ_π, and σ_i while holding the inflation expectations parameter constant at $\zeta = 0$ to minimize the objective function:

$$\left\| \frac{\hat{\Psi} - \Psi(\sigma_x, \sigma_\pi, \sigma_i, \gamma^x, \gamma^\pi, \rho^i; \zeta = 0)}{SE(\hat{\Psi})} \right\|^2 . \tag{30}$$

The vector of target moments $\hat{\Psi}$ includes the moments shown in Figure 2, plus the standard deviations of annual real consumption growth, the annual change in the fed funds rate, and the annual change in survey ten-year inflation expectations shown in the bottom panel of Table 2.[13] The vector of empirical standard errors $SE(\hat{\Psi})$ is computed via the delta method

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[13] Because I match three cross-relationships (output-inflation, output-fed funds, inflation-fed funds) at three different horizons (one, three, and seven quarters) and three volatilities, this step of the calibration procedure effectively chooses six parameters to fit $3 \times 3 + 3 = 12$ (13 for the second subperiod) moments. For the second calibration period when wage inflation data is easily available, I also estimate the specification $(z_t, y_t) = (x_t, \pi^w_t)$ and target the difference $a^{x,\pi}_{1,h} - a^{x,\pi^w}_{1,h}$. I include only one horizon for wage inflation to avoid over-weighting inflation moments by including many nearly identical moments. The grid search procedure is relatively simple and draws 50 random values for (γ^x, γ^π, ρ^i, σ_x, σ_π, σ_i) and picks the combination with the

and Newey-West standard errors with h lags. I match many more empirical moments than I have parameters, so this is a demanding calibration objective. The rationale for including several lags from Figure 2 is that, for example, the negative empirical inflation-output gap relationship (i.e. stagflation) in the top-left panel is clearest at a 6-8 quarter lag horizon. Rather than picking different lags for different variables I include all lags for all variables, effectively averaging across different lead and lag horizons. Because the model is relatively parsimonious, the model cross-correlations should be expected to be matched on average but not at every lag.

The resulting subperiod calibrations shown in Table 1 are intuitive. The 1980s calibration features volatile supply shocks, volatile monetary policy shocks, and small demand shocks. The monetary policy rule in this period is characterized by a high inflation weight, a low output gap weight, and low inertia. Conversely, the 2000s calibration features volatile demand shocks, small supply and monetary policy shocks, and a less inflation-centric but more inertial monetary policy rule. The changing volatility of supply shocks across calibrations is primarily pinned down by the changing empirical inflation-output comovement in Panel A of Figure 2. The volatility of monetary policy shocks is roughly determined by the output-policy rate comovement shown in Panel B, with a higher monetary policy shock volatility making this relationship more negative in the 1980s calibration. The monetary policy inflation weight and inertia parameter are mostly determined by the empirical inflation-policy rate relationship in Panel C, which became flatter and more inertial during the second subperiod.

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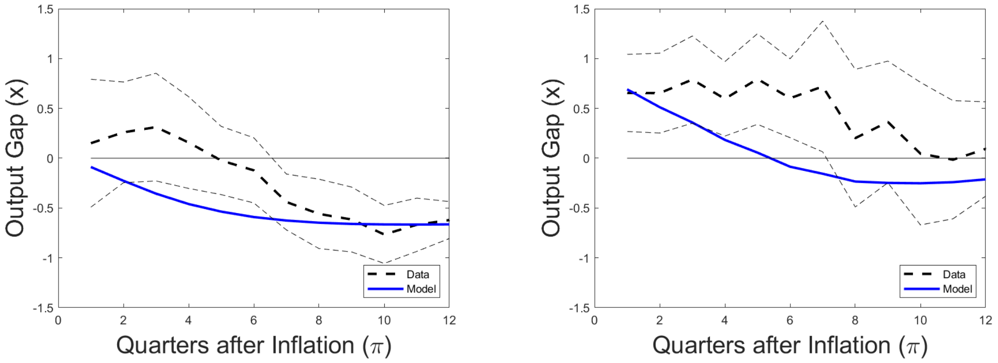
lowest objective function. I repeat this algorithm until convergence, meaning that the grid search result no longer changes starting from the calibrated values for each subperiod calibration. The only parameter value that reaches the externally set upper bound is $\gamma^x = 1$ for the 2000s calibration. I regard this as a plausible upper bound based on economic priors. Empirical ten-year CPI inflation expectations are from the Survey of Professional Forecasters after 1990 and from Blue Chip before that, available from the Philadelphia Fed.

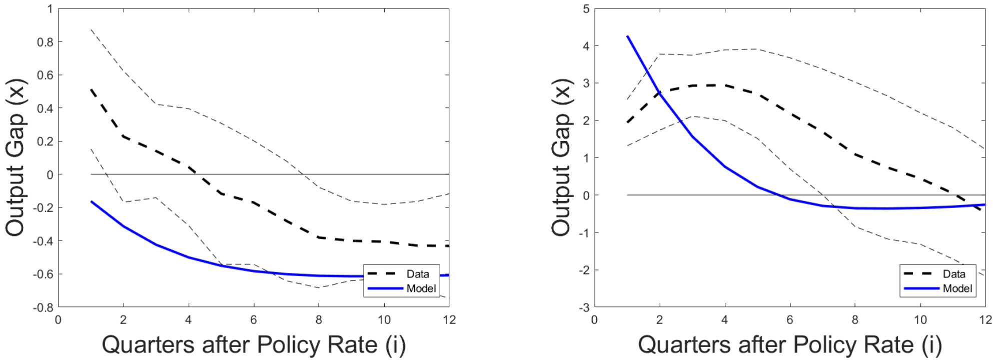
Figure 2: Local Projections for Inflation, Output Gap, and Fed Funds Rate

Panel A: Output Gap onto Lagged Price Inflation

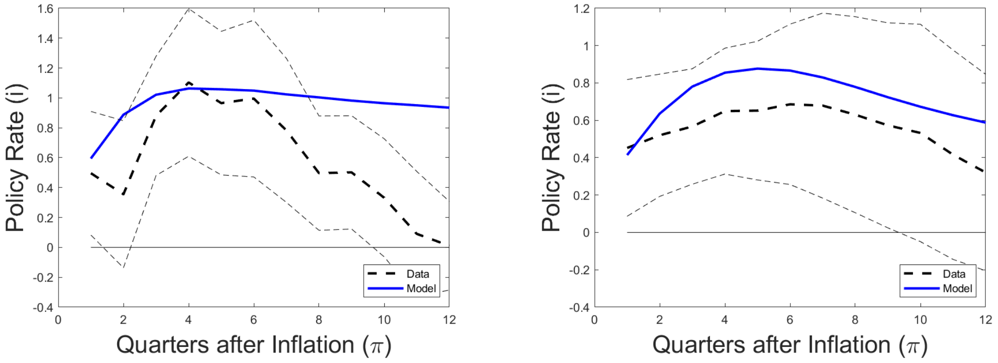
1979.Q4-2001.Q1 2001.Q2-2019.Q4



Panel B: Output Gap onto Lagged Policy Rate



Panel C: Policy Rate onto Lagged Price Inflation



This figure shows quarterly regressions of the form $z_{t+h} = a_{0,h} + a_{1,h} y_t + a_{2,h} y_{t-1} + \varepsilon_{t+h}$ and plots the regression coefficient $a_{1,h}$ on the y-axis against horizon h on the x-axis in the model vs. the data. Panel A uses the output gap on the left-hand side and GDP deflator inflation on the right-hand side, i.e. $z_t = x_t$ and $y_t = \pi_t$. Panel B uses the output gap on the left-hand side and the fed funds rate on the right-hand side, i.e. $z_t = x_t$ and $y_t = i_t$. Panel C uses the fed funds rate on the left-hand side and inflation on the right-hand side, i.e. $z_t = i_t$ and $y_t = \pi_t$. Black dashed lines show the regression coefficients in the data. Thin dashed lines show 95% confidence intervals for the data coefficients based on Newey-West standard errors with h lags. Blue solid lines show the corresponding model regression coefficients averaged across 100 independent simulations of length 1000.

Table 2: Quarterly Asset Prices and Macro Volatilities

	1979.Q4-2001.Q1		2001.Q2-2019.Q4	
Asset Prices: Stocks	Model	Data	Model	Data
Equity Premium	7.33	7.96	8.78	7.64
Equity Vol	14.95	16.42	18.46	16.80
Equity SR	0.49	0.48	0.48	0.45
AR(1) pd	0.96	1.00	0.93	0.84
1 YR Excess Returns on pd	-0.38	-0.01	-0.37	-0.50
1 YR Excess Returns on pd (R^2)	0.06	0.00	0.14	0.28
Asset Prices: Bonds				
Expected Bond Exc. Return	4.26	2.45	-0.76	-0.55
Return Vol.	15.82	14.81	1.91	9.28
Nominal Bond-Stock Beta	0.86	0.24	-0.09	-0.31
Real Bond-Stock Beta	0.05	0.08	-0.08	-0.06
1 YR Excess Return on Yield Spread*	1.26	2.55	-0.32	0.86
1 YR Excess Return on Yield Spread (R^2)	0.01	0.07	0.01	0.02
Macroeconomic Volatilities				
Std. Annual Cons. Growth*	0.76	1.15	1.46	1.15
Std Annual Change Fed Funds Rate*	1.64	2.26	0.59	1.40
Std. Annual Change 10-Year Subj. Infl. Forecast*	0.62	0.47	0.10	0.09

Moments that are explicitly targeted in the calibration procedure are noted with an asterisk. The expected bond excess return in the data starts in 1985 and is defined as the one-year expected return on an 11-year par bond with no Jensen's inequality adjustment using Blue Chip financial forecasters' 4-quarter forecast of 10-year bond yields following Piazzesi, Salomao and Schneider (2015) and Nagel and Xu (2022). The model bond excess return is the steady-state excess return for a zero-coupon ten-year bond. Ten-year CPI inflation expectations are from the Survey of Professional Forecasters after 1990 and from Blue Chip before that. Long-term inflation forecast available from the Philadelphia Fed research website. Model ten-year inflation expectations are computed as. $\tilde{E}_t \pi_{t\to t+40} = \zeta \pi_{t-41\to t-1} + (1-\zeta) E_t \pi_{t\to t+40}$, where E_t denotes rational expectations.

The change in the shock volatilities in Table 1 is consistent with the long-standing macroeconomics DSGE literature with regime switches. Liu et al. (2011) and Bianchi and Ilut (2017) estimate regime-switching DSGE models with two volatility regimes with samples that start significantly earlier and end earlier than the one in this paper, and detect a shift towards a lower volatility of all shocks around 1980. My first subperiod starts at the time of this shift, which is why naturally my approach does not pick up on their shift in volatility regimes. The more reduced-form approach of Sims and Zha (2006) allows for multiple regime switches and also detects a shift in relative volatilities in 2000, supporting the break date and shock calibrations in Table 1.

A simple newspaper count exercise supports the high perceived volatility of supply shocks for the 1980s calibration and a much smaller volatility of supply shocks for the 2000s calibration.[14] Whether one interprets the demand shock as an increase in financial frictions or as an expected growth shock, it is empirically plausible that its volatility increased from the first subperiod to the second subperiod. The standard deviation of the Gilchrist and Zakrajšek (2012) credit spread doubled between the first and the second subperiods in the data (0.54% vs. 1.06%). The standard deviation of expectations of one-year earnings growth similarly more than doubled.[15] The decline in the volatility of long-term inflation expectations from the 1980s to the 2000s is well-matched by the model, and the consumption growth and fed funds rate volatilities are roughly in line with the data.[16]

3.4. Adaptiveness of Inflation Expectations and Leverage

I choose the adaptive inflation expectations parameter $\zeta \in \{0, 0.6\}$ to match the empirical evidence on bond excess return predictability for each subperiod, while holding all other parameters constant at their values chosen in the second step. This step is kept separate because solving for asset prices is orders of magnitude slower than solving for macroeconomic dynamics.[17]

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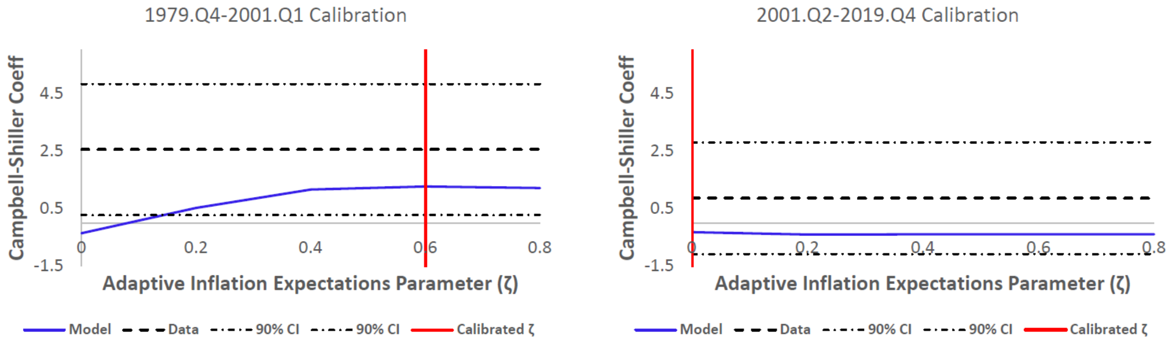
[14] For details of the newspaper count exercise see Appendix Figure A1. Fed Chairman Alan Greenspan argued in favor of supply shocks in 1996 saying "(...) powerful forces have evolved in the past few years to help contain inflationary tendencies. An ever-increasing share of our nation's workforce uses the tools of new technologies. Microchips embodied in physical capital make it work more efficiently, and sophisticated software adds to intellectual capital,"Semiannual monetary policy report, U.S. Senate July 18, 1996.

[15] Quarter-end credit spread data from https://www.federalreserve.gov/econres/notes/feds-notes/updating-the-recession-risk-and-the-excess-bond-premium-20161006.html. Quarterly data on one-year earnings growth expectations from De La'O and Myers (2021) ends in 2015.Q3 and was obtained from https://www.ricardodelao.com/data (accessed 12/12/2022).

[16] The model somewhat undershoots the volatility of changes in the fed funds rate in both periods, potentially due to monetary policy timing decisions about the very short-term that the model does not aim to capture and that are empirically less important for long-term asset prices (Bernanke and Kuttner (2005)).

[17] The objective function minimized in this step is equation (30) plus the squared standardized difference between the model and data Campbell-Shiller bond return predictability coefficient with a weight of 100.

Figure 3: Model Campbell-Shiller Predictability by Inflation Expectations



This figure shows the model Campbell-Shiller bond excess return predictability regression coefficient b from a regression of the form $xr^{\$}_{n,t\to t+4} = a + b\left(y^{\$}_{n,t} - y^{\$}_{1,t}\right) + \varepsilon_t$ using quarterly overlapping observations and $n = 40$ quarters in the model and in the data. On the x-axis is the parameter determining the adaptiveness of inflation expectations, ζ, which determines the backward-looking component of the PC through (22) in the model. All other parameters are as in Table 1. The data coefficient is shown as a black dashed line with 90% confidence intervals based on Newey-West standard errors with 4 lags.

Figure 3 shows the predictability of bond excess returns from the yield spread at different values for the inflation expectations parameter, ζ. The model-implied Campbell-Shiller coefficients in Figure 3 for the 1980s subperiod indicate that fully rational inflation expectations (i.e. $\zeta = 0$) are outside the 90% confidence interval of the data moment, and hence rejected by the data.[18] Of course, the distance to the macroeconomic dynamics is affected by varying ζ in this separate step. However, viewed more broadly within the econometric literature on inflation dynamics the macroeconomic fit improves, as setting $\zeta = 0.6$ in the 1980s calibration makes the policy rate response in the left plot of Panel C more persistent, in line with empirical evidence of a strong persistent inflation component during the 1980s (Stock and Watson (2007)). Appendix Figure A2 shows the macroeconomic model fit with $\zeta = 0$ vs. $\zeta = 0.6$. Intuitively, when inflation is highly persistent the expectations hypothesis term in the yield spread cancels, the yield spread predicts future bond excess returns, and the Campbell-Shiller coefficient is positive. The link between bond excess return predictability and the persistence of inflation is reminiscent of an older empirical literature that has documented that the expectations hypothesis holds in time periods and countries where interest

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Inflation forecast error regressions along the lines of Coibion and Gorodnichenko (2015) further support partially adaptive inflation expectations in the 1980s and rational inflation expectations in the 2000s (see Appendix Table A3).

[18] The delta method standard errors in Table 1 for ζ are larger, but also a less reliable indicator of the true confidence interval. Whereas delta method standard errors linearize the relationship between ζ and model moments, Figure 3 accounts for the full non-linear relationship between ζ and the Campbell-Shiller coefficient in the model.

rates are less persistent (Mankiw, Miron and Weil (1987), Hardouvelis (1994)). It is also consistent with Cieslak and Povala (2015)'s evidence that removing trend inflation uncovers time-varying risk premia in the yield curve. Bond risks therefore contribute to the understanding of forward- vs. backward-looking Phillips curves (Fuhrer (1997)) and expectations in New Keynesian models (Gabaix (2020)).

The leverage parameter effectively scales up stock returns but leaves all other model implications unchanged. I set it to roughly match the volatility of equity returns in the data. The model does not require high leverage, with $\delta = 0.5$ for the 1980s calibration corresponding to a debt-to-assets ratio of 50%, and $\delta = 0.66$ for the 2000s calibration corresponding to a debt-to-assets ratio of 33%.

3.5. Asset Pricing Implications

The top panels of Table 2 show that asset pricing habit preferences generate quantitatively plausible time-varying risk premia and volatilities in stocks and bonds. The model matches the high equity Sharpe ratio, equity volatility, stock excess return predictability, and the persistence of price-dividend ratios, which would not be possible in a model with constant risk aversion (Mehra and Prescott (1985)). Appendix Tables A1 and A2 show that time-varying risk premia are responsible for the vast majority of model stock and bond return variation, and drive about 90% of bond-stock covariances.

The middle panel in Table 2 shows that the model explains the key pattern of bond-stock betas, even though they were not explicitly targeted in the calibration. The model-implied nominal bond beta is strongly positive and much larger than the real bond beta in the 1980s calibration, but negative and close to the real bond beta in the 2000s calibration, similar to the data.[19] Model-implied nominal Treasury bond excess returns are volatile in the 1980s calibration and much less volatile in the 2000s calibration, again similar to the data.[20] Steady-state expected bond excess returns in the model are closely related to betas, and switch sign from positive in the 1980s calibration to negative in the 2000s calibration. This pattern is consistent with empirical expected bond excess returns based on professional survey forecasts, constructed following Piazzesi, Salomao and Schneider (2015) and Nagel and Xu (2022).

The 1980s calibration generates a positive regression coefficient of ten-year nominal bond

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[19] Figure 8 shows that exactly matching the nominal bond-stock beta in the first subperiod starting from the second subperiod also requires a high volatility of supply shocks, further supporting that a high volatility of supply shocks is consistent with financial moments in the first subperiod.

[20] My model is consistent with Duffee (2011)'s evidence of low volatility of inflation expectations relative to bond yields ("inflation variance ratios"), as he also finds that habit models give reasonable implications due to their volatile risk premia. Inflation variance ratios in my model range between 1/3 to 1/2.

excess returns with respect to the lagged slope of the yield curve, as in the data and targeted in the calibration. On the other hand, the 2000s calibration does not generate any such bond excess return predictability, which is also in line with a much weaker and statistically insignificant relationship in the data. In unreported results, I find that the model does not generate return predictability in real bond excess returns. This is broadly in line with the empirical findings of Pflueger and Viceira (2016), who find stronger evidence for predictability in nominal than real bond excess returns after adjusting for time-varying liquidity.

4. Counterfactual Analysis and Economic Mechanism

What would it take for bonds to become similarly risky as in the stagflationary 1980s, and what would this tell us about the economy and monetary policy? In this Section, I show how nominal and real bond betas change in the model as I vary the uncertainty of macroeconomic shocks and the monetary policy rule. The adaptiveness of wage-setters' inflation expectations is found to matter little for bond-stock betas.

4.1. Counterfactual Betas 1980s vs. 2000s

Figure 4 shows that nominal bond betas remain negative but real bond betas increase in the presence of shock volatilities similar to the 1980s, provided that the monetary policy framework is more output-focused, less inflation-focused, and more inertial than during the 1980s.

Panel A starts from the 1980s calibration and shows that changing either the shock volatilities or the monetary policy rule towards the 2000s calibration flips nominal bonds from risky (i.e. positive nominal bond beta) to safe (i.e. zero or negative nominal bond beta).[21] Said differently, the model does not imply positive nominal bond-stock betas unless it has both: 1980s-style shock volatilities and a 1980s-style monetary policy rule. However, different from the 2000s calibration, the real bond-stock beta in the "MP All" counterfactual in Panel A is positive. The real bond-stock beta in this counterfactual is positive because supply and monetary policy shocks dominate, moving the output gap inversely to the real rate along the Euler equation (17). The next two columns in Panel A show that changes in monetary policy inertia (ρ^i) and the long-term inflation and output weights (γ^x, γ^π) both act in the same direction, but that the output and inflation weights are more important quantitatively. The last column shows that the adaptiveness of wage-setters inflation expectations (ζ) has little effect on bond-stock betas.

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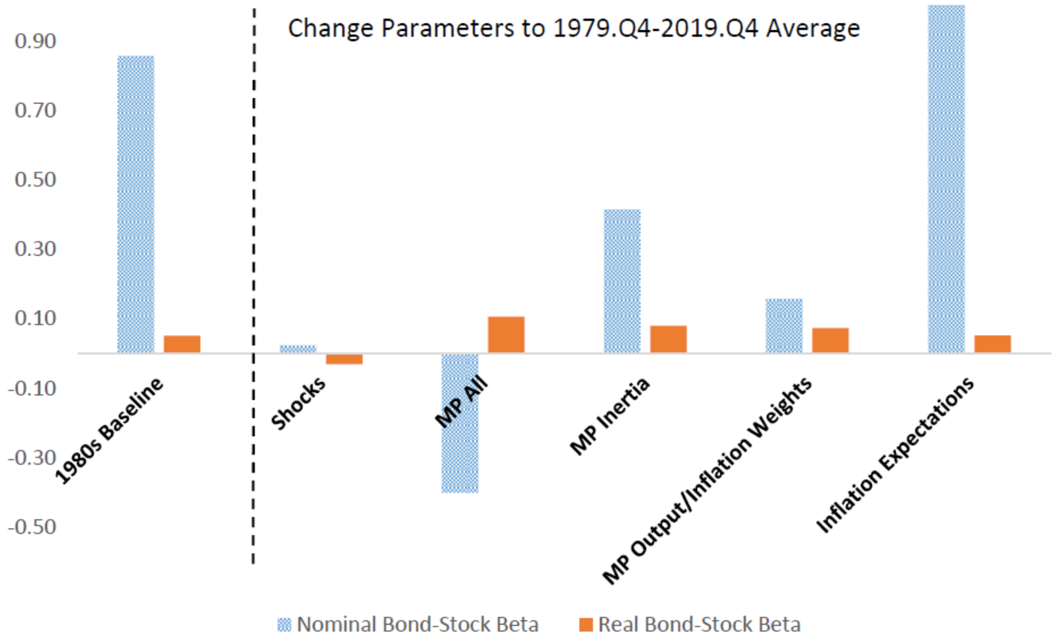
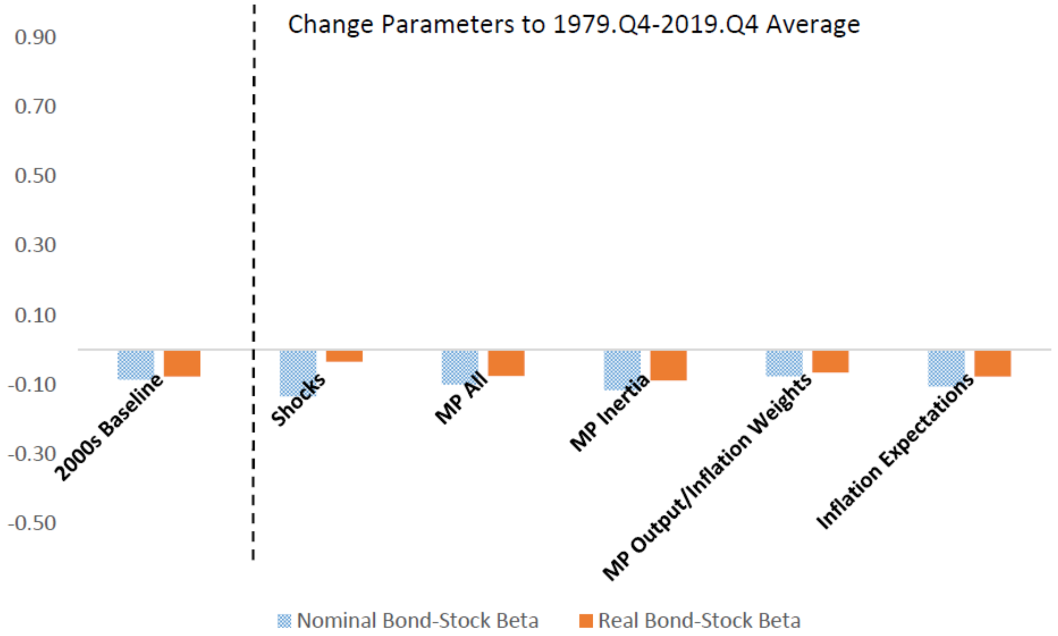
[21] In some cases, the equilibrium may not exist if I move a parameter group all the way to the other calibration, so for comparability I move all parameter groups to the average of the 1980s and 2000s calibrations.

Figure 4: Counterfactual Bond-Stock Betas

Panel A: Starting from 1979.Q4-2001.Q1 Calibration



Panel B: Starting from 2001.Q2-2019.Q4 Calibration



This figure shows model-implied nominal and real bond betas while changing parameter groups one at a time. Panel A sets all parameters to the 1979.Q4-2001.Q1 calibration unless stated otherwise. It reports bond betas while setting the following parameters to their averages of the 1979.Q4-2001.Q1 and 2001.Q2-2019.Q4 calibrations: "Shocks" (σ_x, σ_π, and σ_i), "MP All" (ρ^i, γ^x and γ^π), "MP Inertia" (ρ^i), "MP Output/Inflation Weights" (γ^x and γ^π), and "Inflation Expectations" (ζ). Panel B does the reverse exercise, holding all parameter values constant at the 2001.Q2-2019.Q4 baseline.

Panel B of Figure 4 shows the central result: Starting from the 2000s calibration none of the changes to individual parameter groups have the power to flip the sign of nominal bond betas. Most tellingly, the "Shocks" column implies that even if the shock volatilities were to resemble the 1980s, an inertial and more output-focused monetary policy rule as in the 2000s would keep nominal bond-stock betas negative. Real bond-stock betas in this counterfactual are pushed up by more volatile supply and monetary policy shocks. This is directionally similar to the "MP All" column in Panel A, which combines even more volatile supply and monetary policy shocks with a 2000s-style monetary policy rule. Overall, these counterfactuals indicate that positive nominal bond-stock betas and stagflations are not the result of fundamental economic shocks or monetary policy in isolation, but instead require the interaction to create a "perfect storm". This interpretation is reminiscent of the macroeconomics literature (Bernanke, Gertler and Watson (1997), Primiceri (2006)), though this prior literature did not consider bond-stock betas. The last column in Panel B again shows that the adaptiveness of wage-setters inflation expectations is not priced in bond-stock betas.

My counterfactuals differ from Rudebusch and Swanson (2012)'s counterfactuals for term premia. In their long-run risks model nominal term premia tend to be positive and are largest (i.e. nominal bonds are riskiest) when monetary policy price level targeting is weak. By contrast, here bond-stock betas can be positive or negative, in line with the data, and are highest when the monetary policy inflation coefficient is high. While resolving the debate between leading asset pricing models is beyond this paper, a perspective based on cyclical risk-bearing capacity seems useful as monetary policy has strong and immediate risk premium effects in the data (Bernanke and Kuttner (2005), Boyd, Hu and Jagannathan (2005)).

4.2. Mechanism

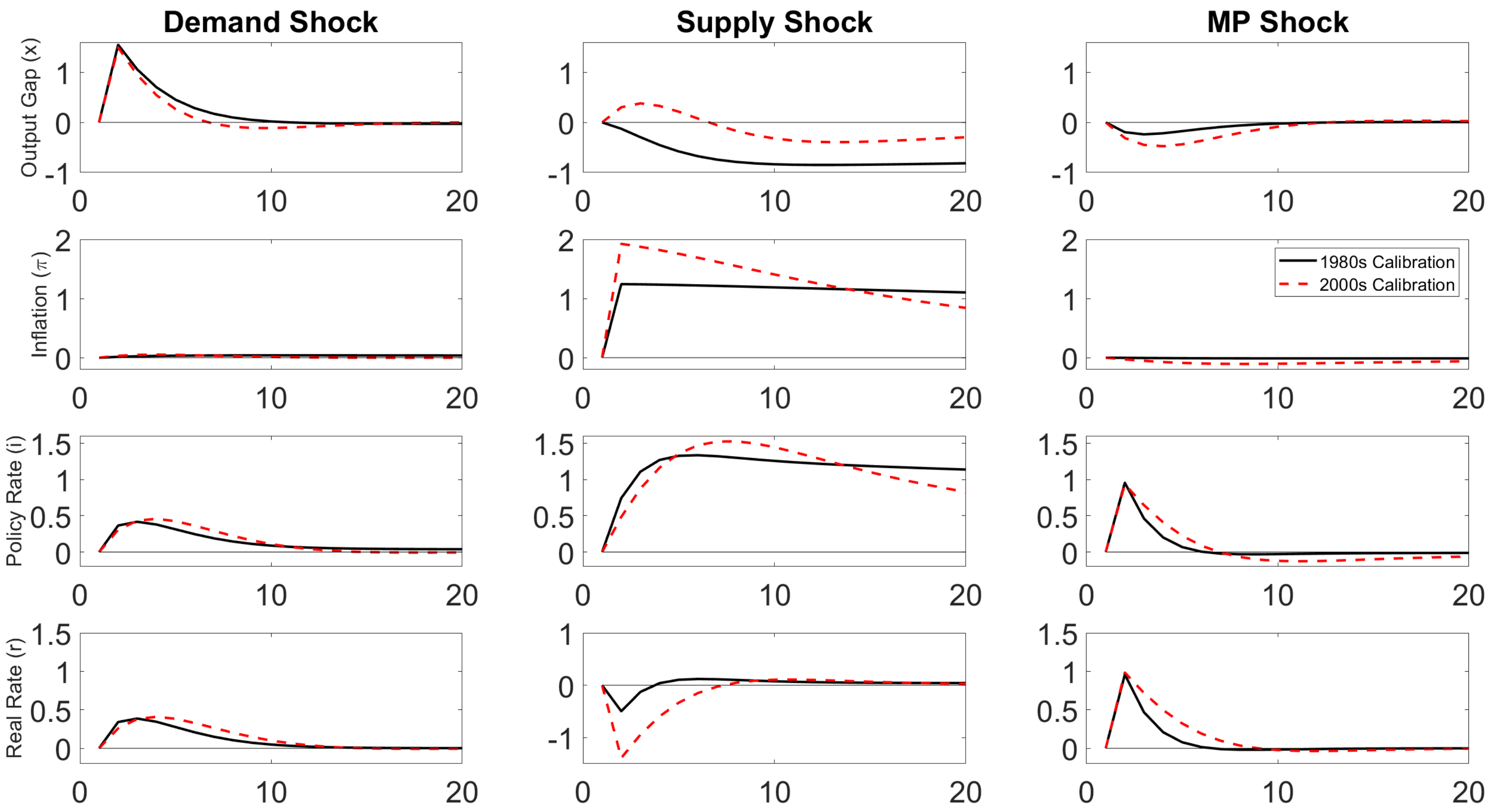
I now illustrate the mechanism through impulse response functions for the macroeconomy and asset prices.

4.2.1. Macroeconomic Impulse Responses

Figure 5 shows model impulse responses for the output gap, nominal policy rate, and wage inflation to one-percentage-point demand, supply, and monetary policy shocks. Because of the structure of the model, the macroeconomic impulse responses preserve the intuition of a standard log-linearized three-equation New Keynesian model for given parameter values, but parameter values are partly chosen to match evidence on bond excess return predictability.

The first column in Figure 5 shows that demand shocks move the output gap, the policy rate, and inflation in the same direction, as if the economy moves along a stable Phillips

Figure 5: Model Macroeconomic Impulse Responses



This figure shows model impulse responses for the output gap (%,), inflation (ann %), nominal policy rate (ann. %), and real one-quarter interest rate (ann. %). The impulse in the left column is a one-percentage-point demand shock, in the middle column is a one-percentage-point Phillips curve or supply shock, and in the right column is a one-percentage-point monetary policy shock. Impulse responses for the 1979.Q4-2001.Q1 calibration are shown in black, while the impulse responses for the 2001.Q2-2019.Q4 calibration are shown in red dashed.

curve. The responses are similar for the 1980s and 2000s calibrations, though of course demand shocks are more important in the 2000s calibration.

The middle column shows the interaction between supply shocks and systematic monetary policy. For the 1980s calibration, a positive supply shock leads to an immediate and persistent jump in inflation, a rapid increase in the nominal policy rate, and a large and persistent decline in the output gap—a stagflation. The inflation response is more persistent in the 1980s calibration due to backward-looking wage-setter inflation expectations. By contrast, for the 2000s calibration, a monetary policy rule that prescribes little immediate tightening in response to such a shock implies a real rate substantially below steady-state for several quarters. As a result, the output gap follows a much more moderate s-shaped path—a "soft landing". There is, however, a trade-off, as can be seen from the higher peak inflation response in the 2000s calibration.

Finally, the third column in Figure 5 shows intuitive responses to monetary policy shocks. A positive monetary policy shock tends to lower the output gap in a hump-shaped fashion and leads to a small and delayed fall in inflation, in line with the empirical evidence from identified monetary policy shocks (Ramey (2016)). The responses to a monetary policy shock are similar across the 1980s and 2000s calibrations.

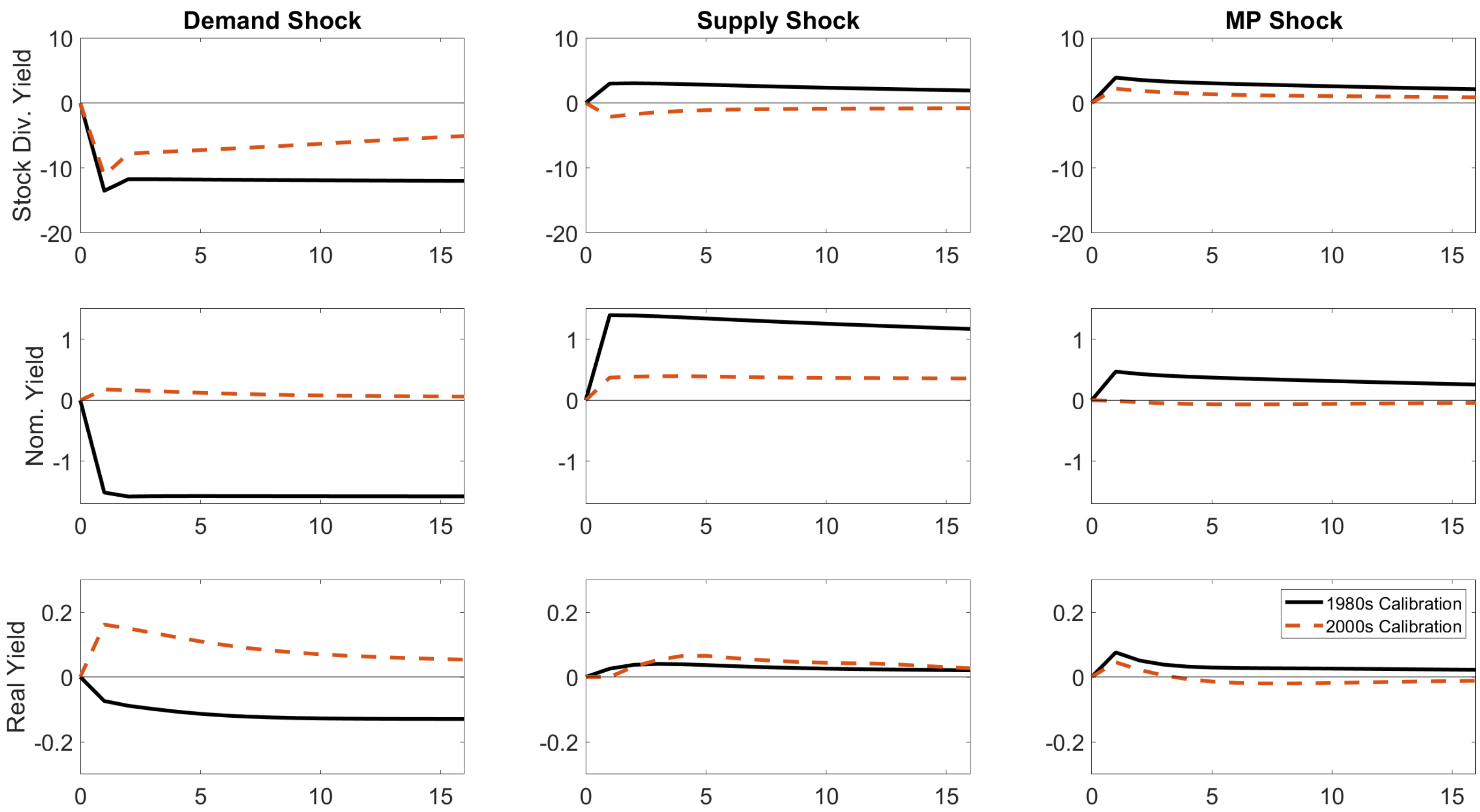
Taken together, the macroeconomic impulse responses show that both supply shock uncertainty and a high monetary policy inflation coefficient are needed to generate stagflations and negative inflation-output gap comovement. By contrast, inflation and the output gap comove little if monetary policy engineers a "soft landing" after an inflationary supply shock. Positive inflation-output gap comovement results after demand or monetary policy shocks. I next show how these macroeconomic dynamics shape bonds and stocks with endogenously time-varying risk premia.

4.2.2. Asset Price Impulse Responses

Since time-varying risk premia dominate the volatilities of asset prices in the model, risk premia are crucial for the responses of bonds and stocks to shocks. As a result, the responses of long-term bond yields in the model may even differ in sign from the expected path of policy rates. The macroeconomic equilibrium is nonetheless at the root of bond-stock comovements by determining whether bonds benefit or suffer from "flight-to-safety" when risk aversion rises.

Figure 6 shows impulse responses for the dividend yield of levered stocks (top row), ten-year nominal bond yield (middle row), and ten-year real bond yield (bottom row). Because dividend yields are inversely related to stock prices and bond yields are inversely related to bond prices, a shock that moves stock dividend yields and bond yields in the same direction tends to induce a positive bond-stock beta and vice versa.

Figure 6: Model Asset Price Impulse Responses



This figure shows model impulse responses for the stock dividend yield, 10-year zero-coupon nominal bond yield, and 10-year zero-coupon real bond yield (all in ann. %). The 1979.Q4-2001.Q1 calibration is shown with black solid lines and the 2001.Q2-2019.Q4 calibration is shown with red dashed lines. The impulse in the left column is a one-percentage-point demand shock, in the middle column is a one-percentage-point Phillips curve or supply shock, and in the right column is a one-percentage-point monetary policy shock.

The stock dividend yield in Figure 6 responds in the opposite direction from the output gap depicted in the top row of Figure 5. Adverse output gap and consumption news lower expected dividends and the surplus consumption ratio, raising risk aversion. The dividend yield hence rises, and stock prices fall more than the expected discounted value of future dividends. The top-middle panel shows that the dividend yield falls and stock prices rise in response to an adverse supply shock in the 2000s calibration, mirroring the initial output gap increase when monetary policy generates a "soft landing" after an adverse supply shock. This sign change in the model stock response is consistent with the empirical finding that "bad news" for the macroeconomy is often "good news" for the stock market, if investors price an accommodative monetary policy response (Boyd, Hu and Jagannathan (2005), Elenev, Law, Song and Yaron (2024)).

The responses of long-term nominal and real bond yields in Figure 6 differ substantially from their short-term counterparts in Figure 5 due to the endogenous nature of time-varying risk premia. For example, the left column in Figure 6 shows that long-term nominal bond yields decrease following a positive demand shock in the 1980s calibration but increase in the 2000s calibration, even though the corresponding policy rate paths in Figure 5 are very similar. This sign flip in the nominal bond yield response occurs because the mix of shocks and monetary policy lead nominal, and to a certain degree real bonds, to resemble positive-α assets in equation (29) in the 1980s calibration, but negative α assets in the 2000s calibration. A positive demand shock raises consumption relative to habit, lowering risk aversion, and thereby making investors willing to pay more for risky nominal bonds in the 1980s calibration. However, nominal bonds have hedging value in the 2000s calibration, so lower risk aversion leads investors to be willing to pay less for nominal bonds after a positive demand shock.

One might wonder whether "sentiment" shocks could turn bond-stock betas negative – if bonds benefit from "flight-to-safety" – or positive – if bonds are viewed as risky similar to stocks. One advantage of the present framework is that such "sentiment" shocks are endogenously linked to macroeconomic factors, reducing the degrees of freedom that the model has to understand changes in bond risks. Intuitively, bonds benefit from "flight-to-safety" only if monetary policy and the macroeconomic shock volatilities render their real cash flows safe, i.e. if bonds pay out when investors' marginal utility is high, such as in the 2000s calibration. In this case, a decrease in consumption and an increase in risk aversion lead investors to reduce their valuations of risky stocks, but raise the amount they are willing to pay for safe bonds. Conversely, if bonds' real cash flows are risky, such as in the 1980s calibration, an increase in investor risk aversion lowers the valuations of both bonds and stocks through risk premia, amplifying the positive bond-stock comovement. As a result, time-varying risk aversion is a quantitatively important driver of bond-stock betas within the model and turns bond-stock betas into forward-looking measures, but does not change the sign of bond-stock betas in equilibrium.

4.3. Counterfactual Bond Betas Prevalent vs. Realized Shocks

Figure 7 shows counterfactual nominal bond-stock betas when out-of-equilibrium shocks are realized. The main finding is that the priced equilibrium (or prevalent shocks) is more important for bond-stock betas than realized shocks, due to time-varying risk premia. The first column in Figure 7 shows nominal bond stock betas in the 1980s calibration next to their risk-neutral counterpart, computed as the model regression coefficient of risk-neutral nominal bond excess returns (i.e. with constant nominal bond risk premia) onto stock excess returns. The second column shows that moving the distributions of both prevalent and realized shocks to the 2000s calibration generates negative nominal bond-stock betas, similar to the 2000s calibration.[22] The picture looks different in the third column, where the equilibrium is priced as if future shocks follow the 1980s distribution but realized shocks are drawn from the 2000s distribution. Different from the second column, in the third column the nominal bond-stock beta remains strongly positive. However, similar to the second column, the risk-neutral nominal bond beta in the third column is slightly negative. This figure hence suggests that overall nominal bond-stock betas reflect prevalent shocks that are priced in equilibrium, while risk-neutral nominal bond-stock betas tend to reflect realized shocks. The mechanism goes back to the asset price impulse responses shown in left column of Figure 6, where time-varying risk premia lead long-term nominal bond yields to comove positively with dividend yields following a demand shock when the 1980s calibration is priced in equilibrium, but not if the 2000s calibration is priced in equilibrium. Endogenously time-varying risk premia therefore matter and imply that the macroeconomic equilibrium is priced in bond-stock betas.

4.4. Replicating 1980s Bond-Stock Betas in the Model

One might wonder whether the high volatility of supply shocks in the 1980s calibration is supported by asset pricing moments during this period. Figure 8 shows that a high supply shock volatility is indeed needed to replicate the bond-stock betas observed in the first subperiod starting from the model calibration for the second subperiod. In addition, it shows that a monetary policy rule with a high inflation weight and low inertia – similar to the rule in the 1980s calibration – is also necessary.

Figure 8 plots nominal bond-stock betas implied by the model starting from the 2000s calibration against an increasing supply shock standard deviation σ_π on the x-axis, and the

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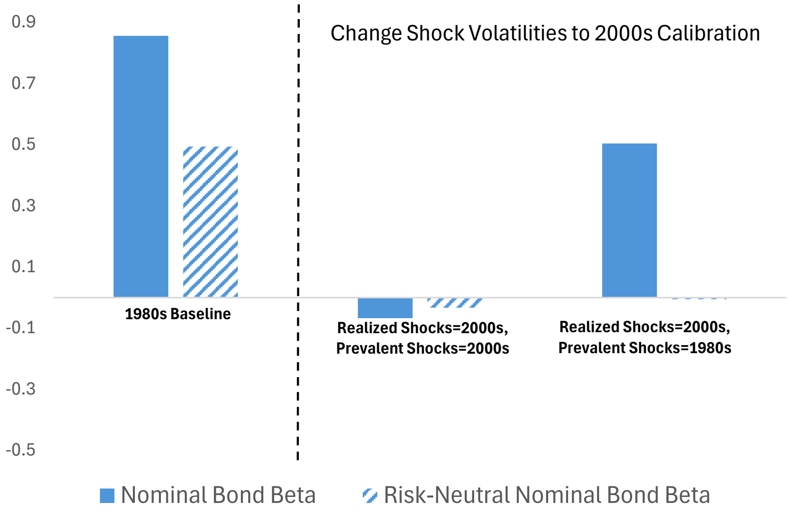
[22] All other parameters, including the monetary policy parameters, are held constant at the 1980s calibration.

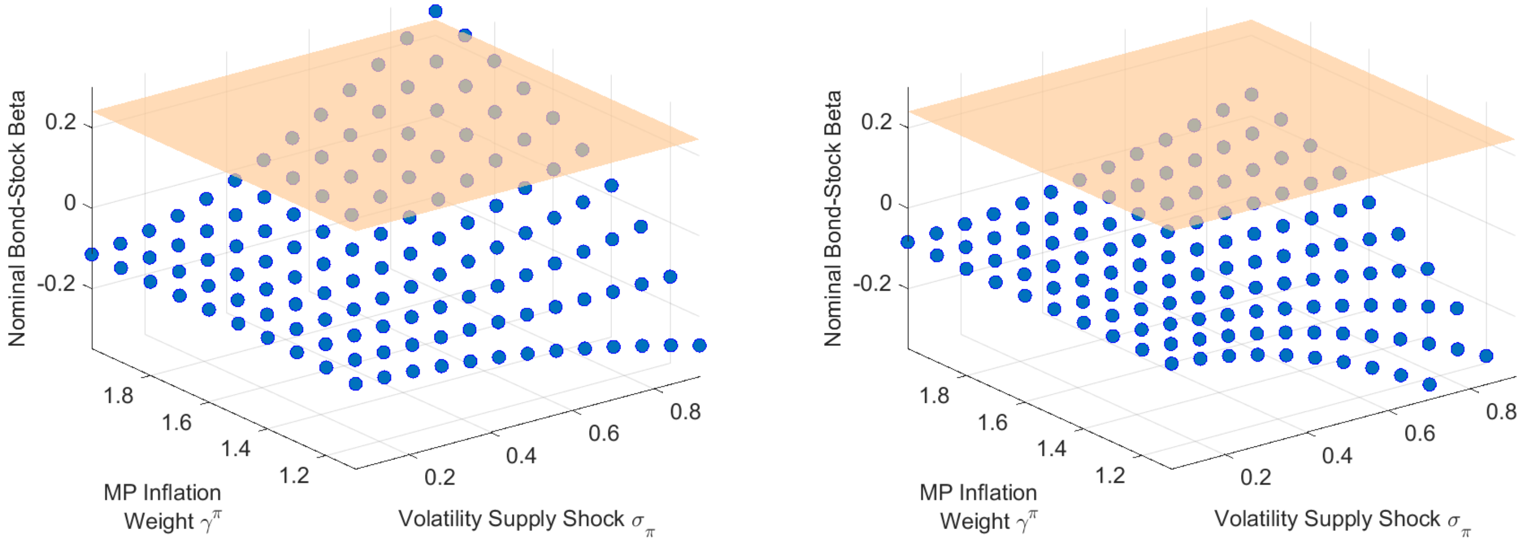
Figure 7: Nominal Bond Betas by Prevalent vs. Realized Shocks



This figure shows model-implied nominal bond betas (solid) and the betas of risk-neutral nominal bond returns with respect to the stock market (dashed) across prevalent and realized shock distributions. The leftmost bars set all parameter values to the 1979.Q4-2001.Q1 calibration. The middle bars change both the realized and prevalent shock volatilities to the 2001.Q2-2019.Q4 values, i.e. the equilibrium is recomputed at the 2001.Q2-2019.Q4 shock volatilities. The rightmost bars change only the realized but not the prevalent shock volatilities to their 2001.Q2-2019.Q4 values, i.e. equilibrium asset prices are not recomputed and only the simulated shocks drawn from the 2001.Q2-2019.Q4 distribution.

monetary policy weight γ^π on the y-axis. The model-implied nominal bond-stock beta is depicted with blue circles on the z-axis, with a plane indicating the empirical 1980s nominal bond-stock beta. Dependence on the monetary policy inertia coefficient ρ^i is also depicted, with $\rho^i = 0.54$ in Panel A and $\rho^i = 0.80$ in Panel B.

Figure 8: Model-Implied Nominal Bond-Stock Beta vs. 1980s Bond-Stock Beta



Panel A: MP Inertia $\rho^i = 0.54$

Panel B: MP Inertia $\rho^i = 0.80$

Note: This figure shows model ten-year nominal bond-stock betas (blue circles) against the standard deviation of supply shocks σ_π on the x-axis and the MP inflation weight γ^π on the y-axis while holding the monetary policy inertia coefficient constant at $\rho^i = 0.54$ (Panel A) and $\rho^i = 0.80$ (Panel B), respectively. All other parameters are set to their values in the 2000s calibration in Table 1. The orange plane indicates the empirical ten-year nominal bond-stock beta for the 1979.Q4-2001.Q1 subperiod.

Figure 8 shows that a high volatility of supply shocks is necessary to explain the empirically observed nominal bond-stock betas within the model. Consistent with the notion that a "perfect storm" is needed to make bonds risky again, it further shows that a high supply shock volatility is necessary but not sufficient to replicate the high nominal bond-stock betas of the 1980s. In both Panels A and B, the model-implied bond-stock beta is highest in the back-right corner, corresponding to a high monetary policy inflation weight and a high volatility of supply shocks. In Panel A, where the monetary policy rule is assumed to have only moderate inertia as plausible for the 1980s, the model can replicate the 1980s bond-stock beta if the supply shock volatility is high at $\sigma_\pi \geq 0.9$ and the monetary policy inflation weight is also high at $\gamma^\pi \geq 2.0$.[23] The model nominal bond-stock betas in Panel B are smaller than the observed nominal bond-stock betas during the 1980s, indicating that lower monetary policy inertia is also necessary to explain bond risks in this earlier period. Overall, reverse-engineering the nominal bond-stock betas observed during the 1980s from the model calibration for the second subperiod provides additional support to the notion that investors viewed supply shocks as highly volatile during this period.

5. Post-Pandemic Bond Risks and Monetary Policy

This Section applies the model to analyze bond-stock betas from daily returns during the recent post-pandemic period. This period was marked by heightened concerns over supply shocks and an inflationary surge unseen since the 1980s. Dividing the analysis into an early post-pandemic (until 2023.Q2) and a late post-pandemic period (2023.Q3-Q4), I find that the model can explain negative nominal and positive real bond-stock betas during the early post-pandemic with a low inflation coefficient and 1980s-style shocks. However, for the later post-pandemic the model requires a high monetary policy inflation coefficient with 1980s-style shocks, explaining positive nominal, real, and breakeven (i.e. nominal-minus-real) bond betas during this last part of the sample.

Figure 9 depicts the timeline of inflation and the federal funds rate from 2018 to 2023. Inflation began to accelerate sharply in 2021. However, monetary policy initially remained passive, with the federal funds rate held at the zero-lower-bound.[24] The Fed lifted off from the zero-lower-bound in March 2022, with the hiking cycle plateauing in July 2023 at a pol-

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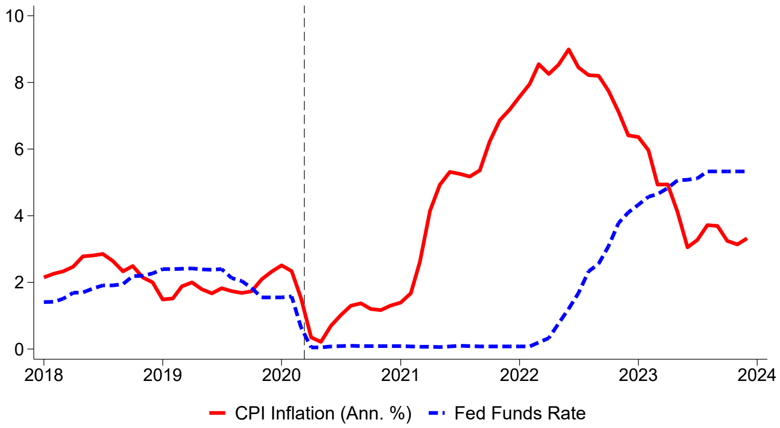
[23] Because Figure 8 starts from the 2000s calibration and hence includes a volatile demand shock, this pushes nominal bond-stock betas downwards. As a result, the supply shock volatility required to explain the positive nominal bond-stock beta in Figure 8 is even larger than the supply shock volatility for the 1980s calibration, which features negligible demand shock volatility.

[24] For example, Fed Chairman Powell reiterated the Fed's commitment to a near-zero rate, despite headline CPI running at 5-6% annually in his 2021 Jackson Hole speech. Jerome Powell, "Monetary Policy in the Time of COVID", Speech at the Jackson Hole Economic Symposium, August 27, 2021.

Figure 9: Timeline of Post-Pandemic Inflation and Monetary Policy



Note: This figure shows CPI headline inflation for all urban consumers (CPIAUCSL) over the past twelve months (ann, %) and the effective federal funds rate (DFF, ann, %) for the sample 01/01/2018 through 31/12/2023. Monthly data is from the St. Louis Fred. A vertical line indicates March 11, 2020 (Covid).

icy rate of 5.25–5.5%. Bauer, Pflueger and Sunderam (2024b) use rich survey data to argue that this late rise in the policy rate led to a late rise in the monetary policy inflation coefficient as perceived by professional forecasters, with the perceived monetary policy inflation coefficient peaking in the second half of 2023.[25] Macroeconomic developments hence suggest dividing the post-pandemic period into two distinct phases: An early post-pandemic phase characterized by a low Fed response and a later phase featuring a substantially more active Fed response to inflation.

Figure 10 shows rolling bond-stock betas computed using daily returns for the post-pandemic period. It shows that despite parallels between the 1980s and 2020s inflation, bond risks evolved differently during the recent post-pandemic period.[26] Panel A shows that throughout 2021 and 2022, nominal bond betas broadly remained negative, even at the inflationary peak, while real bond betas turned slightly positive. Panel B shows that during this period nominal bond-stock betas were either significantly lower than real bond-stock betas or at least not statistically significantly different. Since breakeven (or nominal-

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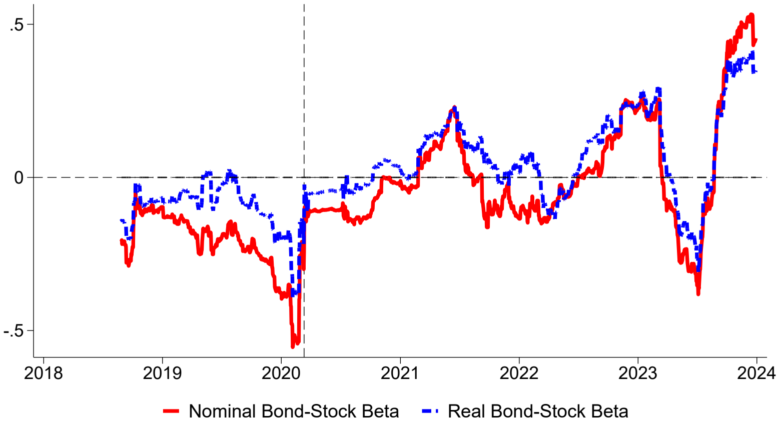
[25] Since the forecast horizon in Bauer, Pflueger and Sunderam (2024b) is shorter, the magnitudes of the estimated perceived inflation coefficients are not directly comparable to those priced in bond-stock betas over the lifetime of the bond. Bocola et al. (2024) also provide evidence that the perceived monetary policy inflation coefficient was low during the earlier post-pandemic period 2021-2022.

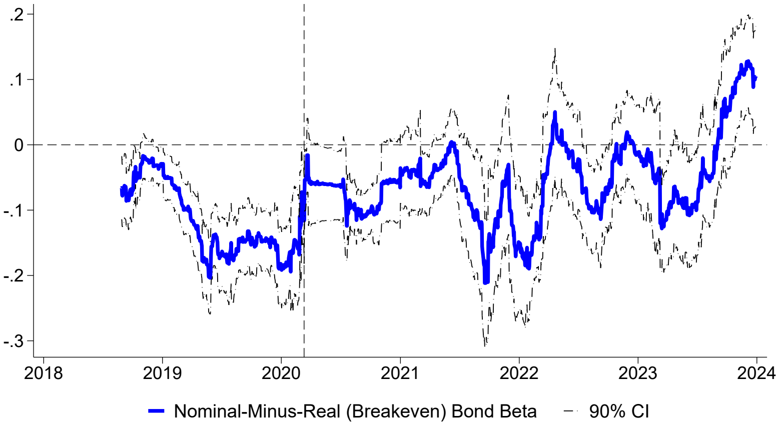
[26] To isolate variation in bond risk over shorter time intervals, bond-stock betas are computed using 120-day rolling window regressions of daily log bond returns onto daily log stock returns. The estimates in Panel A are roughly consistent with the lower-frequency estimates in Figure 1, though of course betas from daily data are more volatile.

Figure 10: Post-Pandemic Bond-Stock Betas from Daily Data

Panel A: Real and Nominal Bond Betas



Panel B: Breakeven Betas



Note: Panel A shows betas from regressing daily ten-year nominal and TIPS bond log returns onto daily US S&P 500 log returns over 120-trading day backward-looking rolling windows for the sample 01/01/2018 through 31/12/2023. Daily log bond returns are computed from zero-coupon yield curves, available from Gürkaynak, Sack and Wright (2007, 2010). A vertical line indicates March 11, 2020 (Covid). 90% confidence intervals based on heteroskedasticity robust standard errors are shown in dashed. Panel B shows the difference between the nominal and real (TIPS) bond-stock beta with 90% confidence intervals based on Huber-White heteroskedasticity robust standard errors.

minus-real bond) returns are inversely related to inflation expectations, this indicates that the inflationary dynamics priced in bond-stock betas were still procyclical. This outcome aligns with the counterfactual combining 1980s shock volatilities with a monetary policy rule reflecting the 1980s-2000s average (see Figure 4 Panel A, “Shocks” column).

However, in the second half of 2023, Figure 1, Panel B shows that breakeven betas did turn significantly positive, suggesting that the priced cyclicality of inflation expectations had changed. I interpret these patterns as providing out-of-sample confirmation of the key

Table 3: Model-Implied Post-Pandemic Monetary Policy and Shocks

	Early Post-Pandemic 2020.Q2-2023.Q2		Late Post-Pandemic 2023.Q3-2023.Q4	
Bond-Stock Betas	Data	Model	Data	Model
Nominal Bond-Stock Beta	-0.01	-0.04	0.49	0.42
Real Bond-Stock Beta	0.05	0.12	0.39	0.14
Model Parameters				
MP Inflation Coefficient γ^{π}	1.3		2	
Shocks	1979.Q4-2001.Q1		1979.Q4-2001.Q1	

Note: This table shows nominal and real bond-stock betas from daily data for the early and late post-pandemic periods, together with the best fit from the model. Daily log stock and bond return data sources are as in Figure 10. The monetary policy inflation weight is allowed to vary over $\gamma^{\pi} \in [1.1, 1.2, ..., 2.0]$. The shock volatilities are allowed to vary over the 1980s calibration, the 2000s calibration, or $(\sigma_x, \sigma_{\pi}, \sigma_i) = (0.00, 0.00, 1.19)$. The following parameters are held constant: $\zeta = 0$, $\gamma^x = 0.5$, and $\rho^i = 0.8$. All other parameter values are as Table 1. Nominal and real bond betas in the data are computed from daily bond and stock log returns.

model predictions if supply shocks were a significant concern throughout the post-pandemic period, but the priced monetary policy rule changed from a low inflation coefficient in the early post-pandemic to a high inflation coefficient in the later post-pandemic.

Table 3 reports nominal and real bond-stock betas using daily log returns for the early and late post-pandemic periods, and the best fit from the model starting from the 2000s calibration. I divide the post-pandemic period into two distinct phases: An early post-pandemic phase (2020.Q2–2023.Q2) characterized by a low or negative breakeven beta, and a later phase (2023.Q3–2023.Q4) featuring a significantly positive breakeven-stock beta. As discussed, this segmentation also lines up roughly with the increase in the monetary policy inflation coefficient as perceived by professionals and investors. I use the model to find the monetary policy inflation weight and the macroeconomic shocks that provide the closest fit for the empirically observed bond-stock betas. To account for strongly anchored long-term inflation expectations during the recent period and to stack the deck against finding a role for volatile long-term inflation expectations, wage-setters' inflation expectations are assumed to be rational in Table 3.[27] I vary only the monetary policy inflation weight γ^{π} for this exercise,

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[27] I minimize an objective function that is the sum of squared differences between the data and model moments listed in the top panel in Table 3. To save on computational complexity the shock volatilities are allowed to take only three sets of possible values, the 1980s calibration, the 2000s calibration, or dominant monetary policy shocks. I set $(\sigma_x, \sigma_{\pi}, \sigma_i) = (0.00, 0.00, 1.19)$ for the third set of shock volatilities. However, the precise magnitude of the volatility of monetary policy shocks is not crucial here, since bond-stock betas are a ratio and therefore reflect the relative volatility of monetary policy shocks compared to other shocks.

as a higher value of γ^π in the presence of supply shocks acts similarly to lower inertia ρ^i or a lower output gap weight γ^x, and varying all three monetary policy parameters would not necessarily be identified. The implied γ^π in Table 3 hence should be interpreted broadly as monetary policy "hawkishness".

I find that the model matches the changes in nominal and real bond-stock betas with a shift from a low to a high inflation coefficient in monetary policy. For the entire post-pandemic period, the model requires that investors priced similar shock volatilities to the 1980s calibration, in line with anecdotal evidence of significant supply shock concerns.[28] The 1980s shock volatilities also feature highly volatile monetary policy shocks, complementing high supply shock uncertainty by further driving up nominal and real bond-stock betas. However, monetary policy shocks by themselves cannot explain the negative nominal bond stock beta in the early post-pandemic period, or the positive breakeven beta in the late post-pandemic period, and therefore the model favors the 1980s mix of shocks with both volatile supply and monetary policy shocks.

Overall, the model's implied sequence of monetary policy coefficients and macroeconomic uncertainty aligns well with the timeline of post-pandemic events. The post-pandemic period therefore provides out-of-sample evidence that supply shock uncertainty combined with inflation-focused monetary policy are both essential to turn bonds into a risky asset class as in the 1980s. As inflationary supply shocks ease and monetary policy recalibrates towards lower inflation responsiveness, the model hence suggests that one might expect bond-stock betas to moderate.

6. Conclusion

A New Keynesian asset pricing model with countercyclical risk-bearing capacity shows that the interaction between supply shocks and inflation-focused monetary policy leads to positive nominal bond-stock betas, as observed during the stagflationary 1980s. Conversely, a combination of 1980s-style shocks with a more output-focused and inertial monetary policy rule leads to a "soft landing", which is priced in negative nominal bond-stock betas, and positive real bond-stock betas. However, bond-stock betas do not price realized shocks in this model, but instead the expected equilibrium mix of shocks going forward.

Monetary policy parameters other than γ^π are held constant at conventional values, $\gamma^x = 0.5$, and $\rho^i = 0.8$. Scatter plots of model nominal and real bond-stock betas for all considered shock volatilities and monetary policy parameters are shown in Appendix Figure A5.

[28] The similarities in supply shock concerns between the 1980s and the recent period are evident in Appendix Figure A1, which shows related article counts in the Wall Street Journal. The literature on recent inflation dynamics also attributes a significant role to supply shocks (Reis (2022), Di Giovanni, Kalemli-Özcan, Silva and Yildirim (2022), Gagliardone and Gertler (2023), Rubbo (2022)).

The mechanism works through the monetary policy trade-off between inflation and output after a supply shock and endogenously time-varying risk premia. An adverse supply shock in the model generally moves inflation expectations up and output down, which leads to simultaneous falls in nominal bond and stock prices. However, monetary policy can alter these implications and engineer a "soft landing" if the central bank keeps nominal rates sufficiently steady and allows the real rate to fall. A less inflation-focused or inertial monetary policy rule mitigates the positive bond-stock comovement that would otherwise result from supply shocks. By contrast, demand shocks move output and inflation up and down together independently of the monetary policy rule, implying negative nominal and real bond-stock betas, as observed during the pre-pandemic 2000s.

Time-varying risk premia generate predictability in stocks and bonds, and imply that bond-stock betas price the distribution of shocks in equilibrium rather than past realized shocks. When investors are surprised by realized demand shocks but bonds and stocks are priced as if 1980s shocks are prevalent, the model nominal bond-stock beta is similarly positive as in the 1980s calibration. Intuitively, bond and stock returns are dominated by time-varying risk premia, and in a 1980s-type equilibrium nominal bonds' real cash flows are stock-like, so risk premia in nominal bonds and stocks also move together.

The framework in this paper provides an intuitive interpretation of post-pandemic developments in bond-stock betas, implying that investors initially priced a low monetary policy inflation coefficient during the initial inflation run-up, but a much higher inflation coefficient towards the peak of the latest hiking cycle. More broadly, when the economy is driven by volatile supply shocks, nominal bond stock betas in the model emerge as a forward-looking indicator of "soft landings". This analysis suggests that further research on financial market comovements and their connection to drivers of the macroeconomy is likely to be fruitful.

References

Abel, A.B., 1990. Asset prices under habit formation and catching up with the Joneses. American Economic Review 80, 38–42.

Albuquerque, R., Eichenbaum, M., Luo, V.X., Rebelo, S., 2016. Valuation risk and asset pricing. Journal of Finance 71, 2861–2904.

Baele, L., Bekaert, G., Inghelbrecht, K., 2010. The determinants of stock and bond return comovements. Review of Financial Studies 23, 2374–2428.

Bauer, M., Pflueger, C., Sunderam, A., 2024b. Changing perceptions and post-pandemic monetary policy. Proceedings of 2024 Jackson Hole Economic Symposium, forthcoming .

Bauer, M.D., Pflueger, C.E., Sunderam, A., 2024a. Perceptions about monetary policy. Quarterly Journal of Economics 139, 2227–2278.

Bauer, M.D., Swanson, E.T., 2023. A reassessment of monetary policy surprises and high-frequency identification. NBER Macroeconomics Annual 37, 87–155.

Beaudry, P., Portier, F., 2006. Stock prices, news, and economic fluctuations. American Economic Review 96, 1293–1307.

Bernanke, B.S., Gertler, M., 2001. Should central banks respond to movements in asset prices? American Economic Review: Papers and Proceedings 91, 253–257.

Bernanke, B.S., Gertler, M., Watson, M., 1997. Systematic monetary policy and the effects of oil price shocks. Brookings Papers on Economic Activity 1997, 91–157.

Bernanke, B.S., Kuttner, K.N., 2005. What explains the stock market's reaction to Federal Reserve policy? Journal of Finance 60, 1221–1257.

Bianchi, F., Faccini, R., Melosi, L., 2023. A fiscal theory of trend inflation. Quarterly Journal of Economics, forthcoming .

Bianchi, F., Ilut, C., 2017. Monetary/fiscal policy mix and agents' beliefs. Review of economic Dynamics 26, 113–139.

Bianchi, F., Lettau, M., Ludvigson, S.C., 2022a. Monetary policy and asset valuation. Journal of Finance 77, 967–1017.

Bianchi, F., Ludvigson, S.C., Ma, S., 2022b. Belief distortions and macroeconomic fluctuations. American Economic Review 112, 2269–2315.

Bianchi, F., Ludvigson, S.C., Ma, S., 2022c. Monetary-based asset pricing: A mixed-frequency structural approach. National Bureau of Economic Research wp30072.

Bianchi, J., Lorenzoni, G., 2021. The prudential use of capital controls and foreign currency reserves. Handbook of International Economics Vol. V .

Blanchard, O.J., Kahn, C.M., 1980. The solution of linear difference models under rational expectations. Econometrica , 1305–1311.

Bocola, L., Dovis, A., Jørgensen, K., Kirpalani, R., 2024. Bond market views of the Fed. NBER Working Paper wp32620.

Bordalo, P., Gennaioli, N., LaPorta, R., Shleifer, A., 2022. Belief overreaction and stock market puzzles Working paper, Oxford, Bocconi, Brown University, and Harvard University.

Boyd, J.H., Hu, J., Jagannathan, R., 2005. The stock market's reaction to unemployment news: Why bad news is usually good for stocks. Journal of Finance 60, 649–672.

Caballero, R.J., Simsek, A., 2020. A risk-centric model of demand recessions and macroprudential policy. Quarterly Journal of Economics forthcoming.

Caballero, R.J., Simsek, A., 2022. A monetary policy asset pricing model. NBER Working Paper wp30132.

Campbell, J.Y., Cochrane, J.H., 1999. By force of habit: A consumption-based explanation of aggregate stock market behavior. Journal of Political Economy 107, 205–251.

Campbell, J.Y., Pflueger, C., Viceira, L.M., 2020. Macroeconomic drivers of bond and equity risks. Journal of Political Economy 128, 3148–3185.

Campbell, J.Y., Shiller, R.J., 1991. Yield spreads and interest rate movements: A bird's eye view. Review of Economic Studies 58, 495–514.

Campbell, J.Y., Shiller, R.J., Viceira, L.M., 2009. Understanding inflation-indexed bond markets. Brookings Papers on Economic Activity , 79–138.

Campbell, J.Y., Sunderam, A., Viceira, L.M., 2017. Inflation bets or deflation hedges? The changing risks of nominal bonds. Critical Finance Review 6, 263–301.

Chan, Y.L., Kogan, L., 2002. Catching up with the joneses: Heterogeneous preferences and the dynamics of asset prices. Journal of Political Economy 110, 1255–1285.

Chernov, M., Lochstoer, L.A., Song, D., 2021. The real explanation of nominal bond-stock puzzles. National Bureau of Economic Research Working Paper, wp 29085.

Christiano, L.H., Eichenbaum, M., Evans, C.L., 2005. Nominal rigidities and the dynamic effects of a shock to monetary policy. Journal of Political Economy 113, 1–45.

Christiano, L.J., Eichenbaum, M., Evans, C.L., 1999. Monetary policy shocks: What have we learned and to what end? Handbook of Macroeconomics 1, 65–148.

Cieslak, A., McMahon, M., Pang, H., 2024. Did i make myself clear? The Fed and the market in the post-2020 framework period. Working Paper.

Cieslak, A., Povala, P., 2015. Expected returns in treasury bonds. Review of Financial Studies 28, 2859–2901.

Cieslak, A., Vissing-Jorgensen, A., 2021. The economics of the Fed put. Review of Financial Studies 34, 4045–4089.

Clarida, R., Gali, J., Gertler, M., 2000. Monetary policy rules and macroeconomic stability: Evidence and some theory. Quarterly Journal of Economics 115, 147–180.

Cochrane, J.H., 2011. Determinacy and identification with taylor rules. Journal of Political Economy 119, 565–615.

Cogley, T., Sargent, T.J., 2008. Anticipated utility and rational expectations as approximations of bayesian decision making. International Economic Review 49, 185–221.

Coibion, O., Gorodnichenko, Y., 2015. Information rigidity and the expectations formation process: A simple framework and new facts. American Economic Review 105, 2644–2678.

David, A., Veronesi, P., 2013. What ties return volatilities to fundamentals and price valuations? Journal of Political Economy 121, 682–746.

De La'O, R., Myers, S., 2021. Subjective cash flow and discount rate expectations. Journal of Finance 76, 1339–1387.

Di Giovanni, J., Kalemli-Özcan, S., Silva, A., Yildirim, M.A., 2022. Global supply chain pressures, international trade, and inflation. National Bureau of Economic Research Working Paper, wp30240.

Drechsler, I., Savov, A., Schnabl, P., 2018. A model of monetary policy and risk premia. Journal of Finance 73, 317–373.

Du, W., Im, J., Schreger, J., 2018. The US Treasury premium. Journal of International Economics 112, 167–181.

Duffee, G.R., 2011. Information in (and not in) the term structure. Review of Financial Studies 24, 2895–2934.

Elenev, V., Law, T.H., Song, D., Yaron, A., 2024. Fearing the Fed: How Wall Street reads Main Street. Journal of Financial Economics 153, 103790.

Fang, X., Liu, Y., Roussanov, N., 2022. Getting to the core: Inflation risks within and across asset classes. National Bureau of Economic Research Working Paper wp30169.

Favilukis, J., Lin, X., 2016. Wage rigidity: A quantitative solution to several asset pricing puzzles. Review of Financial Studies 29, 148–192.

Fuhrer, J., Moore, G., 1995. Inflation persistence. Quarterly Journal of Economics 110, 127–159.

Fuhrer, J.C., 1997. The (un) importance of forward-looking behavior in price specifications. Journal of Money, Credit, and Banking 29, 338–350.

Gabaix, X., 2020. A behavioral new keynesian model. American Economic Review 110, 2271–2327.

Gabaix, X., Maggiori, M., 2015. International liquidity and exchange rate dynamics. Quarterly Journal of Economics 130, 1369–1420.

Gagliardone, L., Gertler, M., 2023. Oil prices, monetary policy and inflation surges. National Bureau of Economic Research wp31263.

Gately, D., 1986. Lessons from the 1986 oil price collapse. Brookings Papers on Economic Activity 1986, 237–284.

Gilchrist, S., Leahy, J.V., 2002. Monetary policy and asset prices. Journal of Monetary Economics 49, 75–97.

Gilchrist, S., Zakrajšek, E., 2012. Credit spreads and business cycle fluctuations. American Economic Review 102, 1692–1720.

Goodfriend, M., 2007. How the world achieved consensus on monetary policy. Journal of Economic Perspectives 21, 47–68.

Gourio, F., Ngo, P., 2020. Risk premia at the ZLB: A macroeconomic interpretation. Working Paper, Federal Reserve Bank of Chicago.

Gourio, F., Ngo, P., 2022. Downward nominal rigidities and term premia preliminary. Working Paper, Chicago Federal Reserve and Cleveland State University.

Greenwood, J., Hercowitz, Z., Huffman, G.W., 1988. Investment, capacity utilization, and the real business cycle. American Economic Review , 402–417.

Gürkaynak, R.S., Sack, B., Wright, J.H., 2007. The US treasury yield curve: 1961 to the present. Journal of Monetary Economics 54, 2291–2304.

Gürkaynak, R.S., Sack, B., Wright, J.H., 2010. The TIPS yield curve and inflation compensation. American Economic Journal: Macroeconomics 2, 70–92.

Hardouvelis, G.A., 1994. The term structure spread and future changes in long and short rates in the g7 countries: Is there a puzzle? Journal of Monetary Economics 33, 255–283.

Hazell, J., Herreno, J., Nakamura, E., Steinsson, J., 2022. The slope of the phillips curve: Evidence from us states. Quarterly Journal of Economics 137, 1299–1344.

Hazell, J., Hobler, S., 2024. Do deficits cause inflation? A high frequency narrative approach.

He, Z., Nagel, S., Song, Z., 2022. Treasury inconvenience yields during the covid-19 crisis. Journal of Financial Economics 143, 57–79.

Itskhoki, O., Mukhin, D., 2021. Exchange rate disconnect in general equilibrium. Journal of Political Economy 129, 2183–2232.

Jiang, Z., Krishnamurthy, A., Lustig, H., 2021. Foreign safe asset demand and the dollar exchange rate. Journal of Finance 76, 1049–1089.

Jurado, K., Ludvigson, S.C., Ng, S., 2015. Measuring uncertainty. American Economic Review 105, 1177–1216.

Kekre, R., Lenel, M., 2021. The flight to safety and international risk sharing. National Bureau of Economic Research Working Paper wp29238.

Kekre, R., Lenel, M., 2022. Monetary policy, redistribution, and risk premia. Econometrica 90, 2249–2282.

Kekre, R., Lenel, M., Mainardi, F., 2024. Monetary policy, segmentation, and the term structure. NBER Working Paper wp32324.

Kozak, S., 2022. Dynamics of bond and stock returns. Journal of Monetary Economics 126, 188–209.

Kozak, S., Santosh, S., 2020. Why do discount rates vary? Journal of Financial Economics 137, 740–751.

Krishnamurthy, A., Vissing-Jorgensen, A., 2012. The aggregate demand for treasury debt. Journal of Political Economy 120, 233–267.

Kung, H., 2015. Macroeconomic linkages between monetary policy and the term structure of interest rates. Journal of Financial Economics 115, 42–57.

Laarits, T., 2022. Precautionary savings and the stock-bond covariance. Working Paper, NYU Stern School of Business.

Li, E.X., Zha, T., Zhang, J., Zhou, H., 2022. Does fiscal policy matter for stock-bond return correlation? Journal of Monetary Economics 128, 20–34.

Liu, Z., Waggoner, D.F., Zha, T., 2011. Sources of macroeconomic fluctuations: A regime-switching DSGE approach. Quantitative Economics 2, 251–301.

Lucas, R.E.J., 1988. On the mechanics of economic development. Journal of Monetary Economics 22, 3–42.

Malmendier, U., Nagel, S., 2016. Learning from inflation experiences. Quarterly Journal of Economics 131, 53–87.

Mankiw, N.G., Miron, J.A., Weil, D.N., 1987. The adjustment of expectations to a change in regime: A study of the founding of the federal reserve. American Economic Review 77, 358–374.

Mehra, R., Prescott, E.C., 1985. The equity premium: A puzzle. Journal of monetary Economics 15, 145–161.

Nagel, S., Xu, Z., 2022. Dynamics of subjective risk premia National Bureau of Economic Research working paper wp29803.

Pflueger, C., Rinaldi, G., 2022. Why does the fed move markets so much? A model of monetary policy and time-varying risk aversion. Journal of Financial Economics 146, 71–68.

Pflueger, C., Siriwardane, E., Sunderam, A., 2020. Financial market risk perceptions and the macroeconomy. Quarterly Journal of Economics 135, 1443–1491.

Pflueger, C.E., Viceira, L.M., 2016. Return predictability in the Treasury market: Real rates, inflation, and liquidity, in: Veronesi, P. (Ed.), Handbook in Fixed-Income Securities. Wiley, New Jersey.

Piazzesi, M., Salomao, J., Schneider, M., 2015. Trend and cycle in bond premia. Working Paper, Stanford University and University of Minnesota.

Piazzesi, M., Schneider, M., 2006. Equilibrium yield curves. NBER Macroeconomics Annual 21, 389–472.

Primiceri, G.E., 2006. Why inflation rose and fell: Policy-makers' beliefs and us postwar stabilization policy. Quarterly Journal of Economics 121, 867–901.

Ramey, V.A., 2016. Macroeconomic shocks and their propagation. Handbook of Macroeconomics 2, 71–162.

Reis, R., 2022. The burst of high inflation in 2021–22: How and why did we get here? Working paper, London School of Economics.

Rotemberg, J.J., 1982. Monopolistic price adjustment and aggregate output. Review of Economic Studies 49, 517–531.

Rubbo, E., 2022. Networks, phillips curves, and monetary policy. Working Paper, University of Chicago.

Rudebusch, G.D., Swanson, E.T., 2012. The bond premium in a DSGE model with long-run real and nominal risks. American Economic Journal: Macroeconomics 4, 105–43.

Sims, C.A., Zha, T., 2006. Were there regime switches in us monetary policy? American Economic Review 96, 54–81.

Smets, F., Wouters, R., 2007. Shocks and frictions in us business cycles: A Bayesian DSGE approach. American Economic Review 97, 586–606.

Song, D., 2017. Bond market exposures to macroeconomic and monetary policy risks. Review of Financial Studies 30, 2761–2817.

Stock, J.H., Watson, M.W., 2007. Why has us inflation become harder to forecast? Journal of Money, Credit and Banking 39, 3–33.

Swanson, E.T., 2021. A macroeconomic model of equities and real, nominal, and defaultable debt. Working paper, University of California, Irvine.

Swanson, E.T., Williams, J.C., 2014. Measuring the effect of the zero lower bound on medium-and longer-term interest rates. American Economic Review 104, 3154–85.

Taylor, J.B., 1993. Discretion versus policy rules in practice. Carnegie-Rochester Conference Series on Public Policy 39, 195–214.

Uhlig, H., 1999. A toolkit for analysing nonlinear dynamic stochastic models easily, in: Marimon, R., Scott, A. (Eds.), Computational Methods for the Study of Dynamic Economics. Oxford University Press, pp. 30–61.