Monetary Policy and Endogenous Asset Supply

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Abstract

Monetary policy operates through long-term interest rates, making yield curve responses a common measure of policy efficacy. Yet long-term rates are equilibrium prices, determined jointly by investor demand and asset supply. Using high-frequency monetary shocks and bond-level data, I show that aggregate corporate bond supply responds to policy. When corporate balance sheets are strong, bond supply and investment respond elastically, while yield curve pass-through is dampened. I develop a production model in which firms choose capital investment and issue long-term bonds subject to financial frictions, and long-term bonds are priced by risk-averse investors in a partially segmented market. Endogenous bond supply generates substitution between real and financial transmission which varies with the corporate sector's financial state. Quantitatively, an issuance-constrained economy features limited, delayed investment responses and a 34% larger long-term yield response than the steady-state economy.

Keywords: monetary policy, corporate bonds, financial constraints, term structure.

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1 Introduction

Central banks set short-term interest rates, but real and financial outcomes such as investment and asset valuation depend on longer-term interest rates. Policymakers and financial markets therefore track the yield curve as a measure of effective borrowing rates and policy efficacy, while continuing to debate the mechanisms through which policy affects long-term rates (Bernanke, 2006). These considerations have also motivated large-scale asset purchases by central banks to target the term structure of interest rates for economic stimulus. However, long-term rates are equilibrium prices that reflect both investor demand and the supply of long-term assets, with monetary policy affecting both of these channels. How then does the endogenous supply of long-term bonds determine the joint transmission of monetary policy to both the real economy and long-term interest rates?

To address this question, I study corporate bond issuance because investment-grade corporate bonds play a critical dual role in the economy. In the real economy, they are an important source of external financing for firms through which they can finance production activity. In financial markets, they are long-duration assets priced jointly with Treasury debt by fixed-income investors (Fang and Xiao, 2025). In response to monetary policy, corporate issuance responses change both firm resources and the quantity of duration in the economy.

The central finding of the paper is that monetary policy has its strongest real effects in states where long-term yield responses are muted. The financial conditions of bond issuers generate this state-dependent transmission. Consider a rate cut which conventionally raises the price of long-maturity assets. This makes long-term financing for the corporate sector effectively cheaper and gives firms an incentive to issue bonds. This incentive is common to all issuers, but their capacity to act on it is not. When the corporate sector has financial capacity, expansionary monetary policy raises bond issuance and investment, while the increased supply of long-duration assets dampens the response of long-term Treasury yields. When corporate issuers lack this financial capacity, issuance and investment respond less elastically, and policy pass-through to the yield curve is larger. Therefore, muted yield curve responses do not necessarily indicate weak monetary transmission to the economy. This finding challenges the conventional interpretation that larger long-term yield responses indicate stronger real monetary transmission.[1]

[1]Monetary pass-through to long-term rates as a signal of the efficacy of policy is often used in the macro-finance literature (e.g., Ray, 2019; Fontanier and Simsek, 2026). More directly, policymakers have historically put forth the effect of policy on long-term rates as a measure of policy success, as demonstrated in then-Chairman Bernanke's Jackson Hole speech (Bernanke, 2012) and President Lagarde's discussion of the Pandemic Emergency Purchase Program (Lagarde, 2021).

This paper makes three primary contributions. The first contribution is evidence that corporate issuance responses vary with issuers' financial capacity, measured by their market capital ratio. Using high-frequency monetary shocks and bond-level issuance data, I show that firms with more financial capacity issue bonds more elastically after monetary easing and use some of the financing to invest in capital. The second contribution is evidence that corporate bond supply in aggregate increases after expansionary policy and that such responses are concentrated in periods when the corporate sector in aggregate has financial capacity. The third contribution is the development of a model of partially segmented bond markets where corporate bond supply is endogenously provided by production firms. The model allows for studying aggregate asset pricing and investment implications of the empirical facts. In the model, firms produce with capital and choose investment, bond issuance, and dividends subject to issuance costs and financial constraints. The model generates endogenous substitution between monetary transmission to yields and quantities, which is economically meaningful in the calibrated economy.

Empirical Analysis. I study a corporate bond-level panel which combines bond amounts sourced from Mergent FISD with secondary-market transaction data, covering July 2002 through October 2023. I then link bond issuances to issuer balance sheets in Compustat. For identification of monetary policy, I use monetary shocks measured from high-frequency changes in interest rate futures around FOMC announcements sourced from Jarociński and Karadi (2020).[2]

The market value of publicly traded corporate bonds over the sample period is approximately the same size as the value of publicly owned Treasury bonds for maturities exceeding five years. This makes corporate bond supply quantitatively relevant for long-maturity bond markets. Corporate and Treasury bonds share exposure to duration risk and are therefore substitutes in fixed income portfolios (Fang and Xiao, 2025). Changes in corporate bond supply can subsequently affect long-term Treasury yields when risk-averse investors have finite wealth to absorb this risk. This is especially applicable in the empirical sample I construct, which is dominated by investment grade corporate bonds that very rarely default.

I estimate the aggregate response of corporate bond supply to conventional monetary policy using the identified monetary shocks. I find a surprise 25 bps rate cut increases the face value of corporate bonds outstanding by approximately 1.5% within a year and over 2.5% within 18 months using local linear projections (Jordà, 2005). Given the size of the corporate bond market, this issuance response is quantitatively large, and represents between $62 billion

[2]Additional exercises confirm the robustness of the empirical results to other high-frequency measures of monetary shocks including orthogonalized series (Jarociński and Karadi, 2020; Bauer and Swanson, 2023) and alternative principal component constructions (Nakamura and Steinsson, 2018).

and $103 billion of market value for bonds in my sample. The same specification applied to publicly held Treasury debt does not estimate significant Treasury issuance responses. Corporate issuance therefore changes the quantity of long-duration assets that investors must absorb following changes in policy.

I then study how bond issuance responses vary across issuers, motivated by findings that investment responses to policy are heterogeneous and related to financial constraints (Ottonello and Winberry, 2020; Cloyne et al., 2023). I use a cross-sectional exposure design in which firms differ by their predetermined financial capacity, measured by a firm's market capital ratio. This ratio is defined as a firm's market equity over the sum of market equity and book debt, which provides a forward-looking measure of effective leverage. I find that issuance responses to policy vary with financial capacity, where financial capacity predicts more elastic issuance responses. In response to a 25 bps rate cut, a firm with a one-standard deviation higher market capital ratio increases its bonds outstanding by approximately 2 percentage points more within a year. At average firm bond amounts, this difference corresponds to $30.2 million in additional bond issuance. In response to the rate cut, firms with higher market capital ratios also accumulate significantly more physical capital and pay higher dividends. These results link differences in financial capacity to both issuance and real responses to policy.

Given the cross-sectional state dependence of bond issuance responses, I then test whether the issuer-level financial capacity mechanism can generate state-dependent asset pricing responses. I estimate regime-dependent local projections for aggregate issuance and long-term bond yields, splitting the time series by whether the aggregate market capital ratio of bond issuers is above its series median (Auerbach and Gorodnichenko, 2012). I find that when issuers have low financial capacity, monetary shocks generate no significant aggregate issuance response, while long-term Treasury yields decline significantly and persistently as in Hanson and Stein (2015). However, when issuers have high market capital ratios, corporate bond quantities respond elastically and long-term Treasury and corporate yield responses to policy are muted. Consistent with the localization hypothesis of segmented bond markets (Vayanos and Vila, 2021), differential long-term yield responses are concentrated in maturities of 5-10 years, the maturities where corporate issuance is active.

Theory. I develop a stylized model to analytically study the role of endogenous asset supply for monetary transmission to bond yields and investment. In the model, a share of long-term bonds are endogenously supplied by production firms which choose investment and bond issuance. Corporate bond issuance is subject to issuance costs and firms face financial constraints on external equity financing and a potentially binding leverage cap motivated by

models of investment and debt issuance (Whited, 1992; Kiyotaki and Moore, 1997; Ottonello and Winberry, 2020). Corporate bonds trade alongside government bonds in a common long-term bond market. Risk-averse arbitrageurs absorb the supply not held by preferred habitat investors and marginally price long-term bonds. The finite-horizon structure yields approximate closed-form solutions for equilibrium yields.

The stylized model delivers three analytical results. First, equilibrium long-term yields decompose into three terms: an expectations-hypothesis component, an exogenous supply factor from preferred habitat demand and government supply, and critically an endogenous corporate supply factor. The presence of endogenous corporate supply causes the term premia to depend on the state of corporate issuers and provides an additional channel for policy to affect asset prices. The second theoretical result is that endogenous corporate bond supply creates state-dependent monetary transmission within bond markets. When firms are unconstrained, issuance dampens monetary pass-through to long-term yields by changing the supply of long-maturity bonds investors must absorb. However, when firms are financially constrained in issuing bonds, monetary pass-through to the yield curve is larger. Third, when firm net worth is low and financial constraints bind, limited financial capacity restricts firms' ability to finance investment, so limited bond issuance translates directly into weaker investment responses than in unconstrained states.

I then extend this stylized model into an infinite-horizon environment with recurring investment and issuance decisions, long-term debt burdens, and occasionally binding financial constraints. In this environment, the joint presence of firms' financing frictions and risk-averse demand determines the long-term interest rates at which both firms and the government borrow. A comparison to two benchmarks clarifies the asset-pricing implications of the model. An economy with risk-neutral bond investors implies the term premium is zero. In an economy with risk-averse investors but frictionless corporate issuance, firms supply long-term bonds elastically, generating a high term premium. The term premium of the proposed model lies between these limit cases because investors require compensation for duration risk, while issuance frictions limit the quantity of duration investors must absorb.

Quantitative Analysis. I calibrate the model to target equilibrium bond yields (Vayanos and Vila, 2021), steady-state investment responses (Winberry et al., 2025), and financial intermediary balance sheets (Kekre, Lenel, and Mainardi, 2026). I first compare the effects of a surprise 25 basis point rate cut across two economies with different initial issuer balance sheets. The steady-state economy is initialized at steady-state quantities and prices, while the constrained economy features higher initial corporate leverage calibrated to bond issuers' balance-sheet conditions in 2009.

In the steady-state economy, the rate cut increases corporate bonds outstanding by over 1.3% after one year and raises the investment rate by 0.54 percentage points. The expansion in bond supply offsets part of the direct effect of monetary easing on bond prices, limiting the on-impact decline in the long-term yield to 10 basis points. The nature of monetary transmission differs in the constrained economy. In response to the same expansionary shock, corporate bonds outstanding rise by less than 0.4% after one year, while the investment response is delayed and the peak response more than 30 basis points smaller. Because constrained issuers expand bond supply less, monetary easing has a larger effect on bond prices. The long-term yield falls by 13.4 basis points on impact, approximately 34% more than in the steady-state economy.

Finally, I assess the degree to which unconventional policies, such as quantitative easing (QE), can stimulate investment and whether they can substitute for conventional rate cuts through the lens of the model. With segmented asset markets, QE changes investor demand and the external-finance premium of firms without directly changing stochastic discount factors. Its real effects are therefore non-monotonic in issuer financial conditions. Unconstrained firms near their optimal scale mainly adjust financing and payouts, while severely leverage-constrained firms cannot issue enough to substantially benefit. QE is most effective when firms need external financing but retain some borrowing capacity. A calibration to the conditions at the time of QE2 places the corporate sector in this region. The intervention lowers the long-term yield by 16.1 basis points, raises corporate bonds outstanding by over 2.5%, and increases the capital stock by more than 1%. Applying the same asset purchase to the more constrained 2009 economy also lowers yields, but issuance and capital responses are weak, while the asset purchases in the steady state cause transitory capital adjustment. Asset purchases therefore operate as a state-dependent external-finance intervention whose real effects depend on both the corporate sector's capacity to adjust bond supply and need for capital.

Related Literature. This paper contributes to a large literature on monetary transmission to long-term interest rates. Many papers study how long-term rates respond to conventional monetary policy (e.g., Gürkaynak, Sack, and Swanson, 2005; Swanson, 2021), finding large and often persistent effects (Hanson and Stein, 2015). As documented in Hanson, Lucca, and Wright (2021), monetary transmission to long-term rates is not constant but can depend on characteristics such as investor demand. Recent work studies state dependence in long-rate pass-through with respect to arbitrageur wealth (Greenwood and Vayanos, 2014; Kekre, Lenel, and Mainardi, 2026), liquidity (Ashtari-Tafti et al., 2025), and the maturity structure of Treasury debt (Andreolli, 2021). I contribute to this literature by identifying the financial

capacity of corporate bond issuers as a novel source of state dependence. I also provide a test of the localization hypothesis of segmented bond markets (Vayanos and Vila, 2021; Droste, Ray, and Gorodnichenko, 2024), and show it features state dependence in maturities where corporate issuers are active.

I contribute to models of the term structure of interest rates featuring market segmentation and preferred habitat investors. This literature dates at least to Culbertson (1957) and Modigliani and Sutch (1966), with the modern framework developed by Vayanos and Vila (2021) and surveyed by Greenwood, Hanson, and Vayanos (2024). A central lesson of this literature is that bond supply affects long-term bond pricing when investors are risk-averse with finite risk-bearing ability. Extensions of this framework incorporate corporate bonds (Greenwood, Hanson, and Liao, 2018), but supply typically remains exogenous. Related work studies how firms structure bond issuance in response to heterogeneous investor demand (Mota and Siani, 2023), and how investor demand and underwriting frictions determine issuance premiums in primary markets (Siani, 2025). My focus is on the dynamic, joint determination of investment, bond supply, and long-term yields. I contribute by embedding dynamic issuance by long-lived production firms into a segmented bond market with preferred habitat investors to study how issuer financial constraints affect asset prices and monetary transmission.

A close theoretical antecedent is Greenwood, Hanson, and Stein (2010), in which firms with fixed financing needs choose between short- and long-term debt in partially segmented bond markets. Their model builds on evidence that firms issue at maturities with high prices and low expected returns (Baker, Greenwood, and Wurgler, 2003). Relatedly, Guibaud, Nosbusch, and Vayanos (2013) endogenize the maturity structure of government debt in response to investor clienteles, emphasizing its role in intergenerational risk sharing. Motivated by the concentration of corporate issuance at longer maturities, I instead abstract from maturity choice and endogenize issuance *size* in a production economy with financial constraints. This allows for the study of monetary transmission jointly to corporate bond supply, investment, and long-term yields.

Because production and asset prices are jointly determined in my framework,[3] this paper also relates to work connecting segmented bond markets to the real economy, especially Ray (2019) and Droste, Ray, and Gorodnichenko (2024). In those works, segmented bond markets affect real activity through borrowing rates faced by households, while bond supply is determined in a preferred habitat block. In contrast, production firms in my model

[3]In this sense, this paper is also related to macroeconomic models with time-varying risk premia. A non-exhaustive selection of this literature also includes Brunnermeier and Sannikov (2014), Caballero and Farhi (2018), Caballero and Simsek (2020), and Kekre and Lenel (2022).

endogenously supply long-maturity bonds to finance capital. This endogeneity of asset supply breaks the linearity of standard preferred habitat models but allows for state-dependent monetary transmission to both asset markets and production.

This paper also contributes to work on corporate bond issuance and monetary policy. Despite the importance of corporate bonds for firm financing, relatively little work studies how conventional monetary policy affects aggregate corporate bond quantities.[4] Much of the existing work focuses on unconventional policy.[5] For conventional policy, Fabiani, Heineken, and Falasconi (2024) show that monetary accommodation lengthens debt maturity and increases the likelihood of bond issuance, while Holm-Hadulla and Thürwächter (2021) study how bank-loan versus bond-finance composition affects transmission across euro-area countries. Relatedly, Fang and Xiao (2025) show in an estimated asset-demand system that corporate bond issuance attenuates policy-induced yield responses. I contribute by estimating the causal response of aggregate corporate bond quantities to conventional monetary shocks in the United States, identifying how this response varies with issuer financial capacity, and embedding this mechanism in an equilibrium model with production and segmented bond markets.

Finally, this paper connects to work on financial constraints and heterogeneous firm responses to monetary policy. The investment channel of monetary policy is central to financial accelerator models (Bernanke, Gertler, and Gilchrist, 1999) and to recent quantitative work on heterogeneous firm responses (Ottonello and Winberry, 2020; Winberry et al., 2025). Empirical studies use cross-sectional exposure to monetary shocks to show that firm responses depend on leverage (Ottonello and Winberry, 2020), dividend payment (Cloyne et al., 2023), liquidity (Jeenas, 2023), and debt maturity (Crouzet, 2021; Jungherr et al., 2024). A similar empirical sample is constructed in Anderson and Cesa-Bianchi (2024) to study heterogeneous, on-impact credit spread responses to monetary policy. I use a related design but focus specifically on corporate bond issuers, with bond issuance as the main outcome variable. The contribution is to show that financial capacity additionally affects aggregate yield transmission through endogenous corporate bond supply.

[4]Existing aggregate evidence differs across settings. Lhuissier and Szczerbowicz (2022) estimate that conventional monetary easing reduces U.S. debt securities including corporate bonds. In contrast, Holm-Hadulla and Thürwächter (2021) find that conventional tightening reduces corporate bond quantities in a panel of euro-area countries.

[5]Studies examining bond issuance in response to quantitative easing include Grosse-Rueschkamp, Steffen, and Streitz (2019), De Santis and Zaghini (2021), Selgrad (2023), Darmouni and Siani (2025), and Giambona et al. (2026).

2 Data

In this section, I detail how I combine widely used sources of firm balance sheets, bond issuances and prices, and monetary shocks to construct my data sample and provide facts on the corporate bond market. Additional data construction details and summary statistics are reported in Appendix B.1.

Monetary Policy Shocks. To measure changes in monetary policy, I follow the large literature using high-frequency identification from movements in futures contracts around FOMC announcements. My baseline monetary policy shock is taken from Jarociński and Karadi (2020) and defined as

$$\epsilon_t^{\text{MPS}} = \text{PCA}_{t,\tau+20} - \text{PCA}_{t,\tau-10}, \tag{1}$$

the change in the first principal component of fed funds futures and Eurodollar Futures contracts over a thirty-minute window around the FOMC announcement at time τ on date t. I use this measure because the paper studies the effects of conventional monetary policy on bond markets and firm outcomes, and the contracts considered are short-term. Therefore, ϵ_t^{MPS} captures how financial markets' expectations about the near-term path of policy rates were changed, as discussed in Jarociński and Karadi (2020).

When constructing monthly or quarterly measures of the monetary shocks, I follow the literature standard (e.g., Gorodnichenko and Weber, 2016; Ottonello and Winberry, 2020) in summing the monetary shocks within the time period being aggregated.

Corporate Bond Data. The primary source of corporate bonds is the Bond Returns database (BRDB) sourced from Wharton Research Data Services (WRDS), a panel of corporate bond prices and quantities. The BRDB is a cleaned monthly corporate bond database built from the Trade Reporting and Compliance Engine (TRACE) Enhanced database, and Mergent Fixed Income Securities database (FISD) issue- and action-level information, with monthly prices, amounts, returns, ratings, coupons, yields, and related bond characteristics for corporate bonds traded since July 2002. I restrict the sample between July 2002 and October 2023.

I use the constructed monthly bond panel to measure the evolution of corporate debt supply over time in terms of both face value and market value. Net bond issuance is measured from changes in face value outstanding, while market value is computed as the end-of-month price times the amount left outstanding. From the BRDB, I also source information on bond-level maturity and duration. I construct bond-level credit spreads by matching reported bond

yields to maturity-matched Treasury yields implied by the nominal yield curve.

The sample includes 104,378 bonds matched to Compustat balance sheets. The median bond carries a rating of BBB+, associated with a historical one-year default rate below 0.14% according to Serino and Kraemer (2025), an S&P Global Ratings report. Weighted by market value, 84% of bonds are investment grade and 0.19% ever default during the 22-year sample, as reported in Table B.1. Figure A.1 compares sample face value with aggregate corporate bond liabilities reported at book value in the Z.1 Financial Accounts and by the Securities Industry and Financial Markets Association (SIFMA). The sample averages about 50% of these aggregate benchmarks, implying that my sample captures a large share of this market.

Firm Balance Sheets and Financial Constraints. I take firm-level balance sheet characteristics from Compustat at a quarterly frequency. Following standard measurement, I construct a measure of capital using real, quarterly book values of property, plant, and equipment. I only consider firms domiciled in the United States and drop industrial conglomerates. For any results on firm balance sheet responses, I restrict the sample to exclude financial firms.

Using the Compustat data, I construct a number of measures of firm-level financial capacity, $f_{j,t-1}$. The baseline measure considered is the *market capital ratio* defined as

$$\text{MR}_{j,t} = \frac{\text{Market Value}_{j,t}}{\text{Market Value}_{j,t} + \text{Book Debt}_{j,t}}, \tag{2}$$

where $\text{Market Value}_{j,t}$ is constructed as equity price at end of quarter $\times$ public shares outstanding. I use the market capital ratio as a preferred measure of financial capacity because it is a forward-looking, market-based measure of effective leverage. This measure was developed as a proxy for financial constraints for intermediaries by He, Kelly, and Manela (2017) who emphasize that market valuation incorporates expectations of profitability, distress, and solvency.

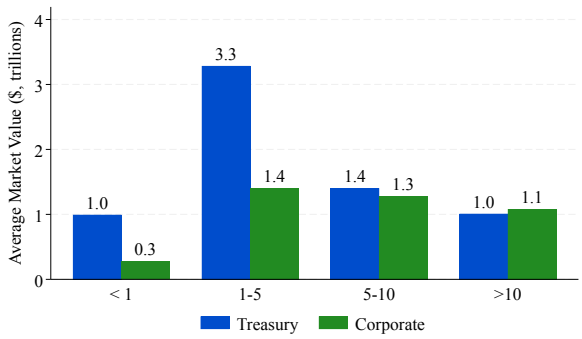
Treasury Yields and Quantities. I source daily nominal and real yields of U.S. Treasuries from the Federal Reserve Board of Governors, which follow the methodologies of Gürkaynak, Sack, and Wright (2007, 2010), respectively. Throughout, I use changes in Treasury Inflation-Protected Securities (TIPS) instantaneous forward rates to proxy for changes in term premia which follows the convention of studies on the responsiveness of long-term rates to monetary policy (Hanson and Stein, 2015; Hanson, Lucca, and Wright, 2021).

For the amount of outstanding Treasury debt, I make use of the CRSP U.S. Treasuries database at the monthly frequency. I also restrict attention to Treasuries which are held

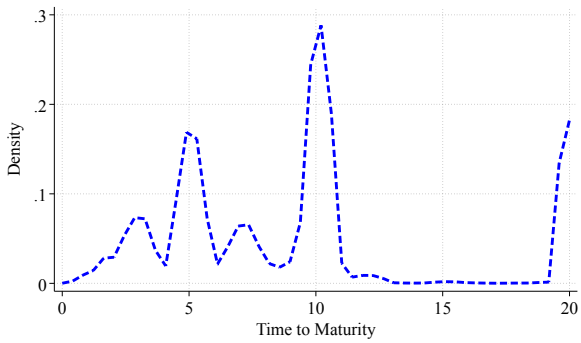
publicly. The Treasury measure excludes holdings of the Federal Reserve and other U.S. government entities, since these securities do not constitute duration that must be absorbed and priced by typical investors.

Corporate Bond Market Size and Maturity. Before turning to the empirical analysis, I first show that corporate bonds are quantitatively important long-maturity assets.

Figure 1: Corporate Bond Markets



(a) Treasury and Corporate Market Size by Maturity Bin



(b) Maturity of New Corporate Issuances

Notes: In Panel (a) values are reported in trillions of real 2019 dollars. Each bar represents the average value outstanding of debt within a maturity bin given in years to maturity. Panel (a) includes publicly held nominal Treasury bonds and notes and excludes TIPS. The $1-5$ bin includes maturities $[1, 5)$ and the 5–10 bin includes maturities $[5, 10]$. Panel (b) plots the distribution of maturity at issuance for new corporate bonds, weighted by initial amount outstanding. Maturities above 20 years are top-coded.

In Figure 1 Panel (a), I compare the market value of corporate bonds in the cleaned BRDB sample with Treasury bonds held by non-government investors. For maturities greater than five years, the corporate bond market is approximately the same size as the amount of Treasuries held by non-government investors. Because corporate bonds are concentrated at longer maturities, an endogenous issuance response to monetary policy changes the supply of duration that investors must absorb precisely at the maturities where monetary transmission to the real economy primarily operates. To illustrate this, Panel (b) of Figure 1 plots the distribution of newly issued corporate bonds. New corporate issuances are highly concentrated in the 5–10 year maturity range, with 10 years the most common maturity at issuance.

3 Empirical Findings

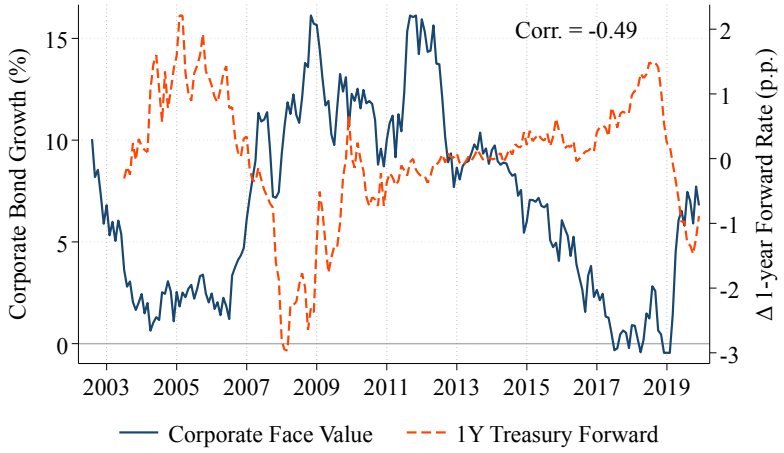
The empirical analysis proceeds in three steps. First, I show that aggregate corporate bonds outstanding respond elastically to conventional monetary policy. Second, I document issuer heterogeneity, finding that firms with more financial capacity respond more elastically

to expansionary policy by issuing more bonds and investing in capital. Third, I estimate state dependent local projections illustrating that monetary pass-through to long-term yields is large when aggregate issuer capacity is weak and bond supply responses muted.

3.1 Aggregate Corporate Bond Issuance and Interest Rates

I find that, in aggregate, corporate bond issuers respond actively to variation in short-term interest rates by changing the total amount of bond issuance. Figure 2 descriptively plots the year-over-year change in the one-year Treasury forward rate against the one-year-ahead log change in corporate bonds outstanding. The time series reveal a strong negative correlation between changes in short rates and corporate bond issuance over the subsequent year. This pattern captures a central mechanism that firms increase bond issuance when financing conditions improve and the path of short-term rates declines.

Figure 2: Corporate Bond Issuance and Treasury Yields



Notes: Plots corporate bond growth (left-axis) with the year-over-year change in the 1-year nominal forward rate (right axis). Corporate bond growth is calculated as the one year ahead log change in the face value of corporate bonds. Against this series is plotted the year over year change in the forward rate of nominal Treasury yields constructed following Gürkaynak, Sack, and Wright (2007). These series have a correlation of -0.49.

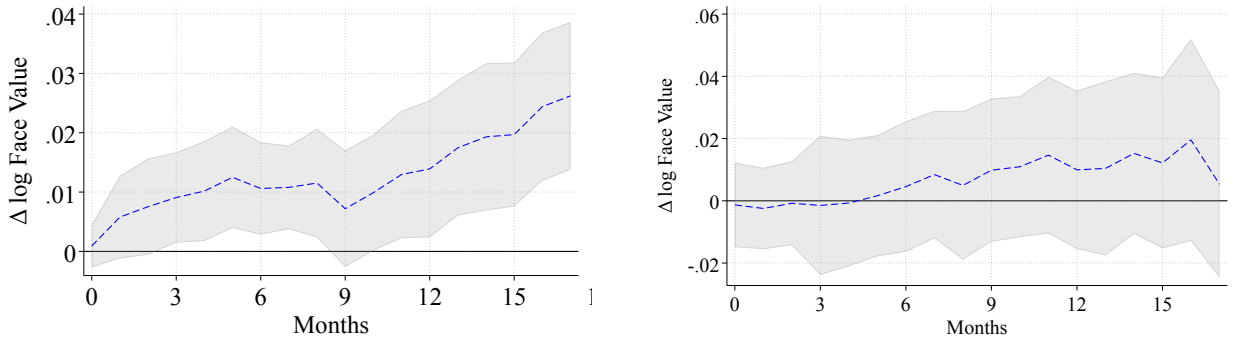
I next test whether this relationship holds causally. I estimate how monetary surprises, which are exogenous changes in the path of expected short-term rates, affect corporate bond issuances. To do so, I estimate a local linear projections regression (Jordà, 2005),

$$\Delta \text{FV}_{t-1,t+h} = \alpha^h + \gamma^h \epsilon_t^{\text{MPS}} + (\Gamma^h)' Z_{t-1} + \delta^h t + u_{t+h}^h, \tag{3}$$

where $\Delta \text{FV}_{t-1,t+h}$ is the log change in corporate bonds outstanding from month $t-1$ to $t+h$. The coefficient γ^h measures the impulse response of bond face value outstanding to the high-

frequency identified monetary shock from Jarociński and Karadi (2020), normalized to a 25 bps rate cut. To absorb predictable variation in issuance, I control for lagged macro-financial conditions: the federal funds rate, CPI inflation, the change in the unemployment rate, the corporate credit spread, prior three-month growth in corporate bonds outstanding, the bond return factor of Cochrane and Piazzesi (2005), and issuer book leverage and market capital ratios. The bond return factor predicts long-term bond returns over the next year, providing a control for bond market conditions and expectations at issuance. The issuer ratios, constructed from Compustat data and aggregated using monthly bond amount weights, control for firms' borrowing capacity. Month and post-COVID indicators are also included.

Figure 3: Aggregate Bond Quantity Responses to Monetary Policy



(a) Corporate Bonds **(b)** Treasury Bonds

Notes: The figure plots estimated OLS coefficients of γ^h from (3) for horizons $h = 0, \ldots, 17$. Shaded bands denote 90% confidence intervals based on Newey-West standard errors with h lags for each horizon. The independent variable is the monetary shock, ϵ_t^{MPS}, measured in Jarociński and Karadi (2020) and normalized to be 25 bps. Panel (a) plots the cumulative response of corporate bond amounts outstanding, aggregated over the BRDB sample. Panel (b) plots the cumulative response of publicly held Treasury bond amounts outstanding, aggregated from the monthly CRSP US Treasuries database.

Figure 3 plots the impulse response of bond face values outstanding estimated from (3) to a monetary shock normalized to be a 25 bps rate cut. In Panel (a) the expansionary shock increases total corporate bond face value outstanding by approximately 1.5% within a year, demonstrating that corporate bond issuers respond elastically to monetary policy. Given the size of the corporate bond market, this response corresponds to, on average, approximately $62 billion in additional bond obligations for issuers over the course of a year. By 18 months after the shock these values have risen to over 2.5% and over $100 billion respectively. These values represent both a large increase in the amount of external financing available to firms and the dollar duration that bond investors must hold in equilibrium.

The channel proposed in this paper is characterized by corporate bond supply responding endogenously to monetary-policy-induced changes in bond prices. This raises the question of

whether Treasury issuances exhibit similar patterns. Panel (b) reports estimates (3) where the outcome is the cumulative change in publicly held Treasury debt. The estimated IRF shows no significant Treasury issuance response to monetary policy. This is consistent with government debt quantities being primarily determined by fiscal commitments and aggregate conditions rather than by price variation caused by changes in monetary policy.

3.2 Cross-Sectional Bond Issuer Responses to Monetary Policy

I next identify a compositional component to the aggregate bond issuance response to monetary policy which speaks to a mechanism through which bond issuance occurs. Motivated by the established role of financial frictions in shaping firms' investment responsiveness to policy (Ottonello and Winberry, 2020; Cloyne et al., 2023), I test whether a firm's financial capacity prior to the monetary shock is associated with issuance responses to policy. Following the local-projection approach of Jordà (2005) and its panel implementation in Jordà and Taylor (2025), I estimate whether firms with more financial capacity differentially increase bond issuance after an accommodative monetary shock.

Throughout this cross-sectional analysis, the main specification is

$$\begin{aligned}\Delta y_{j,t-1,t+h} = \alpha_j^h + \alpha_t^h + \beta^h \left(\epsilon_t^{\text{MPS}} \times f_{j,t-1}\right) + \nu^h f_{j,t-1} \\ + X'_{j,t-1}\Gamma^h + (\Pi^h)' \left(Z_{t-1} \times f_{j,t-1}\right) + \varepsilon^h_{j,t+h} \,,\end{aligned} \tag{4}$$

where $\Delta y_{j,t-1,t+h}$ is the cumulative change in the firm-level outcome from month $t-1$ to $t+h$. The main outcomes are the log changes in corporate bonds outstanding (net issuance) and the market value of corporate bonds. The monetary shock, ϵ_t^{MPS}, is normalized such that a positive value is expansionary. The state variable $f_{j,t-1}$ measures firm j's financial capacity before the realization of the monetary shock. The coefficient of interest, β^h, measures whether firms with more financial capacity increase bond issuance more after an expansionary monetary shock at a specific horizon h. To interpret the results, I normalize $f_{j,t-1}$ to be in units of standard deviation, so the results display the differential response to a 25 bps rate cut of an issuer with a one standard deviation higher market capital ratio.

The specification is saturated to include firm, α_j^h, and time fixed effects, α_t^h. This implies identification comes from within-period cross-sectional differences in firms' exposure to the monetary shock. The specification includes controls for a vector of lagged firm and outstanding bond characteristics, $X_{j,t-1}$, as well as interactions of $f_{j,t-1}$ with lagged aggregate controls Z_{t-1} which I take to be the monthly changes in the CPI index and unemployment rate to capture key business cycle features. The vector of characteristics $X_{j,t-1}$ includes

lagged controls for bond rating, duration, maturity, yield, and spread relative to maturity-matched treasuries. All bond-specific covariates are aggregated to the issuer by taking the bond-amount weighted average at time $t-1$. Firm-level controls include lags of the ratio of cash and short-term investments to total assets (cash ratio), book leverage, the market capital ratio, firm size, and real sales growth relative to a year prior, where these controls are standard in estimating heterogeneous firm responses to policy. For bond-market outcomes, I additionally control for the growth of bond amount outstanding during the three months preceding the monetary policy shock to control for preexisting external financing trends. For balance sheet outcomes, I additionally control for lagged sales growth to capture preexisting revenue trends.

Interpreting the differential responses from (4) as causal requires the identifying assumption that ϵ_t^{MPS} is orthogonal to other aggregate shocks that would differentially affect firms' bond issuance decisions according to their financial states. Measuring ϵ_t^{MPS} in a narrow window around FOMC announcements supports this assumption by plausibly excluding alternative news about the aggregate state.[6] The regression identifies how the causal effect of monetary policy varies with preexisting financial capacity, but does not establish that capacity itself causes these differences.

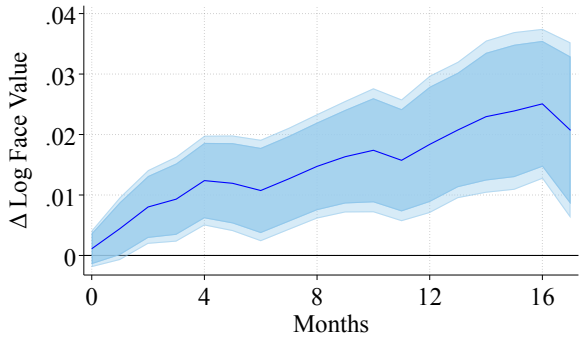
I construct standard errors by clustering by firm and time. I additionally allow for serial correlation in the common time component of the errors up to 12 months.[7] Because the dependent variables are constructed from overlapping monthly local projections and the effects of monetary policy are persistent, the common time component of regression residuals is likely serially correlated across months. Standard two-way clustering may be inappropriate in this setting as discussed in Chiang, Hansen, and Sasaki (2024), who propose allowing for serial dependence of the common time errors. I therefore apply a 12-month HAC bandwidth to the time component while preserving time clustering. An identical approach to standard error construction is also used in the related empirical design of Cloyne et al. (2023). Finally, I restrict the sample to issuers with at least nine consecutive months of data on bond issuance to more precisely estimate fixed effects.

Bond Issuance Responses. Figure 4 plots differential impulse response functions to a 25 bps rate cut conditional on an issuer's predetermined distance from financial constraints, where $f_{j,t-1}$ is the issuer's market capital ratio. In response to the expansionary shock, a firm with a one-standard-deviation higher market capital ratio differentially increases net bond

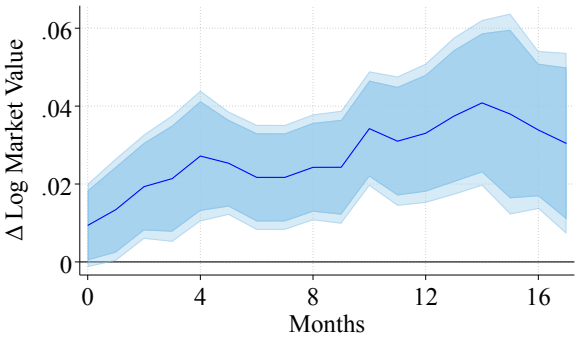
[6] I further assess the credibility of this assumption by extending (4) to include horizons $h \in \{-7, \ldots, -1\}$. Figure A.5 does not support differential issuance trends prior to the monetary shock realization.

[7] The results are robust to using standard two-way clustering by firm and time as demonstrated in Figure A.6.

Figure 4: Differential Bond Issuance Dynamics



(a) Differential Face Value Outstanding Response



(b) Differential Market Value Response

Notes: The figures plot differential impulse response functions to a 25 bps rate cut, given by the β^h coefficients estimated using (4) for horizons $h = 0, \ldots, 17$. The distance from financial constraint measure, $f_{j,t-1}$, is the issuers' market capital ratio defined in (2), where $f_{j,t-1}$ has been normalized so units are standard deviations within sample. Lighter and darker bands denote 95% and 90% confidence intervals, respectively, based on standard errors two-way clustered by firm and date with a 12-month HAC correction in the time dimension.

issuance by nearly 2% after a year, with a corresponding differential increase of about 3% in the market value of its bonds. These net issuance responses are highly significant and persistent for nearly all horizons. The results indicate that the aggregate response documented in Figure 3 has compositional implications.[8]

In Appendix A.2, I report the differential impulse responses of alternative bond issuer outcomes. Figure A.2 reports differential responses of maturity and credit spreads. Following an accommodative shock, firms with a one-standard-deviation higher market capital ratio experience a roughly 40-basis-point larger decline in credit spreads. Together with their stronger issuance response, these results are consistent with an interpretation that firms with stronger balance sheets time issuance to favorable bond market conditions.

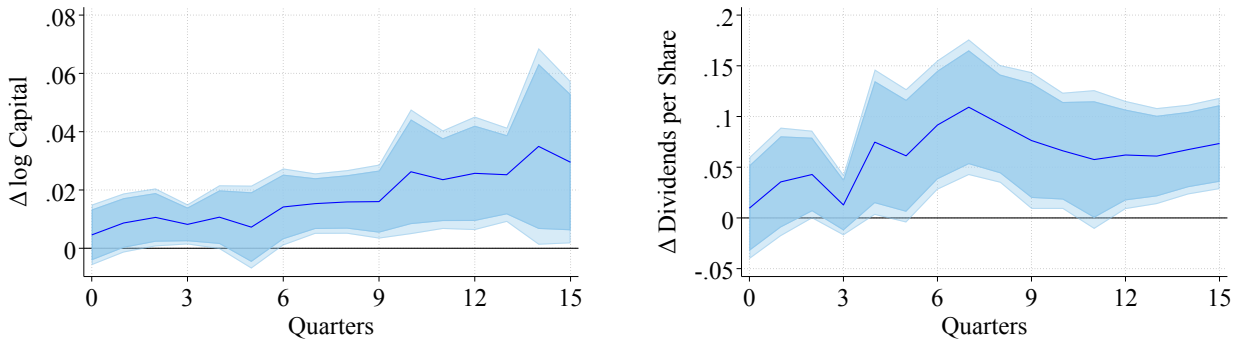
Balance Sheet Responses. Issuers with greater preexisting financial capacity increase bond issuance more in response to a monetary easing. I now study how firms use this external financing to impact the real economy.

To test the real implications of debt issuance, I estimate a quarterly version of (4) using firm-level balance sheet outcomes as dependent variables. These responses are estimated quarterly to match the frequency of Compustat balance sheets. The specification is otherwise identical to the monthly specification, with periods and horizons expressed in quarters. I construct the quarterly monetary policy shock, ϵ_t^{MPS}, by summing all monthly shocks within

[8]This finding is related to Greenwood and Hanson (2013) which shows that favorable credit conditions are associated with differential corporate credit growth by issuer risk.

each quarter.

Figure 5: Differential Firm Dynamics



(a) Differential Capital Response **(b)** Differential Dividends per Share Response

Notes: The figures plot differential impulse response functions to a 25 bps rate cut, given by the β^h coefficients estimated using (4) for horizons $h = 0, \ldots, 15$. The distance from financial constraint measure, $f_{j,t-1}$, is the issuers' market capital ratio defined in (2), where $f_{j,t-1}$ has been normalized so units are standard deviations within sample. Lighter and darker bands denote 95% and 90% confidence intervals, respectively, based on standard errors two-way clustered by firm and date with an 8-quarter HAC correction in the time dimension.

Figure 5 plots the estimated β^h coefficients from (4) for cumulative log capital and dividends per share responses. Firms with higher market capital ratios, the same firms that issue significantly more bonds after monetary easing, differentially accumulate capital and increase dividend payouts. Within a year from the shock, a firm with a one-standard-deviation higher market capital ratio accumulates 0.8% more capital following a 25 bps rate cut, consistent with the magnitude and significance reported in similar exercises (e.g., Ottonello and Winberry, 2020). The dividends per share responses are measured using symmetric growth rates, so the estimates imply that, after a lag, firms also pay out approximately 5–10% more dividends per share in the years that follow. Differential capital and dividends responses rise over similar horizons, suggesting that firms with greater financial capacity allocate expanded financing to both investment and shareholder payouts concurrently.

These differential responses are economically meaningful. Taking average firm values in the regression sample, a firm with a one standard deviation higher market capital ratio issues an additional \$30.2 million in face value of bonds after a 25 bps rate cut, and the market value of its bonds increases \$53.0 million. Over the same horizon, its capital increases by \$23.2 million and its dividends increase by \$4.8 million. These magnitudes indicate that bond issuance is an important source of external funding for firms with more financial capacity after a monetary easing. The remaining balance sheet adjustment responses are not directly estimated within these regressions, but reflect a combination of other asset accumulation, labor costs, or changes in other liabilities such as bank loans outside of the scope of this

paper.

A broader view of balance sheet responses reinforces the interpretation of differential real responses funded by bond issuance. Appendix Figure A.3 shows that sales increase immediately and that earnings eventually rise for firms with higher market capital ratios following a 25 bps rate cut. Appendix Figure A.4 suggests that these firms may temporarily reduce their holdings of short-term assets relative to long-term assets. Finally, there is suggestive but largely insignificant evidence that firms with more financial capacity increase their share repurchases. These results indicate that firms with more financial capacity use bond issuance to expand operations through physical capital and adjust payouts, rather than being used to accumulate more liquid assets. The real responses of capital and sales show that the differential financing response caused by monetary policy is contemporaneous with a cumulative expansion in real firm activity for these issuers.

3.3 Aggregating the Mechanism

The cross-sectional results demonstrate that firms with more financial capacity exhibit larger bond issuance and real responses to monetary shocks. I now examine whether this mechanism affects aggregate monetary transmission. I first test whether bond issuance responds more when issuers, on average, have more financial capacity. I then provide evidence that bond yield responses to monetary policy are state-dependent and related to the state of corporate issuers, suggesting that monetary policy affects long-term yields in a state-dependent manner through corporate issuance.

To do so, I build on a literature that studies the dynamic response of long-term rates to monetary policy shocks. Hanson and Stein (2015) show that monetary policy has large effects on distant forward real rates, while Hanson, Lucca, and Wright (2021) demonstrate that the sensitivity of long-term rates to short-rate movements varies substantially over time. I use a similar time series approach to these studies, but explicitly test whether these heterogeneous yield responses are related to the financial capacity of corporate bond issuers.[9]

To perform time series analysis, I aggregate the bond issuance and balance sheet samples to the monthly level by summing corporate bond face values and market values outstanding across issuers. I aggregate issuer-level controls by constructing value-weighted averages of covariates, where weights are given by each issuer's share of corporate bonds outstanding in

[9]Because the object of interest is aggregate state dependence, the relevant variation is time series variation in aggregate issuer characteristics. A cross-sectional specification such as (4) without time effects would identify average monetary responses conditional on firm-level characteristics. However, it would not directly estimate whether aggregate yield responses vary with the aggregate financial capacity of bond issuers.

that period. Aggregate outcomes, including TIPS forward rates, are described in Section 2.

I estimate regime-dependent local projections to test whether the financial capacity of bond issuers affects the nature of monetary transmission. Following Auerbach and Gorodnichenko (2012), I allow responses to differ across aggregate states and estimate impulse responses using local projections. For horizons $h = 0, \ldots, H$, I estimate

$$\begin{aligned}\Delta y_{t-1,t+h} =& \mathcal{I}_{t-1}\left[\alpha_1^h + \gamma_1^h \epsilon_t^{\text{MPS}} + \theta_1^h X_{t-1}\right] \\ &+ (1-\mathcal{I}_{t-1})\left[\alpha_0^h + \gamma_0^h \epsilon_t^{\text{MPS}} + \theta_0^h X_{t-1}\right] + \delta^h t + u_{t+h}^h,\end{aligned} \tag{5}$$

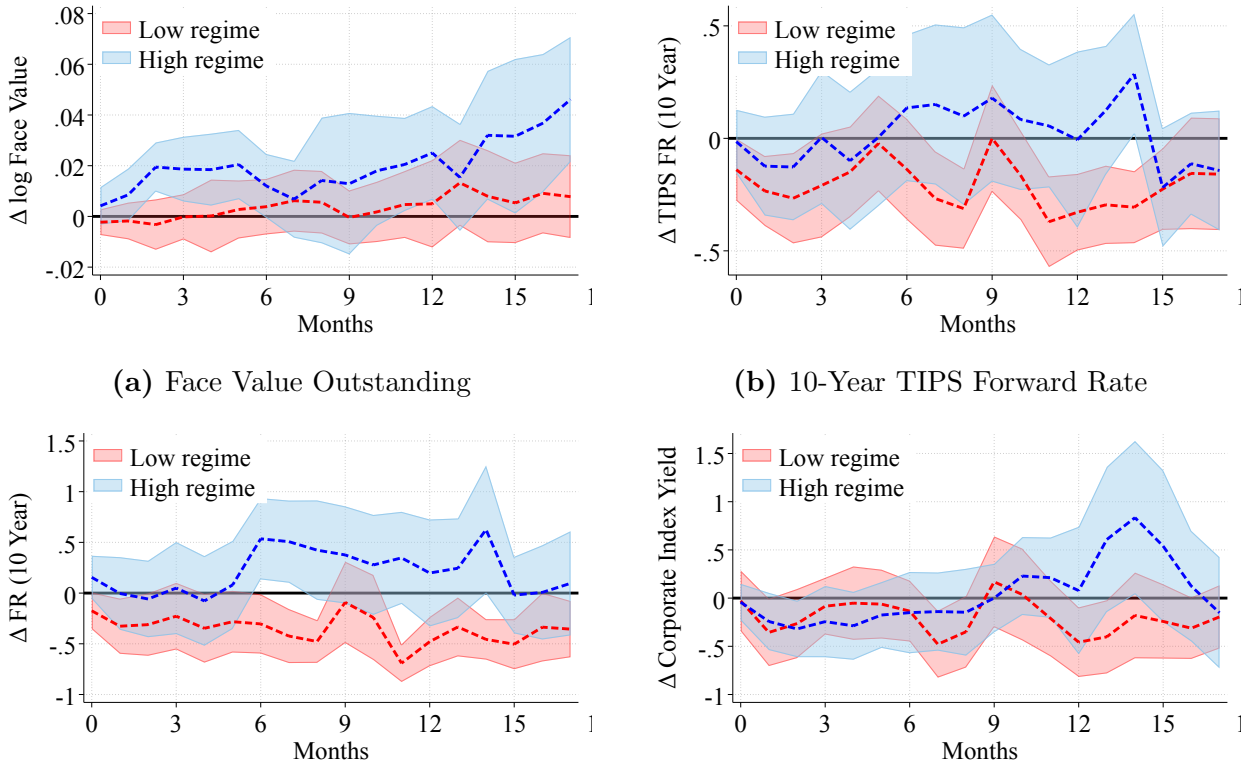
where $\Delta y_{t-1,t+h}$ is the change in the aggregate outcome from $t-1$ to $t+h$, X_{t-1} is a vector of lagged aggregate controls, and ϵ_t^{MPS} is the identified monetary shock. I include a time trend to absorb low-frequency movements in aggregate variables, following Ramey (2016). When corporate face value growth is the outcome, I use the same controls as the aggregate response estimated in (3). When estimating yield or forward rate responses, in addition to the aggregate controls of the fed funds rate, inflation rate, and the change in unemployment, I explicitly control for variables associated with bond pricing: the intermediary capital risk factor and capital ratio from He, Kelly, and Manela (2017), the bond return factor of Cochrane and Piazzesi (2005), the VIX, and the growth rate in corporate bonds the month prior to the shock. This rich set of controls related to the financial state and bond returns is intended to remove predictable covariance between the state of bond issuers and bond markets to better isolate differential changes in long-term bond yields.

The indicator $\mathcal{I}_{t-1}$ equals one when the average issuer market capital ratio is above its time series median.[10] The coefficients $\{\gamma_{\mathcal{I}}^h\}_{h=0}^H$ therefore measure regime-specific impulse responses, where regimes are defined by the financial capacity of corporate bond issuers prior to the monetary shock.

Figure 6 plots the regime-specific impulse responses. Panel (a) shows $\gamma_{\mathcal{I}}^h$ for the aggregate face value of corporate bonds outstanding, Panel (b) the response of 10-year TIPS forward rates, Panel (c) nominal Treasury forward rates, and Panel (d) corporate yields from Moody's. The responses show that issuer financial capacity affects monetary transmission to bond markets and provide suggestive evidence of nonlinear state dependence. When the aggregate market capital ratio of issuers is below its time series median, corporate bond issuance does not respond significantly and the point estimates remain close to zero. When

[10] Several aggregate series exhibit structural breaks beginning in March 2020. For this analysis, I therefore restrict the sample to be pre-2020. Alternative results where I classify high- and low-capacity regimes separately within the pre- and post-COVID periods, while estimating common regime-specific responses across both periods are available upon request.

Figure 6: Regime-Specific Bond Market Responses to Monetary Shocks



(a) Face Value Outstanding

(b) 10-Year TIPS Forward Rate

(c) 10-Year Nominal Forward Rate

(d) Corporate Index Yield

Notes: Regime-specific impulse response functions to a 25 bps rate cut. The figures plot $\gamma_{\mathcal{I}}^h$ coefficients estimated from (5) for horizons $h = 0, \ldots, 17$. Regime $\mathcal{I}_{t-1}$ is determined by whether the aggregate bond issuer market capital ratio is above its time series median. Bands are 90% confidence intervals calculated from Newey-West standard errors with h lags per horizon. Panel (a) plots the response of the log of corporate bond face value outstanding. Panel (b) plots the 10-year TIPS forward rate. Panel (c) plots the 10-year nominal Treasury forward rate. Panel (d) plots the corporate bond index yield from Moody's. The y-axes of Panels (b)–(d) are in percentage points.

issuer capacity is high, the face value of corporate bonds increases by more than 2% after a 25 basis point rate cut which is large and statistically significant.

The state-dependent bond supply response is accompanied by differential yield responses across both Treasury and corporate bond markets. Panels (b)–(d) of Figure 6 show that yield responses suggestively differ across regimes. When the aggregate market capital ratio of bond issuers is below its median, long-term Treasury forward rates decline persistently for over a year following the shock. In several months, the estimated decline exceeds the size of the short-rate shock, consistent with the "overreaction" of long-term yields emphasized by Kekre, Lenel, and Mainardi (2026). Large impact responses of long-term Treasury yields to monetary shocks are well documented (Gürkaynak, Sack, and Swanson, 2005; Swanson,

2021), as is their persistence (Hanson and Stein, 2015; Ashtari-Tafti et al., 2025). Figure 6 further suggests that these responses are related to corporate supply capacity, as long-term yields fall most significantly and persistently when corporate supply responses are insignificant. Corporate yields respond less significantly but follow a similar qualitative pattern.

When corporate bond issuers are relatively unconstrained, long-term yield responses are insignificant and generally attenuated. The responses of Treasury forward rates are relatively muted over time and eventually reverse, with long-term yields estimated to rise, albeit imprecisely, approximately six months after the monetary shock. This reversal occurs in the same regime and over roughly the same horizons in which corporate issuers begin to elastically increase bond supply. Panel (d) shows a similar pattern for corporate yields.[11] Therefore, I find that when firms have the capacity to issue in response to a rate cut, the resulting increase in the supply of dollar duration is associated with dampened monetary pass-through to long-term yields.

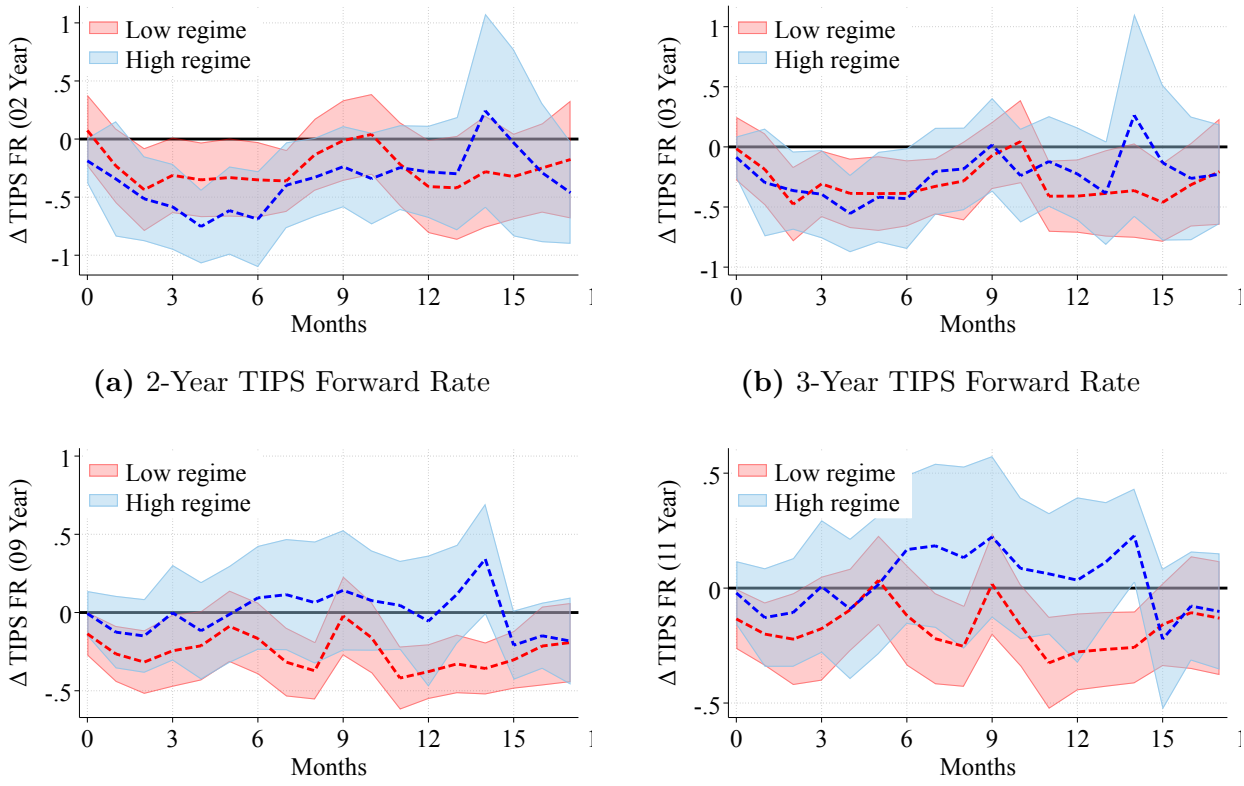
Localization. As indicated in Figure 1, corporate bond issuances are highly concentrated between maturities of 5 to 10 years. A prediction of segmented bond markets is that yield responses to supply shocks will be concentrated, or localized, in maturities for which there is supply risk (Vayanos and Vila, 2021; Droste, Ray, and Gorodnichenko, 2024). The limited exposure of short-term maturities to corporate issuance provides a control group of sorts with which to test whether the state-dependent long-term yield responses are concentrated in maturities where corporate issuances are common.

I provide evidence that the state dependence is concentrated at longer maturities associated with corporate issuance in Figure 7. The top row plots regime-specific responses of two- and three-year TIPS forward rates to a normalized 25 basis point rate cut. Relative to the 10-year responses in Figure 6, these shorter-maturity responses are much more similar across regimes. In contrast, the bottom panels show that other long-term TIPS forward rates around the 10-year benchmark exhibit state dependence similar to the 10-year response.

Table A.1 in the Appendix reports Wald tests of whether the high- vs. low-regime coefficients for the various TIPS maturities are statistically different from each other one year after the monetary shock. The one year change is illustrated as this horizon is consistent with when corporate issuance responses are large and significant (Figure 6). The tests reveal that the state dependence of yield responses to monetary shocks is concentrated at longer maturities. The regime coefficient differences one year after the shock are significant for ma-

[11] In a robustness exercise, I extend the analysis to additional corporate bond yield indices in Figure A.7. I find similar qualitative patterns hold, with the most significant responses occurring suggestively for the safest corporate bonds and corporate bonds with 7-10 years of maturity, the maturity of new issuances.

Figure 7: Regime-Specific TIPS Responses to Monetary Shocks



(a) 2-Year TIPS Forward Rate

(b) 3-Year TIPS Forward Rate

(c) 9-Year TIPS Forward Rate

(d) 11-Year TIPS Forward Rate

Notes: Regime-specific impulse response functions to a 25 bps rate cut. The figures plot $\gamma_{\mathcal{I}}^h$ coefficients estimated from (5) for horizons $h = 0, \ldots, 17$. Regime $\mathcal{I}_{t-1}$ is determined by whether the aggregate bond issuer market capital ratio is above its time series median. Bands are 90% confidence intervals calculated from Newey-West standard errors with h lags per horizon. The y-axes are in percentage points.

turities of 6 to 10 years, and are marginally significant for maturities between 5 and 13. Therefore, the state dependence featured in Figure 7 is statistically concentrated precisely in maturities where corporate bonds are issued, but not for shorter-term maturities.

3.4 Robustness and Additional Results

Measurement Choices. Throughout this section, I have measured the financial capacity of issuers, $f_{j,t-1}$, using the market capital ratio and ϵ_t^{MPS} using changes in short-term futures contracts around FOMC announcements from Jarociński and Karadi (2020). In Appendix B, I show that the results are robust to a variety of alternative measures of both financial capacity and monetary shocks. As alternative measures of $f_{j,t-1}$, I use book leverage, distance-to-default (Gilchrist and Zakrajšek, 2012; Ottonello and Winberry, 2020), and the KZ index (Kaplan and Zingales, 1997). For alternative high-frequency monetary shocks, I

test robustness to the shocks constructed in Nakamura and Steinsson (2018), a series orthogonalized to macro-financial variables constructed following Bauer and Swanson (2023), and the pure monetary shock of Jarociński and Karadi (2020).

Time-Series Specifications. While illustrative and easy to interpret, the median cutoff used in the regime-switching local projections is arbitrary. In Appendix B.7, I show that continuous interactions between monetary shocks and the aggregate market capital ratio generate similar implications for state-dependent bond market transmission.

Aggregate Data and Investment Responses I examine aggregate and state-dependent bond market values and investment responses using Financial Accounts and National Accounts data in Appendix B.8. I find that corporate bond amounts increase significantly, and in the same state-dependent manner using Z.1 aggregate balance sheet data. In line with a large literature, I find that investment follows a hump-shaped response to high-frequency expansionary shocks, and I further demonstrate that significant investment responses are associated with periods of higher corporate financial capacity.

4 A Stylized Model

To understand how endogenous bond supply shapes monetary transmission, I develop a stylized three-period model that integrates firm production with a segmented bond market. Firms jointly choose investment and long-term bond issuance subject to potentially binding financial constraints on external financing, while risk-averse investors price the resulting supply of bonds. This stylized setting clarifies how investor risk aversion and corporate bond issuance subject to financial constraints interact to generate state-dependent responses of bond quantities, investment, and long-term yields.

The model combines elements of a Q-theory investment model with a segmented bond market which prices corporate bond issuances.[12] Endogenous corporate bond supply raises the term premium and generates state-dependent monetary transmission. Unconstrained firms elastically expand issuance after a rate cut, dampening long-term yield responses. Binding leverage constraints instead limit issuance and amplify yield pass-through. When financing constraints link issuance to investment, constrained firms also exhibit weaker investment responses. All proofs are provided in Appendix C.3.

[12]The firm production environment is related to structural models of Q-theory with financial frictions developed in Hennessy and Whited (2007) and Hennessy, Levy, and Whited (2007), which have been recently embedded in New Keynesian environments (Winberry et al., 2025). The segmented bond markets featuring risk-averse arbitrageurs and preferred habitat investors have been surveyed in Greenwood, Hanson, and Vayanos (2024).

4.1 Finite Horizon Environment

Time is discrete and consists of three periods: $t \in \{0, 1, 2\}$.

Production Firms. There exists a continuum of measure one of homogeneous firms that maximize shareholder value through dividends and are endowed with an initial level of capital, K_0, and debt obligation, B_0. The firms operate with technology $f(K_t) = AK_t^\alpha$, where $\alpha \in (0, 1)$. In the initial period, firms choose capital investment for the next two periods, as well as zero-coupon long-term bond issuance that must be repaid in $t = 2$. The firms are owned by a representative risk-neutral household, which generates the stochastic discount factor, β_t, used by the firms to discount dividends. The firms can adjust capital subject to convex, proportional capital adjustment costs (Hayashi, 1982).

Firms may issue two-period bonds, B_2, in the initial period and repay only a fraction $1-\zeta$ of face value. I interpret this repayment subsidy as a reduced-form tax shield capturing the tax advantage of debt (Modigliani and Miller, 1963). Other microfoundations for a debt benefit include demand for safe assets (Caballero and Farhi, 2018) and relative borrower impatience (Dávila and Walther, 2023). Characterizing the precise microfoundations of this debt benefit is beyond the scope of this paper; instead, I use the subsidy to generate a positive baseline level of debt around which firms adjust issuance.

Issuing new bonds incurs a convex cost $\Gamma(B_2, K_0)$ that increases with issuance, B_2, and decreases with initial capital, K_0, which serves as collateral for borrowing. In Appendix E.2, I microfound this cost through a contracting problem between firms and competitive underwriting intermediaries, which pass the costs of underwriting and placing bonds with investors on to issuers. I parameterize the issuance cost as

$$\Gamma(B_2, K_0) = \frac{\psi}{2} \frac{B_2^2}{K_0}, \tag{6}$$

where ψ governs the cost of bond issuance. The debt benefit generates a positive level of bond supply, while the convex issuance cost governs how much firms adjust issuance around that level. This specification will generate a linear bond supply curve in price, following a standard convention in quantitative models of bond issuance (Mota and Siani, 2023; Siani, 2025).

I introduce two standard financial frictions into the environment: a restriction on equity issuance through requiring nonnegative dividends and a leverage constraint. These constraints are widely used in corporate finance models with capital investment (Whited, 1992; Winberry et al., 2025). When firm net worth is sufficiently low, they link financing and investment de-

cisions by limiting firms' ability to fund desired investment with external finance, generating state-dependent investment responses (Ottonello and Winberry, 2020).

I parameterize the constraints as

$$d_0 \geq 0 \ [\mu]\,; \qquad B_2 \leq \lambda K_0 \ [\eta]\,, \tag{7}$$

where μ and η denote the Lagrange multipliers on the equity issuance and leverage constraints, respectively. The first constraint prevents firms from raising external equity from their owners, while the second limits the face value of debt that can be issued against initial capital.

In the initial period, firms solve the following problem to maximize their valuations,

$$\max_{K_2,B_2} \quad d_0 + \beta_1(r_1)d_1 + \beta_2(r_1)d_2 \tag{8}$$

$$\begin{aligned} \text{s.t.} \quad & d_0 = AK_0^\alpha - I_2 - \frac{\phi}{2}\left(\frac{I_2}{K_0} - \delta\right)^2 K_0 + P_0^{(2)}B_2 - (1-\zeta)B_0 - \Gamma(B_2, K_0), \\ & d_1 = AK_2^\alpha, \quad d_2 = AK_2^\alpha - B_2(1-\zeta)\,, \\ & d_0 \geq 0 \ [\mu]\,; \qquad B_2 \leq \lambda K_0 \ [\eta]\,. \end{aligned} \tag{9}$$

Firms discount future dividends using $\beta_t(r_1)$, which are generated by the preferences of the firm's owner, described subsequently. Capital investment is defined as $I_2 = K_2 - (1-\delta)K_0$.

Arbitrageur. The long-term, two-period bonds in this economy are priced by a representative, risk-averse bond investor which I denote the *arbitrageur*. The arbitrageur in the initial period chooses its portfolio weight in two-period bonds to maximize portfolio returns with mean-variance preferences in $t = 1$.[13]

$$\begin{aligned} \max_{\omega_0} \quad & \mathbb{E}_0\left[\frac{W_1}{W}\right] - \frac{1}{2}\text{Var}\left(\frac{W_1}{W}\right) \\ \text{s.t.} \quad & W_1 = W\left(R^{(1)} + \omega_0\left(R^{(2)} - R^{(1)}\right)\right), \end{aligned} \tag{10}$$

where $R^{(1)}$ is the gross return from owning a one-period bond, and $R^{(2)}$ is the gross return on holding a two-period bond realized in $t = 1$. Bonds of either maturity carry zero coupon. The two-period bond price is defined as $P_0^{(2)} \equiv \frac{1}{(1+y^{(2)})^2}$. The yield of a one-period bond that

[13]For analytical tractability, I assume the arbitrageur myopically maximizes a mean-variance approximation to financial returns. This objective can be interpreted as a second-order approximation to the portfolio choice of either (i) a two-period CRRA investor with relative risk aversion γ or (ii) a longer lived investor with Epstein-Zin preferences, an elasticity of intertemporal substitution of one and relative risk aversion γ, under locally small return risk. I use this approximation as the direct objective for the arbitrageur.

pays off in $t = 1$ is r_1, and the yield of a one-period bond that pays off in $t = 2$ is r_2. In the stylized model, I normalize arbitrageur risk aversion to $\gamma = 1$.

Government Supply and Preferred Habitat Investors. As in canonical models of the term structure of interest rates (Greenwood, Hanson, and Vayanos, 2024), I allow for a share of long-term bonds in the economy to be both exogenously supplied and demanded. In this stylized model, the government supplies an exogenous value, G, of two-period bonds. Preferred habitat investors inelastically demand a value, H, of long-term bonds. In the quantitative extension that follows, I will relax these inelastic quantities of bonds. For the analytical results that follow, it is sufficient to restrict focus to $\widetilde{G} = G - H$, the excess supply of government bonds that must be held by the arbitrageurs.

Central Bank. The central bank in this economy exogenously sets one-period government bond yields, r_{t+1}.

The only source of risk in this economy is uncertainty about future short-term bond yields. At $t = 0$, the yield of the one-period bond, r_1, is known. In $t = 1$, the monetary authority sets the one-period bond yield as

$$r_2 = \varepsilon_1, \qquad \mathbb{E}_0[\varepsilon_1] = 0, \qquad \text{Var}(\varepsilon_1) = \sigma_r^2. \tag{11}$$

I assume that ε_1 has compact support contained in $(-1, \infty)$, ensuring that gross interest rates are bounded away from zero and the expected discount factors are well-defined. For simplicity, the expected future short rate is zero, $\mathbb{E}_0[r_2] = 0$, but there is uncertainty over what the short-rate will be.

Owner of the Firms. The owner of the production firms is a risk-neutral household that receives firm dividends for consumption and can save in one-period government bonds yielding r_{t+1}. I assume that the owner discounts future payouts using the sequence of short-term government bond rates. The resulting date-1 discount factor is $\beta_1(r_1) \equiv 1/(1+r_1)$, and the expected cumulative date-2 discount factor is $\beta_2(r_1) \equiv \mathbb{E}_0\left[1/((1+r_1)(1+r_2))\right]$.

The restriction that the owner of the firm does not save in the two-period bonds represents an additional layer of market segmentation that will have implications for how both conventional and unconventional monetary policy transmits to the economy, as will be explored later.

Baseline Capital Decisions. Optimality of the firm problem (8) implies that capital

choice K_2 is given by

$$\alpha A(\beta_1(r_1) + \beta_2(r_1))K_2^{\alpha-1} - (1+\mu)\left(1 + \phi\left(\frac{K_2}{K_0} - 1\right)\right) = 0\,. \tag{12}$$

When the equity financing constraint does not bind, such that $\mu = 0$, the optimal capital choice is independent of the firm's bond issuance decision. In this case, monetary policy determines the firm's optimal capital scale through the standard discount factor channel, while financing and investment decisions are separable. When the equity financing constraint binds, however, $\mu > 0$ and the shadow value of internal funds enters the capital decision. Because this shadow value depends on the firm's financing choices, capital and bond issuance can become nonseparable. As I demonstrate below, this interaction between financial constraints and bond issuance generates state-dependent monetary transmission to investment.

4.2 Monetary Transmission to Bond Markets

Bond Supply. The bond supply from production firms is given by

$$B_2 = \underbrace{\frac{K_0}{\psi}\frac{\beta_2(r_1)\zeta}{1+\mu}}_{\text{Supply Level}} + \underbrace{\frac{K_0}{\psi}\left[P_0^{(2)} - \frac{\beta_2(r_1)}{1+\mu}\right]}_{\text{Financing Motive}} - \underbrace{\frac{K_0}{\psi}\frac{\eta}{1+\mu}}_{\text{Leverage Limit}}\,. \tag{13}$$

The firms' optimal bond supply can be decomposed into three terms. The first is a "Supply Level" term. Because there is a benefit to debt issuance, $\zeta > 0$, firms have an incentive to supply a positive amount of bonds, while convex issuance costs limit the size of this baseline allocation. When the equity financing constraint binds, the shadow value of internal funds, μ, reduces this baseline level. The second term captures how firms adjust issuance around this level in response to bond-market conditions, which I denote the *Financing Motive*. Holding other objects fixed, firms issue more when the current bond price rises and less when the discounted cost of future repayment rises. Therefore, the first term explains why firms issue debt, while the second describes how attractive additional bond financing is at prevailing bond prices. Finally, the "Leverage Limit" term reduces issuance when the leverage constraint binds, with the shadow value η capturing the marginal cost of this constraint.

Bond Market Equilibrium. Standard portfolio optimization gives the arbitrageur portfolio weight

$$\omega_0 = \frac{\mathbb{E}_0\left[R^{(2)} - R^{(1)}\right]}{\mathrm{Var}\left(R^{(2)} - R^{(1)}\right)} \approx \frac{2y^{(2)} - r_1 - \mathbb{E}_0[r_2]}{\sigma_r^2}\,, \tag{14}$$

where the approximation follows from a first-order linearization of bond returns for yields in a neighborhood around zero.

Bond market clearing in this model satisfies the market clearing condition

$$\omega_0 W = P_0^{(2)} B_2 + \widetilde{G}, \tag{15}$$

where $\widetilde{G}$ is the value of exogenously supplied government bonds from the fiscal authority net of preferred habitat demand. Writing $\omega_0 W$ approximately reveals that this term is equivalent to $\frac{W}{\sigma_r^2}(2y^{(2)} - r_1 - \mathbb{E}_0[r_2])$. Therefore, $\frac{W}{\sigma_r^2}$ represents the sensitivity of investor demand to changes in excess bond returns.

Bond Market Transmission. Monetary policy affects bond supply in (13) through two channels. First, using the approximation $\beta_2(r_1) \approx 1 - r_1$, it is clear that a rate cut raises the supply-level component of debt, but also increases the present value of future repayment, weakening the intertemporal financing motive.

Second, monetary policy changes the equilibrium price at which firms can issue long-term bonds. A change in r_1 shifts investor demand for long-term bonds through (14), which changes $P_0^{(2)}$ through market clearing. A higher issuance price means that each unit of face value raises more resources today and therefore makes additional bond issuance more attractive.

The stylized environment allows for an approximately closed-form characterization of equilibrium asset prices.

Proposition 1 (Equilibrium Long-Term Yields)**.** *To first order for small bond yields, the equilibrium two-period bond yield is given by*

$$y^{(2)} = \underbrace{\frac{1}{2} r_1}_{EH} + \frac{1}{2\mathcal{A}} \left[\underbrace{\widetilde{G}}_{\text{Exogenous Supply}} + \underbrace{\frac{K_0}{\psi} \frac{(\mu + \zeta)(1 - 2r_1) - \eta(1 - r_1)}{1 + \mu}}_{\text{Corporate Supply}} \right], \tag{16}$$

$$\text{where } \mathcal{A} \equiv \frac{W}{\sigma_r^2} + \frac{K_0}{\psi} \left(2 - \frac{1 - \zeta + \eta}{1 + \mu} \right). \tag{17}$$

Proposition 1 decomposes equilibrium yields into three terms: an expectations hypothesis term, an exogenous supply term , and a corporate bond supply term. The linear approximation to equilibrium yields provides a decomposition related to the affine term structure characterized in many segmented markets models. The expectations-hypothesis term implies that the two-period yield depends on expected one-period yields. The exogenous supply term

reflects that exogenous supply risk from the excess supply of bonds from the government net of preferred habitat demand raises equilibrium yields. The constant $\mathcal{A}$ captures the combined elasticity of bond demand and corporate bond supply.

The third term, the corporate-supply factor, demonstrates that endogenous corporate debt supply can raise yields and contribute to the term premium. The relevance of this channel depends both on the short-term interest rate and on endowed collateral, K_0. A greater collateral endowment lowers marginal issuance costs and therefore increases firms' capacity to adjust bond supply in response to equilibrium prices.

I now characterize how changes in monetary policy, represented by variation in r_1, affect equilibrium bond markets. I first impose a regularity condition on the magnitude of excess supply $\widetilde{G}$ relative to investor demand elasticity W/σ_r^2.

Assumption 1. *Exogenous long-term excess bond supply satisfies* $0 \leq \widetilde{G} < \zeta(1-r_1)\frac{W}{\sigma_r^2}$.

This assumption ensures that corporate bond supply and the term premium are both positive.

Appendix D.1 provides further characterization of when the financial constraints bind. Define the initial net worth of firms as $n \equiv K_0(1-\delta) - (1-\zeta)B_0$. Under mild regularity conditions, initial net worth partitions firms monotonically into unconstrained, dividend-constrained, and leverage-constrained regions of the solution space.[14] If initial debt obligations are zero, net worth is proportional to K_0, so the initial capital endowment determines which financial constraints bind. For sufficiently high K_0, neither constraint binds. At intermediate levels of K_0, only the dividend constraint binds, while below a lower threshold both constraints bind.

Proposition 2 (Bond Market Transmission across Financial States)**.** *Suppose Assumption 1 is satisfied. Consider an unconstrained state U and a constrained state C ($\mu > 0, \eta > 0$), with $K_0^U > K_0^C$. For $j \in \{U, C\}$, to first order for small bond yields, changing monetary policy affects long-term yields according to*

$$\frac{\partial y^{(2),j}}{\partial r_1} = \underbrace{\frac{1}{2}}_{EH} + \underbrace{\frac{\sigma_r^2}{2\widetilde{W}^j}\left[P_0^{(2),j}\frac{\partial B_2^j}{\partial r_1} - B_2^j\right]}_{Corp.\ Supply}, \tag{18}$$

where $\widetilde{W}^j \equiv W + \sigma_r^2 B_2^j$. If, in addition, equilibrium bond supply is larger in the unconstrained

[14] The regularity conditions that order the state space are (i) unconstrained bond supply is feasible, (ii) bond supply is positive, and (iii) increasing bond issuance raises the resources available to firms. Their parametric conditions are given in Appendix D.1.

state, $B_2^U > B_2^C$,[15] *yield responses satisfy*

$$0 < \frac{\partial y^{(2),U}}{\partial r_1} < \frac{\partial y^{(2),C}}{\partial r_1} < \frac{1}{2}.$$

Therefore, corporate bond supply dampens monetary pass-through to long-term yields, with greater pass-through in the collateral-constrained state.

Corporate bond supply responds to monetary policy according to

$$\frac{\partial B_2^U}{\partial r_1} = \frac{K_0^U}{\psi}\left[(1-\zeta) - 2\frac{\partial y^{(2),U}}{\partial r_1}\right] < \frac{\partial B_2^C}{\partial r_1} = 0. \tag{19}$$

The main implication of Proposition 2 is that endogenous bond supply creates a substitution between yield responses and bond quantity responses to monetary policy. The first term in (18) is the standard expectations-hypothesis force: a rate hike raises long-term yields. The second term captures the endogenous response of corporate bond supply. When monetary policy changes bond prices, firms adjust issuance, changing the quantity of long-maturity debt that investors must absorb. This changes the amount of duration risk that arbitrageurs must hold, which causes the term premium to adjust to compensate these investors. Following a rate cut, the quantity of duration risk increases through corporate issuance, pushing up the term premium. This duration quantity response works against the conventional expectations hypothesis, dampening the fall in long-term bond yields.

The strength of this mechanism critically depends on the financial state of bond issuers. Proposition 2 shows that pass-through to long-term yields is larger when corporate bond issuance is constrained at its leverage limit. This ordering of yield responses further requires an equilibrium region in which bond supply is larger in the unconstrained state. Intuitively, the unconstrained state then features both a larger stock of corporate bonds and an active quantity margin through which monetary policy can be absorbed. At the leverage limit, by contrast, bond supply is locally fixed. Equation (18) then implies that yields must adjust more to clear the bond market. Monetary transmission to the yield curve is therefore stronger when firms have less financial capacity to adjust the supply of long-maturity debt.

The corresponding quantity response is characterized by (19). In the unconstrained state, bond issuance falls following an increase in the short rate, whereas issuance does not respond locally when the leverage constraint binds. Two opposing forces determine the unconstrained response. Consider a rate hike. The increase in r_1 lowers the present value of future repayment

[15] This can be represented parametrically and sufficient conditions for this yield ordering to hold are given by (C.6).

through the firm's stochastic discount factor (SDF), which by itself raises desired issuance. Simultaneously, the higher short-rate raises the equilibrium long yield and lowers $P_0^{(2)}$, so each unit of face value raises fewer resources at issuance. In equilibrium, the investor demand channel which raises long-term rates dominates the repayment channel of the model.

It is also instructive to consider a scenario in which the firm's owner does not save at the short rate and instead discounts the future at a constant discount factor, β. In this hypothetical, the repayment channel of monetary policy through the SDF is absent. Monetary policy affects issuance only through investor demand and the resulting movement in long-term bond prices, so bond issuance unambiguously falls following a rate hike. This is also a description of how policies such as asset purchases transmit to firms as will be explored in Section 6.3.

4.3 Real Monetary Transmission

If the production firms in the economy have sufficient capital endowments, K_0, their capital choice (12) is separable from their financing decision. This is contingent on their external financing constraints remaining slack. However, the effects of financial frictions on firm investment decisions have been widely explored in the theoretical literature, where they play a central role in determining investment responses to aggregate shocks (Kiyotaki and Moore, 1997; Bernanke, Gertler, and Gilchrist, 1999; Jermann and Quadrini, 2012; Ottonello and Winberry, 2020).

When capital endowment of the production firms is low and both financial constraints bind, $d_0 = 0$ and $B_2 = \lambda K_0$, investment is determined by available internal resources and the value of debt financing. In this case, constrained firms' investment responses to policy depend on how monetary policy changes the price of long-term bonds. This is readily observed through the resource constraint of a constrained firm with $\phi \to 0$,

$$K_2^C = A(K_0^C)^\alpha + (1-\delta)K_0^C + P_0^{(2),C}\lambda K_0^C - (1-\zeta)B_0^C - \frac{\psi}{2}\lambda^2 K_0^C. \tag{20}$$

Monetary shocks therefore have different real effects depending on the state of the corporate sector. When firms are unconstrained, investment responds through the standard SDF channel previously described. In contrast, constrained firms' investment decisions depend on how the equilibrium prices of long-term bonds respond to policy changes. The following proposition demonstrates that when firms are constrained, generically, their investment responses to policy will be smaller.

Proposition 3 (Real Transmission across Financial Constraints)**.** *Suppose capital adjust-*

ment costs are small, $\phi \to 0$. Consider an unconstrained state U and a constrained state C ($\mu > 0, \eta > 0$). Define unconstrained capital choice $K_2^\star(r_1) \equiv [2\alpha A(1-r_1)]^{1/(1-\alpha)}$.

If initial borrowing capacity is below the unconstrained capital choice, $\lambda K_0^C < K_2^\star(r_1)$, then a rate hike lowers investment in both states, with a larger response for the unconstrained state

$$\underbrace{-\frac{K_2^\star(r_1)}{(1-\alpha)(1-r_1)}}_{\partial I_2^U/\partial r_1} < \underbrace{-2\lambda K_0^C \frac{\partial y^{(2),C}}{\partial r_1}}_{\partial I_2^C/\partial r_1} < 0.$$

Proposition 3 formalizes the state dependence of investment responses to policy, and how these responses are related to bond markets. The condition for this result is mild, only that the borrowing capacity at constrained firms makes the unconstrained capital choice infeasible, which corresponds to a natural economic region of the state space.

4.4 Model Extensions

Financial Constraints. Appendix D.1 shows that in the baseline environment, under mild regularity conditions, initial net worth $n(K_0, B_0)$ orders firms into leverage-constrained, dividend-constrained, and unconstrained regions, linking financial conditions to the state-dependent responses documented in Section 3.

Corporate Default. The baseline abstracts from default so corporate and government bonds share a long-term bond market, isolating the effects of duration supply.[16] Appendix D.2 extends the environment and introduces default and bankruptcy costs. Despite distinct corporate and Treasury yields, issuance still affects safe long-term yields to first order, dampens monetary pass-through, and generates state-dependent bond-market and investment responses. Contractionary policy also widens credit spreads through lower recovery values.

Maturity Choice. The baseline allows only long-term issuance. Appendix D.3 provides an extension which allows firms to adjust maturity in response to relative prices, subject to convex costs of deviating from a target maturity structure (Greenwood, Hanson, and Stein, 2010). Corporate issuance still generates term premia and dampens yield responses. However, substitution between short- and long-term debt requires more elastic investor demand for

[16] Investment-grade bonds comprise 84% of rated bond value and default is very rare in my sample. More broadly, empirical and structural decompositions generally attribute less than half of corporate credit spreads to expected default losses (Elton et al., 2001; Gilchrist and Zakrajšek, 2012; Bai, Goldstein, and Yang, 2020; Huang, Nozawa, and Shi, 2025). Related evidence suggests that Treasury convenience yields are not primarily driven by default risk (Krishnamurthy and Vissing-Jorgensen, 2012), while Gilchrist and Zakrajšek (2012) find that default risk does not account for the cyclical variation in credit spreads.

long-term bonds to generate amplified supply responses.

5 Infinite-Horizon Model

I extend the stylized model to an infinite-horizon environment in order to quantitatively study the corporate bond issuance channel for bond-market and investment responses to monetary policy. The extended environment adds recurring investment and debt issuance, persistent and endogenous issuer balance sheets, and generalizes preferred-habitat demand for long-term bonds. These features generate nonlinear firm and asset price dynamics and allow the model to quantify how monetary transmission varies across financial states.

5.1 The Firm Environment

The production environment is largely identical to Section 4, but now the firms are infinite-lived agents. A continuum of homogeneous firms maximize lifetime value through issuing dividends while producing output using technology $f(K_t) = AK_t^{\alpha}$. The firms choose investment, $I_t = K_{t+1} - (1-\delta)K_t$, subject to proportional, quadratic adjustment costs, $\frac{\phi}{2}\left(\frac{I_t}{K_t} - \delta\right)^2 K_t$ (Hayashi, 1982). Firms can issue geometrically decaying perpetuities with face value B_t, coupon c, and amortization rate δ_B. Issuance costs continue to be parameterized as $\Gamma(B_t, K_t) \equiv \frac{\psi}{2}\frac{B_t^2}{K_t}$ as in (6), so that marginal issuance costs rise with leverage, while total issuance costs are proportional to firm size at a given leverage ratio.

Firms also continue to receive a debt benefit ζ per unit of outstanding face value each period, resulting in a benefit ζB_{t-1} in period t. As before, this benefit captures tax shields and other advantages of debt financing in reduced form. It allows the model to match the empirically observed leverage ratios of corporate issuers.

The potentially binding financial constraints on external financing, (7), are also present in this environment. Given the infinite-horizon, dividends must be non-negative in every period, $d_t \geq 0$. The leverage limit is expressed as $B_t \leq \lambda K_t$, so the constraint is stated in terms of final goods. The bond issuance costs $\Gamma(\cdot)$ and leverage constraint in this extended environment are further discussed and microfounded in Appendix E.2. Briefly, the microfoundation is that in order to issue bonds, firms must contract with an underwriting intermediary who can create bonds at a cost. Firms reissue their entire debt stock each period, so underwriting costs apply to gross issuance B_t. However, firm capital has limited pledgeability, and the intermediary will only underwrite bond issuances that firms can credibly commit to servicing. This microfoundation follows a large literature on limited pledgeability of firm assets, including Kiyotaki and Moore (1997). The underwriter's no-default requirement in equilib-

rium is closely related to models developed in Rampini and Viswanathan (2013, 2025), and the macroeconomic implications of such constraints are explored in Greenwald (2019) and Ottonello, Perez, and Varraso (2022).

The firm problem to maximize lifetime value is recursively defined as

$$V_t(K_t, B_{t-1}) = \max_{B_t, K_{t+1}} \; d_t + \mathbb{E}_t \left[M_{t,t+1} V_{t+1}(K_{t+1}, B_t) \right] \tag{21}$$

$$\text{s.t.} \quad d_t = \underbrace{f(K_t)}_{\text{Output}} - \underbrace{I_t}_{\text{Investment}} + \underbrace{P_t^L \left[B_t - (1-\delta_B) B_{t-1} \right]}_{\text{Net Bond Issuance}} \tag{22}$$

$$- \underbrace{(c + \delta_B - \zeta) B_{t-1}}_{\text{Debt Repayment Net of Benefit}} - \underbrace{\frac{\phi}{2} \left(\frac{I_t}{K_t} - \delta \right)^2 K_t}_{\text{Adjustment Costs}} - \underbrace{\Gamma(B_t, K_t)}_{\text{Issuance Costs}},$$

$$\underbrace{d_t \geq 0}_{\text{Dividend Constraint}} \quad [\mu_t], \qquad \underbrace{B_t \leq \lambda K_t}_{\text{Collateral Constraint}} \quad [\eta_t]. \tag{23}$$

In (21), firms jointly choose capital investment and bond issuance to maximize the present value of dividends, subject to debt repayment, capital adjustment costs, bond issuance costs, and financial constraints. The stochastic discount factor $M_{t,t+1}$ is determined by the firm's owner, a standard representative household which receives dividends and can save using one-period government bonds. Because bond markets are segmented, the firms' owner does not also own long-term bonds. I define the firm owner's problem in Appendix E.1.

Firm Optimality. Define the investment rate $i_t \equiv I_t/K_t$ and leverage $\ell_t \equiv B_t/K_t$. The investment rate can be written as

$$\frac{I_t}{K_t} = \delta + \frac{1}{\phi} \left(q_t^{\mathcal{P}} + \mathcal{F}_t - 1 \right), \tag{24}$$

where

$$q_t^{\mathcal{P}} \equiv \frac{1}{1+\mu_t} \mathbb{E}_t \left[M_{t,t+1}(1+\mu_{t+1}) \left(f'(K_{t+1}) + 1 - \delta - \frac{\phi}{2}(i_{t+1} - \delta)^2 + \phi(i_{t+1} - \delta) \frac{K_{t+2}}{K_{t+1}} \right) \right], \tag{25}$$

is the productive value of additional installed capital. This term represents the rationale for capital investment represented in the conventional Q-Theory of investment.

The term $\mathcal{F}_t$ in (24) is defined as

$$\mathcal{F}_t \equiv \frac{1}{1+\mu_t} \mathbb{E}_t \left[M_{t,t+1} \left((1+\mu_{t+1}) \frac{\psi}{2} \ell_{t+1}^2 + \lambda \eta_{t+1} \right) \right]. \tag{26}$$

Therefore, $\mathcal{F}_t$ captures the value of additional capital through lower future bond issuance costs and, when the collateral constraint binds, greater debt capacity. Unlike in the finite-horizon model, where current capital is predetermined when bond issuance is chosen, capital accumulation in the infinite-horizon model also improves future financing conditions. Investment and bond issuance decisions are therefore dynamically linked even away from binding constraints, with financial constraints further strengthening this connection.

The optimal issuance decision derived from the firms' first order conditions is

$$B_t = \frac{K_t}{\psi}\Bigg[\underbrace{P_t^L - \frac{1}{1+\mu_t}\mathbb{E}_t\left[M_{t,t+1}\left((1-\delta_B)P_{t+1}^L + c + \delta_B\right)(1+\mu_{t+1})\right]}_{\text{Financing Motive}} + \zeta\frac{\mathbb{E}_t\left[M_{t,t+1}(1+\mu_{t+1})\right]}{1+\mu_t} - \frac{\eta_t}{1+\mu_t}\Bigg]. \tag{27}$$

Optimal issuance has several intuitive properties. First, issuance is higher when the current bond price is high relative to its expected price path, which I denote the *Financing Motive* for corporate issuers. Furthermore, bond issuance scales proportionally with capital which implies that a larger corporate sector will supply more bonds, holding all else constant. The second term in (27) reflects that the debt benefit, ζ, will generate an inclination for positive supply of bonds in equilibrium. The final term reflects that the shadow values of financial frictions (μ_t, η_t) can lower bond issuance.

5.2 Bond Markets and Equilibrium

Financial Assets. There are two classes of assets in this economy. The first asset is a one-period government bond, which carries yield r_{t+1}. The second asset class consists of long-term bonds supplied by both firms and the government. I denote the supply of long-term government bonds G_t. As in the finite-horizon model, corporate bonds carry no default risk and there is no Treasury convenience yield, so both sources of long-duration debt trade in a single market.

Long-term bonds are decaying perpetuities, with price and one-period return

$$P_t^L = \frac{c + \delta_B}{\exp(y_t^L) - (1-\delta_B)}, \tag{28}$$

$$R_{t+1}^L = \frac{c + \delta_B + (1-\delta_B)P_{t+1}^L}{P_t^L}. \tag{29}$$

The central bank sets the short rate according to

$$r_{t+1} = \log\left(1 + \exp\left[\mu_r + \rho_r \log\left(e^{r_t} - 1\right) + \widetilde{\sigma}_r \varepsilon_t\right]\right), \qquad \varepsilon_t \sim N(0,1). \tag{30}$$

The transformed short rate $\log(e^{r_t}-1)$ follows an AR(1) process with intercept μ_r, persistence ρ_r, and innovation standard deviation $\widetilde{\sigma}_r$. This specification ensures positive interest rates. As in the segmented-markets literature (Vayanos and Vila, 2021; Greenwood, Hanson, and Vayanos, 2024), monetary policy is represented by an exogenous, mean-reverting short-rate process, with interest rate uncertainty generating time-varying risk in the economy.

Bond Investors. The first type of investor is a *preferred habitat* investor. These agents demand a quantity of long-term bonds according to an exogenous, price-dependent demand curve, $H(P_t^L)$, generalizing the fixed value of holdings in Section 4. This mass of investors is a stand-in for empirical counterparts such as commercial banks, life insurers, and pension funds who operate with fixed investment mandates to hold long-term debt as an investment vehicle or part of regulation (Greenwood, Hanson, and Vayanos, 2024).

The marginal investors in the long-term bond market continue to be risk-averse *arbitrageurs* with mean-variance preferences over next-period returns, as in Section 4. Arbitrageurs live for two periods. In period t these financial intermediaries are endowed with exogenous wealth W and optimally invest in short-term and long-term debt to maximize the return on their wealth.[17] In the second period, they consume their returns and perish, and a new arbitrageur makes its portfolio choice.

This formulation follows the preferred habitat and segmented bond markets literature, where the financial sector has constant risk-bearing capacity (Greenwood, Hanson, and Vayanos, 2024). The arbitrageur solves

$$\begin{aligned} &\max_{\omega_t} \mathbb{E}_t\left[\frac{W_{t+1}}{W}\right] - \frac{\gamma}{2}\mathrm{Var}_t\left(\frac{W_{t+1}}{W}\right) \\ &W_{t+1} = W\left(R_{t+1} + \omega_t\left(R_{t+1}^L - R_{t+1}\right)\right), \end{aligned} \tag{31}$$

where $R_{t+1} = 1 + r_{t+1}$ is the risk-free return of holding short-term government bonds. The arbitrageur's optimal portfolio is

$$\omega_t = \frac{1}{\gamma}\frac{\mathbb{E}_t\left[R_{t+1}^L\right] - R_{t+1}}{\sigma_t^2}, \tag{32}$$

[17] Endogenous investor wealth dynamics would be an important extension. As Kekre, Lenel, and Mainardi (2026) demonstrate, endogenous risk-bearing capacity from investors is an alternative source of state dependence in long-term asset prices.

where γ is the risk aversion of the arbitrageur, and σ_t^2 is the endogenous conditional variance of long-term bond returns.

Equilibrium. The long-term bond market clears when arbitrageur and preferred habitat demand are equal to the supply of long-term bonds,

$$\omega_t(P_t^L)W + P_t^L H(P_t^L) = P_t^L B_t + P_t^L G_t. \tag{33}$$

An equilibrium consists of firm policies (24) and (27), household consumption and savings detailed in Appendix E.1, arbitrageur portfolios (32), preferred-habitat demand $H(\cdot)$, and long-term bond prices, $P_t^L(\cdot)$, such that all agents optimize and (33) clears the market.

5.3 Asset Pricing with Endogenous Supply

Before calibrating the model, I provide a theoretical comparison across economies to highlight how financial frictions, issuance costs, and risk-averse bond investors shape equilibrium asset prices.

I define the term premium in an economy as the excess return from holding a long-term bond relative to the risk-free one-period bond,

$$\mathrm{TP}_t \equiv \mathbb{E}_t[R_{t+1}^{(L)}] - R_{t+1}\,. \tag{34}$$

Proposition 4 (Term Premia across Economies)**.** *Suppose the owner of the firms is risk-neutral. Consider three economies with otherwise identical parameters and processes,*

1. ***Risk-neutral investors*** *(RN)**:*** $\gamma = 0$.
2. ***Frictionless issuers*** *(F)**:*** $\gamma > 0$*, but no financial constraints or issuance costs.*
3. ***Baseline:*** *the economy detailed in this section.*

Assume each economy admits an equilibrium with $B_t > 0$ and positive, no-bubble bond prices. If the baseline economy's current dividend constraint is slack, $\mu_t = 0$, and $\omega_t \geq 0$, then

$$0 = \mathrm{TP}_t^{RN} \leq \mathrm{TP}_t \leq \mathrm{TP}_t^{F} = \frac{\zeta}{P_t^{L,F}}, \tag{35}$$

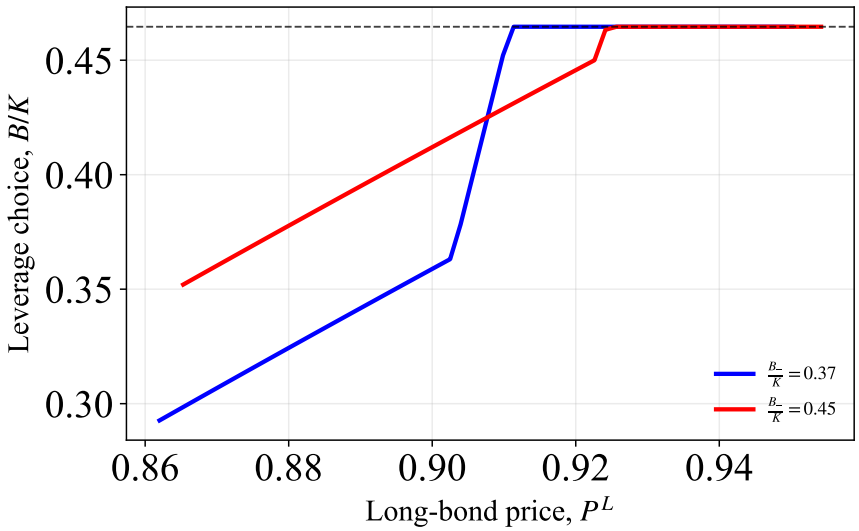
where $P_t^L \geq P_t^{L,F} = \left(1 - \frac{\zeta}{c+\delta_B}\right) P_t^{RN}$.

I compare the infinite-horizon economy with two benchmarks to highlight the joint roles of risk-averse bond markets and frictional bond issuance in equilibrium asset prices. The first benchmark has risk-neutral arbitrageurs, which implies bond prices equal the expected

present value of future payments discounted at short-term risk-free rates. The second benchmark has frictionless issuance of long-term bonds, but preserves the asset pricing environment. To discipline equilibrium term premia across these economies, I assume the natural equilibrium conditions that there is positive bond supply, finite bond prices, and weakly positive arbitrageur holdings of long-term bonds.

Under these definitions, the term premium in the proposed model is bounded above by a frictionless benchmark and below by the risk-neutral premium. Without issuance frictions, bond supply is perfectly elastic and adjusts to clear the market, leaving risk-averse investors holding enough duration to generate a term premium of $\mathrm{TP}_t^F = \frac{\zeta}{P_t^{L,F}} > 0$.[18] With risk-neutral investors, arbitrageur demand is perfectly elastic which implies $\mathrm{TP}_t^{RN} = 0$. Arbitrageurs absorb residual supply without compensation for duration risk, so bond prices depend on the short-rate process independently of bond supply and habitat demand. With frictional corporate bond supply and risk-averse investors, supply is not perfectly elastic and investors demand compensation for duration risk, placing the term premium between these limiting cases.

Figure 8: Partial Equilibrium Supply Curves



Notes: The figure plots partial equilibrium bond supply under the baseline calibration described in Section 6, for initial leverage $\ell = B_{t-1}/K_t$ of 0.37 (blue) and 0.45 (red). The y-axis is chosen leverage, B_t/K_t, and the x-axis is the current long-term bond price. The path of future bond prices is held fixed at its general equilibrium value while the current price varies. The horizontal line represents the leverage limit, λ.

Figure 8 illustrates the nonlinear supply curve with issuance frictions in (27). At low prices, the dividend constraint binds; at intermediate prices, neither constraint binds and

[18] Note that ζ, the repayment benefit, partially determines the supply of corporate bonds and is reflected in the term premium.

supply is elastic; at high prices, firms issue up to the collateral constraint. Higher initial leverage expands the range over which financing is constrained. This nonlinearity generates state-dependent issuance in the quantitative analysis.

6 Quantitative Analysis

In this section, I calibrate the quantitative model described in Section 5 and use the calibrated model to quantify the effects of endogenous bond supply on monetary transmission through counterfactual exercises. First, I compare monetary transmission for two different economies. I compare transmission around the steady state of the economy, which I consider a normal economic period, to monetary transmission in a financially constrained economy, calibrated to the financial capacity of bond issuers in 2009. This counterfactual exercise replicates the time-series and cross-sectional patterns of Section 3, where constrained financial capacity states cause conventional rate cuts to pass through strongly to long-term yields but result in limited bond issuance and investment responses relative to the steady state economy. The second analysis studies the joint real and financial effects of asset purchase policies, quantitative easing, across issuer financial states. I find that conventional and unconventional policies operate through distinct channels, and LSAPs are most effective when issuers have capacity to issue additional bonds but pay no dividends.

6.1 Estimation and Calibration

This section describes how I solve and calibrate the theoretical framework of Section 5.

6.1.1 Model Solution

The general model's equilibrium is defined in Section 5.2. To solve this system of equations, I follow a global solution algorithm detailed in Appendix F.1. I implement a global solution because a time-varying term premium is both one of the model's central mechanisms for real transmission and one of its main quantitative outcomes. Standard DSGE methods, particularly for heterogeneous-agent economies, typically linearize around the steady state and compute responses to small, unexpected shocks along perfect-foresight transition paths (Reiter, 2009; Boppart, Krusell, and Mitman, 2018). As emphasized by Auclert et al. (2021), this approach is inappropriate when risk premia are central equilibrium objects. In this environment, the term premium is jointly determined by firms' endogenous bond issuance, the state of issuers' balance sheets, and intermediaries' risk-bearing capacity. I therefore use

the global nonlinear solution to compute generalized impulse responses that integrate over future uncertainty along the transition path.

6.1.2 Calibration

The model is calibrated such that a period is a month. Additional calibration details on joint parameter identification and data used in the calibration are documented in Appendix F.3. I divide the structural parameters of the model into two groups: fixed parameters and internally calibrated parameters.

Externally Fixed Parameters. Table 1 details the model parameters that are fixed externally. I set firm-level returns to scale to $\alpha = 0.7$, in the middle of decreasing-returns estimates of Li, Whited, and Wu (2016) and consistent with calibrations in the quantitative macro-finance literature, such as Ottonello and Winberry (2020) and Jungherr et al. (2024). For scaling parameters, I set the scalar on firm revenue to $A = .1$ and the coupon rate to be 4% annually.[19] To study a benchmark, I parametrize the representative household which owns the firms to be risk-neutral and discount at rate $(1 + r_{t+1})^{-1}$.

Table 1: Externally Fixed Parameters.

Parameter	Description	Value	Target
Firm			
α	Return to Scale	0.7	Literature (Li, Whited, and Wu, 2016)
λ	Leverage Constraint	0.465	$p_{90}\left(\widehat{\ell}_t\right)$
A	TFP scalar	0.1	Normalization
Bonds			
c	Annual Coupon Rate	4.0%	Median Treasury Bond Coupon: 4.375%
δ_B	Amortization Rate	0.83%	10-Year Maturity upon Issuance
γ	Arb. Risk Aversion	4.0	Kekre, Lenel, and Mainardi (2026)
Interest Rate			
$\bar{r}$	Mean short-term rate	0.29%	Avg. 1-Year Treasury Yield = 3.51%
σ_r	Short-rate volatility	0.211%	S.d. 1-Year Treasury Yield = 2.61%
ρ_r	Short-rate autocorr.	0.991	Autocorr. Annual 1-Year Treasury Yield = 89.7%

Notes: Unless otherwise stated, values are interpreted as monthly. The Treasury yield moments are estimated on a nominal, monthly sample from 1985–2019.

The arbitrageur's risk aversion is set to $\gamma = 4$ as in the calibrated estimate in Kekre, Lenel, and Mainardi (2026). I set the amortization of bonds to be $\delta_B = 0.83\%$ to match a

[19] Both parameters primarily determine levels rather than the model's key ratios and returns. The coupon rate is consistent with coupons paid on Treasury bonds and governs the mapping from equilibrium yields into bond-price levels. The total factor productivity scalar A normalizes the scale of firm profits and capital and is chosen for numerical stability. Because the quantitative targets are ratios, returns, or dynamics, neither parameter is directly disciplined by a calibration target.

bond maturity of 10 years. In the quantitative exercises I normalize the exogenous supply of government bonds to zero, $G = 0$. The supply of government bonds is exogenous in the model and empirically does not respond systematically to monetary changes as demonstrated in Section 3.1. Therefore, government supply only shifts the level of aggregate long-bond supply and is not separately identified from the preferred habitat demand intercept, θ_0. I therefore treat the fixed supply of government bonds as a normalization.

The collateral constraint limit is set to $\lambda = 0.465$. This value is chosen because the mean issuer leverage in the data is approximately 37% and its time-series standard deviation is 4.8%. I detail how issuer leverage moments are constructed in Appendix F.3 using book leverage and firm market valuations. The leverage limit λ equals the 90^{th} percentile of empirical issuer leverage. Figure 6 provides suggestive empirical support for the parametrization of this constraint as it demonstrates that when bond issuers are below their median distance from their financial constraints, there is no significant bond issuance in response to a monetary shock. In Appendix F.6, I demonstrate that quantitative results are not sensitive to alternative calibrations of λ.

Finally, I calibrate the short-term interest rate process in (30) to target the empirical moments for one-year nominal Treasury yields from 1985–2019. I set ρ_r using the estimated persistence of Treasury yields and choose μ_r and $\widetilde{\sigma}_r$ such that $\mathbb{E}[r_t] = \bar{r}$ and $\text{SD}(r_t) = \sigma_r$. I consider this calibration a conservative benchmark, as preferred habitat models of the term structure of interest rates often calibrate the short-term interest rate process to fit additional empirical moments of long-term yields, which I leave untargeted.

Internally Calibrated Parameters. I estimate the remaining parameters by matching the model's estimated moments to empirical moments sourced from the bond-issuer panel described in Section 2, moments on broker-dealer balance sheets from the Z.1 Financial Accounts tables, and literature estimates on investment responses to policy. Table 2 reports the estimated values, targeted moments, and model fit. For the asset-pricing moments below, I target 10-year Treasury yields and use the superscript (10) for quantities associated with the model's long-term bond. The model's geometrically amortizing bond has a ten-year average maturity, and its yield serves as an approximate counterpart to empirical long-term yields.

I parametrize the preferred habitat investors by defining $H(P^{(10)})$ to be affine in log bond prices. Habitat demand is

$$H(P_t^L) = \theta_0 - \theta_y \log\left(P_t^{(10)}\right), \tag{36}$$

which follows the standard parametrization of habitat positions in the preferred habitat

literature (Vayanos and Vila, 2021; Kekre, Lenel, and Mainardi, 2026).

Table 2: Internally Calibrated Parameters.

Parameter	Description	Value	Moment	Model	Target
Bond Investors					
W	Arb. endowment	89.7	Arb. leverage	1.38	1.38
θ_0	Pref. habitat intercept	1390.6	$\mathbb{E}\left[\frac{(P^L B)^A}{(P^L B)^H}\right]$	0.10	0.10
θ_y	Pref. habitat slope	112.1	$\mathbb{E}\left[y^{(10)}\right]$	5.3%	5.0%
Firm Investment and Debt					
ζ	Debt benefit	0.032	Firm leverage, $\widehat{\ell}_t$	0.38	0.37
δ	Depreciation rate	0.83%	$\frac{I^*}{K^*}$	10.0%	10.0%
ϕ	Cap. adj. cost	0.665	$\frac{\partial I/K}{\partial MPS}$	0.54	0.55
ψ	Debt adj. cost	0.08	$\frac{\lvert\Delta B^*\rvert}{K}$	0.13%	0.16%

Notes: Moment targets are described in text. Arbitrageur leverage is calculated as the value of long-term bond holdings of broker-dealers over equity. Firm leverage is described in Appendix F.3 and uses firm book debt values from the Compustat sample described in Section 2 with the firms' market valuations. The average ratio of arbitrageur over preferred habitat bond holdings assumes arbitrageurs are broker-dealers and preferred habitat investors are life insurers. The $|\Delta B^*|$ moment is Monte Carlo simulated in the model and compared to net bond issuance over assets in the panel of bond issuers described in Section 2.

I internally calibrate the financial intermediary parameters $\{W, \theta_0, \theta_y\}$ using quarterly aggregate bond holdings from the Federal Reserve's Z.1 Financial Accounts over the 1985–2019 period. Empirically, I assign broker-dealers as the proxy for the model's arbitrageurs, and life insurers as the model's preferred habitat investors. The rationale for this mapping is that life insurers are highly exposed to duration risk and hold large quantities of long-term bonds, as shown in Table 2. Furthermore, Greenwood, Hanson, and Vayanos (2024) identify life insurers as a leading candidate for preferred habitat investors in their review of the segmented bond markets literature. I use average broker-dealer holdings of long-term corporate and Treasury bonds relative to their equity to discipline the arbitrageur wealth parameter, W. Broker-dealer holdings relative to those of life insurers discipline the intercept of preferred habitat demand, θ_0, while the average 10-year nominal Treasury yield disciplines its slope, θ_y.

I calibrate the remaining firm parameters using moments from the bond issuer panel. The bond repayment benefit, ζ, matches average issuer leverage of 0.37 in my sample, which

the model closely reproduces. Because ζ induces firms to hold positive debt in equilibrium, issuer leverage directly disciplines this parameter. I target the standard annual depreciation of 10% for capital depreciation, δ. Finally, I calibrate bond issuance costs, ψ, to unconditional quarterly bond issuance relative to total assets. In the empirical bond issuer panel, issuance is measured as the absolute quarterly change in bonds outstanding relative to total balance-sheet assets. Total assets are used in constructing empirical moments because, empirically, firms own significant assets beyond physical capital.

Following recent calibration approaches in the heterogeneous-agent New Keynesian literature, I calibrate capital adjustment costs, ϕ, using the investment response to monetary policy. Following Winberry et al. (2025), I target the peak response of the investment rate to an accommodative monetary shock from the steady state, using the aggregate investment estimates of Cloyne et al. (2023). This steady-state investment response is the model's only targeted impulse-response moment. All asset-supply, yield, and out-of-steady-state investment dynamics to policy are untargeted.

Estimation Results. The calibrated model generates meaningful variation in asset prices depending on the state of the firm issuers. I plot the equilibrium yield as a function of the state (K_t, B_{t-1}) relative to the steady state in Figure A.9. The model predicts yields are lowest when the capital stock is low and debt obligations are intermediately high- reflecting states where supply-risk is low for bond investors. As a validation exercise, I test the model's untargeted fit with time-series data through estimating time-series regressions of industrial production, long-term yields, and bond supply in Appendix F.4. I find that the model is able to reproduce the sign and relative magnitudes of the empirical comovement between these key series without having targeted these moments.

6.2 State-Dependent Responses to Conventional Monetary Policy

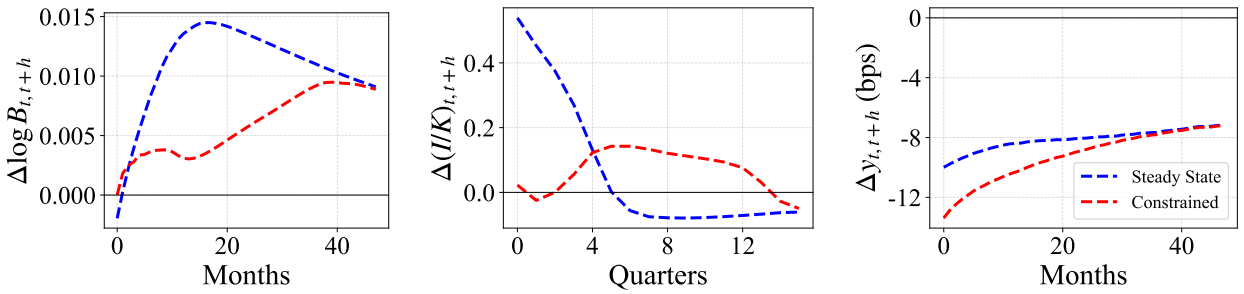
Using the calibrated model, I measure IRFs of the model's endogenous outcomes to a change in the short-term interest rate, r_{t+1}.

Throughout this subsection, I compare the *steady-state economy* with a *constrained economy*. The steady-state economy is initialized at the steady-state quantities and prices, where firms are endogenously unconstrained. The constrained economy is initialized with 97.5% of steady-state capital and 133% of the steady-state debt burden, yielding a leverage ratio 36% higher than in the steady-state economy. This calibration reflects the fact that bond issuers in 2009 had leverage ratios 36% above the sample average. Appendix F.3 provides further discussion of the calibration. The counterfactual exercises that follow can therefore be interpreted as comparisons of conventional monetary transmission during normal and crisis

periods.

A 25 bps rate cut. Figure 9 displays state-dependent IRFs for the model's key outcomes: bond issuance, investment, and long-term yields following a 25 bps rate cut in the short-term yield. I present the dynamic responses for both the steady-state and constrained economies.

Figure 9: State-Dependent IRFs to Monetary Accommodation



(a) $\Delta \log B_{t,t+h}$ **(b)** $\Delta \left(\frac{I}{K}\right)_{t,t+h}$ **(c)** $\Delta y^{(10)}_{t,t+h}$

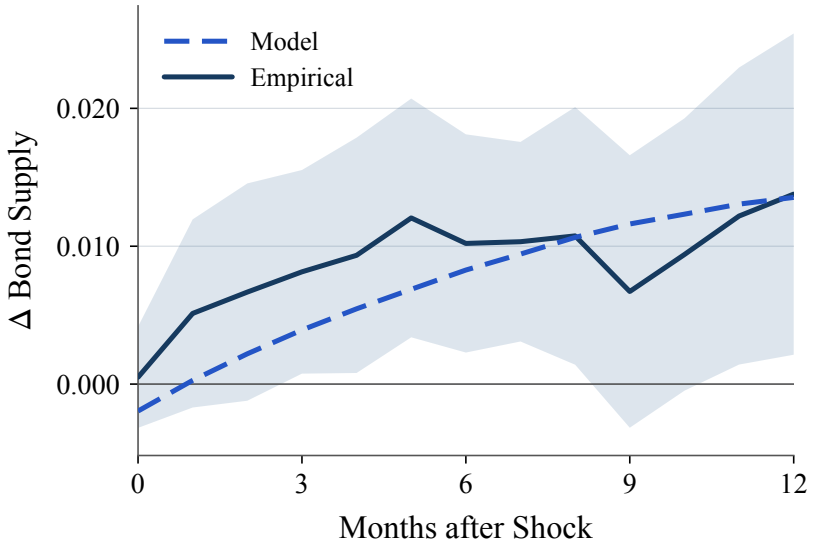
Notes: Generalized IRFs generated by Monte Carlo simulation following a 25 bps cut in the annualized 1-year rate from its steady-state level $\bar{r}$. Panel (a) plots the log face value response, Panel (b) the investment rate response (p.p.), and Panel (c) the yield response $y^{(10)}$ (bps). Horizons are measured in months for face value and yields and in quarters for investment. Blue lines show responses starting from steady-state (SS) capital and debt. Red lines show responses starting from 97.5% of SS capital and 133% of SS debt.

Panel (a) of Figure 9 plots the endogenous bond issuance of firms in different initial states due to a 25 bps rate cut, the proposed central mechanism of monetary transmission. The model predicts that in the steady state, a rate cut will raise the total stock of corporate bonds to a peak of 1.4% after 18 months. The model also implies that in the constrained economy where issuers are leverage-constrained ($\eta_t > 0$), bond issuance responses are small and delayed. The bond supply response in the constrained economy qualitatively resembles the time series results in Figure 6, where periods with low market capital ratios generated close to zero and insignificant bond issuance responses to a monetary shock in the year that follows.

Despite the impulse response of bond supply to monetary shocks not being targeted in the calibration, the steady-state dynamics follow closely the implied empirical IRF of Figure 3 for the year following the shock. To demonstrate this, I plot the direct comparison of the empirical and model response in Figure 10.

Panel (b) of Figure 9 plots the investment responses of a 25 bps rate cut. The steady-state economy's peak investment rate response to this shock is targeted to discipline the capital adjustment costs in the model, so this moment matches aggregate investment responses by design. The investment dynamics in the steady-state economy after the initial shock

Figure 10: Model vs. Data Bond Issuance Dynamics



Notes: The dashed "Model" line shows the generalized impulse response of bond supply to a 25 basis point cut in the annualized one-year rate, starting from the steady state. The solid "Empirical" line shows the local-projection response described in Panel (a) of Figure 3; the shaded band denotes its 90% confidence interval. The horizontal axis measures months after the shock, and the vertical axis reports the log response of bond supply, B_t.

follow the typical investment responses estimated in the literature for just over a year.[20] Approximately 18 months following the shock, investment rates decline, which coincides with the periods when firms' outstanding bond amounts begin to decline in the steady-state economy. This suggests that the model generates an endogenous leverage cycle because of time-varying term premia and bond supply. In the constrained economy, investment responses are initially negligible and highly delayed. After two years, capital has increased by 1.63% relative to its no-shock path in the steady-state economy, compared with only 0.59% in the constrained economy. These responses imply that the investment channel of monetary policy is of limited relevance when firms lack the financial capacity to issue bonds.

The responses of equilibrium long-term bond yields across these economies are plotted in Panel (c) of Figure 9. The model endogenously generates significant state-dependence in yield responses to monetary shocks. In the steady-state economy, a 25 bps rate cut causes bond yields to decline by approximately 10 bps. The same shock in the constrained economy results in substantially more monetary pass-through to yields on impact. The model estimates that yields decline by 13.4 bps, a 34% larger decline relative to the steady-state economy.

[20] See for example the aggregate investment IRFs estimated in Ottonello and Winberry (2020), Jungherr et al. (2024), and Winberry et al. (2025). As in these papers, the model generates immediate investment responses rather than the hump shaped responses in Christiano, Eichenbaum, and Evans (2005), because frictions are on capital rather than investment adjustment and the model does not feature habit formation.

Evaluated jointly with the bond supply responses, the calibrated model implies that increased supply of duration from the corporate sector has large effects on the yield responses to policy.

While the state-dependence of yield responses and the persistence of such responses are untargeted and qualitatively successful, the model does not generate the same level of yield pass-through as observed in the data. Given the formulation of intermediary preferences, this is an expected result. In canonical partially segmented bond market models with preferred habitat investors on which I build, long-term yields underreact relative to short-term yield movements partially because investors have constant risk-bearing capacity.[21] Given this caveat, the simulated yield responses estimated are quantitatively reasonable. In response to a similar shock in Vayanos and Vila (2021), 10-year yields decline approximately 12.5 bps unconditionally. As in Section 4, bond issuance dampens yield pass-through but in the constrained economy, the implied yield transmission to the yield curve is large.

To further characterize the equilibrium forces driving these dynamic responses, I decompose the quantitative IRFs of the investment rate and the term premium into various channels in Figure 11. Panels (a) and (b) plot the separate channels through which firms adjust their investment in response to an expansionary monetary shock. The stylized model of Section 4 implied that, when firms are unconstrained, investment responses would be independent of bond issuance. Because bond issuance and investment are dynamically linked in the infinite-horizon model (24), an initial fraction of bond issuance funds investment responses. However, as in the stylized model, most of the investment response is driven by firms adjusting their dividends, while the costs of adjusting issuance and capital work against the positive investment response. In the constrained economy, initially the bond quantity adjustment drives most of the limited investment response as predicted.

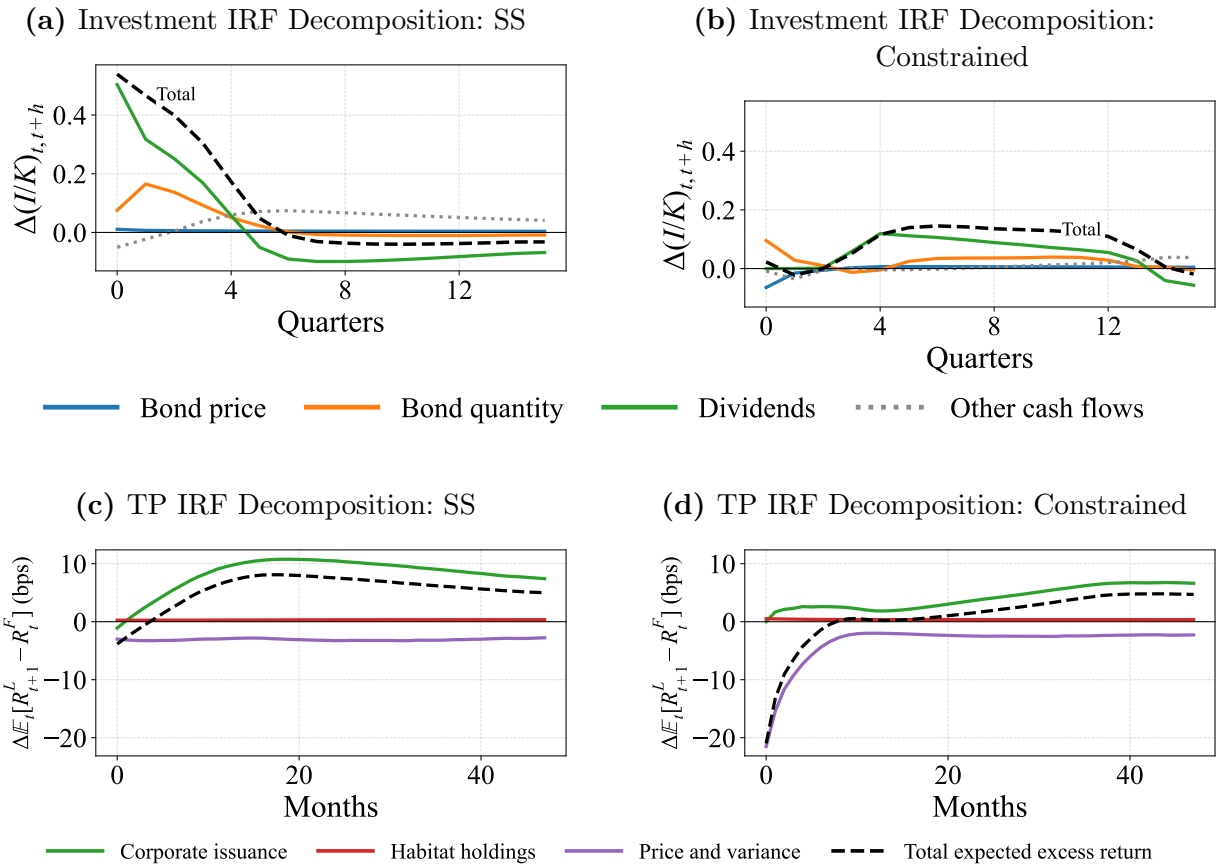
Panels (c) and (d) decompose the term premium response to an expansionary monetary shock. Consistent with empirical estimates of term premia responses to expansionary policy, I find that the term premium drops on impact in both economies (Gertler and Karadi, 2015; Hanson and Stein, 2015). From market clearing, the term premium is characterized as

$$\mathrm{TP}_t \equiv \mathbb{E}_t[R^L_{t+1}] - R_{t+1} = \frac{\gamma \sigma_t^2 P^L_t}{W} \left[B_t + G_t - H(P^L_t) \right], \tag{37}$$

where $\sigma_t^2 = \mathrm{Var}(R^L_{t+1})$. In either economy, the combined response of bond prices and return variance lowers the term premium, and corporate supply attenuates the term premium

[21] This is formalized theoretically for forward rates in a similar environment in Proposition 2 of Vayanos and Vila (2021). Because the long-term bond yield with a low coupon rate is approximately a weighted average of forward rates and a discounted cash flow correction term, to first-order this result affects this environment.

Figure 11: Quantitative IRF Decompositions



Notes: Decomposes the gIRFs of an annualized 25 bps cut in the 1-year rate starting from $\bar{r}$ annualized into distinct equilibrium channels. Panels (a) and (b) decompose the investment rate IRFs of the steady state and constrained economies into the responses of dividends, bond prices, bond quantities, and other cash flows. Panels (c) and (d) decompose the term premium responses of the steady state and constrained economies into the responses of bond prices and return variances, corporate issuance, and habitat holdings.

response. In the steady state economy, supply is elastic and after a few months the term premium response turns positive because of the increase in duration that bond investors must hold. However, in the constrained economy, the limited supply response implies that the decline in the term premium is larger and more persistent. Therefore, the model qualitatively reproduces the state-dependent term premium responses implied empirically by the regime-specific TIPS forward responses.

Additional Conventional Policy Results. Appendix F.5 shows that the model generates asymmetric responses to monetary shocks, with greater state dependence following rate cuts. The rationale for these asymmetries is due to the asymmetric nature of financial constraints. Financial constraints bind when issuance is high relative to dividends or capital, whereas contractionary shocks reduce desired issuance and therefore do not encounter the same constraints. This produces asymmetric dynamic responses. The appendix also shows

that the model qualitatively generates positive dividend responses to rate cuts after an initial decline in dividends to finance investment. I also compare dynamics to rate cuts when bonds are priced by risk-neutral intermediaries in Appendix F.7. I find that risk-neutral bond pricing cannot generate state-dependent yield responses to policy and overestimates investment responses.

6.3 The Real and Financial Transmission of Quantitative Easing

Conventional vs. Unconventional Transmission Channels. The empirical and quantitative importance of the corporate bond channel motivates asking how this channel operates under unconventional policy. A natural application is quantitative easing (QE), which directly targets the supply of long-term assets. As Droste, Ray, and Gorodnichenko (2024) discuss, identifying the mechanisms and effects of QE on both financial and aggregate outcomes has been challenging, with much of the literature approaching QE from either solely financial or solely macroeconomic perspectives. In contrast, this paper develops a segmented-market model with joint real and financial monetary transmission. Studying these channels jointly reveals that conventional monetary policy and QE are not interchangeable ways of lowering the same long-term interest rate.

Conventional policy operates through two margins. First, changes in the short rate induce investors to rebalance across maturities, moving long-term yields. Second, conventional policy changes the stochastic discount factor of the firm's owner, directly affecting the present valuation of investment, dividends, and internal funds. This second margin is the standard transmission mechanism in many macroeconomic models.

QE operates only through the first margin. Because the firm's owner is segmented from long-term bond markets, asset purchases change the term premium and price of external bond finance without directly changing the owner's stochastic discount factor. Consequently, policies producing the same long-term yield need not generate the same issuance, investment, or payout decisions. Segmentation therefore creates an additional separation between yield and real responses to unconventional policy.

Related work studies QE policies in medium-scale DSGE environments that share elements of this transmission decomposition. Chen, Cúrdia, and Ferrero (2012) model segmentation among households trading government bonds, so asset purchases affect aggregate demand through the consumption-saving decisions of long-bond holders. Carlstrom, Fuerst, and Paustian (2017) and Sims and Wu (2021) more directly connect segmented bond markets to investment by requiring a fixed share of investment to be financed with long-term debt. In those settings, firms' exposure to long-bond financing is mechanically fixed, allow-

ing the analysis to isolate how asset purchases alter long-term financing wedges, but not the endogenous determination of term premia. The present model instead endogenizes corporate bond issuance and separates the firm owner's valuation margin from investor-demand forces, making issuer capacity an endogenous state variable governing the relative transmission of QE and conventional policy.

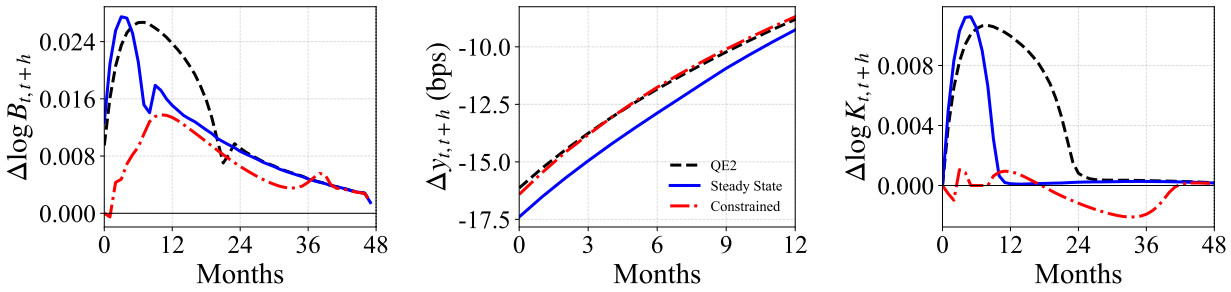
A QE2 Experiment. I model QE as a surprise increase in the intercept of preferred habitat demand, θ_0, which is mechanically equivalent to reducing the quantity of long-term bonds arbitrageurs must absorb. I calibrate the experiment to approximate the QE2 asset purchases implemented in the fourth quarter of 2010. Because the model does not provide a direct mapping from dollar purchases into θ_0, I discipline the intervention using its effect on long-term yields. Estimates of QE effects span a relatively wide range (Bhattarai and Neely, 2022). For QE2 specifically, Swanson (2011) and Krishnamurthy and Vissing-Jorgensen (2011) estimate declines of approximately 15–18 bps in 10-year yields.

In addition to the steady-state and constrained issuer states previously described, I consider a QE2 economy, where I initialize bond issuers at 114% of the steady-state leverage ratio to match issuer financial conditions in 2010Q4. All economies have the short rate initialized at 1% to approximate policy near the effective lower bound. I set the initial increase in θ_0 to 25%, which generates a 16.1 bps decline in the long-term yield in the QE2 economy, consistent with the literature estimates. I model the intervention as persistent but temporary and parametrize this through θ_0 decaying at 5% per month and set back to its baseline value after four years. Once announced, the intervention path is known with perfect foresight. I solve for policies and prices by backwards induction from the global solution and report impulse responses relative to a no-QE counterfactual under identical short-rate histories.

Figure 12 shows that the real effects of QE are not monotonically ordered by firms' financial constraints. Asset purchases lower long-term yields in all three economies, but issuance and capital respond most persistently and substantially in the intermediate, dividend-constrained region represented by the QE2 economy (black line). In the steady-state economy, the firm is already close to its optimal productive scale. Because QE lowers the term premium on external finance without changing the firm owner's stochastic discount factor, it provides little incentive to expand the capital stock. Firms instead respond to higher bond prices primarily by adjusting the timing of issuance and dividends, producing a sharp but transitory capital response. In this region, QE operates mainly as a financial shock that allows firms to restructure financing and payouts to increase shareholder value.

The real effects of QE are both effective and persistent when the dividend constraint binds but the leverage constraint remains slack, combining a high marginal value of external

Figure 12: QE2 Simulation: 25% increase in θ_0



(a) $\Delta \log B_{t,t+h}$ **(b)** $\Delta y^{(10)}_{t,t+h}$ **(c)** $\Delta \log K_{t,t+h}$

Notes: Generalized impulse responses to an announced QE2 intervention that raises the preferred habitat demand intercept, θ_0, by 25% on impact. The increase decays geometrically at a monthly persistence of 0.95 and is set exactly to zero after 48 months. Each response is the difference between the QE and no-QE economies simulated using identical short-rate histories. The solid blue line begins at the steady state, $(K_t, B_{t-1}) = (K^*, B^*)$. The dashed black line begins at the QE2-calibrated state, $(K_t, B_{t-1}) = (0.98K^*, 1.12B^*)$. The red dash-dot line begins at the adverse high-debt state, $(K_t, B_{t-1}) = (0.975K^*, 1.33B^*)$. The short rate is initialized at 1% annualized in all three simulations; the dashed black specification matches the bond-issuer and aggregate states in 2010Q4, when QE2 was implemented. The horizontal axis denotes months after the asset purchases. Panels a) and c) display the full 48-month horizon. Appendix Figure F.5 plots dividend responses and yield responses over the entire experiment.

funds with the capacity to issue bonds. This characterizes the conditions surrounding QE2 as firms begin with relatively little capital and substantial inherited debt, while higher bond prices reduce refinancing costs and increase proceeds from new issuance. Corporate bonds outstanding consequently rise by approximately 2.5% within six months and the capital stock increases by more than 1%. Because the full purchase path is announced at the outset, firms bring issuance and investment forward. Capital returns toward its counterfactual path within two years even as bond quantities remain elevated and long-term yields remain depressed. The financial effects therefore outlast the real stimulus.

The real effects of QE weaken once the leverage constraint binds. Although asset purchases continue to raise bond prices and lower measured yields, highly constrained firms cannot use those prices to issue substantially more debt or reorganize their capital structures. Issuance responds weakly and with a delay, while the capital response is small and eventually reverses. Yield responses may therefore appear similar across financial states even when real transmission differs sharply. QE works through investor demand, but investor demand affects production only when firms can elastically supply bonds. This also distinguishes QE from conventional policy. Conventional accommodation changes both investor demand and the stochastic discount factor entering the capital Euler equation, whereas QE targets only the external-finance margin. QE is therefore most effective in the intermediate region where financing needs are elevated but debt capacity remains available.

7 Conclusion

This paper demonstrates that endogenous corporate bond supply jointly shapes the real and financial transmission of monetary policy. Investment grade bonds play a dual role in financing firms' investment while simultaneously supplying dollar duration to segmented bond markets. Monetary policy therefore changes the equilibrium supply of bonds through corporate issuance in addition to investor demand for long-maturity assets. The central finding of this paper is that endogenous bond supply generates stronger transmission to investment precisely when pass-through to the yield curve is weaker.

Empirically, I document three primary facts. First, expansionary monetary policy raises aggregate corporate bond issuance. Second, issuance responses are concentrated among firms with financial capacity, and these firms use the bond proceeds to increase investment and dividends. Third, consistent with this financial capacity mechanism, long-term yields respond less when issuers are unconstrained and bond supply expands, but more when issuer constraints limit the supply response.

To interpret these findings, I develop a model in which firms issue long-term bonds to finance investment subject to financial frictions, while risk-averse intermediaries price the resulting supply in a partially segmented bond market. Endogenous issuance creates a substitution between real and yield-curve transmission. Stronger long-yield responses therefore do not indicate stronger real monetary transmission. Weak pass-through to long-term rates may reflect stronger transmission through issuance and investment rather than policy ineffectiveness. The results show that asset-market policies operate through equilibrium adjustments in both prices and quantities, making asset-supply responses essential for interpreting conventional monetary policy, quantitative easing, and related interventions in long-maturity markets.

While the paper focuses on monetary policy, the framework also could extend to a broader set of applications. By embedding production firms inside a segmented asset market, the model provides a way to study how financial-market interventions affect real activity through both prices and quantities. This structure is naturally suited to questions about financial regulation and intermediary balance-sheet constraints. In each case, policy changes the capacity or willingness of financial markets to absorb asset supply, while firms respond through financing and investment decisions. Policies aimed at asset markets can affect real activity by changing asset prices and the quantity of assets supplied by firms.

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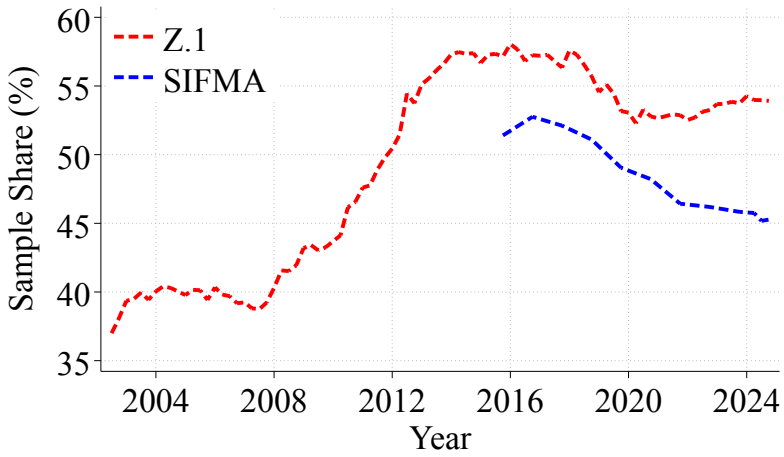
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A Additional Figures and Tables

A.1 Descriptive Figures

Figure A.1: Bond Sample Comparison to Corporate Market Values

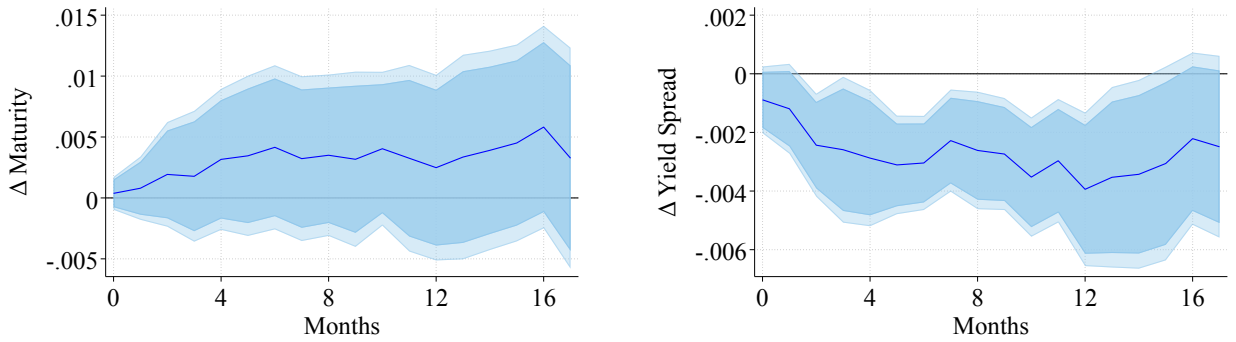


Notes: The figure reports sample bond face value as a percentage of aggregate corporate bond liabilities measured at book value. The Z.1 comparison covers U.S. nonfinancial issuers; the SIFMA comparison also includes financial issuers. Values are measured at quarter-end, with SIFMA observations available annually through 2023 and quarterly from 2024Q2.

A.2 Supplementary Cross-Sectional Analysis Results

In this Appendix, I estimate the cross-sectional exposure to monetary policy specification (4) for a variety of alternative outcomes. Figure A.2 estimates the monthly IRFs of corporate bond maturity and credit spread. The credit spread is constructed by matching the yield of a corporate bond to its implied zero-coupon Treasury equivalent by the time to maturity. In Figure A.3, I plot the estimated cross-sectional IRFs of firm sales and EBITDA. Finally, Figure A.4 plots the cross-sectional IRFs for firm liquidity and the number of its own shares repurchased within a given quarter. Firm liquidity is constructed as net short-term assets over total assets.

Figure A.2: Differential Maturity and Credit Spread Response

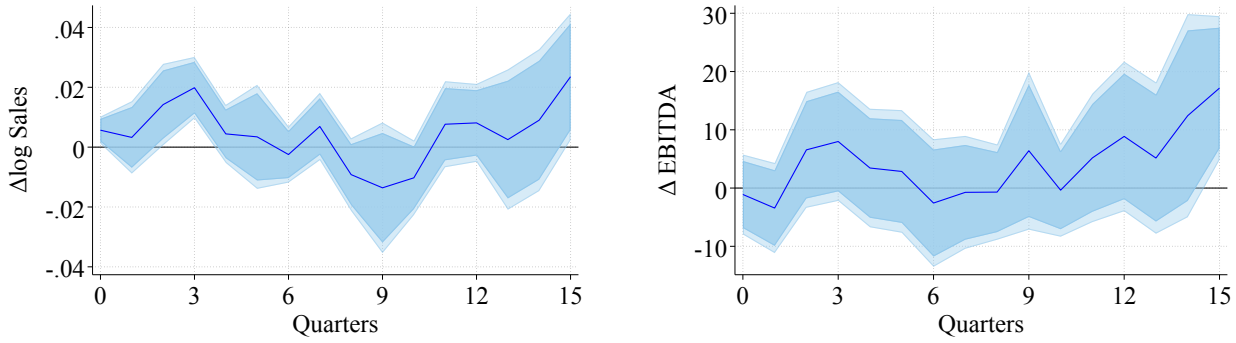


(a) Differential Issuer Maturity (Years) Responses

(b) Differential Credit Spread Response (0.01 = 1%)

Notes: Differential impulse response functions to 25 bps rate cut. The figures plot β^h coefficients estimated from (4) for horizons $h = 0, \ldots, 17$. The distance from financial constraint measure, $f_{j,t-1}$, is the issuers' market capital ratio defined in (2), where $f_{j,t-1}$ has been normalized so units are standard deviations within sample. Lighter and darker bands denote 95% and 90% confidence intervals, respectively, based on standard errors two-way clustered by firm and date with a 12-month HAC correction in the time dimension.

Figure A.3: Differential Firm Sales and Earnings Dynamics

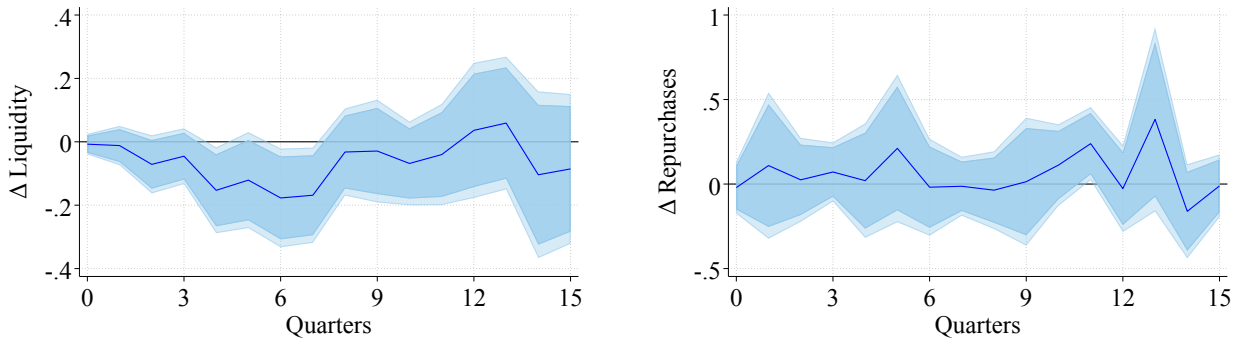


(a) Differential Sales Response

(b) Differential EBITDA Response

Notes: Differential impulse response functions to 25 bps rate cut. The figures plot β^h coefficients estimated from (4) for horizons $h = 0, \ldots, 15$. The distance from financial constraint measure, $f_{j,t-1}$, is the issuers market capital ratio defined in (2), where $f_{j,t-1}$ has been normalized so units are standard deviations within sample. Lighter and darker bands denote 95% and 90% confidence intervals, respectively, based on standard errors two-way clustered by firm and date with an 8-quarter HAC correction in the time dimension. EBITDA responses are in changes of millions of dollars.

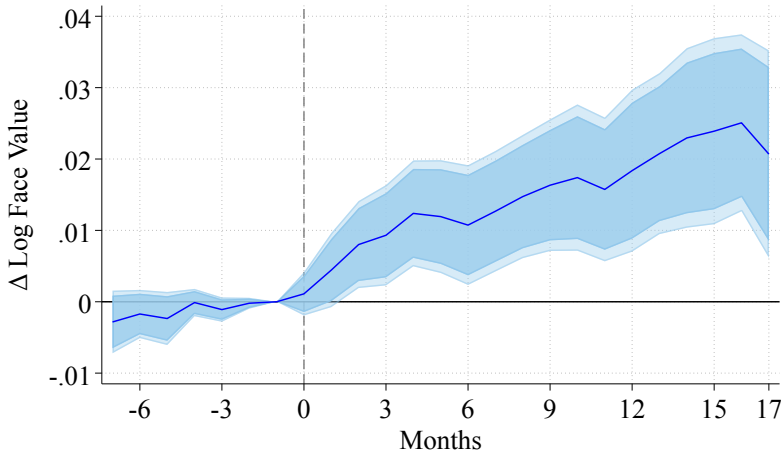
Figure A.4: Differential Liquidity and Repurchase Dynamics



(a) Differential Liquidity Response **(b)** Differential Share Repurchase Response

Notes: Differential impulse response functions to 25 bps rate cut. The figures plot β^h coefficients estimated from (4) for horizons $h = 0, \ldots, 15$. The distance from financial constraint measure, $f_{j,t-1}$, is the issuers market capital ratio defined in (2), where $f_{j,t-1}$ has been normalized so units are standard deviations within sample. Lighter and darker bands denote 95% and 90% confidence intervals, respectively, based on standard errors two-way clustered by firm and date with an 8-quarter HAC correction in the time dimension. Liquidity is measured as the ratio of net short term assets over total assets at the firm.

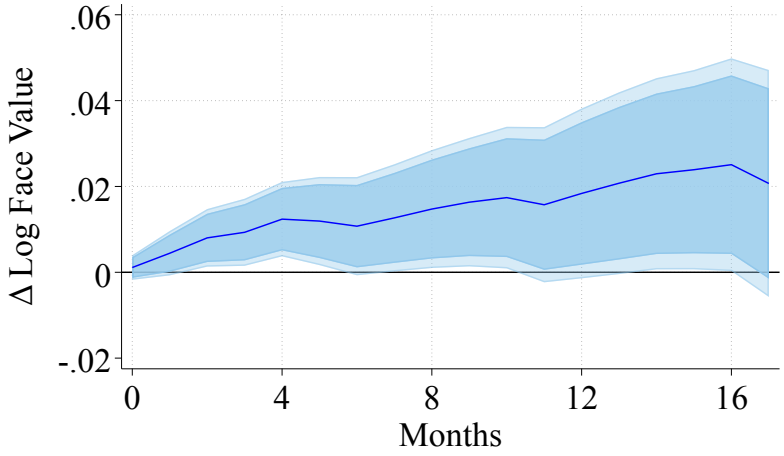
Figure A.5: Differential Net Issuance (Pre-Trend)



(a) Differential Face Value Outstanding Response

Notes: Differential impulse response function to 25 bps rate cut. The figures plot β^h coefficients estimated from (4) for horizons $h = -7, \ldots, 17$. The distance from financial constraint measure, $f_{j,t-1}$, is the issuers market capital ratio defined in (2), where $f_{j,t-1}$ has been normalized so units are standard deviations within sample. Lighter and darker bands denote 95% and 90% confidence intervals, respectively, based on standard errors two-way clustered by firm and date with a 12-month HAC correction in the time dimension.

Figure A.6: Differential Net Issuance Dynamics (Two-way Clustered)

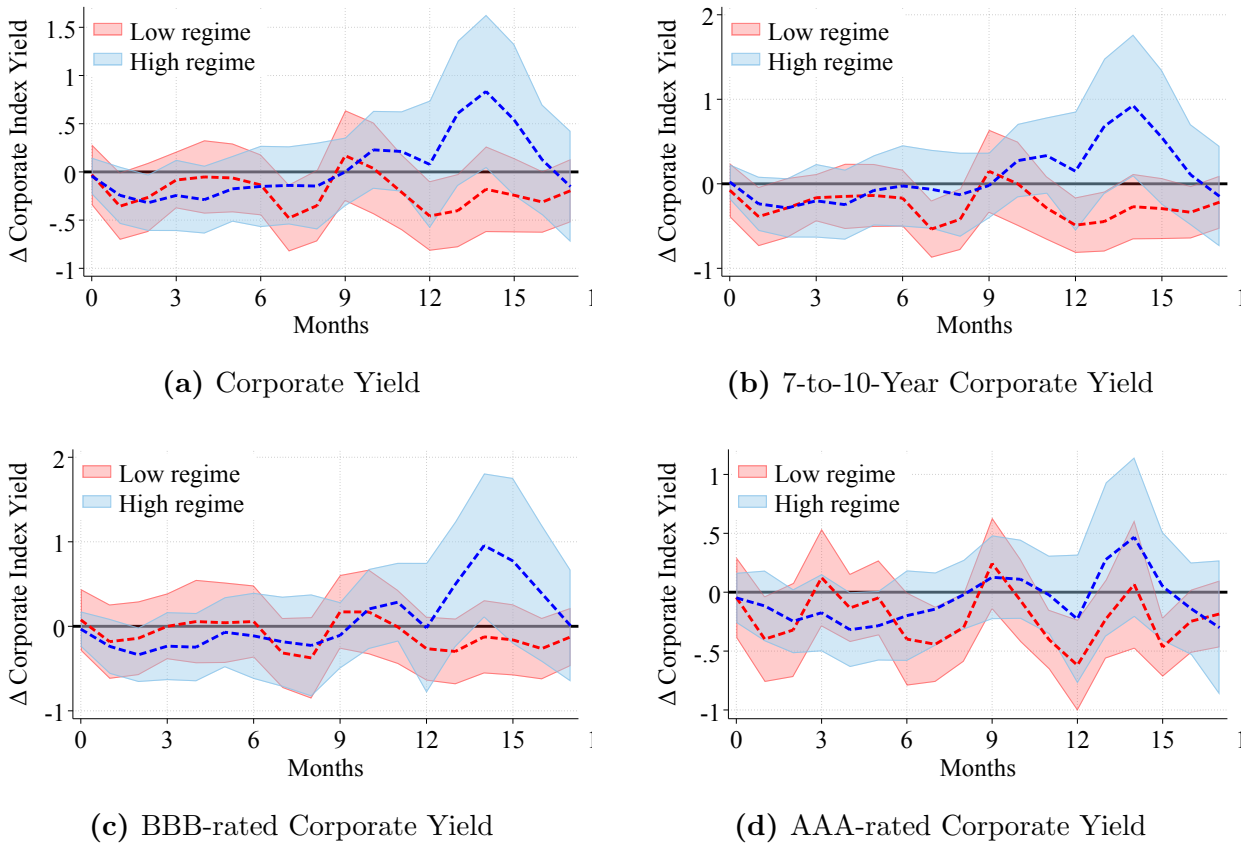


(a) Differential Face Value Outstanding Response

Notes: Differential impulse response functions to 25 bps rate cut. The figures plot β^h coefficients estimated from (4) for horizons $h = 0, \ldots, 17$. The distance from financial constraint measure, $f_{j,t-1}$, is the issuers market capital ratio defined in (2), where $f_{j,t-1}$ has been normalized so units are standard deviations within sample. Lighter and darker bands denote 95% and 90% confidence intervals, respectively, based on standard errors two-way clustered by firm and date.

A.3 State-Dependent Localization of Yield Responses

Figure A.7: Regime-Specific Corporate Bond Index Yield Responses to Monetary Shocks



(a) Corporate Yield

(b) 7-to-10-Year Corporate Yield

(c) BBB-rated Corporate Yield

(d) AAA-rated Corporate Yield

Notes: Regime-specific impulse response functions. Dependent variables are corporate bond index yields from Moody's. The figures plot $\gamma_{\mathcal{I}}^{h}$ coefficients estimated from (5) for horizons $h = 0, \ldots, 17$. Regime $\mathcal{I}_{t-1}$ is determined by whether the aggregate bond issuer market capital ratio is above its time series median. Bands are 90% confidence intervals calculated from Newey-West standard errors with h lags per horizon. The y-axes are in percentage points.

Table A.1 reports the estimated regime-specific responses approximately one year after a 25 basis point monetary-policy easing. At maturities of two to four years, the high- and low-regime responses are not statistically distinct from each other. The difference increases with maturity and is largest between six and ten years, where the high-minus-low gap is approximately 0.46 percentage points and statistically significant at the 5 percent level. The difference is at least marginally significant for maturities 5 through 13 years before declining at the longest maturities. Economically, yields in the low regime decline substantially at these maturities, whereas the corresponding high-regime responses are close to zero. Thus, the state dependence is concentrated near the maturity range in which corporate issuance is most active, rather than being uniform across the yield curve. This maturity profile is consistent

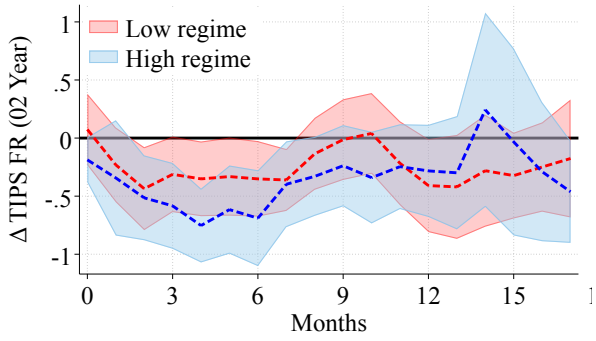
Table A.1: High-versus-Low TIPS FR Responses One Year Ahead

Maturity	γ^H	γ^L	$\gamma^H - \gamma^L$	t-statistic	p-value
2	-0.246	-0.217	-0.029	-0.088	0.930
3	-0.121	-0.410	0.289	0.931	0.353
4	-0.072	-0.492	0.420	1.454	0.148
5	-0.033	-0.526	0.493*	1.812	0.072
6	-0.005	-0.527	0.523**	2.062	0.041
7	0.016	-0.503	0.519**	2.197	0.029
8	0.032	-0.465	0.497**	2.234	0.027
9	0.046	-0.419	0.465**	2.183	0.030
10	0.055	-0.371	0.426**	2.064	0.040
11	0.062	-0.325	0.387*	1.917	0.057
12	0.067	-0.286	0.352*	1.774	0.078
13	0.069	-0.255	0.323*	1.657	0.099
14	0.070	-0.234	0.304	1.590	0.114
15	0.071	-0.226	0.297	1.589	0.114

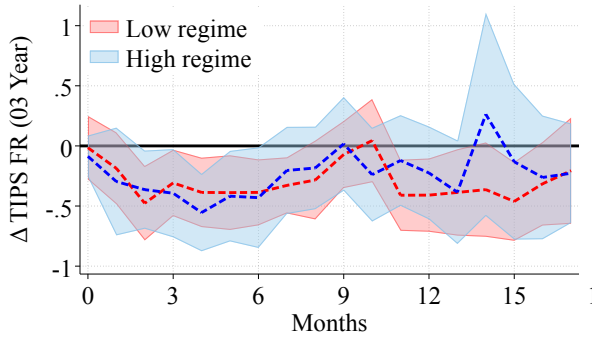
Notes: Responses are percentage points following a 25 basis point monetary-policy easing. Coefficients are generated from estimating (5). The last three columns report the high-minus-low difference and its two-sided Wald test. Newey–West standard errors use 11 lags. The estimation sample ends in December, 2019. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

with the localization mechanism. I plot the regime-specific IRFs for various horizons in Figure A.8.

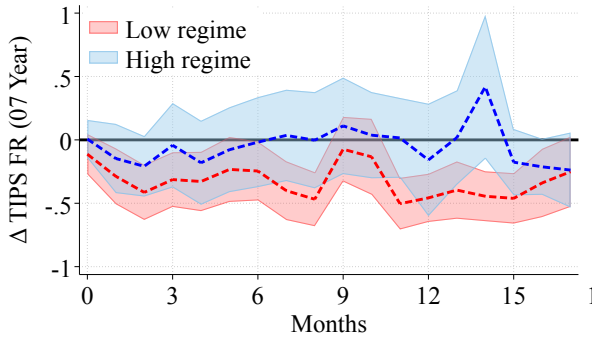
Figure A.8: Regime-Specific TIPS Responses to Monetary Shocks (Additional Maturities)



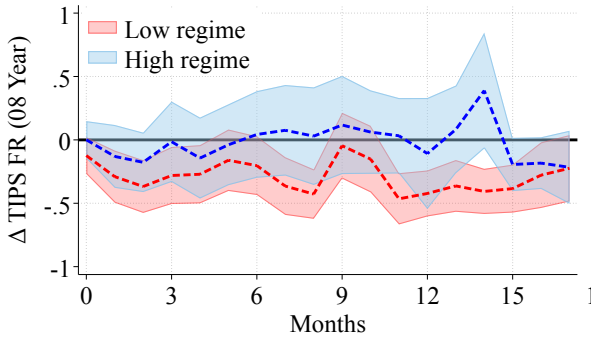
(a) 2-Year TIPS Forward Rate



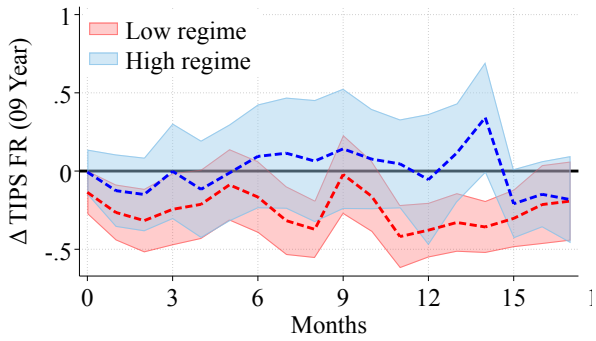
(b) 3-Year TIPS Forward Rate



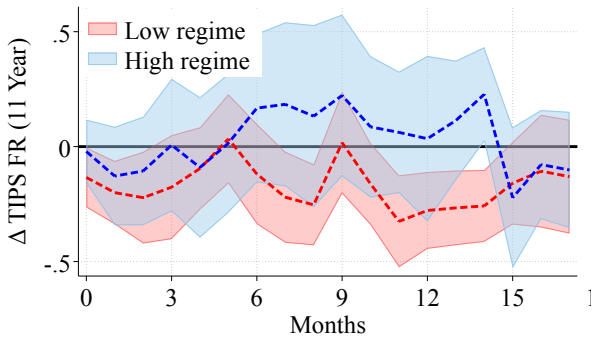
(c) 7-Year TIPS Forward Rate



(d) 8-Year TIPS Forward Rate



(e) 9-Year TIPS Forward Rate

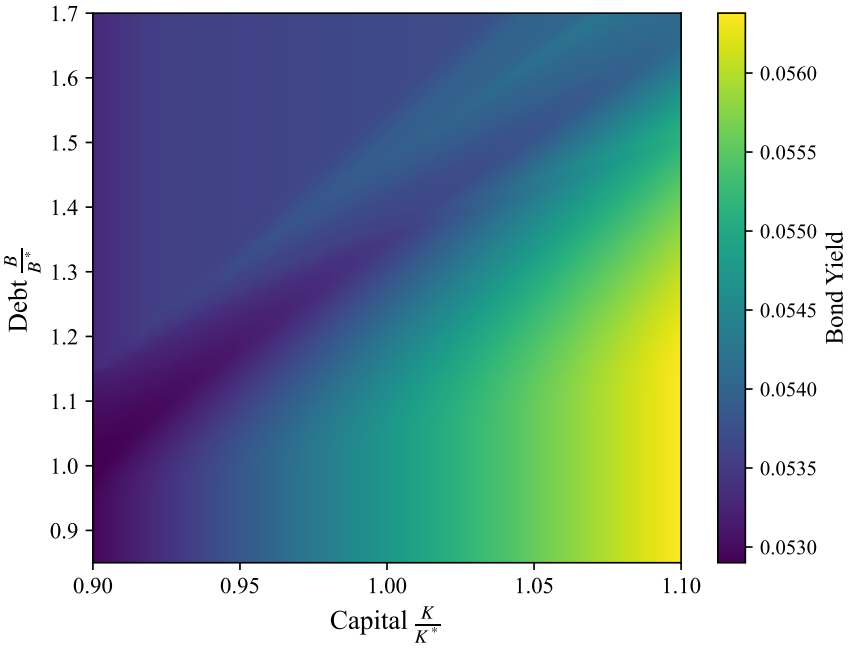


(f) 11-Year TIPS Forward Rate

Notes: Regime-specific impulse response functions. The figures plot $\gamma_{\mathcal{I}}^{h}$ coefficients estimated from (5) for horizons $h = 0, \ldots, 17$. Regime $\mathcal{I}_{t-1}$ is determined by whether the aggregate bond issuer market capital ratio is above its time series median. Bands are 90% confidence intervals calculated from Newey-West standard errors with h lags per horizon. The y-axes are in percentage points.

A.4 Additional Quantitative Figures

Figure A.9: Equilibrium Yields



Notes: Calibrated equilibrium yields for different values of $(K_t, B_{t-1}, \bar{r})$. Calibration is found in Tables 1 and 2.

B Empirical Appendix

B.1 Data Appendix

This appendix provides supplementary data construction details and summary statistics for Section 2.

Monetary Policy Shocks. The contracts used to construct the baseline monetary policy shock are primarily settled within a few months from the FOMC announcement, and the longest contract duration is a year after the announcement.

In sensitivity exercises, I confirm that the results are robust to alternative monetary policy shock measures. These include the first principal component of changes in fed funds and Eurodollar Futures contracts with maturities up to one year, as in Nakamura and Steinsson (2018) and updated by Acosta (2022); shocks orthogonalized with respect to macroeconomic and financial news, as in Bauer and Swanson (2023); and the pure monetary shocks identified from contemporaneous asset-price movements in Jarociński and Karadi (2020).

Corporate Bond Data. The TRACE data is cleaned using an algorithm that removes canceled and reversed bond trades as well as double counted agency trades.[1] Throughout the analysis, I measure bond variables at the end of the relevant month (e.g., yield is computed from the last price in a given month). Credit ratings are S&P ratings when available and Moody's ratings when S&P is unavailable.

I merge the BRDB with Mergent FISD bond data to perform additional data filtering. The sample does not include bonds issued under Rule 144A or variable coupon bonds. I further exclude convertible bonds, convertible on call bonds, exchangeable bonds, and putable bonds. I also validate principal amounts outstanding in the BRDB against the underlying FISD bond action data. I set amounts outstanding to zero before the offering month and drop observations where the BRDB reports positive amounts outstanding after maturity and default did not occur.

Firm Balance Sheets and Financial Constraints. I construct other balance sheet measures such as quarterly liquidity as balance sheet cash and short-term investments divided by total assets, and real annual sales growth.

[1] Recent work, including Dickerson, Robotti, and Rossetti (2026), has emphasized that TRACE data contains noisy transaction prices subject to measurement error which can be problematic in constructing returns. While this study does not construct bond returns, I clean the TRACE-derived prices and yields using cleaned data provided by Dickerson, Robotti, and Rossetti (2026). Specifically, whenever a bond-by-month mapping exists, I replace end of month prices and yields in my sample with the cleaned data from Dickerson, Robotti, and Rossetti (2026) whenever the absolute percentage difference relative to TRACE values in prices or yields exceeds 2.5%.

To link the BRDB to the firm balance sheets sourced from Compustat, WRDS provides crosswalks of both the BRDB and Compustat to Center for Research in Security Prices (CRSP) equity data. I crosswalk the BRDB to CRSP using bond CUSIP. Because CUSIPs can change over time, the crosswalk is only valid for specific dates. I ensure that in the crosswalk, bonds are linked to their parent company only when such historical links are valid. Compustat is similarly linked to CRSP via a firm's *permno* in a given quarter. I then restrict attention to the sample of bonds which have a valid parent company in a given month.

The market capital ratio in (2) contrasts with the book leverage ratio, $\ell_{j,t} = \frac{\text{Book Debt}_{j,t}}{\text{Book Assets}_{j,t}}$. Book leverage is backward looking and can be high either because a firm is distressed or because it has borrowed to finance projects expected to raise future value. The market capital ratio helps distinguish these cases by scaling debt by market value, which incorporates investors' expectations about future profitability and solvency.

In Appendix B, I map the market capital ratio to both a firm's book leverage and its market value of capital, $Q_{j,t}$, and relate this mapping to the theoretical model. I further construct other proxies of $f_{j,t-1}$ which include distance-to-default, the Kaplan-Zingales index, and book leverage.

Treasury Yields and Quantities. When constructing credit spreads I compare the corporate bonds to maturity-matched zero-coupon nominal yields. I drop callable Treasury bonds and notes, and exclude TIPS securities for direct comparison to nominal corporate bonds. Nominal market values are constructed by multiplying the total amount of publicly held outstanding debt by the monthly average of the bid-ask midpoint price.

Over the sample period, Treasury holdings of non-government investors average approximately \$6.7 trillion, while corporate bonds average approximately \$4.1 trillion in 2019 dollars.

Aggregate Variables. In both the cross-sectional and time series analysis, I control for and test the response of a series of aggregate variables. Series on GDP and non-residential private investment are taken from the Bureau of Economic Analysis, and I source the VIX from the Chicago Board Options Exchange. I use the Consumer Price Index (CPI) to convert variables to real values. Finally, market-level corporate bond yields for different maturities and ratings are taken from Moody's.

Bond Summary Statistics. Table B.1 reports bond-level summary statistics weighted by market value for the BRDB sample used in the subsequent empirical analysis, which requires matching to Compustat balance sheets. The average bond has over \$1 billion outstanding, matures in 8.5 years, and trades at a 4.13% yield to maturity.

Table B.1: Bond Characteristics

	Mean	Std. Dev.	10th Percentile	Median	90th Percentile
Amount Outstanding	1,141.97	1,075.88	260.06	788.47	2,489.51
Market Value	1,157.09	1,085.60	273.01	802.41	2,522.25
Numeric Rating	8.00	3.11	4.50	8.00	12.00
Coupon	4.74	2.09	2.15	4.75	7.45
Yield	4.13	2.55	1.87	4.11	6.29
Credit Spread	1.57	1.68	0.44	1.14	3.42
Years to Maturity	8.52	8.99	1.55	5.12	25.66
Duration	5.68	4.25	1.56	4.39	13.91
Ever Defaults	0.19	4.33	0.00	0.00	0.00

Notes: The sample is for 104,378 bonds from July 2002 to October 2023. Statistics are weighted by market value. Investment grade bonds comprise 84% of the market value of the sample. Amount outstanding and market value are reported in millions. Bond yields, credit spreads, and whether a bond ever defaults are reported in percentage points. The numeric rating is taken from S&P numeric ratings where an 8 corresponds to a rating of BBB+, and a 1 is AAA. These summary statistics are constructed by averaging values over a bond's life cycle.

B.2 The Market Capital Ratio

The baseline measure of $f_{j,t-1}$ in the main text is the market capital ratio. I apply this measure in a new setting to characterize the financial health of bond issuers, although it has been used in other contexts, notably as a measure of broker-dealer distance from financial constraints in He, Kelly, and Manela (2017).

The market capital ratio is not intended to isolate a single structural financing constraint. Rather, it provides a market-based measure of the firm's overall financial position. Market value capitalizes expectations about the future returns generated by the firm, while scaling this value by debt captures the value of the firm relative to its outstanding obligations. This interpretation also has a natural connection to standard Q-theory. Defining average Q as

$$Q_{j,t} = \frac{ME_{j,t} + B_{j,t}}{K_{j,t}}, \tag{B.1}$$

the market capital ratio can be written as

$$MR_{j,t} = \frac{ME_{j,t}}{ME_{j,t} + B_{j,t}} = 1 - \frac{B_{j,t}/K_{j,t}}{Q_{j,t}}. \tag{B.2}$$

Thus, the market capital ratio combines leverage relative to the firm's capital stock with the market valuation of that capital. Holding $B_{j,t}/K_{j,t}$ fixed, firms with higher Q have higher market capital ratios.

This mapping is particularly natural in the model. The firm state $K_{j,t}$ both raises produc-

tive returns and lowers borrowing costs. Accordingly, the full capital Euler equation values an additional unit of capital through both its productive return and its effect on financing conditions. The market capital ratio therefore allows the empirical measure of firm financial position to reflect both components, rather than relying only on the book value of the firm's capital stock.

A potential concern is that market valuation may also reflect firm-specific investment opportunities unrelated to financing conditions. Several features of the empirical design make this interpretation less likely. Firm fixed effects absorb persistent differences in valuation and growth opportunities across firms, while controls for the aggregate state absorb common movements in valuations and investment conditions. More importantly, as I demonstrate subsequently, the state-dependent issuance response is also present using alternative measures of financial position, including book leverage, the KZ index, and distance-to-default. Thus, the results are not specific to the market-value component of the baseline measure.

B.3 Alternative Measures of Monetary Shocks and Financial Constraints

In this appendix, I verify that use of this specific measure does not drive any of the empirical results, and that the results are broadly robust to alternative, commonly used measures of distance from financial constraints.

Alternative Measures of Distance to Financial Constraint I test robustness of the regression specifications to three alternative measures of $f_{j,t-1}$. The first is the standard *book leverage* of the firm at time $t-1$. This is constructed using balance sheet data from Compustat and is simply the ratio of total book debt to total book assets. The second measure I consider is *Distance-to-Default* (DD) proposed in Merton (1974), and I follow Gilchrist and Zakrajšek (2012) in the construction of this measure[2]. Finally, I construct the KZ index as proposed in Lamont, Polk, and Saá-Requejo (2001), following the estimation of

[2]The firm-specific DD measure is calculated as

$$DD_{j,t} = \frac{\log(V/D) + (\mu_V - 0.5\sigma_V^2)}{\sigma_V},$$

where V is the value of the firm and D is the value of debt. I solve for V numerically following Gilchrist and Zakrajšek (2012) by inferring V from the market value of the firm and the volatility of equity prices using the Black-Scholes-Merton option pricing framework.

Kaplan and Zingales (1997). The KZ index is constructed as[3]

$$KZ_{j,t} = -1.002 \times \frac{\text{Cash Flow}}{K} + 0.283 \times \text{Tobin's Q} + 3.139 \times \ell_{j,t-1} - 39.368 \times \frac{\text{Dividends}}{K} - 1.315 \times \frac{\text{Cash}}{K} . \tag{B.3}$$

Table B.2: $f_{j,t-1}$ Correlation Matrix

	Market Capital Ratio	Book Leverage	Distance to Default	Kaplan-Zingales Index
Market Capital Ratio	1.000			
Book Leverage	-0.674	1.000		
Distance to Default	0.700	-0.385	1.000	
Kaplan-Zingales Index	-0.565	0.794	-0.341	1.000

Notes: The table reports pairwise correlations among quarterly issuer-level $f_{j,t}$ variables. These correlations are estimated under the same data cleaning and sample selection steps detailed in Section 2.

In Table B.2, the pairwise correlations of possible measures $f_{j,t}$ are reported. Unsurprisingly, the market capital ratio is highly correlated with the other financial measures. It is negatively correlated with book leverage and the KZ index, which reflects that higher values of these measures conventionally imply a firm is more constrained. The market capital ratio is highly positively correlated with distance-to-default however. That these correlations are high (ranging in absolute values from 0.57 to 0.70) is reassuring and provides some external validity to the use of the market capital ratio as the baseline measure. Notably, book leverage and the KZ index are either entirely or almost entirely comprised of balance sheet characteristics. Much of the variation in distance-to-default and the market capital ratio is driven by market valuations of the firm, providing an alternative view of distance from financial constraints.

Alternative Measures of High-Frequency Monetary Shocks The literature on identifying high-frequency monetary shocks has grown substantially in recent years. The baseline measure of ϵ_t^{MPS} used in the main text is sourced from Jarociński and Karadi (2020), and is the change in Fed Funds and EuroDollar futures contracts in a 30-minute window around the FOMC announcement. These changes are then summed within a month (or quarter) for use in the empirical analysis. I test robustness of this measure in two dimensions.

Because the focus of this paper is conventional policy, I use the raw shocks in Jarociński and Karadi (2020) as the baseline measure. However, I alternatively consider the high frequency shocks developed in Nakamura and Steinsson (2018), where similarly the first principal component of changes in Fed Funds and EuroDollar Futures contracts with up to a year

[3]In (B.3), K is proxied by book assets. Cash flow is calculated as income plus depreciation and amortization. Tobin's Q is calculated as the sum of the market value of the firm, total book assets less common equity, divided by book assets. I denote book leverage as $\ell_{j,t}$.

of settlement is taken, and used as the measure for ϵ_t^{MPS}. The alternative shocks largely use similar contract maturities in their construction and allow for the monetary shock to encode a potentially wider set of monetary tools, such as medium-term forward guidance. I use a series of shocks constructed with this methodology developed in Nakamura and Steinsson (2018) and updated in Acosta (2022).

In recent years, studies including Nakamura and Steinsson (2018), Jarociński and Karadi (2020), Bauer and Swanson (2023), and Sastry (2026) have argued that measures of ϵ_t^{MPS} constructed as described above may be biased by either information revealed during the FOMC that is not directly related to monetary policy or because the Fed is responding to news which the market has not internalized. This reflects the dual role of FOMC announcements: the Fed both changes policy and signals its assessment of macroeconomic conditions, generating what Nakamura and Steinsson (2018) term the "Fed information effect." Because this informational component is partially predictable from macroeconomic and financial news, the baseline measure of ϵ_t^{MPS} may contain variation not induced by monetary policy itself. To address this concern, I test robustness of the empirical results to two separate procedures designed to isolate the monetary component of ϵ_t^{MPS} from variation driven by news or economic fundamentals.

The first measure which separates monetary shocks from information channel effects is proposed by and sourced from Jarociński and Karadi (2020). They separate monetary shocks from information shocks using high-frequency co-movement of Fed Funds futures and the S&P 500 around announcements: a rate surprise with falling stock prices identifies a monetary policy shock, while a rate surprise with rising stock prices identifies a central-bank information shock. In their baseline Bayesian VAR, these sign restrictions purge monetary shocks of the information component, statistically restricting the monetary component to resemble standard exogenous policy-rule shocks.

I also test robustness of the empirical results to accounting for potential information effects by constructing *orthogonalized* monetary shocks as proposed in Bauer and Swanson (2023). In Bauer and Swanson (2023), the first principal component changes in futures contracts around FOMC announcements are orthogonalized on a vector of macroeconomic and financial news which were in market participants' information sets prior to the FOMC announcement. To construct an orthogonalized monetary shock measure, I download replication data from Bauer and Swanson (2023), and regress the raw principal component on five of their factors: prior nonfarm payroll surprises, nonfarm payroll growth, the change in the S&P 500, a commodity price index, and the slope of the yield curve for my sample running from July 2002 to October 2023. I then aggregate over such shocks in a given month or quarter. In one

respect, I depart from their construction in excluding option-implied Treasury yield skewness from the set of shock predictors.[4]

B.4 Aggregate Bond Issuance Robustness

I replicate the aggregate bond issuance response given by specification (3) in the main text for the alternative monetary shocks. I re-estimate (3) using the pure monetary shock of Jarociński and Karadi (2020), an orthogonalized shock constructed with the data and methodology of Bauer and Swanson (2023), and the principal component of monetary shocks as in Nakamura and Steinsson (2018).

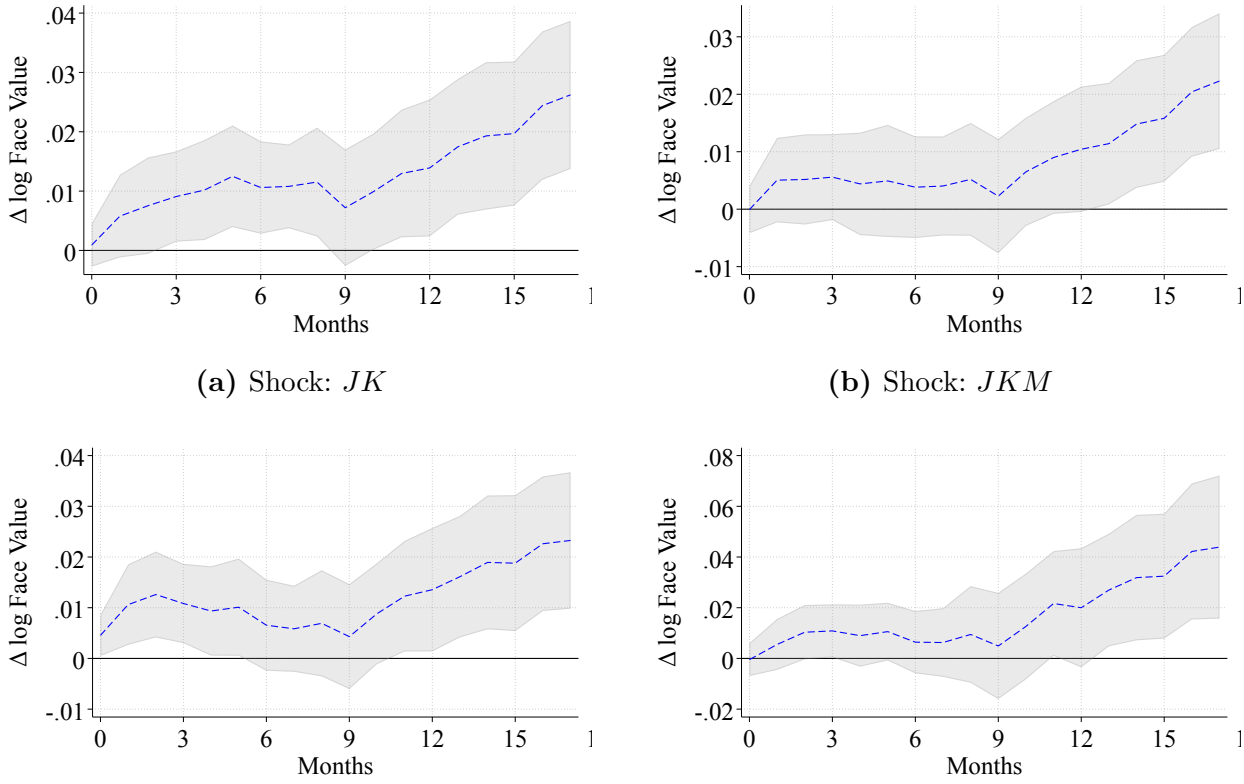
The estimated IRFs of aggregate corporate issuance for alternative measures are plotted in Figure B.1. The responses of corporate bond issuance in response to a 25 bps expansionary shock are similar across different measures of monetary policy. The orthogonalized measure estimated with the methodology of Bauer and Swanson (2023) is very similar in terms of magnitude and similar in significance to the baseline measure from Jarociński and Karadi (2020). The pure monetary shock from Jarociński and Karadi (2020) yields results very similar in dynamics and magnitude as the baseline measure with slightly larger confidence intervals at earlier horizons. Finally, using the Nakamura and Steinsson (2018) shocks yields significant and materially larger bond responses. The robustness exercise indicates that the key mechanism: endogenous bond issuance to policy, is robust across alternative measures of policy. However, the quantitative differences in the magnitude of the responses indicate that the precise magnitude of this channel in aggregate can be influenced by shock construction, particularly the maturity of futures contracts considered because of the large magnitude of the Nakamura and Steinsson (2018) responses.

For completeness to the main text, I estimate (3) for the log change in Treasury face values outstanding. The estimated IRFs are plotted in Figure B.2. As in the main text, Treasury responses are not sensitive to high frequency monetary shocks for any alternative series.

The null results in Figure B.2 do not mean that the stock of Treasury debt does not change with aggregate conditions. Instead, (3) tests whether *conditional on the aggregate state*, the Treasury responds to monetary shocks because they change the equilibrium Treasury yields. Conditional on the aggregate state, I find no evidence that the Treasury increases the quantity

[4]Treasury market skewness differs from the other predictors in that Bauer and Chernov (2024) show it forecasts bond excess returns, and hence the cost of issuing debt, rather than only the Federal Reserve's response to public information. Projecting the surprise onto it therefore may remove essential variation related directly to the mechanism: the market returns that drive issuance. I reproduce the main results to the original shock series in Figure B.8. The aggregate results are quantitatively and qualitatively similar, although the cross-sectional responses are insignificant.

Figure B.1: Aggregate Corporate Bond Quantity Responses

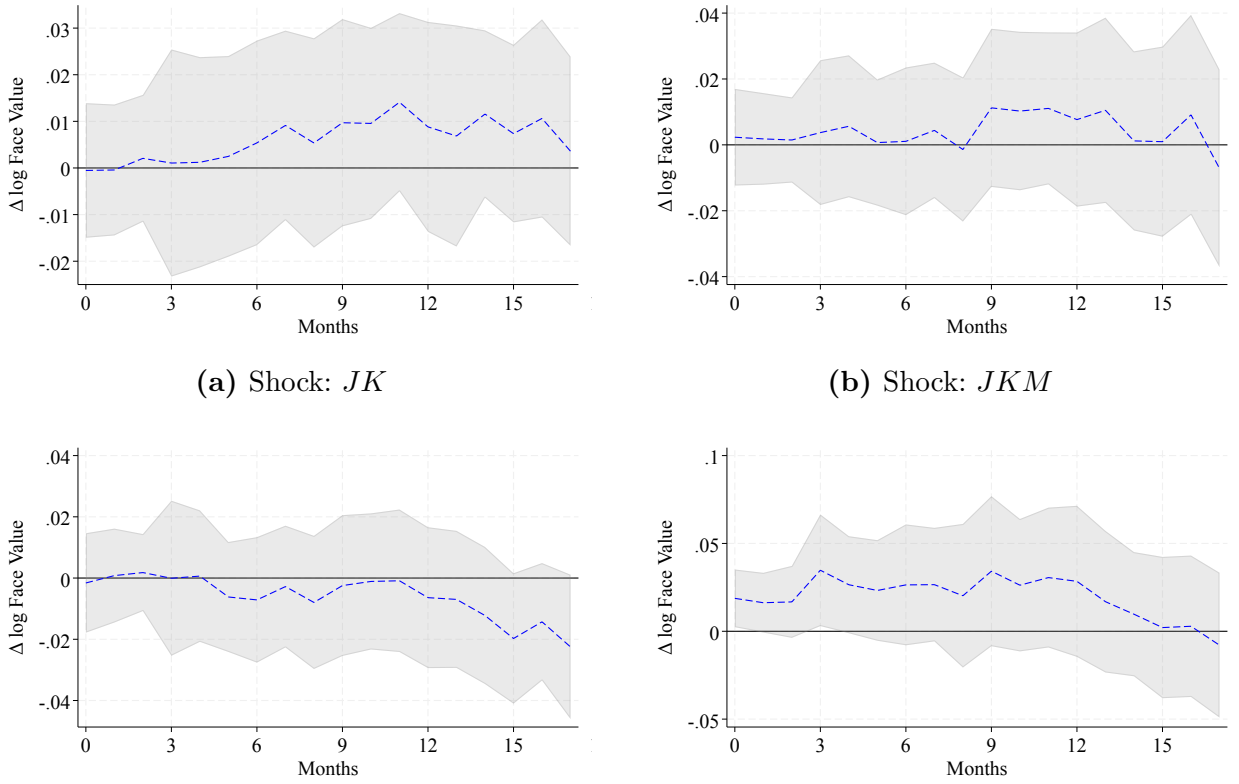


(a) Shock: JK **(b)** Shock: JKM

(c) Shock: $ORTH$ **(d)** Shock: NS

Notes: The figure plots estimated OLS coefficients of γ^h from (3) for horizons $h = 0, \ldots, 17$. Shaded bands denote 90% confidence intervals based on Newey-West standard errors with h lags per horizon. The dependent variable is the cumulative log change in corporate face value outstanding from the BRDB. The independent variable is the monetary shock, ϵ_t^{MPS}, measured in a different way for each specification. Panel (a) plots the baseline measure from Jarociński and Karadi (2020), Panel (b) plots the pure monetary measure from Jarociński and Karadi (2020), Panel (c) plots an orthogonalized measure using Bauer and Swanson (2023), and Panel (d) plots the monetary shock from Nakamura and Steinsson (2018). The IRFs are normalized to be interpreted as a 25 bps expansionary shock.

Figure B.2: Aggregate Treasury Bond Quantity Responses



(a) Shock: JK **(b)** Shock: JKM

(c) Shock: $ORTH$ **(d)** Shock: NS

Notes: The figure plots estimated OLS coefficients of γ^h from (3) for horizons $h = 0, \ldots, 17$. Shaded bands denote 90% confidence intervals based on Newey-West standard errors with h lags per horizon. The dependent variable is the cumulative log change in Treasury face values held by the public. The independent variable is the monetary shock, ϵ_t^{MPS}, measured in a different way for each specification. Panel (a) plots the baseline measure from Jarociński and Karadi (2020), Panel (b) plots the pure monetary measure from Jarociński and Karadi (2020), Panel (c) plots an orthogonalized measure using Bauer and Swanson (2023), and Panel (d) plots the monetary shock from Nakamura and Steinsson (2018). The IRFs are normalized to be interpreted as a 25 bps expansionary shock.

of Treasury bonds due to monetary shocks, indicating the Treasury may not issue more in response to bond market conditions, but instead its issuance amounts are determined by fiscal obligations.

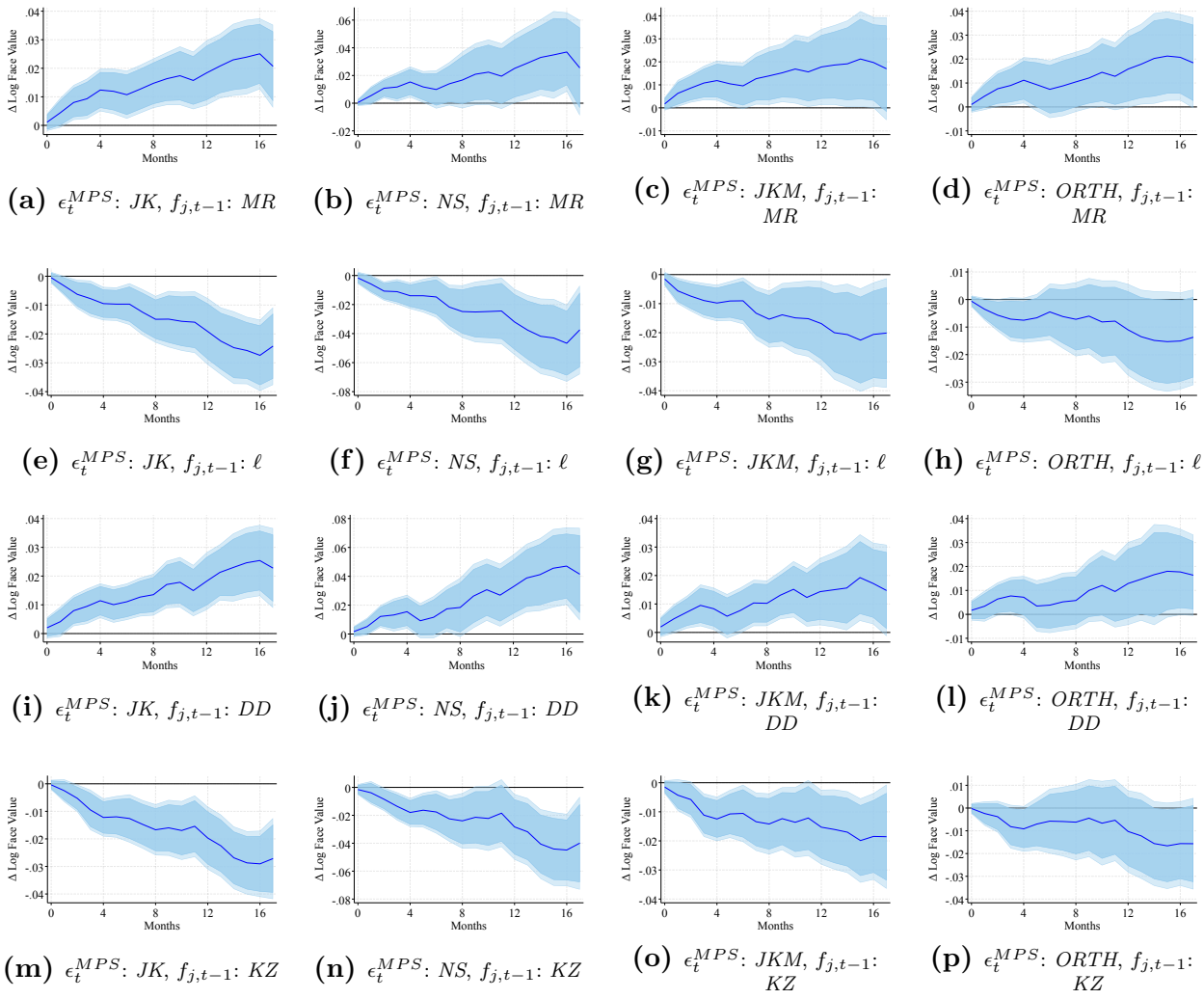
B.5 Cross-Sectional Robustness

In this section I test the robustness of the cross-sectional estimates documented in Section 3.2.

I begin by plotting the estimated impulse responses from (4) of corporate bond amounts outstanding using the alternative measures of distance from financial constraints and monetary shocks in Figure B.3. Each panel represents a different permutation of monetary shock and measure of financial constraints. Broadly, the results are very comparable across different specifications. Having higher market capital ratios or distance-to-default causes firms to issue more elastically regardless of shock construction, while higher leverage or KZ indices imply that firms are more constrained and issue less. Regardless of measure of $f_{j,t-1}$ the shocks constructed from Nakamura and Steinsson (2018) and Jarociński and Karadi (2020) are highly significant and very similar in magnitude to the estimates reported in Figure 4. Using the orthogonalized monetary shocks in the methodology of Bauer and Swanson (2023) somewhat reduces significance for some measures of $f_{j,t-1}$, but remains similar in magnitude and largely marginally significant at longer horizons. A one standard deviation increase of $f_{j,t-1}$, regardless of measure chosen, is economically significant with most measures resulting in a peak, absolute differential issuance response of between 1.5-4.5%.

The analogous impulse responses estimated from (4) of market values of bonds and changes in capital stock using the alternative measures of distance from financial constraints and monetary shocks are plotted in Figures B.4–B.5. The implied differential impulse responses for market values of bonds are highly significant and economically large across all variations of ϵ_t^{MPS} and $f_{j,t-1}$. The quarterly differential responses of capital accumulation are similar in dynamics and magnitude to those reported in Figure 5. However, there emerge some differences in significance across financial constraint measures. Largely, the market capital ratio and leverage measures show significant, large responses in the theoretically expected direction. Distance-to-default is marginally significant for some shock measures (such as orthogonalized shocks in the methodology Bauer and Swanson, 2023), whereas the KZ index largely is in the theoretically implied direction but insignificant for the shocks from Nakamura and Steinsson (2018). Given the relatively tight range in significance and magnitudes on the amount of specifications tried, I conclude that the results reported in Section 3.2 are robust to alternative measurement decisions.

Figure B.3: Differential Face Value of Bond Responses



(a) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: *MR* **(b)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: *MR* **(c)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: *MR* **(d)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: *MR*

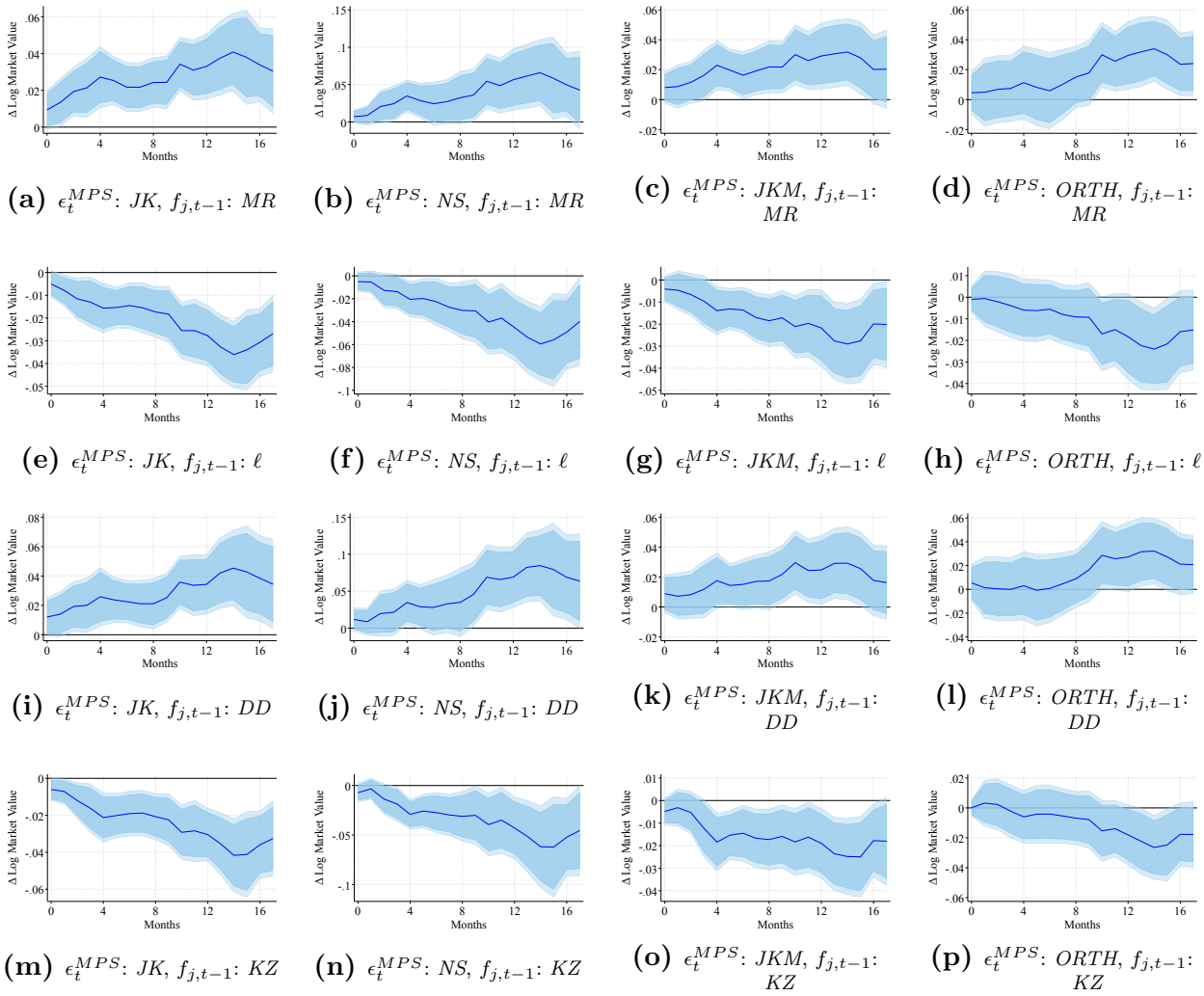
(e) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: ℓ **(f)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: ℓ **(g)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: ℓ **(h)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: ℓ

(i) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: *DD* **(j)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: *DD* **(k)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: *DD* **(l)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: *DD*

(m) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: *KZ* **(n)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: *KZ* **(o)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: *KZ* **(p)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: *KZ*

Notes: The figures plot differential impulse response functions to a 25 bps rate cut, given by the β^h coefficients estimated using (4) for horizons $h = 0, \ldots, 17$. The distance from financial constraint measure, $f_{j,t-1}$, is one of the {market capital ratio, book leverage (ℓ), distance-to-default, KZ index}, where $f_{j,t-1}$ has been normalized so units are standard deviations within sample. The shocks are *JK*: changes in interest rate futures contracts from Jarociński and Karadi (2020), *NS*: Nakamura and Steinsson (2018), *JKM*: the pure monetary shock from Jarociński and Karadi (2020), and *ORTH*: constructed similarly to Bauer and Swanson (2023). Lighter and darker bands denote 95% and 90% confidence intervals, respectively, based on standard errors two-way clustered by firm and date with a 12-month HAC correction in the time dimension.

Figure B.4: Differential Market Value of Bond Responses



(a) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: *MR* **(b)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: *MR* **(c)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: *MR* **(d)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: *MR*

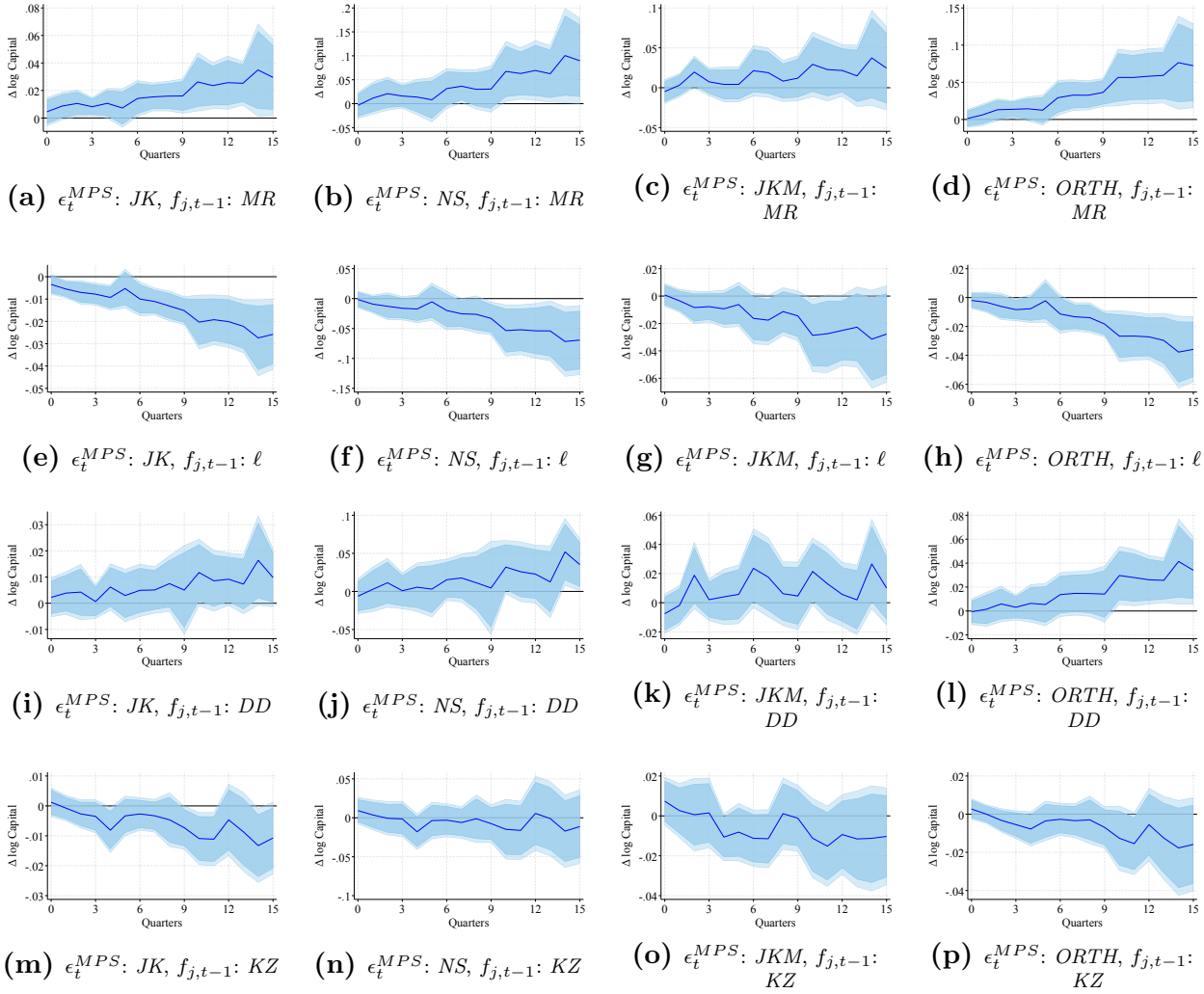
(e) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: ℓ **(f)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: ℓ **(g)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: ℓ **(h)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: ℓ

(i) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: *DD* **(j)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: *DD* **(k)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: *DD* **(l)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: *DD*

(m) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: *KZ* **(n)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: *KZ* **(o)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: *KZ* **(p)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: *KZ*

Notes: The figures plot differential impulse response functions to a 25 bps rate cut, given by the β^h coefficients estimated using (4) for horizons $h = 0, \ldots, 17$. The distance from financial constraint measure, $f_{j,t-1}$, is one of the {market capital ratio, book leverage (ℓ), distance-to-default, KZ index}, where $f_{j,t-1}$ has been normalized so units are standard deviations within sample. The shocks are *JK*: changes in interest rate futures contracts from Jarociński and Karadi (2020), *NS*: Nakamura and Steinsson (2018), *JKM*: the pure monetary shock from Jarociński and Karadi (2020), and *ORTH*: orthogonalized shocks similarly constructed to Bauer and Swanson (2023). Lighter and darker bands denote 95% and 90% confidence intervals, respectively, based on standard errors two-way clustered by firm and date with an 12-month HAC correction in the time dimension.

Figure B.5: Differential Capital Accumulation Responses



(a) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: *MR* **(b)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: *MR* **(c)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: *MR* **(d)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: *MR*

(e) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: ℓ **(f)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: ℓ **(g)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: ℓ **(h)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: ℓ

(i) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: *DD* **(j)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: *DD* **(k)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: *DD* **(l)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: *DD*

(m) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: *KZ* **(n)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: *KZ* **(o)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: *KZ* **(p)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: *KZ*

Notes: The figures plot differential impulse response functions to a 25 bps rate cut, given by the β^h coefficients estimated using (4) for horizons $h = 0, \ldots, 15$. The distance from financial constraint measure, $f_{j,t-1}$, is one of the {market capital ratio, book leverage (ℓ), distance-to-default, KZ index}, where $f_{j,t-1}$ has been normalized so units are standard deviations within sample. The shocks are *JK*: changes in interest rate futures contracts from Jarociński and Karadi (2020), *NS*: Nakamura and Steinsson (2018), *JKM*: the pure monetary shock from Jarociński and Karadi (2020), and *ORTH*: orthogonalized shocks similarly constructed to Bauer and Swanson (2023). Lighter and darker bands denote 95% and 90% confidence intervals, respectively, based on standard errors two-way clustered by firm and date with an 8-quarter HAC correction in the time dimension.

B.6 Time Series Robustness

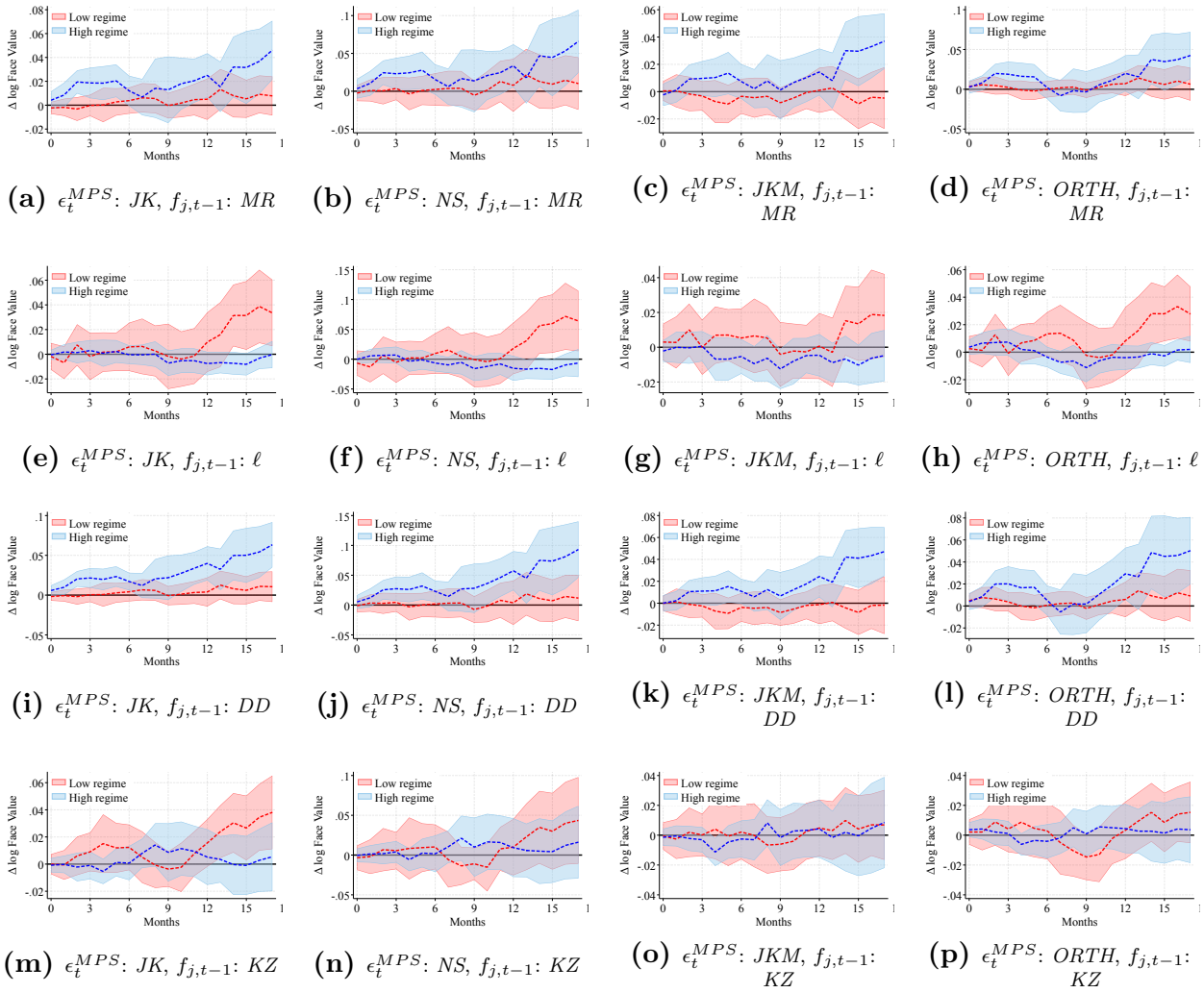
Finally, the regime-switching LLP analysis of Section 3.3 is re-estimated for the sets of alternative distances of financial constraints $f_{j,t-1}$ and monetary shock, ε_t^{MPS}. In Figure B.6, I plot the estimated face value measures under the alternative measures. Broadly, the results are consistent with Panel (a) of Figure 6 in the main text. That there is higher issuance in more high financial capacity states is consistently true for the shocks sourced from Jarociński and Karadi (2020) and Nakamura and Steinsson (2018) and the orthogonalized shocks constructed as in Bauer and Swanson (2023). The Kaplan-Zingales index appears less informative in determining state-dependent responses for late horizons for most of the shock measures except the baseline raw surprise of Jarociński and Karadi (2020). The distance-to-default responses are similar to the market capital ratio regime responses for all shock measures, generally large and even more significant. Similarly, book leverage appears informative in determining aggregate issuance responses, however the difference between regimes emerges relatively late, with significantly different responses occurring a year or later from the monetary shock

Figure B.7 plots regime-specific 10-year TIPS forward rate responses. Similarly, the results are broadly consistent with Figure 6. A high aggregate market capital ratio predicts that yield responses to a monetary shock will be insignificant over the following 18 months regardless of shock measure. A low market capital ratio predicts persistent and often significant declines in 10-year TIPS forward rates. The converse result holds for having a high book leverage consistently across shock measures. The Kaplan-Zingales measure is largely uninformative in differentiating yield responses across regime states. In general, the distance-to-default measure is similar to the market capital ratio responses, however, the low distance-to-default states are less persistently significant except when using the baseline Jarociński and Karadi (2020) or orthogonalized monetary shock measures. Taken together, the broad point remains that yield responses are typically insignificant or weakly positive in the medium-to-long-term when bond issuers have more financial capacity. This robustness exercise provides a source of validation that the supply of duration can change the asset pricing transmission implications of monetary policy.

B.7 Continuous State-Dependent Time Series Results

I test whether the state-dependent time series results of Section 3.3 hold when considering a more general form of aggregate state-dependence. As in the main text, I restrict the time series to end in December 2019 to exclude the COVID-19 period. For log bond issuance, I

Figure B.6: Regime-Specific Face Value Responses to Monetary Shocks



(a) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: *MR* **(b)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: *MR* **(c)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: *MR* **(d)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: *MR*

(e) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: ℓ **(f)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: ℓ **(g)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: ℓ **(h)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: ℓ

(i) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: *DD* **(j)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: *DD* **(k)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: *DD* **(l)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: *DD*

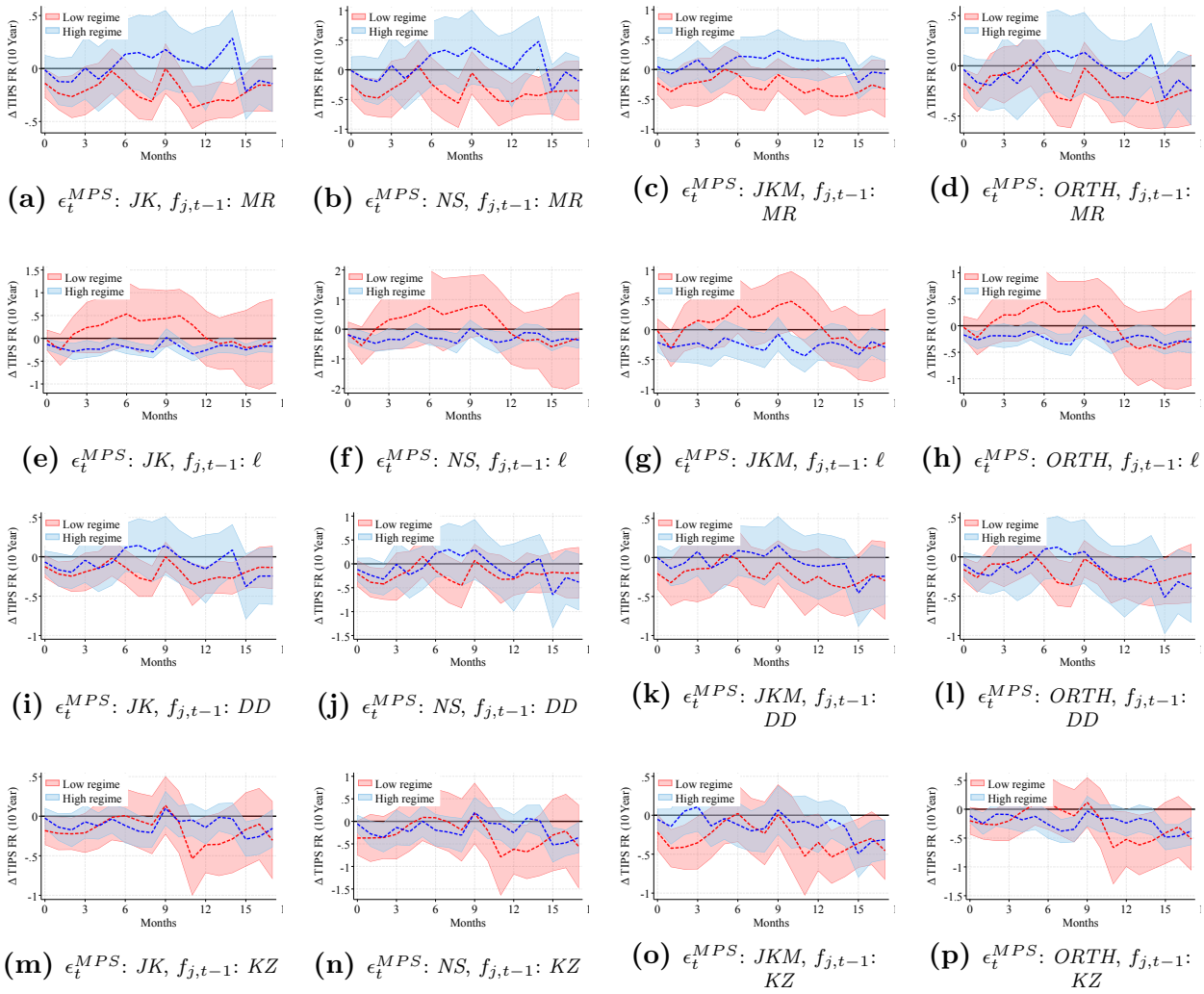
(m) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: *KZ* **(n)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: *KZ* **(o)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: *KZ* **(p)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: *KZ*

Notes: Regime-specific impulse response functions. The figures plot $\gamma_{\mathcal{I}}^h$ coefficients estimated from (5) for horizons $h = 0, \ldots, 17$. Regime $\mathcal{I}_{t-1}$ is determined by whether the aggregate bond issuer f_{t-1} measure is above its time-series median. The distance from financial constraint measure, $f_{j,t-1}$, is one of the {market capital ratio, book leverage (ℓ), distance-to-default, KZ index}, where $f_{j,t-1}$ has been normalized so units are standard deviations within sample. The shocks are *JK*: changes in interest rate futures contracts from Jarociński and Karadi (2020), *NS*: Nakamura and Steinsson (2018), *JKM*: the pure monetary shock from Jarociński and Karadi (2020), and *ORTH*: constructed similarly to Bauer and Swanson (2023). Bands are 90% confidence intervals calculated from Newey-West standard errors with h lags per horizon.

add the interaction of the aggregate, lagged market capital ratio with the monetary shock to the face value IRF specification (3). For TIPS forward rates, I estimate

$$\Delta y_{t-1,t+h}^{(10)} = \alpha^h + \gamma^h \epsilon_t^{MPS} + \nu^h \widetilde{F}_{t-1} + \theta^h \left(\epsilon_t^{MPS} \times \widetilde{F}_{t-1}\right) + \delta^h t + \left(\Gamma^h\right)' X_{t-1} + \left(\Theta^h\right)' \left(X_{t-1} \times \widetilde{F}_{t-1}\right) + u_{t+h}^h, \tag{B.4}$$

Figure B.7: Regime-Specific 10-year TIPS Forward Rate Responses to Monetary Shocks



(a) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: *MR* **(b)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: *MR* **(c)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: *MR* **(d)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: *MR*

(e) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: ℓ **(f)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: ℓ **(g)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: ℓ **(h)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: ℓ

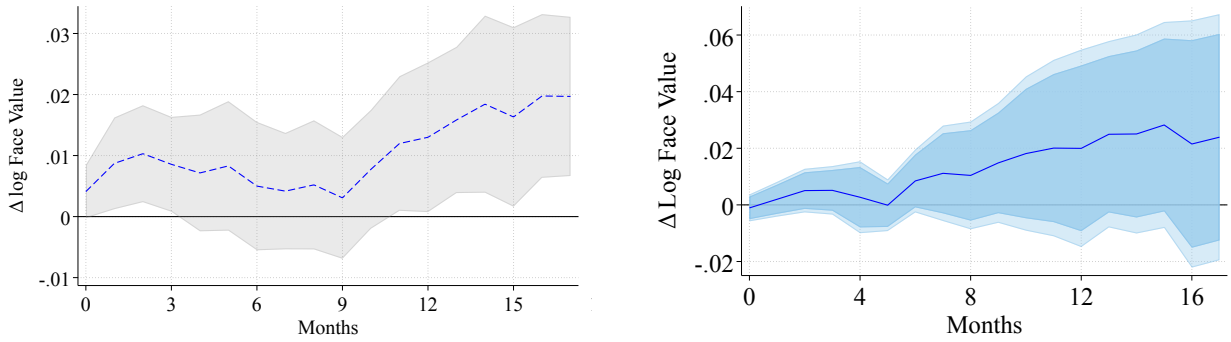
(i) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: *DD* **(j)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: *DD* **(k)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: *DD* **(l)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: *DD*

(m) ϵ_t^{MPS}: *JK*, $f_{j,t-1}$: *KZ* **(n)** ϵ_t^{MPS}: *NS*, $f_{j,t-1}$: *KZ* **(o)** ϵ_t^{MPS}: *JKM*, $f_{j,t-1}$: *KZ* **(p)** ϵ_t^{MPS}: *ORTH*, $f_{j,t-1}$: *KZ*

Notes: Regime-specific impulse response functions. The figures plot $\gamma_{\mathcal{I}}^h$ coefficients estimated from (5) for horizons $h = 0, \ldots, 17$. Regime $\mathcal{I}_{t-1}$ is determined by whether the aggregate bond issuer f_{t-1} measure is above its time-series median. The distance from financial constraint measure, $f_{j,t-1}$, is one of the {market capital ratio, book leverage (ℓ), distance-to-default, KZ index}, where $f_{j,t-1}$ has been normalized so units are standard deviations within sample. The shocks are *JK*: changes in interest rate futures contracts from Jarociński and Karadi (2020), *NS*: Nakamura and Steinsson (2018), *JKM*: the pure monetary shock from Jarociński and Karadi (2020), and *ORTH*: orthogonalized shocks similarly constructed to Bauer and Swanson (2023). Bands are 90% confidence intervals calculated from Newey-West standard errors with h lags per horizon.

where X_{t-1} includes the intermediary capital risk factor of He, Kelly, and Manela (2017), the bond return factor of Cochrane and Piazzesi (2005), and the share of corporate bonds maturing in one year. I parsimoniously add these controls in an effort to absorb variation associated with the risk-bearing capacity of the financial sector, the expected return of long-term bond holdings, and ex ante corporate duration risk in long-term bond markets.

Figure B.8: Aggregate and Cross-Sectional Issuance with Bauer and Swanson (2023) Shocks



(a) Corporate Net Bond Issuance **(b)** Differential Bond Issuance

Notes: The left panel plots estimated OLS coefficients of γ^h from (3) for horizons $h = 0, \ldots, 17$ when using the monetary shock series from Bauer and Swanson (2023), normalized to represent a 25 bps rate cut. Shaded bands denote 90% confidence intervals based on Newey-West standard errors with h lags for each horizon. The right panel plots the β^h coefficients estimated from (4) for horizons $h = 0, \ldots, 17$, when using the Bauer and Swanson (2023) shock series. The differential response is measured in units of standard deviations of $f_{j,t-1}$ where $f_{j,t-1}$ is the baseline market capital ratio. Lighter and darker bands denote 95% and 90% confidence intervals, respectively, calculated from standard errors two-way clustered by firm and date with a 12-month HAC correction in the time dimension.

However, I purposefully keep this specification low-dimensional to provide clarity on whether the state-dependent yield responses are broadly sensitive to controls. For both specifications, $\widetilde{F}_{t-1}$ denotes the aggregate market capital ratio of bond issuers, re-centered around its time series mean.

The results of the continuous interaction specifications are reported in Table B.3. Qualitatively, the state-dependent results presented in Section 3.3 using regime-switching local projections hold using these alternative specifications. For the first four months, the expansionary shock reduces long-term yields when the market capital ratio is low. For most horizons between 8 to 12 months, the yield responses depend on the state of the corporate sector, where a low market capital ratio indicates persistent pass-through to long-term yields. The face value responses feature similar state-dependence. Higher market capital ratios predict large and significant issuance responses throughout the sample for most horizons. Therefore, the implications of the regime-switching IRFs of Section 3.3 are robust to considering specifications which continuously interact the aggregate bond issuer state with the monetary shock series.

Table B.3: Continuous Interaction Estimates

	10-Year TIPS Forward Rates		Log Face Value	
Horizon	ϵ_t^{MPS}	$\epsilon_t^{MPS} \times MR_{t-1}$	ϵ_t^{MPS}	$\epsilon_t^{MPS} \times MR_{t-1}$
0	-0.090	2.910**	0.002	0.070
	(0.060)	(1.429)	(0.002)	(0.054)
1	-0.165*	4.312**	0.005	0.137*
	(0.093)	(1.839)	(0.004)	(0.075)
2	-0.166	4.241**	0.008**	0.208**
	(0.103)	(2.103)	(0.004)	(0.080)
3	-0.074	4.948*	0.008*	0.192*
	(0.107)	(2.773)	(0.005)	(0.100)
4	-0.094	3.501	0.010	0.279**
	(0.107)	(2.600)	(0.006)	(0.111)
5	-0.052	1.590	0.013**	0.257***
	(0.110)	(2.525)	(0.005)	(0.091)
6	-0.062	4.016	0.010*	0.161
	(0.134)	(2.952)	(0.006)	(0.112)
7	-0.162	3.216	0.015**	0.234
	(0.135)	(2.613)	(0.007)	(0.147)
8	-0.109	5.530**	0.019**	0.286*
	(0.129)	(2.462)	(0.007)	(0.161)
9	0.173	5.854**	0.014*	0.293*
	(0.142)	(2.462)	(0.008)	(0.160)
10	0.059	5.800**	0.018**	0.343*
	(0.127)	(2.623)	(0.008)	(0.180)
11	-0.187	3.764	0.020**	0.369**
	(0.170)	(2.935)	(0.008)	(0.185)
12	-0.115	5.384**	0.024***	0.448**
	(0.139)	(2.696)	(0.008)	(0.193)
13	-0.089	3.484	0.024**	0.364
	(0.125)	(2.799)	(0.010)	(0.224)
14	-0.056	3.428	0.029***	0.522**
	(0.130)	(2.551)	(0.010)	(0.217)
15	-0.282**	0.242	0.026**	0.515**
	(0.142)	(2.547)	(0.010)	(0.218)
16	-0.175	1.176	0.035***	0.638***
	(0.135)	(2.444)	(0.010)	(0.227)
17	-0.145	2.428	0.040***	0.750***
	(0.137)	(2.428)	(0.011)	(0.213)

Notes: The estimates of the coefficients γ^h and θ^h from (B.4) are reported. Newey–West standard errors are in parentheses. The monetary shock ϵ_t^{MPS} is normalized to be a 25 bps rate cut. The lagged market capital ratio is centered at its pre-2020 sample mean. All response windows end by December 2019. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

B.8 Aggregate Investment and Bond Market Responses

In Section 3, I demonstrated that expansionary monetary policy causally increases bond supply using FISD data in both aggregate and the cross-section. The cross-sectional exposure design also supported that bond issuers used some of the bond issuance to invest in capital using Compustat data. In this appendix, I validate the aggregate time series results based on the micro-data sources described in Section 2 using conventional macroeconomic time series data and methods. Given the availability of high-frequency monetary policy surprises, I use a sample from 1991Q1 to 2019Q4, avoiding the structural time-series breaks in investment that occurred during COVID-19.

To construct real investment at the quarterly frequency, I use private nonresidential fixed investment at a seasonally adjusted annual rate and deflate it by the nonresidential investment deflator. I construct series on corporate bonds, the market capital ratio, and leverage using data from the Z.1. Financial Accounts, deflating the value of corporate bonds by the CPI index. The corporate bond series is not in terms of face values, but instead book values as reported on nonfinancial firm balance sheets, and therefore an approximation to the FISD amounts outstanding. The market capital ratio is the corporate equity market value divided by itself and its total liabilities, whereas the book leverage ratio is the value of corporate debt securities and loans divided by total assets valued at historical cost. Finally I include the excess bond premium available through the Board of Governors of the Federal Reserve as described in Gilchrist and Zakrajšek (2012). The excess bond premium measures the component of credit spreads unexplained by expected default risk, and is typically included as a control in related macroeconomic time series studies (Gertler and Karadi, 2015).

Aggregate Bond Issuance. I test whether expansionary policy shocks expand corporate bond values in the Financial Accounts by estimating

$$\Delta \log Y^h_{t-1,t+h} = \alpha^h + \beta^h \epsilon^{\text{MPS}}_t + \delta^h t + \left(\Gamma^h\right)' X^B_{t-1} + \delta^h_{q(t)} + u^h_{t+h} \,, \tag{B.5}$$

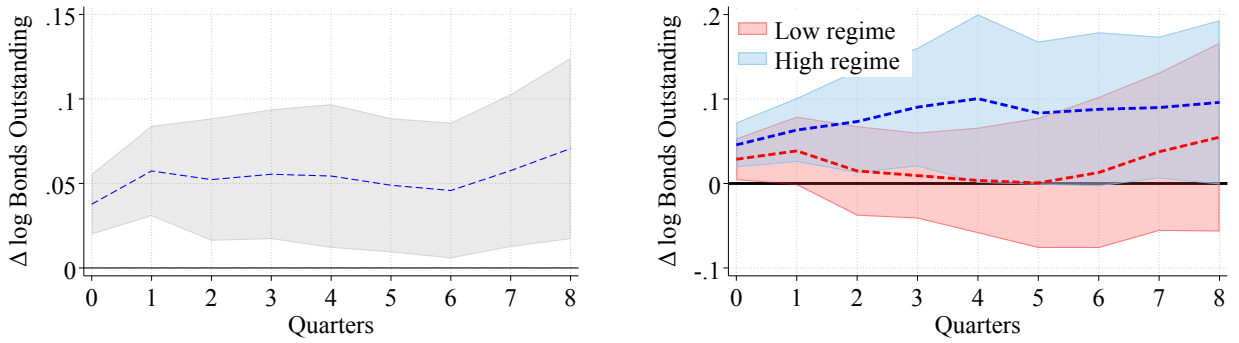
where Y_t is the aggregate nonfinancial corporate bond market size, $\Delta \log Y_{t,t+h} = \log Y_{t+h} - \log Y_{t-1}$, and ϵ^{MPS}_t is an expansionary shock sourced from Jarociński and Karadi (2020), normalized to be 100 bps. In (B.5), I control for a lag of the aggregate state

$$X^B_t \equiv (MR_t,\ VIX_t,\ \Delta \log CPI_t,\ FFR_t,\ \Delta U_t,\ Spread_t,\ \ell_t,\ EBP_t)' \,,$$

where MR_t, ℓ_t, and EBP_t are the aggregate market capital ratio, book leverage ratio, and excess bond premium respectively. Also controlled for are the lagged quarter over quarter

changes in the CPI and unemployment rate (U_t), the lag of the fed funds rate, and the credit spread is Moody's *Baa* seasoned corporate bond yield less a ten-year treasury at constant maturity. Finally quarter fixed effects are included.

Figure B.9: Aggregate Bond Market Responses to Expansionary Policy



(a) Aggregate Corporate Bond Values **(b)** Regime Switching: Corporate Bond Values

Notes: Panel (a) plots estimated OLS coefficients of β^h from (B.5) using the monetary shock series from Jarociński and Karadi (2020), normalized to represent a 100 bps rate cut. Panel (b) plots the γ_R^h coefficients estimated from (B.6), where regime is calculated from whether the lagged market capital ratio is above or below its time series median. The horizons are measured in quarters. Bands denote 90% confidence intervals based on Newey-West standard errors with h lags for each horizon.

I also consider an augmented, regime-switching version of (B.5),

$$\begin{aligned}\Delta \log Y^h_{t-1,t+h} = \mathcal{I}_{t-1}\left[\alpha_1^h + \gamma_1^h \epsilon_t^{\text{MPS}} + \left(\Theta_1^h\right)' X^B_{t-1}\right] \\ + (1-\mathcal{I}_{t-1})\left[\alpha_0^h + \gamma_0^h \epsilon_t^{\text{MPS}} + \left(\Theta_0^h\right)' X^B_{t-1}\right] + \delta^h t + \delta^h_{q(t)} + u^h_{t+h}\ ,\end{aligned} \tag{B.6}$$

where $\mathcal{I}_{t-1}$ takes a value of one if the aggregate market capital ratio is above its time series median. This specification directly tests whether aggregate state dependence of bond issuance to policy is present using alternative measurement of the size of the bond market.

Figure B.9 reports the impulse response functions for aggregate bond values (B.5) in Panel a) and Panel b) plots the regime-switching coefficients estimated by (B.6). Expansionary monetary policy causes a large and immediate increase in nonfinancial corporate bond values, with a 100 bps rate cut causing an increase in bond values of 5% a quarter after the shock. This is highly similar in magnitude, and even more consistently significant than the IRFs presented in Section 3. This empirical result supports the quantitative exercises of state-dependent monetary transmission in Section 6. These state-dependent impulse responses support the results using FISD data in Section 3.3, although it should be noted that bond values in the Z.1 Financial Accounts are book measures that do not separately identify bond prices and face values.

Aggregate Investment Responses. I follow a large tradition of measuring investment responses to monetary policy by estimating impulse response functions of private nonresidential investment to high-frequency monetary shocks,

$$\Delta \log Y^h_{t-1,t+h} = \alpha^h + \beta^h \epsilon^{\text{MPS}}_t + \lambda^h t + \sum_{\tau=1}^{4} \left(\Gamma^h_\tau\right)' X^I_{t-\tau} + \delta^h_{q(t)} + u^h_{t+h}. \tag{B.7}$$

The aggregate variable Y_t is real nonresidential private investment and $\lambda^h t$ and $\delta^h_{q(t)}$ capture a linear time trend and calendar-quarter fixed effects. I include the following controls in the specification:

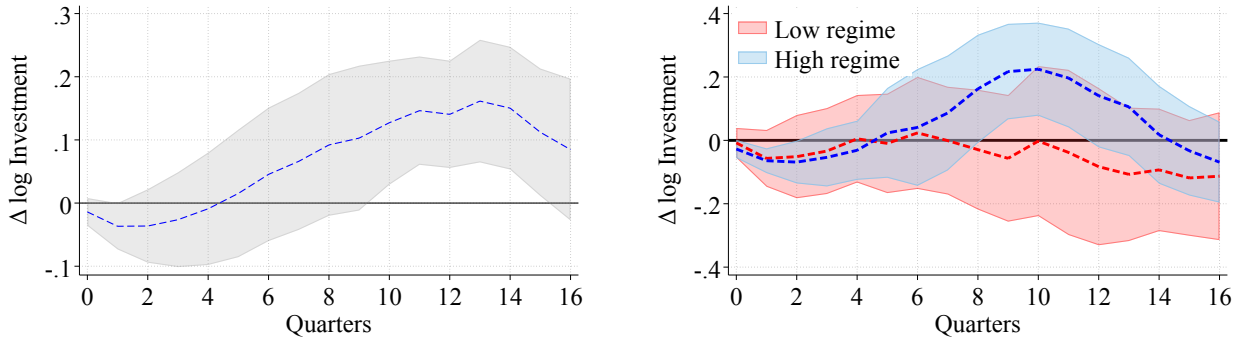
$$X^I_t \equiv \left(\Delta \log I_t, \epsilon^{\text{MPS}}_t, \Delta \log GDP_t, \Delta \log CPI_t,\ FFR_t,\ EBP_t\right)'.$$

The controls include a year of lags, four quarterly lags, of every component of X^I_t following the standard estimation of local projections of investment to a monetary shock (Gertler and Karadi, 2015; Jarociński and Karadi, 2020; Bauer and Swanson, 2023; Ma and Zimmermann, 2023), and which follows the recommendations of robust local projection inference (Montiel Olea and Plagborg-Møller, 2021). The controls I use are standard in the literature and include real activity, inflation, policy rates, and credit-market conditions. Finally, I augment (B.7) by interacting all variables except the quarter effects and time trend in (B.7) with the indicator $\mathcal{I}_{t-1}$, where $\mathcal{I}_{t-1}$ takes a value of one when the aggregate market capital ratio is above its time series median. This regime-switching specification tests whether investment responses to policy are different depending on the state of the corporate sector.

Figure B.10 plots investment responses to an expansionary monetary policy shock normalized to 100 basis points. Panel (a) shows a hump-shaped response, consistent with Christiano, Eichenbaum, and Evans (2005), with the largest responses approximately 2.5–3.5 years after the shock. Panel (b) shows statistically significant positive responses when the corporate market capital ratio is above its median before the shock, while responses in the low-ratio regime are imprecisely estimated.

Finally, to provide evidence of the model's implication that corporate bonds can be used to finance investment, I replace the monetary shock ϵ^{MPS}_t and its four lags in (B.7) with the quarterly log change in real corporate bond values, $\Delta \log(P_t B_t)$, and its four lags. Figure B.11 plots the resulting investment responses. After approximately two years, a one percent increase in real corporate bond values is associated with approximately one percent higher real investment, although the estimate is only marginally significant and confidence intervals are wide. These estimates are descriptive and noncausal. In the model developed in

Figure B.10: Aggregate Investment Responses



(a) Investment Response to ϵ_t^{MPS} **(b)** Regime Switching: Investment Response

Notes: Panel (a) plots the estimated OLS coefficients β^h from (B.7), with real private nonresidential investment as the outcome and the monetary shock from Jarociński and Karadi (2020), normalized to represent a 100 bps rate cut, as the independent variable. Panel (b) plots the regime-specific coefficients where regime is calculated from whether the lagged market capital ratio is above or below its time series median. The horizons are measured in quarters. Shaded bands denote 90% confidence intervals based on Newey-West standard errors with h lags for each horizon.

Section 5, bond issuance finances investment when financial constraints bind and supports dividend smoothing when firms have financial capacity. Therefore, a positive, but statistically imprecise, relationship between issuance and investment is consistent with the theory developed.

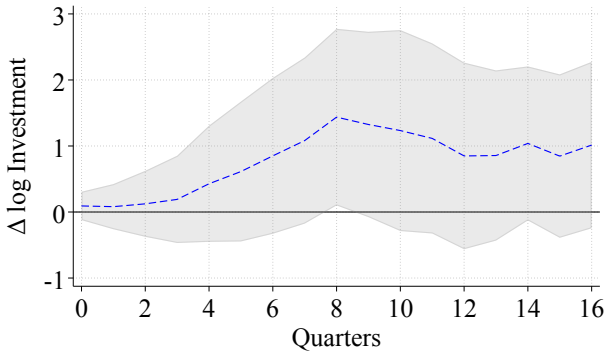


Figure B.11: Investment Following a Change in Corporate Bond Growth

Notes: This displays the estimated OLS coefficients β^h from (B.7), with real private nonresidential investment as the outcome and the quarterly log change in real corporate bond values, $\Delta \log(P_t B_t)$ as the independent variable. The horizons are measured in quarters. Shaded bands denote 90% confidence intervals based on Newey-West standard errors with h lags for each horizon.

C Omitted Derivations and Proofs in the Main Text

C.1 Omitted Derivations

Quadratic Solution to Equilibrium Yields.

For the comparative statics reported in Section 4, it is convenient to work with the economically relevant solution to the quadratic bond-price equation.[5] I characterize this solution and its properties in the following Lemma.

Lemma C.1 (Quadratic Solution to Bond Yields.)**.** *Suppose Assumption 1 is satisfied and consider the unconstrained state, where $\mu = \eta = 0$. Define*

$$\mathcal{D}_{bond} = \sqrt{\left[\frac{W}{\sigma_r^2} - \frac{K_0}{\psi}(1-\zeta)(1-r_1)\right]^2 + 4\frac{K_0}{\psi}\left[\frac{W}{\sigma_r^2}(1-r_1) - \widetilde{G}\right]}. \tag{C.1}$$

Then for a first-order approximation to long-term yields, $P_0^{(2)} \approx 1 - 2y^{(2)}$, the unique equilibrium yield with a positive bond price is given by

$$y^{(2)} = \frac{1}{2}r_1 + \frac{\frac{W}{\sigma_r^2} + \frac{K_0}{\psi}(1+\zeta)(1-r_1) - \mathcal{D}_{bond}}{4K_0/\psi}. \tag{C.2}$$

This solution implies

$$(1-\zeta)(1-r_1) < P_0^{(2)} < 1 - r_1, \tag{C.3}$$

so that both $B_2 > 0$ and $y^{(2)} > \frac{1}{2}r_1$.

Proof. In the unconstrained state, $\mu = \eta = 0$, so optimal bond supply (13) reduces to

$$B_2 = \frac{K_0}{\psi}\left[P_0^{(2)} - (1-\zeta)(1-r_1)\right].$$

Substituting this expression into market clearing (15) gives the quadratic equation

$$\frac{K_0}{\psi}\left(P_0^{(2)}\right)^2 + \left[\frac{W}{\sigma_r^2} - \frac{K_0}{\psi}(1-\zeta)(1-r_1)\right]P_0^{(2)} - \frac{W}{\sigma_r^2}(1-r_1) + \widetilde{G} = 0. \tag{C.4}$$

The quadratic coefficient is positive, and under Assumption 1, the constant term is negative.

[5] There are in principle two solutions to the quadratic system, but one of the solutions gives negative prices which I disregard.

Therefore, there is one positive root which is characterized by

$$P_0^{(2)} = \frac{\frac{K_0}{\psi}(1-\zeta)(1-r_1) - \frac{W}{\sigma_r^2} + \mathcal{D}_{bond}}{2K_0/\psi}.$$

Substituting the approximation that $y^{(2)} \approx \frac{1}{2} - \frac{1}{2}P_0^{(2)}$ provides (C.2).

Evaluating the left-hand side of (C.4) at $P_0^{(2)} = (1-\zeta)(1-r_1)$ gives the expression

$$\widetilde{G} - \frac{W}{\sigma_r^2}(1-r_1)\zeta < 0,$$

under Assumption 1. Evaluating the left-hand side of (C.4) at $P_0^{(2)} = (1-r_1)$ gives the expression

$$\frac{K_0}{\psi}\zeta(1-r_1)^2 + \widetilde{G} > 0,$$

which implies

$$(1-\zeta)(1-r_1) < P_0^{(2)} < 1 - r_1\,. \tag{C.5}$$

Substituting the bounds of this expression into (13) with $\mu = \eta = 0$ demonstrates $B_2(K_0) > 0$. Furthermore, (C.3) implies that

$$y^{(2)} - \frac{1}{2}r_1 = \frac{1 - r_1 - P_0^{(2)}}{2} > 0\,,$$

so the term premium is positive. □

Alternative parametric conditions for yield-response ordering. The debt-level restriction $B_2^U > B_2^C$ in Proposition 2 is sufficient for the ordering of yield responses. This ordering also follows from restrictions on primitive parameters using the affine yield approximation in Proposition 1. Maintain Assumption 1 and consider an unconstrained state U and a constrained state C, with $K_0^U > K_0^C$. Suppose

$$\lambda < \frac{\zeta}{\psi}, \qquad \frac{W}{\sigma_r^2} > \frac{(1-\zeta)K_0^U}{\psi} + \frac{2\widetilde{G}}{\zeta(1-2r_1)}. \tag{C.6}$$

The first restriction places the leverage ceiling below the zero-rate, unit-price benchmark for desired leverage. The second requires sufficiently elastic investor demand relative to corporate and government supply. Substituting the unconstrained yield from Proposition 1 shows

that this restriction is equivalent to $2y^{(2),U} < (1-\zeta)r_1 + \zeta/2$. In other words, the equilibrium price discount of long-term bonds relative to par value must remain moderate relative to the debt benefit. When preferred habitat investors absorb all government supply, $\widetilde{G} = 0$, the second restriction simplifies to $W/\sigma_r^2 > (1-\zeta)K_0^U/\psi$. If monetary policy did not affect the discount rate of the firm, then this would further hold generically.

To see how these conditions alternatively cause the yield ordering to hold, note that under the linear approximation the unconstrained yield response is

$$\frac{\partial y^{(2),U}}{\partial r_1} = \frac{W/\sigma_r^2 + (1-\zeta)K_0^U/\psi}{2[W/\sigma_r^2 + (1+\zeta)K_0^U/\psi]}.$$

In the constrained state, bond supply is fixed at $B_2^C = \lambda K_0^C$, so market clearing gives

$$\frac{\partial y^{(2),C}}{\partial r_1} = \frac{W/\sigma_r^2}{2(W/\sigma_r^2 + \lambda K_0^C)}.$$

Since $K_0^C < K_0^U$, a sufficient condition for the unconstrained yield response to be smaller is

$$\psi\lambda\left[1 + \frac{(1-\zeta)\sigma_r^2 K_0^U}{\psi W}\right] < 2\zeta.$$

The second restriction in (C.6) makes the bracket smaller than two, while the first implies $\psi\lambda < \zeta$. Therefore,

$$0 < \frac{\partial y^{(2),U}}{\partial r_1} < \frac{W/\sigma_r^2}{2(W/\sigma_r^2 + \lambda K_0^U)} < \frac{\partial y^{(2),C}}{\partial r_1} < \frac{1}{2}.$$

Thus the parameter restrictions establish yield-response ordering without explicitly imposing a ranking of equilibrium debt levels.

C.2 Quantitative Model Derivations

Starting from (21), the capital Euler equation can be derived as

$$\left(1 + \phi\left(\frac{I_t}{K_t} - \delta\right)\right)(1+\mu_t) = \mathbb{E}_t\left[M_{t,t+1}\left\{\begin{array}{l}(1+\mu_{t+1})\left(f'(K_{t+1}) + 1 - \delta - \frac{\phi}{2}\left(\frac{K_{t+2}}{K_{t+1}} - 1\right)^2\right. \\ \qquad \left. + \phi\left(\frac{K_{t+2}}{K_{t+1}} - 1\right)\frac{K_{t+2}}{K_{t+1}} + \underbrace{\frac{\psi}{2}\left(\frac{B_{t+1}}{K_{t+1}}\right)^2}_{\text{Collateral Channel}}\right) + \lambda\eta_{t+1}\end{array}\right\}\right]. \tag{C.7}$$

Relative to a standard investment Euler equation, optimal capital accumulation includes a term related to its collateral value: owning more capital lowers the marginal cost of future bond issuance. The multipliers μ_t and η_t further make investment depend nonlinearly on the firm's balance-sheet state.

C.3 Main Text Proofs and Additional Results

This appendix provides the formal proofs of all propositions in the text.

Proof of Proposition 1

Proof. Using $\beta_2 \approx 1 - r_1$ and $P_0^{(2)} \approx 1 - 2y^{(2)}$, firm bond supply is

$$B_2 = \frac{K_0}{\psi}\left[1 - 2y^{(2)} - \frac{(1-\zeta)(1-r_1)+\eta}{1+\mu}\right].$$

Bond market clearing is

$$\frac{W}{\sigma_r^2}\left(2y^{(2)} - r_1\right) = P_0^{(2)} B_2 + \widetilde{G}.$$

Substituting bond supply into market clearing and using $\left(P_0^{(2)}\right)^2 \approx 1 - 4y^{(2)}$ gives

$$\frac{W}{\sigma_r^2}\left(2y^{(2)} - r_1\right) = \frac{K_0}{\psi}\left[1 - 4y^{(2)} - \frac{(1-\zeta)(1-r_1-2y^{(2)})+\eta(1-2y^{(2)})}{1+\mu}\right] + \widetilde{G}.$$

Collecting terms in $y^{(2)}$ yields

$$2\mathcal{A}y^{(2)} = \frac{W}{\sigma_r^2}r_1 + \widetilde{G} + \frac{K_0}{\psi}\left[1 - \frac{(1-\zeta)(1-r_1)+\eta}{1+\mu}\right],$$

where $\mathcal{A} := \frac{W}{\sigma_r^2} + \frac{K_0}{\psi}\left(2 - \frac{1-\zeta+\eta}{1+\mu}\right)$. Rewriting the right-hand side gives

$$2\mathcal{A}y^{(2)} = \mathcal{A}r_1 + \widetilde{G} + \frac{K_0}{\psi}\frac{(\mu+\zeta)(1-2r_1)-\eta(1-r_1)}{1+\mu}.$$

Therefore,

$$y^{(2)} = \frac{1}{2}r_1 + \frac{1}{2\mathcal{A}}\left[\widetilde{G} + \frac{K_0}{\psi}\frac{(\mu+\zeta)(1-2r_1)-\eta(1-r_1)}{1+\mu}\right].$$

□

Proof of Proposition 2

Proof. I first derive the yield response, which applies in either financial state. Using the first-order approximation $P_0^{(2),j} = 1 - 2y^{(2),j}$, market clearing (15) satisfies

$$\frac{W}{\sigma_r^2}\left(2y^{(2),j} - r_1\right) = P_0^{(2),j} B_2^j + \widetilde{G}.$$

Differentiating with respect to r_1 and rearranging gives

$$\frac{\partial y^{(2),j}}{\partial r_1} = \frac{1}{2} + \frac{P_0^{(2),j}\frac{\partial B_2^j}{\partial r_1} - B_2^j}{2(W/\sigma_r^2 + B_2^j)},$$

which establishes (18).

I next consider the unconstrained state U. In this state both financial constraints are slack, so $\mu^U = \eta^U = 0$. Bond supply (13) therefore reduces to

$$B_2^U = \frac{K_0^U}{\psi}\left[P_0^{(2),U} - (1-\zeta)(1-r_1)\right].$$

Differentiating gives

$$\frac{\partial B_2^U}{\partial r_1} = \frac{K_0^U}{\psi}\left[(1-\zeta) - 2\frac{\partial y^{(2),U}}{\partial r_1}\right].$$

To establish the bounds on the unconstrained yield response, apply Lemma C.1 at K_0^U. The positive-price root implies

$$\mathcal{D}_{bond}^U = \frac{W}{\sigma_r^2} + \frac{K_0^U}{\psi}\left[2P_0^{(2),U} - (1-\zeta)(1-r_1)\right] > 0,$$

where positivity follows from (C.3). Differentiating the quadratic equation (C.4) with respect to r_1 gives

$$\mathcal{D}_{bond}^U \frac{\partial P_0^{(2),U}}{\partial r_1} + \frac{W}{\sigma_r^2} + \frac{K_0^U}{\psi}(1-\zeta)P_0^{(2),U} = 0.$$

Since $\partial P_0^{(2),U}/\partial r_1 = -2\partial y^{(2),U}/\partial r_1$,

$$\frac{\partial y^{(2),U}}{\partial r_1} = \frac{\frac{W}{\sigma_r^2} + \frac{K_0^U}{\psi}(1-\zeta)P_0^{(2),U}}{2\mathcal{D}_{bond}^U} > 0. \tag{C.8}$$

Furthermore,

$$\mathcal{D}^U_{bond} - \left[\frac{W}{\sigma_r^2} + \frac{K_0^U}{\psi}(1-\zeta)P_0^{(2),U}\right] = \frac{K_0^U}{\psi}\left[(1+\zeta)P_0^{(2),U} - (1-r_1)(1-\zeta)\right] > 0,$$

which follows from (C.3). Therefore,

$$0 < \frac{\partial y^{(2),U}}{\partial r_1} < \frac{1}{2}.$$

To establish the sign of the unconstrained issuance response, rewrite market clearing as

$$P_0^{(2),U}\left(\frac{W}{\sigma_r^2} + B_2^U\right) = \frac{W}{\sigma_r^2}(1-r_1) - \widetilde{G}.$$

Thus inverse bond demand is

$$P_0^{(2),U} = \frac{\frac{W}{\sigma_r^2}(1-r_1) - \widetilde{G}}{\frac{W}{\sigma_r^2} + B_2^U}.$$

Differentiating inverse demand and unconstrained bond supply and collecting terms gives

$$\left[\frac{\psi}{K_0^U} + \frac{P_0^{(2),U}}{W/\sigma_r^2 + B_2^U}\right]\frac{\partial B_2^U}{\partial r_1} = (1-\zeta) - \frac{W/\sigma_r^2}{W/\sigma_r^2 + B_2^U}. \tag{C.9}$$

Using unconstrained bond supply and inverse bond demand,

$$(1-\zeta) - \frac{W/\sigma_r^2}{W/\sigma_r^2 + B_2^U} = -\frac{1}{1-r_1}\left[\frac{\psi B_2^U}{K_0^U} + \frac{\widetilde{G}}{W/\sigma_r^2 + B_2^U}\right] < 0.$$

The coefficient multiplying $\partial B_2^U/\partial r_1$ in (C.9) is positive, so

$$\frac{\partial B_2^U}{\partial r_1} < 0.$$

I next consider the collateral-constrained state C. In this state both financial constraints bind, so $\mu^C > 0$, $\eta^C > 0$, and complementary slackness implies

$$B_2^C = \lambda K_0^C.$$

Holding the financial regime fixed,

$$\frac{\partial B_2^C}{\partial r_1} = 0.$$

Substituting into (18) gives

$$\frac{\partial y^{(2),C}}{\partial r_1} = \frac{1}{2} - \frac{B_2^C}{2(W/\sigma_r^2 + B_2^C)} = \frac{W/\sigma_r^2}{2(W/\sigma_r^2 + B_2^C)} \in \left(0, \frac{1}{2}\right).$$

Finally, suppose $B_2^U > B_2^C$. This is equivalent to assuming the following parametric condition holds,

$$\frac{W}{\sigma_r^2}\zeta(1-r_1) - \widetilde{G} > \lambda K_0^C \left[(1-\zeta)(1-r_1) + \frac{\psi W}{\sigma_r^2 K_0^U} + \frac{\psi \lambda K_0^C}{K_0^U}\right]. \tag{C.10}$$

Since $P_0^{(2),U} > 0$ and $\partial B_2^U/\partial r_1 < 0$, (18) implies

$$\frac{\partial y^{(2),U}}{\partial r_1} < \frac{1}{2} - \frac{B_2^U}{2(W/\sigma_r^2 + B_2^U)} = \frac{W/\sigma_r^2}{2(W/\sigma_r^2 + B_2^U)}.$$

Because $B/(W/\sigma_r^2 + B)$ is strictly increasing in B, $B_2^U > B_2^C$ implies

$$\frac{W/\sigma_r^2}{2(W/\sigma_r^2 + B_2^U)} < \frac{W/\sigma_r^2}{2(W/\sigma_r^2 + B_2^C)} = \frac{\partial y^{(2),C}}{\partial r_1}.$$

Therefore,

$$0 < \frac{\partial y^{(2),U}}{\partial r_1} < \frac{\partial y^{(2),C}}{\partial r_1} < \frac{1}{2},$$

while independently,

$$\frac{\partial B_2^U}{\partial r_1} < \frac{\partial B_2^C}{\partial r_1} = 0.$$

□

Proof of Proposition 3

Proof. When $\phi \to 0$, the unconstrained capital choice is given by its first-order condition. Throughout I use $\beta_1 = \beta_2 \approx 1 - r_1$. Consider first the unconstrained capital choice for $t = 2$,

$$K_2^U = K^\star(r_1) = (2\alpha A(1 - r_1))^{\frac{1}{1-\alpha}}.$$

Then the comparative static with respect to a monetary shock is given by

$$\frac{\partial K_2^U}{\partial r_1} = -\frac{K^\star(r_1)}{(1-\alpha)(1-r_1)} < 0.$$

In the constrained region, $B_2^C = \lambda K_0^C$ and $d_0 = 0$. Therefore, capital choice satisfies

$$K_2^C = A(K_0^C)^\alpha + (1-\delta)K_0^C + P_0^{(2),C}\lambda K_0^C - (1-\zeta)B_0^C - \frac{\psi}{2}\lambda^2 K_0^C.$$

Therefore,

$$\frac{\partial K_2^C}{\partial r_1} = -2\lambda K_0^C \frac{\partial y^{(2),C}}{\partial r_1} = -\frac{\lambda K_0^C \frac{W}{\sigma_r^2}}{\lambda K_0^C + \frac{W}{\sigma_r^2}} < 0.$$

Finally, using $\lambda K_0^C < K^\star(r_1)$,

$$\left|\frac{\partial K_2^C}{\partial r_1}\right| < \lambda K_0^C < K^\star(r_1) < \frac{K^\star(r_1)}{(1-\alpha)(1-r_1)} = \left|\frac{\partial K_2^U}{\partial r_1}\right|,$$

which completes the proof. □

Proof of Proposition 4

Proof. The long-term bond return in each economy is

$$R_{t+1}^{L,j} = \frac{c + \delta_B + (1-\delta_B)P_{t+1}^{L,j}}{P_t^{L,j}}, \tag{C.11}$$

with $P_t^{L,RN} = P_t^{RN}$. The coupon, amortization rate, debt benefit, and conditional law of the exogenous short-rate process are common across economies. In particular, $R_s^f > 0$ is known at date s, and $0 \le \delta_B \le 1$.

Risk-neutral investors. Their optimality condition requires $\mathbb{E}_t[R_{t+1}^{L,RN}] = R_t^f$, so $\mathrm{TP}_t^{RN} = 0$

and

$$R_t^f P_t^{RN} = c + \delta_B + (1-\delta_B)\mathbb{E}_t[P_{t+1}^{RN}]. \tag{C.12}$$

For the benchmark economies, the no-bubble condition is

$$\lim_{n\to\infty} \mathbb{E}_t\left[\frac{(1-\delta_B)^n P_{t+n}^{L,j}}{\prod_{k=0}^{n-1} R_{t+k}^f}\right] = 0, \qquad j \in \{RN, F\}. \tag{C.13}$$

Iterating (C.12) therefore gives

$$P_t^{RN} = (c+\delta_B)\mathbb{E}_t\left[\sum_{j=1}^{\infty} \frac{(1-\delta_B)^{j-1}}{\prod_{k=0}^{j-1} R_{t+k}^f}\right]. \tag{C.14}$$

Frictionless issuers. With $\psi = 0$ and no financing constraints, the firm's debt Euler equation is

$$R_t^f P_t^{L,F} = c + \delta_B - \zeta + (1-\delta_B)\mathbb{E}_t[P_{t+1}^{L,F}]. \tag{C.15}$$

Iterating this equation under (C.13) yields the same discounted sum as (C.14), with $c+\delta_B$ replaced by $c+\delta_B-\zeta$. Thus,

$$P_t^{L,F} = \left(1 - \frac{\zeta}{c+\delta_B}\right) P_t^{RN} > 0. \tag{C.16}$$

Using (C.11) in (C.15) also gives

$$\mathrm{TP}_t^F = \mathbb{E}_t[R_{t+1}^{L,F}] - R_t^f = \frac{\zeta}{P_t^{L,F}}. \tag{C.17}$$

This holds under $\zeta < c+\delta_B$, which is further implied by the condition that prices are positive and finite.

Baseline bond prices. Let $\mu_s \geq 0$ and $\eta_s \geq 0$ denote the dividend- and leverage-constraint multipliers. At every date s, the debt Euler equation is

$$(1+\mu_s)\left(P_s^L - \psi\frac{B_s}{K_s}\right) - \eta_s = \frac{1}{R_s^f}\mathbb{E}_s\left[(1+\mu_{s+1})(P_s^L R_{s+1}^L - \zeta)\right]. \tag{C.18}$$

Expand the bond payoff on the right. Since $\psi B_s/K_s \geq 0$, $\eta_s \geq 0$, $\mu_{s+1} \geq 0$, and $c+\delta_B-\zeta > 0$, this implies

$$(1+\mu_s)P_s^L \geq \frac{c+\delta_B-\zeta}{R_s^f} + \frac{1-\delta_B}{R_s^f}\mathbb{E}_s\left[(1+\mu_{s+1})P_{s+1}^L\right]. \tag{C.19}$$

Iterating (C.19) for n periods and discarding the nonnegative terminal term gives

$$(1+\mu_t)P_t^L \geq (c+\delta_B-\zeta)\mathbb{E}_t\left[\sum_{j=1}^{n}\frac{(1-\delta_B)^{j-1}}{\prod_{k=0}^{j-1}R_{t+k}^f}\right]. \tag{C.20}$$

The value of the summation is nonnegative. Taking $n\to\infty$, using $\mu_t=0$, and applying (C.14) and (C.16) establishes

$$P_t^L \geq \left(1-\frac{\zeta}{c+\delta_B}\right)P_t^{RN} = P_t^{L,F}. \tag{C.21}$$

Note that this argument allows both constraints to bind in future states; it does not require the terminal shadow-value term to converge to zero.

Baseline term premia. Net repayments in the baseline model satisfy

$$P_t^L R_{t+1}^L - \zeta = c+\delta_B-\zeta+(1-\delta_B)P_{t+1}^L > 0. \tag{C.22}$$

Consequently, setting $\mu_t=0$ in (C.18) and dropping the nonnegative future dividend-constraint term yields

$$P_t^L \geq P_t^L - \psi\frac{B_t}{K_t} - \eta_t \geq \frac{P_t^L\mathbb{E}_t[R_{t+1}^L]-\zeta}{R_t^f}. \tag{C.23}$$

Rearranging, then using (C.21) and $\zeta\geq 0$, gives

$$\mathrm{TP}_t \leq \frac{\zeta}{P_t^L} \leq \frac{\zeta}{P_t^{L,F}} = \mathrm{TP}_t^F. \tag{C.24}$$

Finally, mean-variance arbitrageur optimality implies

$$\mathrm{TP}_t = \gamma\,\mathrm{Var}_t(R_{t+1}^L)\omega_t \geq 0, \tag{C.25}$$

where $\gamma>0$ is arbitrageur risk aversion and $\omega_t\geq 0$ is the portfolio weight on long-term bonds. Combining (C.24), (C.25), and $\mathrm{TP}_t^{RN}=0$ proves (35). The expression $P_t^L \geq P_t^{L,F} = \left(1-\frac{\zeta}{c+\delta_B}\right)P_t^{RN}$ follows from (C.16) and (C.21). □

D Three Period Model Extensions

All proofs are provided in Appendix D.4.

D.1 Financial Constraints Region Characterization

In this appendix, I provide further details and characterization of the stylized model presented in Section 4. I primarily characterize regularity conditions under which the financial constraints become binding monotonically in initial net worth endowment of the production firms.

Financial Constraint Regimes. To further characterize equilibria in this environment with occasionally binding financial constraints, as in Winberry et al. (2025), it is useful to partition the initial state space, (K_0, B_0), into regions where the endogenous Lagrange multipliers bind sequentially. Define $B_2^U = \frac{K_0}{\psi}\left[P_0^U - (1-\zeta)(1-r_1)\right]$, where P_0^U is given in (16) with $\eta = \mu = 0$. To simplify the analysis, I consider the linearized equilibrium characterized in Section 4, and impose the following regularity conditions.

Assumption D.1. *Unconstrained bond supply is feasible,* $B_2^U < \lambda K_0$.

Assumption D.2. *Equilibrium price is sufficiently high,* $P_0^U > 1 - \zeta$.

Assumption D.3. *Parameters satisfy* $\frac{W}{\sigma_r^2}(1 - r_1 - \psi\lambda) > \widetilde{G} + 2\lambda K_0$.

Both B_2^U and P_0^U are, to first order, analytical expressions of parameters. Assumption D.1 guarantees that in equilibrium there is no region where the firm pays positive dividends while at its leverage constraint. Assumption D.2 is a natural sufficient condition for firms to supply net positive bonds when unconstrained. Assumption D.3 guarantees that, for all bond choices below the leverage cap, marginal debt issuance raises current resources net of issuance costs. This condition orders the dividend-constrained and constrained regions in net worth.

The following lemma characterizes net worth orderings for which constraint binds when the capital stock is fixed, and debt obligations vary.

Lemma D.1 (Regime Characterization with Fixed Capital.)**.** *Suppose Assumptions (D.1)-(D.3) hold. Consider an initial endowment* (K_0, B_0) *and define net worth* $n := K_0(1-\delta) - (1-\zeta)B_0$. *To first-order approximation of long-term bond yields, there exist thresholds* $\underline{n}(K_0) \leq \bar{n}(K_0)$ *such that*

$$
\begin{aligned}
n > \bar{n}(K_0) &\Rightarrow (K_0, B_0) \in \mathcal{R}^U := \{(K_0, B_0) : \mu = 0, \eta = 0\}, \\
\underline{n}(K_0) < n \leq \bar{n}(K_0) &\Rightarrow (K_0, B_0) \in \mathcal{R}^D := \{(K_0, B_0) : \mu \geq 0, \eta = 0, d_0 = 0\}, \\
n \leq \underline{n}(K_0) &\Rightarrow (K_0, B_0) \in \mathcal{R}^C := \{(K_0, B_0) : \mu \geq 0, \eta \geq 0, d_0 = 0, B_2 = \lambda K_0\}.
\end{aligned}
$$

The regions $\mathcal{R}^U$, $\mathcal{R}^D$, *and* $\mathcal{R}^C$ *denote unconstrained, dividend-constrained, and constrained firms, respectively.*

Proof. See Appendix D.4. □

Lemma D.1 provides an intuitive partition of the state space. For firms with the highest net worth, fixing the level of capital, $n > \bar{n}(K_0)$, neither the dividend nor leverage constraint binds, and the firm is unconstrained. For intermediate net worth, the leverage constraint is slack but the firm pays zero dividends. For the lowest net worth, $n \leq \underline{n}(K_0)$, both constraints bind. The lemma therefore formalizes how initial issuer balance sheets determine the elasticity of endogenous corporate bond supply under mild regularity conditions.

The following lemma provides the companion to Lemma D.1, fixing initial debt level, it characterizes how increasing capital endowments orders firms into different constraint regions.

Lemma D.2 (Regime Characterization with Fixed Debt.)**.** *Fix $B_0 \geq 0$ and suppose $\phi = 0$. Suppose Assumptions (D.1)-(D.3) hold. To first-order approximation of long-term bond yields, there exist thresholds $\underline{K}_0(B_0) \leq \overline{K}_0(B_0)$ such that*

$$\begin{aligned} K_0 > \overline{K}_0(B_0) &\implies (K_0, B_0) \in \mathcal{R}^U, \\ \underline{K}_0(B_0) < K_0 \leq \overline{K}_0(B_0) &\implies (K_0, B_0) \in \mathcal{R}^D, \\ K_0 \leq \underline{K}_0(B_0) &\implies (K_0, B_0) \in \mathcal{R}^C. \end{aligned}$$

Some regions may be empty within the interval. Thus, holding initial debt fixed, increasing initial capital relaxes the leverage constraint and then the dividend constraint.

Under Lemma D.2, increasing K_0 would raise the market capital ratio of the firms using the empirical to theoretical mapping discussed in Appendix B.2. Analogously, increasing B_0 while holding K_0 fixed would reduce the market capital ratio. Therefore, Lemmas D.1–D.2 demonstrate that, under the regularity conditions, there is a monotonic mapping from the model's notion of financial constraints to the empirical measure of financial capacity.

D.2 Extension with Default Risk

In this appendix, I develop a three-period model similar to Section 4 with default risk as an alternative microfoundation to firm bond issuance. Proofs of theoretical results are provided in Appendix D.4.

Production Environment. A continuum of identical firms are endowed with an initial level of capital, K_0, and debt obligation, B_0. In the initial period, the firms choose capital investment for the next two periods, as well as bond issuance with contractual maturity at $t = 2$.

In this extension, corporate defaults occur at $t = 1$, after production. Defaulted firms cease operating, and their bondholders receive recovery payments immediately. Surviving firms continue producing and repay their bonds at $t = 2$.

Let $\pi_1 \in [0, 1]$ denote the default probability conditional on the aggregate default state realized at $t = 1$. Conditional on this state, individual defaults satisfy a law of large numbers, so the realized fraction of defaulting firms equals π_1. I assume

$$\pi_1 = \bar{\pi} + \varepsilon_\pi. \tag{D.1}$$

The default-rate innovation satisfies

$$\mathbb{E}_0 [\varepsilon_\pi] = 0, \qquad \text{Var} (\varepsilon_\pi) = \sigma_\pi^2,$$

with support contained in $[-\bar{\pi}, 1 - \bar{\pi}]$, ensuring that $\pi_1 \in [0, 1]$. Thus $\bar{\pi}$ is the expected aggregate default rate and σ_π^2 captures aggregate default risk.

Conditional on default, having a larger face value of debt raises the resource costs of resolving bankruptcy, which is internalized by the firms. This cost to the firm represents legal costs related to renegotiation and liquidation frictions. I assume that these bankruptcy costs increase convexly with bonds outstanding and fall when firms have higher collateral values in the initial period. I parametrize these costs to be,

$$\Phi(B_2, K_0) = \frac{\hat{\psi}}{2} \frac{B_2^2}{K_0}.$$

Thus, bankruptcy is more costly for firms with higher debt burdens and less costly for firms with greater pledgeable collateral. Bankruptcy costs are incurred at $t = 1$, when default occurs, after production. To maintain a tight correspondence to the results of Section 4, the bankruptcy costs are quadratic. The potentially binding financial constraints on external equity issuance and a leverage limit from Section 4, defined in (7) remain.

At $t = 0$, a firm solves the following problem,

$$\max_{K_2, B_2} \quad d_0 + \mathbb{E}_0 \left[\beta_1 d_1 + \beta_2 d_2 \right] \tag{D.2}$$

$$\text{s.t.} \quad d_0 = AK_0^\alpha - I_2 - \frac{\phi}{2} \left(\frac{K_2}{K_0} - 1 \right)^2 K_0 + P_0^C B_2 - (1 - \zeta) B_0, \tag{D.3}$$

$$d_1 = AK_2^\alpha - z_{j,1} \frac{\hat{\psi}}{2} \frac{B_2^2}{K_0},$$

$$d_2 = \begin{cases} AK_2^\alpha - (1 - \zeta) B_2, & \text{if } z_{j,1} = 0, \\ 0, & \text{if } z_{j,1} = 1, \end{cases}$$

$$d_0 \geq 0, \qquad B_2 \leq \lambda K_0. \tag{D.4}$$

As before, firms choose capital investment subject to standard capital adjustment frictions. In this extension, the convex underwriting cost is replaced by a bankruptcy cost incurred upon default at $t = 1$. The firm-specific default indicator is $z_{j,1} \in \{0, 1\}$, with $\Pr(z_{j,1} = 1 \mid \pi_1) = \pi_1$. Corporate bond issuance continues to benefit from the repayment subsidy, ζ. Firms take the prices of their bond issuances as given. I denote the corporate bond price by P_0^C, which generally differs from the long-term government bond price, P_0^G. Firm owners are risk-neutral and have access to one-period government bonds.

The SDF is generated by a risk-neutral owner of the firm who discounts at the one-period government bond rates. Specifically, this gives the following definitions of per-period SDF's,

$$\beta_1(r_1) = \frac{1}{1 + r_1},$$
$$\beta_2(r_1) = \mathbb{E}_0 \left[\frac{1}{(1 + r_1)(1 + r_2)} \right].$$

Under the maintained independence of default and short-rate shocks, optimality of the firms' problem (D.2) implies that capital choice K_2 satisfies

$$\alpha A \left(\beta_1 + (1 - \bar{\pi}) \beta_2 \right) K_2^{\alpha - 1} - (1 + \mu) \left[1 + \phi \left(\frac{K_2}{K_0} - 1 \right) \right] = 0. \tag{D.5}$$

Throughout the analysis, I take the limit of capital adjustment costs $\phi \to 0$ for tractability.

The firms' optimal bond issuance is

$$B_2 = \frac{K_0}{\hat{\psi} \bar{\pi} \beta_1(r_1)} \left[(1 + \mu) P_0^C - \eta - \beta_2(r_1)(1 - \bar{\pi})(1 - \zeta) \right]. \tag{D.6}$$

As in the model without default, (13), firms issue more when long-term bond prices are high, holding all else constant. A binding leverage constraint, $\eta > 0$, limits issuance. The issuance decision balances current financing proceeds against expected repayment at $t = 2$ and expected bankruptcy costs at $t = 1$. Default affects issuance through expected bankruptcy costs, repayment probabilities, and equilibrium bond prices.

Bond Markets with Default. There are two asset classes and three assets in this environment, all zero-coupon bonds. The first asset class consists of one-period risk-free government bonds issued every period. Their interest rates are set by the central bank, and they are in zero net supply. The second asset class consists of government and corporate bonds with contractual maturity at $t = 2$, issued at $t = 0$. Government bonds pay off with certainty at $t = 2$. Corporate bonds are supplied endogenously according to (D.6) and are exposed to default at $t = 1$, after production.

The aggregate fraction of corporate issuers defaulting at $t = 1$ is π_1. Upon default, bondholders immediately receive a recovery payment per unit of face value given by

$$\mathcal{P}(K_2) = \kappa K_2, \qquad \kappa \in (0, 1). \tag{D.7}$$

Thus, greater investment at $t = 0$ raises recovery values. I restrict attention to equilibria in which

$$0 \leq \kappa K_2 \leq 1, \tag{D.8}$$

so recovery does not exceed face value. This is a reduced-form specification of recovery per unit of debt. Since firms choose identical capital stocks, recovery per unit of face value is identical across defaulting firms.

At $t = 0$, government and corporate bonds are priced by a risk-averse arbitrageur endowed with wealth W. For expositional clarity, I assume that habitat demand does not exist in this stylized environment, although the results could be easily extended to include their inelastic demand as in Section 4. The arbitrageur invests in two-period government bonds, a diversified portfolio of corporate bonds, and one-period government bonds yielding r_1. At $t = 1$, after the short rate and defaults are observed, the arbitrageur receives recovery payments and sells its remaining bond holdings to continuation investors. It then consumes its wealth and exits. Surviving corporate bonds and government bonds have certain payoffs at $t = 2$, so their date-1 prices follow from no arbitrage without requiring continuation investors to be risk-neutral.

The arbitrageur chooses its initial portfolio weights to maximize date-1 returns under

mean-variance preferences:

$$\begin{aligned} \max_{\omega_C,\omega_G} \quad & \mathbb{E}_0\left[\frac{W_1}{W}\right] - \frac{1}{2}\operatorname{Var}_0\left(\frac{W_1}{W}\right) \\ \text{s.t.} \quad & W_1 = W\left[(1-\omega_C-\omega_G)(1+r_1) + \omega_G R_1^G + \omega_C R_1^C\right]. \end{aligned} \tag{D.9}$$

Here R_1^G is the gross holding-period return on government bonds, and R_1^C is the gross return on the diversified corporate-bond portfolio, including recovery payments. The portfolio problem is evaluated using the first-order return approximations derived below.

As in Section 4, the short rate r_1 is known at $t = 0$, while the short rate prevailing at $t = 1$ is uncertain,

$$r_2 = \varepsilon_1, \qquad \mathbb{E}_0[\varepsilon_1] = 0, \qquad \operatorname{Var}(\varepsilon_1) = \sigma_r^2, \tag{D.10}$$

and I assume that gross interest rates have positive support. Both r_2 and π_1 are observed before the arbitrageur sells its remaining bond holdings.

Assumption D.4. *Monetary shocks and default shocks are independent, $\varepsilon_1 \perp \pi_1$.*

Assumption D.4 isolates the effects of interest-rate uncertainty and aggregate default risk. Monetary policy can nevertheless affect recovery values through firms' investment decisions.

Standard portfolio optimization gives

$$\mathbb{E}_0[R_1^G] - (1+r_1) = \omega_G \operatorname{Var}_0(R_1^G) + \omega_C \operatorname{Cov}_0(R_1^G, R_1^C), \tag{D.11}$$

$$\mathbb{E}_0[R_1^C] - (1+r_1) = \omega_G \operatorname{Cov}_0(R_1^G, R_1^C) + \omega_C \operatorname{Var}_0(R_1^C). \tag{D.12}$$

At $t = 1$, each surviving corporate bond and each government bond pays one unit with certainty at $t = 2$. Let P_1^C denote the ex-recovery value of the corporate-bond portfolio per unit of face value initially purchased. No arbitrage implies

$$P_1^G = \frac{1}{1+r_2}, \tag{D.13}$$

$$P_1^C = \frac{1-\pi_1}{1+r_2}. \tag{D.14}$$

The holding-period returns are therefore

$$R_1^G = \frac{P_1^G}{P_0^G} = \frac{1}{P_0^G(1+r_2)}, \tag{D.15}$$

$$R_1^C = \frac{P_1^C + \pi_1 \kappa K_2}{P_0^C} = \frac{1}{P_0^C}\left[\frac{1-\pi_1}{1+r_2} + \pi_1 \kappa K_2\right]. \tag{D.16}$$

Immediate recovery payments are not discounted by $1+r_2$ because the arbitrageur receives them at $t=1$.

It is convenient to define the expected undiscounted corporate payoff per unit of initial face value as $D(K_2) \equiv (1-\bar{\pi}) + \bar{\pi}\kappa K_2$. At $t=0$, bond markets clear according to

$$\omega_G W = P_0^G G, \tag{D.17}$$

$$\omega_C W = P_0^C B_2. \tag{D.18}$$

The first theoretical result characterizes equilibrium bond yields using a first-order approximation around small short rates and bond yields ($y^i, r_t \to 0$). The resulting yield equations distinguish the expectations-hypothesis component, expected default losses, and supply-related risk premia.

Proposition D.1. *Suppose capital adjustment costs satisfy $\phi \to 0$. Using $\beta_1 \simeq \beta_2 \simeq 1 - r_1$, equilibrium corporate and government bond yields satisfy, to first order,*

$$y^C = \frac{1}{2\mathcal{A}^D}\left[\underbrace{r_1}_{EH} + \underbrace{(1-D(K_2))}_{Expected\ Loss} + \underbrace{\frac{G(1-\bar{\pi})}{W}\sigma_r^2}_{Govt\ Supply} + \underbrace{\frac{Q(K_2)K_0}{\hat{\psi}\bar{\pi}W}\left[(1+r_1)(1+\mu-\eta) - (1-\bar{\pi})(1-\zeta)\right]}_{Corp\ Supply}\right], \tag{D.19}$$

$$y^G = \frac{1}{2}\left[\underbrace{r_1}_{EH} + \frac{\sigma_r^2}{W}\left\{\underbrace{G}_{Govt\ Supply} + \underbrace{(1-\bar{\pi})\frac{K_0}{\bar{\pi}\hat{\psi}}\left[(1+r_1-2y^C)(1+\mu) - (1-\bar{\pi})(1-\zeta) - \eta(1+r_1)\right]}_{Corp\ Supply}\right\}\right]. \tag{D.20}$$

Where terms are defined

$$D(K_2) \equiv (1-\bar{\pi}) + \bar{\pi}\kappa K_2,$$
$$Q(K_2) \equiv (1-\bar{\pi})^2\sigma_r^2 + (\kappa K_2 - 1)^2\sigma_\pi^2,$$
$$\mathcal{A}^D \equiv 1 + \frac{K_0 Q(K_2)}{\hat{\psi}\bar{\pi}W}(1+\mu).$$

Proposition D.1 shows that the equilibrium yield decomposition in Section 4 is preserved in an environment with corporate default. Two-period government bond yields are still determined by three forces: the expectations hypothesis, exogenous government bond supply, and endogenous corporate supply. Corporate issuance contributes to the term premium on default-free government bonds because surviving corporate bonds expose the arbitrageur to the same interest-rate risk as government bonds. Since recovery is paid immediately at $t = 1$, this shared exposure is proportional to the expected surviving fraction, $1 - \bar{\pi}$. Thus, corporate default changes the magnitude of the supply effect without eliminating the channel. The endogenous supply mechanism studied in Sections 4 and 5 therefore does not require corporate and government bonds to be perfect substitutes.

The corporate debt yield, y^C, is a distinct equilibrium object in this environment. To first order, it reflects the same forces as government bond yields: the expectations hypothesis, government supply, and corporate supply. Default affects these supply components through corporate return risk, $Q(K_2)$, and the issuance incentives governed by bankruptcy costs, $\hat{\psi}$, and the expected default rate, $\bar{\pi}$. Additionally, the corporate yield includes the expected-default-loss term $1 - D(K_2)$. This term captures the expected shortfall in repayment, while compensation for bearing default risk enters through the supply-related risk premium involving $Q(K_2)$.

Proposition D.1 therefore preserves the main asset-pricing mechanism in an alternative microfoundation with corporate default. Does this environment also preserve the intuition of Section 4 that endogenous bond supply dampens equilibrium yield responses to monetary policy in a state-dependent manner? I next characterize the model's comparative statics across regions where financial constraints bind. Throughout, I use the superscripts U and C to denote unconstrained and constrained initial states, respectively. The corporate yield in a constrained state is therefore written $y^{C,C}$, while the corporate yield in an unconstrained state is denoted $y^{C,U}$. Appendix D.1 provides intuition for how low initial capital endowments, K_0, can cause financial constraints to bind.

Proposition D.2 (Bond Market Transmission with Default.)**.** *Suppose* $\phi \to 0$ *and* $\alpha < 1$.

Consider an unconstrained state U ($\eta = \mu = 0$) with positive bond supply, and a constrained state C ($\eta, \mu > 0$). Suppose recovery satisfies (D.8). Denote equilibrium choices in state j by (K_2^j, B_2^j), and define $K_r^U \equiv \partial K_2^U / \partial r_1 < 0$. To first order for small bond yields, holding each financial regime fixed,

1. *Bond supply is decreasing in r_1 when firms are unconstrained and does not respond when firms are constrained:*

$$\frac{\partial B_2^U}{\partial r_1} = \frac{\frac{K_0^U}{\hat{\psi}} \kappa K_r^U \left[1 + \frac{2B_2^U(1-\kappa K_2^U)\sigma_\pi^2}{\bar{\pi} W}\right]}{1 + \frac{K_0^U Q(K_2^U)}{\hat{\psi}\bar{\pi} W}} < 0 = \frac{\partial B_2^C}{\partial r_1}.$$

2. *Endogenous supply dampens government bond yield sensitivity to policy:*

$$\frac{\partial y^{G,U}}{\partial r_1} = \frac{1}{2}\left[\underbrace{1}_{>0} + \underbrace{\frac{\sigma_r^2}{W}(1-\bar{\pi})\frac{\partial B_2^U}{\partial r_1}}_{<0}\right] < \frac{1}{2} = \frac{\partial y^{G,C}}{\partial r_1}.$$

When there is a change in monetary stance, the model with default preserves the state-dependent dampening effect of endogenous corporate supply on government bond yields. Specifically, when firms are sufficiently endowed to choose capital and bond issuance unconstrained, a higher r_1 reduces desired capital and therefore lowers recovery values. Under the recovery bound (D.8), lower capital also weakly increases corporate return risk. These changes make bond financing less attractive and cause firms to reduce issuance. The resulting decline in corporate supply reduces the duration risk that arbitrageurs must absorb, lowering the supply-related term premium and dampening the response of government yields. When the leverage constraint binds, corporate issuance is locally fixed, and government yields respond with the expectations-hypothesis sensitivity of 1/2 at the order of approximation considered. This statement concerns the response of yields, but note that their level continues to include a supply-related term premium.

Proposition D.2 therefore shows that the state-dependent monetary transmission detailed in the baseline model survives the introduction of corporate default under the stated conditions. Joint pricing by the arbitrageur is central to this result because changes in corporate supply affect the risk borne by the marginal investor in government bonds. Regarding corporate yields, for a given financial state of the production firms $j \in \{U, D, C\}$, define

$K_r^j \equiv \partial K_2^j / \partial r_1$. The corporate yield response to a monetary shock is

$$\frac{\partial y^{C,j}}{\partial r_1} = \frac{1}{2}\left[1 - \bar{\pi}\kappa K_r^j + \frac{B_2^j Q_K(K_2^j)}{W} K_r^j + \frac{Q(K_2^j)}{W}\frac{\partial B_2^j}{\partial r_1}\right], \tag{D.21}$$

where $Q_K(K_2) = 2\kappa(\kappa K_2 - 1)\sigma_\pi^2$. The final term captures the dampening effect of endogenous supply when firms reduce issuance following a rate hike. The recovery terms capture an opposing force: when investment falls, expected default losses increase and, under (D.8), corporate return risk weakly increases. Corporate yield responses therefore combine attenuation through issuance with amplification through lower recovery values.

The presence of defaultable corporate debt also introduces a recovery channel for credit spreads. Because recovery per unit of face value is κK_2, changes in monetary policy affect both expected default losses and compensation for default risk through firms' investment decisions.

Proposition D.3. *Maintain the conditions of Proposition D.2, and consider an unconstrained state U ($\mu = \eta = 0$). Then, to first order for small bond yields, the credit spread is increasing in r_1:*

$$\frac{\partial \mathcal{S}^U}{\partial r_1} > 0,$$

where $\mathcal{S}^U \equiv y^{C,U} - y^{G,U}$.

Therefore, reassuringly, this economy endogenously generates a credit spread that increases after a contractionary monetary shock when firms are unconstrained. This increase in credit spreads is consistent with the empirical findings of Gertler and Karadi (2015). The rationale for this result in the model is that contractionary policy endogenously reduces investment, which lowers recovery per unit of corporate debt in default. This increases expected losses and, under (D.8), weakly raises default-related return risk. Although the endogenous decline in corporate bond supply dampens yield responses, it does not offset these effects on the credit spread. Equilibrium corporate yields therefore rise by more than government yields.

I finally demonstrate that the state-dependent real implications of monetary transmission characterized in Section 4 hold in an environment with default risk. Specifically, when dividend and leverage constraints bind, investment depends on the proceeds from bond issuance. Sufficiently tight borrowing limits then imply that investment responses are smaller in magnitude for constrained firms than for unconstrained firms.

Proposition D.4 (Investment Responses with Default.)**.** *Maintain the conditions of Proposition D.2, and consider an unconstrained state U ($\eta = \mu = 0$) and a constrained state C ($\eta, \mu > 0$). Suppose constrained borrowing capacity is less than the optimal unconstrained capital choice, $0 < \lambda K_0^C < \bar{K}_2^U \equiv [\alpha A(2 - \bar{\pi})]^{\frac{1}{1-\alpha}}$, and recovery is sufficiently insensitive to investment,*

$$0 < \kappa \leq \frac{\alpha}{\bar{K}_2^U \left[\bar{\pi} + \frac{2\lambda K_0^C \sigma_\pi^2}{W}\right]}.$$

Then, to first order for small bond yields,

$$\left|\frac{\partial I_2^U(K_0^U)}{\partial r_1}\right| > \left|\frac{\partial I_2^C(K_0^C)}{\partial r_1}\right| > 0\,, \tag{D.22}$$

so investment responses to policy are larger in magnitude in the unconstrained state.

Therefore, default risk does not change the main implications of a state-dependent investment channel of policy. Proposition D.4 closely resembles Proposition 3, with analogous regularity conditions. When default is added, an additional condition is required ensuring that recovery values in the case of default are sufficiently low, as higher default recovery value raises equilibrium bond prices even in the constrained state. If there were no recovery, $\kappa = 0$, then this would hold generically.

Discussion of Default Environment. This appendix rewrites the microfoundation of debt issuance used in Section 4 materially by allowing corporate debt to default, and for bankruptcy costs on this default to provide an interior bond issuance solution. In this environment, there is stochastic aggregate default risk π_1 which is exogenous to firm decisions and independent of monetary shocks. These assumptions provide clarity into the implications of having default risk in equilibrium while preserving analytical tractability. The presence of default risk substantially changes the asset pricing environment, as corporate and government long-term bonds are now imperfect substitutes and there is a time-varying credit spread in the economy.

Despite the altered asset pricing environment, the extension delivers qualitatively similar results to the baseline finite horizon model detailed in Section 4. Because the same arbitrageurs invest in both corporate and government debt and their returns covary, endogenous corporate bond supply still affects safe yields to first order. The equilibrium yield decomposition Proposition D.1 provides a direct and similar analogue to the baseline decomposition in Proposition 1, where the expectations hypothesis and exogenous supply forces are present but there is a novel endogenous corporate supply term driving term premia. As in the base-

line, endogenous corporate supply attenuates yield responses (Proposition D.2) when firms have the financial capacity to issue bonds in response to policy. Therefore, there is natural state dependence in yield and issuance responses depending on the financial state of the corporate sector. The presence of defaultable corporate debt generates an endogenous, time-varying credit spread which is related to a large literature on the role of external financing in macroeconomic dynamics (e.g., Bernanke, Gertler, and Gilchrist, 1999). Finally, this extension demonstrates that default risk does not change the implications of state-dependent real transmission when recovery values of default are low, as unconstrained financial states tend to feature a more elastic investment channel to policy.

D.3 Extension with Short-Term Maturity Choice

In this extension, I incorporate maturity choice into the baseline model of Section 4. Firms can choose to issue some share of bonds short-term, in addition to the previously studied long-term issuance. This allows firms to substitute between long- and short-term debt optimally. I introduce this maturity choice by adding the maturity target friction of Greenwood, Hanson, and Stein (2010). By doing so, the model allows for transparent comparison of endogenous financing needs and maturity choice.

I retain the financial constraints of Section 4. Because firms can now issue debt at two maturities, I define the leverage constraint over total bond face value. Therefore, when the leverage constraint binds, firms cannot change the total size of their debt issuance but may continue to adjust its maturity composition. I show that this additional margin does not overturn the main results of Section 4: endogenous corporate bond supply continues to dampen monetary transmission to long-term yields, this attenuation is weaker when firms are financially constrained, and investment responses remain smaller in constrained states.

D.3.1 Maturity Choice Extension Environment

Production Firms. The continuum of homogeneous production firms in the baseline environment is largely unchanged. They are still endowed with initial capital and bond obligations (K_0, B_0). Their objective is to maximize shareholder value for the three periods in which they are active. Their bond issuance costs and capital adjustment costs are unchanged from Section 4.

The only way the firms' financing problem differs is that they now may issue short-term bonds, B_1, which they repay in $t = 1$. This is in addition to the previously studied long-term debt, B_2, that firms repay in $t = 2$. I follow Greenwood, Hanson, and Stein (2010) and

introduce that firms have a target share of long-term bonds, $\bar{m}$, that they exogenously wish to issue in equilibrium. There is a cost of deviating from this target long-term issuance share defined as

$$\Upsilon(B_1, B_2) \equiv \frac{\upsilon}{2}\left(P_0^{(2)}B_2 + P_0^{(1)}B_1\right)\left(\frac{P_0^{(2)}B_2}{P_0^{(2)}B_2 + P_0^{(1)}B_1} - \bar{m}\right)^2. \tag{D.23}$$

This cost is isomorphic to the maturity-choice friction studied in Greenwood, Hanson, and Stein (2010). I define total bond issuance as $B \equiv B_1 + B_2$, and total issuance costs remain

$$\Gamma(B, K_0) = \frac{\psi}{2}\frac{B^2}{K_0}.$$

With this new maturity choice dimension, the production firms maximize shareholder value by solving

$$\max_{K_2, B_1, B_2} \quad d_0 + \beta_1(r_1)d_1 + \beta_2(r_1)d_2 \tag{D.24}$$

$$\begin{aligned}
\text{s.t. } d_0 &= AK_0^{\alpha} - I_2 - \frac{\phi}{2}\left(\frac{I_2}{K_0} - \delta\right)^2 K_0 \\
&\quad + P_0^{(2)}B_2 + P_0^{(1)}B_1 - (1-\zeta)B_0 - \Upsilon(B_1, B_2) - \Gamma(B, K_0), \\
d_1 &= AK_2^{\alpha} - (1-\zeta)B_1, \\
d_2 &= AK_2^{\alpha} - (1-\zeta)B_2, \\
d_0 &\geq 0 \ [\mu], \qquad B_1 + B_2 \leq \lambda K_0 \ [\eta].
\end{aligned} \tag{D.25}$$

Optimality with respect to capital implies

$$\alpha A\left(\beta_1 + \beta_2\right)K_2^{\alpha-1} - (1+\mu)\left[1 + \phi\left(\frac{K_2}{K_0} - 1\right)\right] = 0. \tag{D.26}$$

When the dividend constraint is slack, $\mu = 0$, capital choice is unchanged relative to Section 4 and remains separable from the firm's financing decision. When the dividend constraint binds, the shadow value of internal funds enters the capital decision as before.

For notational convenience define, $\Upsilon_i \equiv \frac{\partial \Upsilon}{\partial B_i}$, for maturities $i \in \{1, 2\}$. The bond first-order conditions are

$$0 = (1+\mu)\left[P_0^{(1)} - \Upsilon_1 - \psi\frac{B_1 + B_2}{K_0}\right] - \beta_1(1-\zeta) - \eta, \tag{D.27}$$

$$0 = (1+\mu)\left[P_0^{(2)} - \Upsilon_2 - \psi\frac{B_1 + B_2}{K_0}\right] - \beta_2(1-\zeta) - \eta. \tag{D.28}$$

The common issuance cost and leverage multiplier enter both maturity choices identically. Therefore, subtracting the two conditions eliminates these terms. Since $\beta_1 \approx \beta_2 \approx 1 - r_1$ to first order, the financial constraints do not directly alter the relative maturity choice of the firm.

Bond Investors, Central Bank, and Firm Owner. The arbitrageur and preferred habitat investors in this extension are identical to their descriptions in Section 4. Because one-period firm bonds carry no default risk, by arbitrage $P_0^{(1)} = \frac{1}{1+r_1}$.

The central bank and owner of the production firms are also unchanged from Section 4.

D.3.2 Bond Yields and Monetary Transmission with Maturity Choice

To characterize equilibrium bond supply, it is convenient to collect the following parameters and denote them as

$$a^M \equiv \bar{m}^2 - \bar{m} + \frac{1}{\upsilon}. \tag{D.29}$$

To first order, the maturity-choice condition implies

$$\frac{P_0^{(2)} B_2}{P_0^{(2)} B_2 + P_0^{(1)} B_1} \approx \bar{m} + \frac{r_1 - 2y^{(2)}}{\upsilon}. \tag{D.30}$$

Total bond issuance satisfies

$$B \approx \frac{K_0}{\psi}\left[\frac{\mu + \zeta - \eta}{1+\mu} + \left(\frac{1-\zeta}{1+\mu} - (1-\bar{m})\right) r_1 - 2\bar{m} y^{(2)}\right]. \tag{D.31}$$

Combining (D.30) and (D.31), long-term bond issuance is

$$\begin{aligned} B_2 \approx \frac{K_0}{\psi}\Bigg[&\frac{\bar{m}(\mu + \zeta - \eta)}{1+\mu} \\ &+ \left\{\bar{m}\left(\frac{1-\zeta}{1+\mu} - (1-\bar{m})\right) + a^M \frac{\mu + \zeta - \eta}{1+\mu}\right\} r_1 \\ &- 2\left\{\bar{m}^2 + a^M \frac{\mu + \zeta - \eta}{1+\mu}\right\} y^{(2)}\Bigg]. \end{aligned} \tag{D.32}$$

The extension with maturity choice continues to allow for an approximately closed-form characterization of equilibrium asset prices.

Proposition D.5. *To first order for small bond yields, the equilibrium two-period bond yield*

is

$$y^{(2)} = \underbrace{\frac{1}{2}r_1}_{EH} + \frac{1}{2\mathcal{A}^M}\left[\underbrace{\widetilde{G}}_{Exogenous\ Supply} + \underbrace{\frac{K_0}{\psi}\frac{\bar{m}}{1+\mu}\left\{(\mu+\zeta-\eta) - [2(\mu+\zeta)-\eta]\, r_1\right\}}_{Corporate\ Supply}\right], \quad \text{(D.33)}$$

where

$$\mathcal{A}^M \equiv \frac{W}{\sigma_r^2} + \frac{K_0}{\psi}\left[\bar{m}^2 + \left(\bar{m}^2 + \frac{1}{\upsilon}\right)\frac{\mu+\zeta-\eta}{1+\mu}\right]. \quad \text{(D.34)}$$

Proposition D.5 preserves the same decomposition of equilibrium yields as in Section 4. Long-term yields contain an expectations-hypothesis component, an exogenous supply risk factor from government supply and preferred habitat demand, and an endogenous corporate-supply factor. Maturity choice changes the elasticity of long-term corporate supply because firms may substitute between short- and long-term debt, while the financial constraints determine the total amount of debt that firms can issue.

When $\mu = \eta = 0$, Proposition D.5 reduces to the unconstrained maturity-choice environment. In this case bond market elasticity is given,

$$\mathcal{A}^M = \frac{W}{\sigma_r^2} + \frac{K_0}{\psi}\left[\bar{m}^2(1+\zeta) + \frac{\zeta}{\upsilon}\right],$$

and the corporate-supply term becomes $\frac{K_0}{\psi}\bar{m}\zeta(1-2r_1)$.

Bond Market Transmission. I next characterize how monetary policy affects bond supply and long-term yields across financial states. Define total bond supply as $B = B_1 + B_2$.

Proposition D.6. *Suppose capital adjustment costs are small, $\phi \to 0$, and consider an unconstrained state U and a dividend- and collateral-constrained state C, where $K_0^U > K_0^C$. Suppose $a^M > 0$ and investor demand is sufficiently elastic,*

$$\frac{W}{\sigma_r^2} > \frac{K_0^U}{\psi}\left|\bar{m}^2(1+\zeta) - 2\bar{m}\zeta + \frac{\zeta}{\upsilon}\right|. \quad \text{(D.35)}$$

Then

1. *Total bond issuance responds more strongly in the unconstrained state*

$$\frac{\partial B^U(K_0^U)}{\partial r_1} < \frac{\partial B^C(K_0^C)}{\partial r_1} = 0. \tag{D.36}$$

2. *Long-term issuance satisfies*

$$\frac{\partial B_2^U(K_0^U)}{\partial r_1} < 0 < \frac{\partial B_2^C(K_0^C)}{\partial r_1}. \tag{D.37}$$

3. *If, in addition, equilibrium long-term bond supply is larger in the unconstrained state, $B_2^U > B_2^C$, then monetary pass-through to long-term yields is larger in the constrained state,*

$$0 < \frac{\partial y^{(2),U}(K_0^U)}{\partial r_1} < \frac{\partial y^{(2),C}(K_0^C)}{\partial r_1} < \frac{1}{2}. \tag{D.38}$$

Proposition D.6 demonstrates that maturity choice does not overturn the state-dependent bond-market transmission of Section 4. When firms are unconstrained, both the total size and maturity composition of debt can respond to policy. Under sufficiently elastic investor demand, a rate hike lowers long-term issuance and total bond supply.

When the leverage constraint binds, total bond issuance is locally fixed at $B^C = \lambda K_0^C$. Unlike the baseline environment, however, constrained firms retain a maturity-composition margin. A rate hike can induce firms to shift a fixed amount of total debt toward long-term bonds. The positivity condition on (D.29) ensures that this maturity-substitution response is weakly positive. Despite this additional margin, long-term yields remain more responsive in the constrained state when unconstrained firms supply a larger amount of long-term debt. Thus, the central substitution between bond quantity and yield responses survives the introduction of maturity choice conditional on natural regularity conditions.

Real Monetary Transmission. Finally, I characterize investment responses across financial states. When firms are unconstrained, maturity choice does not affect their desired capital scale because investment and financing remain separable. When both financial constraints bind, however, investment is determined by the market value of the fixed amount of debt the firm can issue.

Proposition D.7. *Suppose capital adjustment costs are small, $\phi \to 0$, and consider an unconstrained state U and a dividend- and collateral-constrained state C. Suppose $a^M \geq 0$. Define unconstrained capital at $r_1 = 0$ as $\bar{K}_2^U \equiv (2\alpha A)^{\frac{1}{1-\alpha}}$. If constrained borrowing capacity is less than the unconstrained capital choice, $\lambda K_0^C < \bar{K}_2^U$, then a rate hike lowers investment*

in both states, with a larger absolute response in the unconstrained state:

$$\left|\frac{\partial I_2^U}{\partial r_1}\right| > \left|\frac{\partial I_2^C}{\partial r_1}\right| > 0. \tag{D.39}$$

Proposition D.7 demonstrates that the real transmission result of Section 4 also survives maturity choice. The ability to substitute between short- and long-term debt changes how constrained firms raise resources from a fixed debt capacity, but does not allow them to expand total external financing. Consequently, their investment response remains smaller than that of unconstrained firms whenever their borrowing capacity is below the unconstrained desired capital stock.

D.4 Section D Proofs

Proof of Lemma D.1

Proof. Using $I_2 = K_2 - (1-\delta)K_0$, period-0 dividends can be written as

$$d_0 = n + AK_0^\alpha - K_2 - \frac{\phi}{2}\left(\frac{K_2}{K_0} - 1\right)^2 K_0 + P_0^{(2)} B_2 - \frac{\psi}{2}\frac{B_2^2}{K_0}\,.$$

Therefore, the inherited debt burden enters the firm problem only through n.

The inequality constraints are

$$d_0 \geq 0, \qquad\qquad B_2 \leq \lambda K_0.$$

The complementary slackness conditions imply

$$\mu \geq 0, \qquad \eta \geq 0, \qquad \mu d_0 = 0, \qquad \eta(\lambda K_0 - B_2) = 0.$$

Therefore there are four potential cases to consider:

$$d_0 > 0,\ B_2 < \lambda K_0, \qquad d_0 = 0,\ B_2 < \lambda K_0, \qquad d_0 = 0,\ B_2 = \lambda K_0, \qquad d_0 > 0,\ B_2 = \lambda K_0.$$

$\boldsymbol{\mu = 0 \implies \eta = 0}$. I first rule out the fourth case where the dividend constraint is slack but the leverage constraint binds. Suppose $d_0 > 0$ and $B_2 = \lambda K_0$. Then complementary slackness gives

$$\mu = 0, \qquad\qquad \eta \geq 0.$$

For any candidate bond supply $\tilde{B}_2$, the linearized market-clearing equation implies

$$P_0^{(2)}(\tilde{B}_2) = 1 - 2\frac{\frac{W}{\sigma_r^2}r_1 + \tilde{B}_2 + \widetilde{G}}{2\left(\frac{W}{\sigma_r^2} + \tilde{B}_2\right)}$$
$$= \frac{\frac{W}{\sigma_r^2}(1 - r_1) - \widetilde{G}}{\frac{W}{\sigma_r^2} + \tilde{B}_2}.$$

The unconstrained bond choice is defined as

$$B_2^U = \frac{K_0}{\psi}\left[P_0^U - (1-\zeta)(1-r_1)\right],$$

where $P_0^U = P_0^{(2)}(B_2^U)$. By Assumption D.1,

$$B_2^U < \lambda K_0 .$$

Define

$$F(B) := P_0^{(2)}(B) - \psi\frac{B}{K_0}.$$

Assumption D.3 implies[6]

$$\frac{W}{\sigma_r^2}(1 - r_1) - \widetilde{G} > 0.$$

Therefore $P_0^{(2)}(B)$ is strictly decreasing in B, and hence $F(B)$ is strictly decreasing in B. Since $B_2^U < \lambda K_0$,

$$F(\lambda K_0) < F(B_2^U).$$

Using the definition of B_2^U,

$$F(B_2^U) = P_0^U - \psi\frac{B_2^U}{K_0}$$
$$= (1-\zeta)(1-r_1).$$

[6]This follows from expanding Assumption D.3 to be $\frac{W}{\sigma_r^2}(1 - r_1) - \widetilde{G} > 2\lambda K_0 + \frac{W}{\sigma_r^2}\psi\lambda$.

Hence

$$P_0^{(2)}(\lambda K_0) - \psi\lambda < (1-\zeta)(1-r_1).$$

The optimal supply of bonds is derived as

$$B_2 = \frac{K_0}{\psi}\left[P_0^{(2)} - \frac{(1-\zeta)(1-r_1)+\eta}{1+\mu}\right] .$$

Substituting $\mu = 0$ and $B_2 = \lambda K_0$ gives

$$\eta = P_0^{(2)}(\lambda K_0) - \psi\lambda - (1-\zeta)(1-r_1) .$$

The preceding inequality implies $\eta < 0$, contradicting $\eta \geq 0$, completing the proof.

Region Ordering. I now show that the remaining regions are ordered in n. Let (K_2^U, B_2^U, P_0^U) denote the unconstrained equilibrium. Define

$$\bar{n}(K_0) := -\left[AK_0^\alpha - K_2^U - \frac{\phi}{2}\left(\frac{K_2^U}{K_0} - 1\right)^2 K_0 + P_0^U B_2^U - \frac{\psi}{2}\frac{(B_2^U)^2}{K_0}\right].$$

Evaluating dividends at the unconstrained allocation gives

$$d_0^U = n - \bar{n}(K_0).$$

Thus, if $n > \bar{n}(K_0)$, the unconstrained allocation satisfies $d_0 > 0$. Since $B_2^U < \lambda K_0$, the firm is in $\mathcal{R}^U$. If $n \leq \bar{n}(K_0)$, the unconstrained allocation weakly violates the dividend constraint, so the firm must satisfy $d_0 = 0$.

Consider the dividend-constrained branch with $\eta = 0$. Let B_2^D, K_2^D, and P_0^D denote the bond supply, capital choice, and bond price in this region. The bond supply in this region is implicitly defined as

$$P_0^D(B_2^D) - \psi\frac{B_2^D}{K_0} = \frac{(1-\zeta)(1-r_1)}{1+\mu}.$$

The left-hand side is $F(B_2^D) := P_0^D(B_2^D) - \psi B_2^D/K_0$. By the argument in the first part of the proof, $F(\cdot)$ is strictly decreasing in B_2^D, while the right-hand side is strictly decreasing in μ. Therefore,

$$\frac{\partial B_2^D}{\partial \mu} > 0,$$

by the implicit function theorem.

The capital first-order condition on the same branch is

$$\alpha A(\beta_1 + 1 - r_1)(K_2^D)^{\alpha-1} = (1+\mu)\left[1 + \phi\left(\frac{K_2^D}{K_0} - 1\right)\right].$$

Implicit differentiation implies

$$\frac{\partial K_2^D}{\partial \mu} < 0.$$

The sign follows because the left-hand side is decreasing in K_2^D, while the right-hand side is increasing in both μ and K_2^D.

On the dividend-constrained branch, $d_0 = 0$, implying

$$n = -\left[AK_0^\alpha - K_2^D - \frac{\phi}{2}\left(\frac{K_2^D}{K_0} - 1\right)^2 K_0 + P_0^D(B_2^D)B_2^D - \frac{\psi}{2}\frac{(B_2^D)^2}{K_0}\right].$$

Define n^D as current resources on the dividend-constrained branch. The capital component of n^D is decreasing in K_2^D:

$$\frac{\partial n^D}{\partial K_2^D} = \frac{\partial}{\partial K_2^D}\left[-K_2^D - \frac{\phi}{2}\left(\frac{K_2^D}{K_0} - 1\right)^2 K_0\right] = -\left[1 + \phi\left(\frac{K_2^D}{K_0} - 1\right)\right] < 0.$$

The inequality follows from the capital first-order condition (12), as $1 + \phi\left(\frac{K_2^D}{K_0} - 1\right) > 0$. Because $\partial K_2^D/\partial\mu < 0$, an increase in μ lowers investment and raises the capital component of current resources.

The debt component of current resources is defined as $\mathcal{B}^D := P_0^D(B_2^D)B_2^D - \frac{\psi}{2}\frac{(B_2^D)^2}{K_0}$. Differentiating this component with respect to B_2^D yields

$$\frac{\partial \mathcal{B}^D}{\partial B_2^D} = \frac{\frac{W}{\sigma_r^2}\left[\frac{W}{\sigma_r^2}(1-r_1) - \widetilde{G}\right]}{\left(\frac{W}{\sigma_r^2} + B_2^D\right)^2} - \psi\frac{B_2^D}{K_0}.$$

Assumption D.3 guarantees that this expression is positive[7] for all $B_2^D \leq \lambda K_0$. Since $\partial B_2^D/\partial\mu >$

[7] Assumption D.3 implies

$$\frac{\frac{W}{\sigma_r^2}\left[\frac{W}{\sigma_r^2}(1-r_1) - \widetilde{G}\right]}{\left(\frac{W}{\sigma_r^2} + \lambda K_0\right)^2} > \psi\lambda.$$

Since the left-hand side is minimized over $B_2^D \leq \lambda K_0$ at $B_2^D = \lambda K_0$, the derivative is positive for all $B_2^D \leq \lambda K_0$.

0, the debt component of current resources also increases with μ.

Therefore current resources are strictly increasing in μ in the dividend-constrained region. Since n is the negative of current resources on this branch, $\frac{\partial n}{\partial \mu} < 0$. Together with $\partial B_2^D / \partial \mu > 0$, this implies

$$\frac{\partial B_2^D}{\partial n} < 0.$$

Thus, as net worth falls, bond issuance rises monotonically when $\mu > 0$ and $\eta = 0$.

It remains to show that within this region, issuance continues until the leverage constraint binds. Because $F(B)$ is strictly decreasing and $B_2^U < \lambda K_0$,

$$F(\lambda K_0) < F(B_2^U) = (1-\zeta)(1-r_1).$$

Assumption D.3 also implies $P_0^D(\lambda K_0) - \psi\lambda > 0$. Rearranging the optimal bond supply,

$$P_0^D(B_2^D) - \psi \frac{B_2^D}{K_0} = \frac{(1-\zeta)(1-r_1)}{1+\mu},$$

demonstrates that the right-hand-side decreases continuously from $(1-\zeta)(1-r_1)$ to zero as μ rises. Therefore, there exists a unique finite μ^λ such that

$$P_0^D(\lambda K_0) - \psi\lambda = \frac{(1-\zeta)(1-r_1)}{1+\mu^\lambda}.$$

At this value, the bond first-order condition is satisfied at $B_2^D = \lambda K_0$. Define $\underline{n}(K_0)$ as the corresponding value of net worth.

Therefore, if

$$\underline{n}(K_0) < n \leq \bar{n}(K_0),$$

then the dividend constraint binds and the leverage constraint is slack, so $(K_0, B_0) \in \mathcal{R}^D$. If instead

$$n \leq \underline{n}(K_0),$$

then the dividend-constrained branch would require $B_2^D \geq \lambda K_0$, so the leverage constraint binds and $(K_0, B_0) \in \mathcal{R}^C$.

The three regions are mutually exclusive by complementary slackness and are ordered in

net worth by the two thresholds $\bar{n}(K_0)$ and $\underline{n}(K_0)$. □

Proof of Lemma D.2

Proof. Write inverse bond demand as $P_0^{(2)}(B_2)$, which is strictly decreasing under Assumption D.3. With $\phi = 0$, unconstrained capital is

$$K_2^U = [2\alpha A(1 - r_1)]^{1/(1-\alpha)},$$

independent of K_0. Unconstrained bond issuance satisfies

$$P_0^{(2)}(B_2^U) - \psi \frac{B_2^U}{K_0} = (1 - \zeta)(1 - r_1).$$

Because inverse demand is decreasing, this equation implies that B_2^U increases with K_0.

At the boundary where the leverage constraint just binds, set $B_2^\lambda = \lambda K_0$ and $\eta = 0$. Combining the capital and bond first-order conditions gives

$$K_2^\lambda \equiv \left[\frac{2\alpha A}{1 - \zeta} \left(P_0^{(2)}(\lambda K_0) - \psi \lambda \right) \right]^{1/(1-\alpha)}.$$

Assumption D.3 ensures that the bracket is positive. Since $P_0^{(2)}(\lambda K_0)$ decreases with K_0, so does K_2^λ.

Evaluate initial dividends at these two candidate allocations:

$$d_0^j(K_0) = AK_0^\alpha + (1 - \delta)K_0 - (1 - \zeta)B_0 - K_2^j + P_0^{(2)}(B_2^j)B_2^j - \frac{\psi}{2} \frac{(B_2^j)^2}{K_0}, \qquad j \in \{U, \lambda\}.$$

Assumption D.3 ensures that bond proceeds net of issuance costs increase with B_2 up to the leverage cap. They also increase with K_0 holding B_2 fixed. Therefore, both $d_0^U(K_0)$ and $d_0^\lambda(K_0)$ are strictly increasing: internal resources rise, net financing rises, and desired capital is either constant or decreasing.

Moreover, Assumption D.1 implies $B_2^\lambda > B_2^U$ and $K_2^\lambda < K_2^U$, so $d_0^\lambda(K_0) > d_0^U(K_0)$. Consequently, the zero of d_0^λ precedes the zero of d_0^U. These define $\underline{K}_0(B_0)$ and $\overline{K}_0(B_0)$ whenever the crossings occur within the interval. Applying Lemma D.1 at each K_0 gives the stated ordering. □

Proof of Proposition D.1

Proof. I linearize endogenous capital choice and bond supply from the firms' problem to first order. Throughout, I use first-order approximations to bond yields and interest rates, assuming they are in a neighborhood of zero.

To characterize equilibrium bond yields, I first characterize the return moments used in the arbitrageur's portfolio choice. Using the no-arbitrage prices of surviving bonds and immediate recovery payments at $t = 1$, the two-period bond returns are

$$R_1^G = \frac{(1+y^G)^2}{1+r_2} \approx (1+y^G)^2(1-r_2)\,,$$
$$R_1^C = (1+y^C)^2\left[\frac{1-\pi_1}{1+r_2} + \pi_1\kappa K_2(r_1)\right] \approx (1+y^C)^2\left[D(K_2) - (1-\bar{\pi})r_2 + (\kappa K_2 - 1)\varepsilon_\pi\right]\,.$$

Denote these approximated returns by $\tilde{R}_1^i$. Using the independence of monetary and default shocks in Assumption D.4, their moments are

$$\begin{aligned}
\mathbb{E}_0\left[\tilde{R}_1^C\right] &= (1+y^C)^2 D(K_2)\,,\\
\mathbb{E}_0\left[\tilde{R}_1^G\right] &= (1+y^G)^2\,,\\
\mathrm{Var}_0\left(\tilde{R}_1^C\right) &= (1+y^C)^4 \underbrace{\left[(1-\bar{\pi})^2\sigma_r^2 + (\kappa K_2 - 1)^2\sigma_\pi^2\right]}_{\equiv Q(K_2)}\,,\\
\mathrm{Var}_0\left(\tilde{R}_1^G\right) &= \sigma_r^2(1+y^G)^4\,,\\
\mathrm{Cov}_0\left(\tilde{R}_1^G, \tilde{R}_1^C\right) &= (1-\bar{\pi})(1+y^G)^2(1+y^C)^2\sigma_r^2\,.
\end{aligned}$$

To keep the notation tractable, I define $D(K_2) \equiv (1-\bar{\pi}) + \bar{\pi}\kappa K_2$ and $Q(K_2) \equiv (1-\bar{\pi})^2\sigma_r^2 + (\kappa K_2 - 1)^2\sigma_\pi^2$. Both depend on the model's parameters and the endogenous capital choice K_2.

Using the market-clearing conditions (D.17)–(D.18), I rewrite the arbitrageur's portfolio weights as

$$\omega_G = \frac{G}{(1+y^G)^2 W}\,, \qquad \omega_C = \frac{B_2}{(1+y^C)^2 W}\,.$$

Substituting these portfolio weights and return moments into (D.11) and dividing each con-

dition by $(1+y^i)^2$ gives

$$\frac{1+r_1}{(1+y^C)^2} = D(K_2) - \frac{G(1-\bar{\pi})\sigma_r^2 + B_2 Q(K_2)}{W} ,$$
$$\frac{1+r_1}{(1+y^G)^2} = 1 - \frac{\sigma_r^2}{W}\left[G + (1-\bar{\pi})B_2\right] .$$

Using the first-order approximation $(1+r_1)/(1+y^i)^2 \approx 1 + r_1 - 2y^i$, equilibrium yields can therefore be decomposed as

$$y^C \approx \frac{1}{2}\left[1 - D(K_2) + r_1 + \frac{G(1-\bar{\pi})\sigma_r^2 + B_2 Q(K_2)}{W}\right] ,$$
$$y^G \approx \frac{1}{2}\left[r_1 + \frac{\sigma_r^2}{W}\left((1-\bar{\pi})B_2 + G\right)\right] .$$

At this stage, the main implication of Proposition D.1 is already present. Equilibrium yields are decomposed into terms representing the expectations hypothesis, government supply, and endogenous corporate supply. In the case of the corporate yield, there is also an expected-default-loss term related to the likelihood of default ($\bar{\pi}$) and recovery capital (K_2). Because recovery is paid immediately at $t = 1$, only surviving corporate bonds contribute to the covariance with government bond returns.

The final step is substituting the linearized, endogenous corporate bond supply and solving for yields. Using $\beta_1 \simeq \beta_2 \simeq 1 - r_1$ and $P_0^C \simeq 1 - 2y^C$, I linearize bond supply with default risk (D.6) as

$$B_2 \approx \frac{K_0}{\bar{\pi}\hat{\psi}}\left[(1+\mu)(1+r_1-2y^C) - (1-\bar{\pi})(1-\zeta) - \eta(1+r_1)\right] . \tag{D.40}$$

Substituting (D.40) into the expressions for (y^C, y^G) allows for explicit characterization of equilibrium yields.

To first order, these are

$$y^C = \frac{1}{2\left[1 + \frac{K_0 Q(K_2)}{\bar{\pi}\hat{\psi}W}(1+\mu)\right]}\left[\begin{array}{l} r_1 + 1 - D(K_2) + \dfrac{G(1-\bar{\pi})}{W}\sigma_r^2 \\ + \dfrac{Q(K_2)K_0}{\hat{\psi}\bar{\pi}W}\left((1+r_1)(1+\mu-\eta) - (1-\bar{\pi})(1-\zeta)\right)\end{array}\right] ,$$
$$y^G = \frac{1}{2}\left[r_1 + \frac{\sigma_r^2}{W}\left\{G + (1-\bar{\pi})\frac{K_0}{\hat{\psi}\bar{\pi}}\left[(1+\mu)(1+r_1-2y^C) - (1-\bar{\pi})(1-\zeta) - \eta(1+r_1)\right]\right\}\right] .$$

Using the definition of $\mathcal{A}^D$ in the above expressions completes the proof. □

Proof of Proposition D.2

Proof. Part a) First, I linearize capital around the no-adjustment-costs benchmark for small interest rates.

$$K_2 \approx \left[\frac{\alpha A(2-\bar{\pi})(1-r_1)}{1+\mu}\right]^{\frac{1}{1-\alpha}}.$$

For each regime $j \in \{U, C\}$, barred quantities denote values evaluated at $r_1 = 0$, and the subscript r denotes the derivative with respect to r_1 at that point, holding the regime fixed. Therefore,

$$\bar{K}_2^j = \left[\frac{\alpha A(2-\bar{\pi})}{1+\bar{\mu}^j}\right]^{\frac{1}{1-\alpha}},$$

noting that $K_2^j \approx \bar{K}_2^j + K_r^j r_1$, where

$$K_r^j = -\frac{\bar{K}_2^j}{1-\alpha}\left[1 + \frac{\mu_r^j}{1+\bar{\mu}^j}\right]. \tag{D.41}$$

Part b) Then I rewrite the corporate payoffs using their first-order approximations. Let H^j denote the date-1 corporate payoff per unit of initial face value, including immediate recovery and the resale value of surviving bonds. Approximating in the return shocks while retaining the dependence on endogenous capital gives

$$H^j \approx D(K_2^j) - (1-\bar{\pi})r_2 + (\kappa K_2^j - 1)\varepsilon_\pi.$$

At the expansion point, define

$$\begin{aligned} D^j &\equiv (1-\bar{\pi}) + \bar{\pi}\kappa\bar{K}_2^j, \\ Q^j &\equiv (1-\bar{\pi})^2\sigma_r^2 + (\kappa\bar{K}_2^j - 1)^2\sigma_\pi^2, \\ Q_K^j &\equiv Q'(\bar{K}_2^j) = 2\kappa(\kappa\bar{K}_2^j - 1)\sigma_\pi^2. \end{aligned}$$

Because recovery depends on capital, the corresponding first-order expansions in r_1 are

$$\begin{aligned} D(K_2^j) &\approx D^j + \bar{\pi}\kappa K_r^j r_1, \\ Q(K_2^j) &\approx Q^j + Q_K^j K_r^j r_1. \end{aligned}$$

Using these approximations, the regime-specific yields can be written

$$y^{C,j} \approx \frac{1}{2}\left[1 - D^j + \left(1 - \bar{\pi}\kappa K_r^j + \frac{\bar{B}_2^j Q_K^j K_r^j}{W}\right) r_1 + \frac{G(1-\bar{\pi})\sigma_r^2}{W} + \frac{Q^j}{W} B_2^j\right], \tag{D.42}$$

$$y^{G,j} \approx \frac{1}{2}\left[r_1 + \frac{\sigma_r^2}{W}\left(G + (1-\bar{\pi})B_2^j\right)\right]. \tag{D.43}$$

The term involving Q_K^j retains the change in corporate return risk induced by changes in recovery capital.

Part c) Generically, the comparative statics for yields are then given by

$$\frac{\partial y^{C,j}}{\partial r_1} = \frac{1}{2}\left[1 - \bar{\pi}\kappa K_r^j + \frac{\bar{B}_2^j Q_K^j}{W} K_r^j + \frac{Q^j}{W}\frac{\partial B_2^j}{\partial r_1}\right],$$

$$\frac{\partial y^{G,j}}{\partial r_1} = \frac{1}{2}\left[1 + \frac{\sigma_r^2(1-\bar{\pi})}{W}\frac{\partial B_2^j}{\partial r_1}\right].$$

Part d) The corporate bond-supply comparative static is then given by differentiating the linearized bond supply, (D.40). Evaluating at $r_1 = 0$ results in

$$\frac{\partial B_2^j}{\partial r_1} = \frac{K_0^j}{\bar{\pi}\hat{\psi}}\left[1 + \bar{\mu}^j - \bar{\eta}^j + (1 - 2\bar{y}^{C,j})\mu_r^j - \eta_r^j - 2(1+\bar{\mu}^j)\frac{\partial y^{C,j}}{\partial r_1}\right]. \tag{D.44}$$

Part e) **Characterizing the Unconstrained Regime.** In the unconstrained regime, $\mu^U = \eta^U = 0 = \mu_r^U = \eta_r^U$. Therefore, the capital response to policy is characterized as

$$K_r^U = -\frac{\bar{K}_2^U}{1-\alpha} < 0. \tag{D.45}$$

Substituting this into (D.44) with the approximation for $\partial y^{C,U}/\partial r_1$ gives

$$\left(1 + \frac{K_0^U Q^U}{\bar{\pi}\hat{\psi}W}\right)\frac{\partial B_2^U}{\partial r_1} = \frac{K_0^U}{\bar{\pi}\hat{\psi}}\left(\bar{\pi}\kappa - \frac{\bar{B}_2^U Q_K^U}{W}\right) K_r^U.$$

Using the definition of Q_K^U, this becomes

$$\frac{\partial B_2^U}{\partial r_1} = \frac{\frac{K_0^U}{\hat{\psi}}\kappa K_r^U\left[1 + \frac{2\bar{B}_2^U(1-\kappa\bar{K}_2^U)\sigma_\pi^2}{\bar{\pi}W}\right]}{1 + \frac{K_0^U Q^U}{\bar{\pi}\hat{\psi}W}} < 0.$$

The inequality follows from $K_r^U < 0$, positive bond supply, and the recovery bound (D.8), which makes the term in square brackets weakly greater than one. This proves the uncon-

strained issuance statement.

Regarding government yields, substituting the derived $\partial B_2^U/\partial r_1$ into $\partial y^{G,U}/\partial r_1$ gives

$$\frac{\partial y^{G,U}}{\partial r_1} = \frac{1}{2}\left[1 + \frac{\sigma_r^2(1-\bar{\pi})}{W}\frac{\partial B_2^U}{\partial r_1}\right] < \frac{1}{2},$$

which follows because $1 - \bar{\pi} > 0$ and $\sigma_r^2 > 0$.

Part f) **Characterizing the Constrained Regime.** In the constrained regime, $d_0^C = 0$ and $B_2^C = \lambda K_0^C$ by definition. Therefore,

$$\frac{\partial B_2^C}{\partial r_1} = 0$$

follows immediately. Substituting this bond issuance response into $\partial y^{G,C}/\partial r_1$ implies

$$\frac{\partial y^{G,C}}{\partial r_1} = \frac{1}{2}.$$

This completes the proof. □

Proof of Proposition D.3

Proof. From the first-order corporate and government yield responses in the unconstrained state,

$$\frac{\partial y^{C,U}}{\partial r_1} = \frac{1}{2}\left[1 - \bar{\pi}\kappa K_r^U + \frac{\bar{B}_2^U Q_K^U}{W}K_r^U + \frac{Q^U}{W}\frac{\partial B_2^U}{\partial r_1}\right],$$
$$\frac{\partial y^{G,U}}{\partial r_1} = \frac{1}{2}\left[1 + \frac{(1-\bar{\pi})\sigma_r^2}{W}\frac{\partial B_2^U}{\partial r_1}\right],$$

where all derivatives are evaluated at $r_1 = 0$, $Q^U = Q(\bar{K}_2^U)$, $Q_K^U = 2\kappa(\kappa\bar{K}_2^U - 1)\sigma_\pi^2$, and $\bar{B}_2^U$ denotes bond issuance at $r_1 = 0$. Therefore, the spread comparative static is given by

$$\frac{\partial \mathcal{S}^U}{\partial r_1} = \frac{1}{2}\left[-\left(\bar{\pi}\kappa - \frac{\bar{B}_2^U Q_K^U}{W}\right)K_r^U + \frac{Q^U - (1-\bar{\pi})\sigma_r^2}{W}\frac{\partial B_2^U}{\partial r_1}\right]. \tag{D.46}$$

In the unconstrained state,

$$K_r^U = -\frac{\bar{K}_2^U}{1-\alpha} < 0,$$

and bond issuance satisfies

$$\frac{\partial B_2^U}{\partial r_1} = \frac{\frac{K_0^U}{\hat{\psi}\bar{\pi}}\left(\bar{\pi}\kappa - \frac{\bar{B}_2^U Q_K^U}{W}\right) K_r^U}{1 + \frac{K_0^U Q^U}{\hat{\psi}\bar{\pi}W}} < 0.$$

The inequality follows from $K_r^U < 0$, positive bond issuance, and $Q_K^U \leq 0$ under (D.8). Substituting into (D.46) yields

$$\frac{\partial \mathcal{S}^U}{\partial r_1} = -\frac{\left(\bar{\pi}\kappa - \frac{\bar{B}_2^U Q_K^U}{W}\right) K_r^U \left(1 + \frac{(1-\bar{\pi})\sigma_r^2 K_0^U}{\hat{\psi}\bar{\pi}W}\right)}{2\left(1 + \frac{K_0^U Q^U}{\hat{\psi}\bar{\pi}W}\right)} > 0,$$

where the inequality follows from $K_r^U < 0$ and the positivity of all remaining factors. This completes the proof. □

Proof of Proposition D.4

Proof. Investment in this environment is defined as $I_2 = K_2 - (1-\delta)K_0$, therefore, $\frac{\partial I_2}{\partial r_1} = \frac{\partial K_2}{\partial r_1}$. Throughout, derivatives are evaluated at $r_1 = 0$ within each financial constraint regime.

When firms are unconstrained, $j = U$, investment decisions are given to first order by

$$\alpha A(2-\bar{\pi})(1-r_1)\left(K_2^U\right)^{\alpha-1} = 1.$$

Therefore, the unconstrained investment response is

$$\frac{\partial I_2^U}{\partial r_1} = -\frac{\bar{K}_2^U}{1-\alpha} < 0,$$

where $\bar{K}_2^U = [\alpha A(2-\bar{\pi})]^{\frac{1}{1-\alpha}}$.

For a constrained firm, $j = C$, policies satisfy $B_2^C = \lambda K_0^C$ and $d_0^C = 0$. Therefore, capital choice is defined as

$$K_2^C = A\left(K_0^C\right)^{\alpha} + (1-\delta)K_0^C + P_0^C \lambda K_0^C - (1-\zeta)B_0^C.$$

To first order, the investment response is given by

$$\frac{\partial K_2^C}{\partial r_1} = -2\lambda K_0^C \frac{\partial y^{C,C}}{\partial r_1},$$

where

$$\frac{\partial y^{C,C}}{\partial r_1} = \frac{1}{2}\left[1 - \left(\bar{\pi}\kappa - \frac{\lambda K_0^C Q_K^C}{W}\right)\frac{\partial K_2^C}{\partial r_1}\right],$$

since constrained bond issuance is fixed. Here, $Q_K^C = 2\kappa(\kappa\bar{K}_2^C - 1)\sigma_\pi^2$, where $\bar{K}_2^C$ denotes constrained capital at $r_1 = 0$. Therefore, investment responses in constrained states are characterized by

$$\frac{\partial I_2^C}{\partial r_1} = -\frac{\lambda K_0^C}{1 - \bar{\pi}\kappa\lambda K_0^C + \frac{(\lambda K_0^C)^2 Q_K^C}{W}}.$$

The assumed bound on κ and the recovery bound (D.8) imply

$$0 < \bar{\pi}\kappa - \frac{\lambda K_0^C Q_K^C}{W} \leq \kappa\left[\bar{\pi} + \frac{2\lambda K_0^C \sigma_\pi^2}{W}\right] \leq \frac{\alpha}{\bar{K}_2^U}.$$

Together with $0 < \lambda K_0^C < \bar{K}_2^U$, this gives

$$1 - \bar{\pi}\kappa\lambda K_0^C + \frac{(\lambda K_0^C)^2 Q_K^C}{W} \geq 1 - \frac{\alpha\lambda K_0^C}{\bar{K}_2^U} > 1 - \alpha > 0.$$

Therefore,

$$\frac{\partial I_2^U}{\partial r_1} = -\frac{\bar{K}_2^U}{1-\alpha} < -\frac{\lambda K_0^C}{1-\alpha} < \frac{\partial I_2^C}{\partial r_1} < 0.$$

Taking absolute values completes the proof. □

Proofs for the Maturity Choice Extension

Derivation of (D.30)–(D.32). Subtracting the first-order conditions for B_1 and B_2 eliminates both the common issuance cost and the leverage multiplier,

$$(1+\mu)\left[P_0^{(1)} - P_0^{(2)} - (\Upsilon_1 - \Upsilon_2)\right] = (\beta_1(r_1) - \beta_2(r_1))(1-\zeta).$$

To first order, $\beta_1 \approx \beta_2 \approx 1 - r_1$, so the relative maturity condition is unchanged by the financial constraints. Using $P_0^{(1)} \approx 1 - r_1$ and $P_0^{(2)} \approx 1 - 2y^{(2)}$ gives

$$\frac{P_0^{(2)} B_2}{P_0^{(2)} B_2 + P_0^{(1)} B_1} \approx \bar{m} + \frac{r_1 - 2y^{(2)}}{\upsilon}. \tag{D.47}$$

To characterize total issuance, multiply each bond first-order condition by its face-value share and sum across maturities. Since the maturity cost is homogeneous of degree one and quadratic in deviations from the target share, it drops to first order. Therefore,

$$B \approx \frac{K_0}{\psi}\left[\frac{\mu+\zeta-\eta}{1+\mu}+\left(\frac{1-\zeta}{1+\mu}-(1-\bar{m})\right)r_1-2\bar{m}y^{(2)}\right]. \tag{D.48}$$

Define $a^M \equiv \bar{m}^2-\bar{m}+1/\upsilon$. Expanding (D.30) in terms of the face-value maturity share gives $B_2/B \approx \bar{m}+a^M(r_1-2y^{(2)})$. Combining this with (D.31) yields

$$\begin{aligned} B_2 \approx \frac{K_0}{\psi}\Bigg[&\frac{\bar{m}(\mu+\zeta-\eta)}{1+\mu}+\left\{\bar{m}\left(\frac{1-\zeta}{1+\mu}-(1-\bar{m})\right)+a^M\frac{\mu+\zeta-\eta}{1+\mu}\right\}r_1 \\ &-2\left\{\bar{m}^2+a^M\frac{\mu+\zeta-\eta}{1+\mu}\right\}y^{(2)}\Bigg]. \end{aligned} \tag{D.49}$$

□

Proof of Proposition D.5

Proof. Bond-market clearing is $\frac{W}{\sigma_r^2}(2y^{(2)}-r_1)=P_0^{(2)}B_2+\widetilde{G}$. Using $P_0^{(2)}\approx 1-2y^{(2)}$ and (D.32), the market value of long-term corporate debt is

$$\begin{aligned} P_0^{(2)}B_2 \approx \frac{K_0}{\psi}\Bigg[&\frac{\bar{m}(\mu+\zeta-\eta)}{1+\mu}+\left\{\bar{m}\left(\frac{1-\zeta}{1+\mu}-(1-\bar{m})\right)+a^M\frac{\mu+\zeta-\eta}{1+\mu}\right\}r_1 \\ &-2\left\{\bar{m}^2+\left(\bar{m}^2+\frac{1}{\upsilon}\right)\frac{\mu+\zeta-\eta}{1+\mu}\right\}y^{(2)}\Bigg]. \end{aligned}$$

Substituting into market clearing and collecting terms gives

$$2\mathcal{A}^M y^{(2)} = \mathcal{A}^M r_1+\widetilde{G}+\frac{K_0}{\psi}\frac{\bar{m}}{1+\mu}\left[(\mu+\zeta-\eta)-(2(\mu+\zeta)-\eta)\,r_1\right],$$

where $\mathcal{A}^M \equiv \frac{W}{\sigma_r^2}+\frac{K_0}{\psi}\left[\bar{m}^2+\left(\bar{m}^2+\frac{1}{\upsilon}\right)\frac{\mu+\zeta-\eta}{1+\mu}\right]$. Dividing through by $2\mathcal{A}^M$ completes the proof. □

Proof of Proposition D.6

Proof. First consider the unconstrained state, where $\mu^U = \eta^U = 0$. Differentiating the equilibrium yield and long-term bond supply gives

$$\frac{\partial y^{(2),U}}{\partial r_1} = \frac{\frac{W}{\sigma_r^2} + \frac{K_0^U}{\psi}\left[\bar{m}^2(1+\zeta) - 2\bar{m}\zeta + \frac{\zeta}{v}\right]}{2\mathcal{A}^{M,U}} > 0, \tag{D.50}$$

$$\frac{\partial B_2^U}{\partial r_1} = -\frac{K_0^U}{\psi}\frac{\bar{m}\zeta\left[\frac{W}{\sigma_r^2} - \frac{K_0^U}{\psi}\left(\bar{m}^2(1+\zeta) - 2\bar{m}\zeta + \frac{\zeta}{v}\right)\right]}{\mathcal{A}^{M,U}} < 0, \tag{D.51}$$

where $\mathcal{A}^{M,U} = \frac{W}{\sigma_r^2} + \frac{K_0^U}{\psi}\left[\bar{m}^2(1+\zeta) + \frac{\zeta}{v}\right]$, and both inequalities follow from (D.35).

Total issuance satisfies $\frac{\partial B^U}{\partial r_1} = \frac{K_0^U}{\psi}\left[\bar{m} - \zeta - 2\bar{m}\frac{\partial y^{(2),U}}{\partial r_1}\right]$. Since $\partial B_2^U/\partial r_1 < 0$ and $a^M > 0$, it follows that $2\partial y^{(2),U}/\partial r_1 > (\bar{m} - \zeta)/\bar{m}$, and therefore

$$\frac{\partial B^U}{\partial r_1} < 0. \tag{D.52}$$

In the fully constrained state, $B^C = B_1^C + B_2^C = \lambda K_0^C$, so $\partial B^C/\partial r_1 = 0$. The maturity condition implies

$$\frac{\partial B_2^C}{\partial r_1} = \lambda K_0^C a^M \left(1 - 2\frac{\partial y^{(2),C}}{\partial r_1}\right).$$

Combining this expression with differentiated bond-market clearing gives

$$\frac{\partial y^{(2),C}}{\partial r_1} = \frac{\frac{W}{\sigma_r^2} + \lambda K_0^C a^M}{2\left[\frac{W}{\sigma_r^2} + \lambda K_0^C(\bar{m} + a^M)\right]}, \qquad \frac{\partial B_2^C}{\partial r_1} = \frac{a^M \bar{m}\lambda^2 (K_0^C)^2}{\frac{W}{\sigma_r^2} + \lambda K_0^C(\bar{m} + a^M)} > 0. \tag{D.53}$$

Since $a^M > 0$, $0 < \partial y^{(2),C}/\partial r_1 < 1/2$.

Finally, differentiated market clearing implies generically

$$\frac{\partial y^{(2),j}}{\partial r_1} = \frac{\frac{W}{\sigma_r^2} + \frac{\partial B_2^j}{\partial r_1}}{2(\frac{W}{\sigma_r^2} + B_2^j)}, \qquad j \in \{U, C\}.$$

Therefore, if $B_2^U > B_2^C$,

$$\frac{\partial y^{(2),U}}{\partial r_1} < \frac{\frac{W}{\sigma_r^2}}{2(\frac{W}{\sigma_r^2} + B_2^U)} < \frac{\frac{W}{\sigma_r^2}}{2(\frac{W}{\sigma_r^2} + B_2^C)} < \frac{\partial y^{(2),C}}{\partial r_1} < \frac{1}{2},$$

completing the proof. □

Proof of Proposition D.7

Proof. Since $I_2 = K_2 - (1-\delta)K_0$, $\partial I_2/\partial r_1 = \partial K_2/\partial r_1$. In the unconstrained state, $\mu^U = 0$, so with $\phi \to 0$ the capital Euler equation is $2\alpha A(1-r_1)(K_2^U)^{\alpha-1} = 1$. Evaluating around $r_1 = 0$ therefore gives

$$\frac{\partial I_2^U}{\partial r_1} = -\frac{\bar{K}_2^U}{1-\alpha} < 0, \qquad \bar{K}_2^U \equiv (2\alpha A)^{\frac{1}{1-\alpha}}. \tag{D.54}$$

In the fully constrained state, $d_0^C = 0$ and $B_1^C + B_2^C = \lambda K_0^C$. Hence

$$K_2^C = A(K_0^C)^\alpha + (1-\delta)K_0^C + P_0^{(1)}B_1^C + P_0^{(2)}B_2^C - (1-\zeta)B_0^C - \Upsilon(B_1^C, B_2^C) - \frac{\psi}{2}\lambda^2 K_0^C.$$

At the expansion point, $B_1^C = (1-\bar{m})\lambda K_0^C$ and $B_2^C = \bar{m}\lambda K_0^C$. The maturity-target cost is second order around the target and $\partial B_1^C/\partial r_1 + \partial B_2^C/\partial r_1 = 0$. Using $\partial P_0^{(1)}/\partial r_1 = -1$ and $\partial P_0^{(2)}/\partial r_1 = -2\partial y^{(2),C}/\partial r_1$ therefore gives

$$\frac{\partial I_2^C}{\partial r_1} = -\lambda K_0^C \left[(1-\bar{m}) + 2\bar{m}\frac{\partial y^{(2),C}}{\partial r_1}\right]. \tag{D.55}$$

Proposition D.6 implies $0 < \partial y^{(2),C}/\partial r_1 < 1/2$, and therefore $0 < |\partial I_2^C/\partial r_1| < \lambda K_0^C$. By assumption, $\lambda K_0^C < \bar{K}_2^U$, while $\alpha \in (0,1)$ implies $\bar{K}_2^U < \bar{K}_2^U/(1-\alpha) = |\partial I_2^U/\partial r_1|$. Thus,

$$\left|\frac{\partial I_2^U}{\partial r_1}\right| > \left|\frac{\partial I_2^C}{\partial r_1}\right| > 0,$$

which completes the proof. □

E Supplementary Theoretical Appendix

E.1 Firm Ownership

There is a representative capitalist household that owns all of the production firms. The household is infinitely lived and maximizes expected lifetime utility over consumption, with utility function $U(\cdot)$ satisfying $U'(C_t) > 0$ and $U''(C_t) \leq 0$. The household receives the firm's dividend stream and can save in short-term one-period government bonds. The household's problem is

$$\begin{aligned} &\max_{\{C_t, a_{t+1}, A_{t+1}\}_{t\geq 0}} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t U(C_t) \right] \\ &\text{s.t. } C_t + A_{t+1} + a_{t+1}(V_t - d_t) \leq (1 + r_t)A_t + a_t V_t, \end{aligned} \tag{E.1}$$

where A_t is the household's position in government bonds and a_t is the household's share of the firm. Because the household is the only owner of the firm and equity is in fixed supply, I normalize $a_t = a_{t+1} = 1$ throughout the analysis. The household's optimization yields the stochastic discount factor used by firms, $M_{t,t+1} = \beta \frac{U'(C_{t+1})}{U'(C_t)}$.

For the case where the firms' owner is risk-neutral, I replace β^t in (E.1) with $\prod_{s=0}^{t-1}(1 + r_{s+1})^{-1}$, with the empty product equal to one. The household takes the short-rate process and these discount weights as exogenous. This specification yields $M_{t,t+1} = (1 + r_{t+1})^{-1}$ and makes the household's short-term bond Euler equation hold at every date. This formulation is common in the corporate finance literature (Hennessy and Whited, 2007), and is isomorphic to quantitative macro-finance models with more general risk-aversion that study perfect foresight monetary shocks (Ottonello and Winberry, 2020).

E.2 Financial Frictions Microfoundation: Underwriting with Limited Pledgeability

In this appendix I derive a microfoundation of the financial frictions faced by the firms in Section 5.1. I show how the collateral constraint and convex debt issuance cost can arise from a contracting environment with a competitive underwriter of firm bonds. The key friction is that firms cannot fully commit to servicing debt payments and have only limited pledgeable collateral.

There exists a competitive underwriting intermediary whose function is to underwrite bond offerings from the corporate sector and to place issuances with investors, both arbi-

trageurs and preferred habitat. The underwriter offers a contract (B_t, F_t) with $B_t \geq 0$ as the face value of a consol bond issued from the corporate sector, and F_t is a contemporaneous underwriting fee. This formulation is closely related to models developed in Rampini and Viswanathan (2013) and Rampini and Viswanathan (2025), where issuer collateral is pledgeable based on today's tangible assets. Like Rampini and Viswanathan (2013), I formally derive a micro-founded collateral constraint from this environment where firms have limited commitment to repay debt and the underwriter is willing to underwrite only contracts for which repayment of next period's debt servicing payment is enforcement-feasible.

The underwriter produces a bond with marginal cost of debt,

$$MC(b, K_t) = \psi \frac{b}{K_t},$$

which is decreasing in the amount of capital the firm has. That the marginal cost is decreasing in K_t reflects that higher levels of assets or collateral reduce the cost of underwriting the bond and placing it among investors. Denote capital adjustment costs, $\Phi(I_t, K_t)K_t$.

Of the capital stock, fraction $\hat{\lambda} \in (0, 1)$ is pledgeable to be recovered by the underwriter. Because firms re-issue debt every period, the underwriter only offers contracts for which payment in the next period $(c + \delta_B)B_t$ is enforcement-feasible. In period $t + 1$, after output is realized and after K_{t+1} is in place, the firm has the option to renege on servicing the debt from the bond issued in period t. If a firm reneges, the underwriter seizes pledgeable collateral services of value $\hat{\lambda}K_t$ in period $t+1$. The debt benefit ζB_t accrues on outstanding debt and is received under both servicing and reneging, independently of whether the scheduled payment is made. Conditional on K_{t+1}, servicing and reneging yield the same continuation value for any given choice of (K_{t+2}, B_{t+1}); the only difference between the two actions is that servicing requires payment of $(c + \delta_B)B_t$, whereas reneging triggers seizure of value $\hat{\lambda}K_t$.

Let d^S_{t+1} and d^R_{t+1} denote dividends under servicing and reneging, respectively:

$$\begin{aligned} d^S_{t+1} &= f(K_{t+1}) - I_{t+1} + P_{t+1}\left(B_{t+1} - (1 - \delta_B)B_t\right) + \zeta B_t \\ &\quad - \Phi(I_{t+1}, K_{t+1})K_{t+1} - F_{t+1} - (c + \delta_B)B_t, \end{aligned} \tag{E.2}$$

$$d^R_{t+1} = d^S_{t+1} + (c + \delta_B)B_t - \hat{\lambda}K_t, \tag{E.3}$$

where $I_{t+1} = K_{t+2} - (1 - \delta)K_{t+1}$ and F_{t+1} is the underwriting fee on B_{t+1}. Both actions face the same future underwriting contracts.

The value of reneging to the firm is then given by

$$V^R_{t+1}(K_{t+1}, B_t) = \max_{K_{t+2}, B_{t+1}} \left\{ d^R_{t+1} + \mathbb{E}_{t+1}[M_{t+1,t+2} V_{t+2}(K_{t+2}, B_{t+1})] \right\}, \tag{E.4}$$
$$\text{s.t.} \quad d^R_{t+1} \geq 0,$$

whereas the value of servicing the scheduled debt-service payment is

$$V^S_{t+1}(K_{t+1}, B_t) = \max_{K_{t+2}, B_{t+1}} \left\{ d^S_{t+1} + \mathbb{E}_{t+1}[M_{t+1,t+2} V_{t+2}(K_{t+2}, B_{t+1})] \right\}, \tag{E.5}$$
$$\text{s.t.} \quad d^S_{t+1} \geq 0.$$

For each issuance quantity B_t, competition among underwriters drives the fee to the cost of underwriting. A competitive contract therefore satisfies

$$F_t - \int_0^{B_t} \psi \frac{b}{K_t}\, db = 0, \tag{E.6}$$
$$V^S_{t+1}(K_{t+1}, B_t) \geq V^R_{t+1}(K_{t+1}, B_t) \qquad [IC].$$

I now characterize the feasible set of competitive contracts offered to the firm, which provides a microfoundation for the firm's problem in Section 5.

Proposition E.1. *Competitive underwriting implies the following issuance costs and collateral constraint:*

1. *The underwriting fee is* $F_t = \frac{\psi}{2} \frac{B_t^2}{K_t}$.
2. *A contract* (B_t, F_t) *that can be serviced while satisfying* $d^S_{t+1} \geq 0$ *is enforcement-feasible if and only if*

$$(c + \delta_B) B_t \leq \hat{\lambda} K_t.$$

Proof. Part i) Perfect competition implies that underwriters earn zero profits. Integrating the marginal underwriting cost and applying the zero-profit condition in (E.6) yields

$$F_t = \int_0^{B_t} \psi \frac{b}{K_t} db = \frac{\psi}{2} \frac{B_t^2}{K_t}.$$

Part ii) The contract offered by the underwriter is enforcement-feasible if and only if the firm prefers servicing its debt payment to reneging. This is reflected in the incentive compatibility constraint $V^S_{t+1}(K_{t+1}, B_t) \geq V^R_{t+1}(K_{t+1}, B_t)$. For any given choices of (K_{t+2}, B_{t+1}),

dividends satisfy

$$d^S_{t+1} - d^R_{t+1} = \hat{\lambda} K_t - (c + \delta_B) B_t.$$

If $(c+\delta_B)B_t \leq \hat{\lambda} K_t$, any choices satisfying $d^R_{t+1} \geq 0$ also satisfy $d^S_{t+1} \geq 0$ and yield weakly higher dividends with the same continuation payoff. Maximizing therefore gives

$$V^S_{t+1} \geq V^R_{t+1} + \hat{\lambda} K_t - (c + \delta_B) B_t \geq V^R_{t+1}.$$

If reneging cannot satisfy its dividend constraint, its value is $-\infty$ and servicing is preferred because servicing is feasible.

Conversely, if $(c + \delta_B)B_t > \hat{\lambda} K_t$, the optimal servicing choices also satisfy $d^R_{t+1} \geq 0$ and yield strictly higher dividends under reneging, with the same continuation payoff. Consequently,

$$V^R_{t+1} \geq V^S_{t+1} + (c + \delta_B) B_t - \hat{\lambda} K_t > V^S_{t+1}.$$

Therefore, enforcement-feasible issuance satisfies

$$B_t \leq \lambda K_t,$$

where $\lambda := \frac{\hat{\lambda}}{c+\delta_B}$. □

F Quantitative Appendix

F.1 Model Solution

This appendix documents how the model detailed in Section 5 is solved globally. I first discuss the solution method to the model. Then I detail how generalized IRFs are estimated in this environment.

The solution method is the following algorithm.

1. *Solve the steady state.* Solve numerically the system of equations that define the steady state of the economy, detailed in F.2. Denote the levels of steady state capital, corporate debt, and bond yields as $\{K^*, B^*, y^*\}$.
2. *Global discretization.* Initialize grids of capital and corporate bond choice centered around (K^*, B^*). The grid of r_{t+1} is constructed from a Markov-Rouwenhorst discretization method, using 12 grid points.
3. *Initialize policies and prices.* Initialize the bond price schedule $P^L(K, B_-, r')$, capital policy $K'(K, B_-, r')$, and bond policy $B'(K, B_-, r')$. Also initialize the constraint region at the tensor product (K, B_-, r'). Specifically, guess whether $Regime(K, B_-, r') = \{U, D, L, C\}$, where U denotes $\mu = \eta = 0$, D denotes dividends bind $\mu > 0,\ \eta = 0$, L denotes leverage binds $\mu = 0,\ \eta > 0$, and C denotes both constraints bind $\mu > 0,\ \eta > 0$.
4. *Compute Bond Continuation Prices.* Given policies and prices, compute the expected future bond prices using the Markov transition matrix approximated for r_{t+1}. This gives the continuation value of $P_t^L(\cdot)$, $\mathbb{E}_t\left[P_t^L(K, B_-, r')\right]$.
5. *Update unconstrained capital policy using EGM.* Given the estimated continuation of bond prices and policy functions, update the unconstrained capital choice via the endogenous grid method. This avoids solving a nonlinear maximization problem at every node. This solution is implied in (C.7) with Lagrange multipliers set to zero.
6. *Update the unconstrained bond policy.* Similarly, given the estimated continuation of bond prices and policy functions, solve for optimal bond issuance from (27).
7. *Apply OBC using an active-set KKT Algorithm.* For the tensor product (K, B_-, r'), evaluate the possible KKT regimes,
   - $U\ :\ \mu = 0,\ \eta = 0$,
   - $D\ :\ \mu > 0,\ \eta = 0$,
   - $L\ :\ \mu = 0,\ \eta > 0$,
   - $C\ :\ \mu > 0,\ \eta > 0$.

If dividends bind at implied solution, impose $d = 0$. If the leverage constraint binds at the solution, impose $B = \lambda K$. If neither binds, use the unconstrained policies implied from the previous two steps. For each regime, after imposing the relevant constraints, infer the Lagrange multipliers $\mu(K, B_-, r')$ and $\eta(K, B_-, r')$ from the corrected solutions to (C.7) and (27).

8. *Update Policy and Lagrange multiplier functions.* After the previous step, store the updated firm policies $K'(K, B_-, r')$ and $B(K, B_-, r')$, the implied $Regime(K, B_-, r')$, and compute the implied Lagrange multipliers

$$\mu(K, B_-, r'), \quad \eta(K, B_-, r'),$$

from the solved policies.

9. *Solve Bond Market Clearing.* Holding the solved policy functions and multipliers fixed, solve the bond market clearing condition (33) for the tensor product (K, B_-, r'). For each element in the tensor product, this is a one-dimensional non-linear equation in the bond price. I solve this equation using a Newton method.

10. *Update equilibrium bond prices and moments.* Because policies and prices are updating simultaneously, I dampen the price updates, such that $P^{New} = \tilde{\rho} P^{old} + (1 - \tilde{\rho}) P^{Newton}$ to aid monotonicity of convergence. Then, for each element in (K, B_-, r'), I similarly update conditional price moments $\mathbb{E}_t [P_{t+1}(\cdot)]$ and $\text{Var}_t (P_{t+1}(\cdot))$.

11. *Iterate to a fixed point.* Check if policies, prices, and moments have converged to numerical tolerance, if not repeat.

Generalized IRF Solution. The generalized impulse response functions (IRFs) reported in the main text are computed from the solved global equilibrium. For a given initial state (K, B_-, r'), I Monte Carlo simulate paired baseline and shocked paths over a horizon T. The baseline starts at the initial rate-grid point. The shocked path starts at the adjacent grid point in the direction of the shock with a probability chosen to deliver an expected initial rate change of 25 annualized basis points; otherwise, it starts at the baseline rate. Thus, the experiment delivers a 25-basis-point shock in expectation across simulations. Subsequent rates follow the discretized Markov process, using common random numbers across paired paths.

Along each simulated path, capital, debt, and bond prices are obtained from the globally solved functions $K'(K, B_-, r')$, $B(K, B_-, r')$, and $P^L(K, B_-, r')$, using bilinear interpolation over capital and inherited debt when these states lie between grid points. The IRFs are constructed from the Monte Carlo mean paths for the shocked and baseline experiments,

with transformations and differences corresponding to the units reported in each figure.

F.2 Steady State Characterization

This appendix characterizes the steady-state point used to center the global solution. It combines a deterministic firm block, evaluated at the mean short-rate $\bar{r}$, with the stationary long-term bond price schedule generated by the short-rate process. The latter retains interest-rate risk and therefore implies that the arbitrageur's conditional return variance is nonzero. To begin, I collect parameter and equilibrium terms and denote,

$$q_B \equiv 1 - \delta_B, \qquad \kappa_B \equiv c + \delta_B, \qquad \ell^* \equiv \frac{B^*}{K^*}.$$

In a deterministic steady state,

$$K_{t+1} = K_t = K^*, \qquad B_t = B_{t-1} = B^*, \qquad I^* = \delta K^*.$$

Consequently, investment adjustment costs and their marginal terms are zero. Assuming the parametrization of a risk-neutral firm owner, the steady-state stochastic discount factor is $M^* = (1 + \bar{r})^{-1}$. Substituting these relations into the firm's capital and debt first-order conditions gives

$$1 + \bar{r} = \alpha A (K^*)^{\alpha - 1} + 1 - \delta + \frac{\psi}{2}(\ell^*)^2 + \frac{\lambda \eta^*}{1 + \mu^*}, \tag{F.1}$$

$$\psi \ell^* = P^{L,*} - \frac{\kappa_B + q_B P^{L,*} - \zeta}{1 + \bar{r}} - \frac{\eta^*}{1 + \mu^*}. \tag{F.2}$$

The steady-state payout is

$$d^* = A (K^*)^{\alpha} - \delta K^* + \left[\delta_B P^{L,*} - \kappa_B + \zeta\right] B^* - \frac{\psi}{2} \frac{(B^*)^2}{K^*}, \tag{F.3}$$

and the complementary-slackness conditions are

$$\begin{aligned} &d^* \geq 0, && \mu^* \geq 0, && \mu^* d^* = 0, \\ &B^* \leq \lambda K^*, && \eta^* \geq 0, && \eta^* (\lambda K^* - B^*) = 0. \end{aligned} \tag{F.4}$$

In the calibrated steady state both financial constraints are slack, so $\mu^* = \eta^* = 0$.[8] For further clarity, suppose the calibration will imply that this is the case, and denote the steady

[8] This is a calibration outcome, and not literally imposed.

state long-bond financing wedge

$$\Xi(P^*;\bar{r}) \equiv P^* - \frac{\kappa_B + q_B P^*}{1+\bar{r}} = \frac{(\bar{r}+\delta_B)P^* - \kappa_B}{1+\bar{r}}.$$

Equations (F.1)–(F.2) then yield the closed-form firm block

$$\ell^* = \frac{\zeta/(1+\bar{r}) + \Xi(P^{L,*};\bar{r})}{\psi}, \tag{F.5}$$

$$K^* = \left[\frac{\alpha A}{\bar{r}+\delta-\frac{\psi}{2}(\ell^*)^2}\right]^{\frac{1}{1-\alpha}}, \tag{F.6}$$

$$B^* = \ell^* K^*, \qquad I^* = \delta K^*. \tag{F.7}$$

An interior steady state requires $\bar{r}+\delta-\frac{\psi}{2}(\ell^*)^2 > 0$, together with $\ell^* < \lambda$ and $d^* > 0$. When steady-state leverage ℓ^{tar} is targeted in the calibration, (F.5) can instead be inverted to obtain

$$\zeta = (1+\bar{r})\left[\psi\ell^{\text{tar}} - \Xi(P^{L,*};\bar{r})\right]. \tag{F.8}$$

It remains to determine the long-bond price. Let r_t follow any stationary stochastic process, and let P_t^* denote the associated stationary long-bond price process, holding (K^*, B^*) fixed. The conditional moments of the one-period long-bond return are

$$\mathbb{E}_t[R^L_{t+1}] = \frac{\kappa_B + q_B\mathbb{E}_t[P^*_{t+1}]}{P^*_t}, \qquad \text{Var}_t(R^L_{t+1}) = \frac{q_B^2\,\text{Var}_t(P^*_{t+1})}{(P^*_t)^2}. \tag{F.9}$$

Hence arbitrageur demand is

$$\omega^*_t = \frac{\mathbb{E}_t[R^L_{t+1}] - (1+r_{t+1})}{\gamma\,\text{Var}_t(R^L_{t+1})}. \tag{F.10}$$

Under the normalization $G = 0$, the stationary price process solves

$$\omega^*_t W + P^*_t H(P^*_t) = P^*_t B^*, \qquad H(P^*_t) = \theta_0 - \theta_y \log P^*_t, \tag{F.11}$$

for every realization of the short-rate state. Finally, prices and yields satisfy

$$y^*_t = \log\left(q_B + \frac{\kappa_B}{P^*_t}\right), \qquad \bar{y}^* = \mathbb{E}[y^*_t], \qquad P^{L,*} = \frac{\kappa_B}{\exp(\bar{y}^*) - q_B}. \tag{F.12}$$

Here the unconditional expectation is taken under the stationary law of the short-rate process. This characterization applies to any stationary process for which the required con-

ditional moments exist. Equations (F.5)–(F.12) form the system solved numerically for $(K^*, B^*, \bar{y}^*)$ and the stationary pricing function that generates P_t^* (and for ζ when leverage is targeted). The calibrated solution satisfies the strict inequalities in (F.4), validating the unconstrained formulas above.

F.3 Calibration Details

This appendix provides additional details on calibration moments. As discussed in Section 3.3, COVID-19 generated structural breaks in several of the time series considered, so I calibrate the model using aggregate data from 1986-2019 when available. The main text in Section 6.1 provides detailed descriptions of much of the calibration, so this appendix is supplementary and includes further details.

Joint Identification Arguments. I jointly calibrate the internally estimated parameter vector $\mathcal{V} \equiv \{W, \theta_0, \theta_y, \zeta, \delta, \phi, \psi\}$ using the seven moments reported in Table 2. The mapping between moments and parameters is not diagonal because equilibrium asset prices jointly determine investor holdings and firm policies. I now discuss how each moment is informative of the joint calibration.

The investor parameters $\{W, \theta_0, \theta_y\}$ are jointly disciplined by arbitrageur leverage, the ratio of arbitrageur to preferred-habitat bond holdings, and the average ten-year yield. Under the normalization $G = 0$, market clearing and habitat demand satisfy

$$P_t^L B_t = \underbrace{\omega_t W}_{\text{Arbitrageur Holdings}} + \underbrace{P_t^L H(P_t^L)}_{\text{Habitat Holdings}},$$
$$\text{where} \quad H(P_t^L) = \theta_0 - \theta_y \log P_t^L.$$

Arbitrageur wealth W scales the dollar amount of risk-bearing capacity available to absorb the excess supply of long-term bonds.[9] For a given value of excess supply, a larger W allows arbitrageurs to hold that supply with a smaller portfolio weight and a smaller required expected excess return. The level of arbitrageur long-bond holdings is therefore informative about W.

The holdings ratio provides a direct mapping to the habitat intercept. Let χ^* denote the steady-state ratio of the market value of arbitrageur holdings to the market value of

[9] Here, excess supply refers to the amount of bonds not absorbed through preferred habitat demand.

preferred-habitat holdings. Under the maintained $G = 0$,

$$\chi^* \equiv \frac{(P^{L,*}B^*)^A}{(P^{L,*}B^*)^H} = \frac{P^{L,*}[B^* - H(P^{L,*})]}{P^{L,*}H(P^{L,*})} = \frac{B^*}{H(P^{L,*})} - 1, \qquad H(P^{L,*}) = \frac{B^*}{1+\chi^*},$$
$$\implies \theta_0 = \frac{B^*}{1+\chi^*} + \theta_y \log P^{L,*}.$$

The common bond price cancels from the holdings ratio, so the empirical target directly determines the quantity of bonds held by habitat investors as a share of total supply. Conditional on the jointly determined bond price, total bond supply, and habitat slope, the moment therefore pins down θ_0. Increasing θ_0 transfers a larger share of outstanding bonds to habitat investors and reduces the residual quantity absorbed by arbitrageurs. The normalization $G = 0$ is important for this mapping because a fixed supply of government bonds and the habitat intercept both shift the level of residual supply and cannot be separately disciplined by these aggregate holdings moments.[10]

The parameter θ_y governs the price sensitivity of habitat demand,

$$\frac{\partial H(P^L)}{\partial P^L} = -\frac{\theta_y}{P^L}.$$

It therefore affects the long-bond price required for investors to absorb the equilibrium supply of bonds. Conditional on the balance-sheet moments that discipline W and the level of habitat demand, the average ten-year yield is informative about θ_y. Together, these three moments jointly discipline $\{W, \theta_0, \theta_y\}$ because each parameter affects equilibrium prices and, through prices, the holdings of both investor classes.

Turning to the firm parameters, the depreciation rate δ is directly connected to steady-state investment. Since $K_{t+1} = K_t = K^*$, capital accumulation implies

$$\frac{I^*}{K^*} = \delta.$$

The target for annual investment relative to capital therefore directly disciplines the monthly depreciation rate.

The debt benefit ζ primarily governs the level of firm leverage. In the calibrated steady state, the dividend and leverage constraints are slack, and the steady-state debt first-order

[10] This is also why $G = 0$ is chosen, without an additional moment, G is not uniquely determined in the model since it functions analogously to θ_0. Allowing θ_y to scale bond prices makes bond supply exogenously state-dependent, so further parameterizing G would not separately generate new economic meaning for the model. The underlying scale of government debt supply is absorbed through θ_0 and χ^*.

condition implies

$$\ell^* \equiv \frac{B^*}{K^*} = \frac{\zeta/(1+\bar{r}) + \Xi(P^{L,*};\bar{r})}{\psi}, \qquad \zeta = (1+\bar{r})\left[\psi \ell^{\text{tar}} - \Xi(P^{L,*};\bar{r})\right],$$

where $\Xi(P^{L,*};\bar{r})$ is the long-bond financing wedge defined in Appendix F.2, and ℓ^{tar} is the empirical leverage target. Holding the equilibrium bond price and issuance cost parameter fixed, a larger ζ raises desired leverage. Average leverage among bond issuers is consequently informative about ζ. The second equality makes clear that the leverage target disciplines ζ conditional on the jointly determined values of ψ and the long-bond price.

The remaining parameters ϕ and ψ are disciplined primarily by dynamic moments. Define the investment rate as $i_t \equiv I_t/K_t$ and conventionally denote q_t the expected discounted marginal value of installed capital, given by the right-hand side of the unconstrained capital Euler equation (C.7). The adjustment cost and the capital Euler equation can be written as

$$\Phi(i_t, K_t) = \frac{\phi}{2}(i_t - \delta)^2 K_t, \qquad 1 + \phi(i_t - \delta) = q_t,$$
$$i_t - \delta = \frac{q_t - 1}{\phi}, \qquad \frac{\partial i_t}{\partial q_t} = \frac{1}{\phi}.$$

The adjustment cost and its marginal effect are zero in steady state, so steady-state levels contain little information about ϕ. Monetary policy changes bond prices and continuation values, which changes q_t. The equations above show that ϕ governs how strongly the investment rate responds to this change in the marginal value of capital. A larger ϕ dampens the investment response, so the peak response of I_t/K_t to an accommodative monetary shock is informative about ϕ.

The issuance cost parameter ψ governs how much firms change their debt in response to financing conditions. Define the bond-financing wedge, including the debt benefit and constraint shadow values as

$$\widetilde{\Xi}_t \equiv P_t^L - \frac{\mathbb{E}_t\left[M_{t,t+1}(1+\mu_{t+1})(c + \delta_B + (1-\delta_B)P_{t+1}^L - \zeta)\right] + \eta_t}{1+\mu_t},$$
$$\ell_t \equiv \frac{B_t}{K_t} = \frac{\widetilde{\Xi}_t}{\psi},$$
$$\implies \mathbb{E}\left[\left|\frac{\Delta B_t}{K_t}\right|\right] = \frac{1}{\psi}\mathbb{E}\left[\left|\Delta\widetilde{\Xi}_t + \widetilde{\Xi}_{t-1}\frac{\Delta K_t}{K_t}\right|\right].$$

The last line is the model counterpart of the unconditional absolute issuance moment. In the model, capital represents firm assets. Conditional on the financing-wedge and capital-growth

paths, $1/\psi$ scales the absolute issuance moment. Because ζ is jointly calibrated to target issuer leverage, the leverage moment disciplines the level of debt while the issuance moment disciplines how elastically debt changes.

In summary, the balance-sheet and yield moments discipline who absorbs long-term bond supply and the price required for them to do so. The steady-state firm moments discipline the levels of investment and leverage; and the impulse-response and issuance moments discipline the dynamic elasticities of capital and debt. The joint calibration allows for all of the cross-effects implied by equilibrium prices and quantities.

Intermediary Balance Sheets. The financial intermediary-related parameters $\{W, \theta_0\}$ make use of moments taken from the Z.1. Financial accounts data. As previously described, I choose that broker-dealers and life insurers are the empirical counterparts to arbitrageurs and preferred habitat investors respectively. This classification is consistent with literature discussions (Greenwood, Hanson, and Vayanos, 2024), and is conservative. Allowing for pension funds to also represent preferred habitat investors would cause broker-dealer holdings to be significantly smaller relative to preferred habitat, and thus make any supply responses transmit more strongly to prices.

As discussed, arbitrageur leverage is informative for calibrating W. To take the moment to data, I measure arbitrageur bond holding values as the reported value of debt securities on their balance sheet. This includes the value of their net positions in Treasury securities, agency securities, municipal securities, and corporate bonds. Because I do not model several sources for long-term bonds, I use the joint value of these positions for broker-dealers to be consistent with the model. To create their leverage ratio, I divide the value of their bond holdings by the value of their book equity.[11] To construct the ratio of arbitrageur-to-preferred habitat holdings, I take the ratio of corporate and Treasury securities held by broker-dealers divided by corporate and Treasury securities held by life insurers from the Financial Accounts.

Bond Issuer Financial States. To measure bond issuers' financial states, I construct a market-value leverage ratio guided by Q-theory. Book leverage treats the accounting value of total assets as the relevant asset base, even though this value is not marked to market and includes cash and other assets unrelated to productive capital. It therefore fails to reflect changes in expected profitability that alter the value supporting a firm's debt. Instead, I

[11] I exclude bonds issued by investment bank parents which are invested in broker-dealer subsidiaries as equity because this is debt funding, not capital. Furthermore, measurement for this series stopped during 2008, so excluding prevents structural breaks in the calculation of broker-dealer equity. This source of financing is also excluded in equity construction of Kekre, Lenel, and Mainardi (2026).

define issuer leverage as

$$\hat{\ell}_{j,t} = \frac{P_t^L B_{j,t}}{P_t^L B_{j,t} + ME_{j,t} - Cash_{j,t}}.$$

The denominator measures the market value of the firm's productive assets rather than their accounting value. Let $Q_{j,t}$ denote average Q, the market value of productive assets per unit of installed capital. By definition,

$$ME_{j,t} = Q_{j,t}K_{j,t} + Cash_{j,t} - P_t^L B_{j,t},$$

which implies

$$\hat{\ell}_{j,t} = \frac{P_t^L B_{j,t}}{Q_{j,t}K_{j,t}}.$$

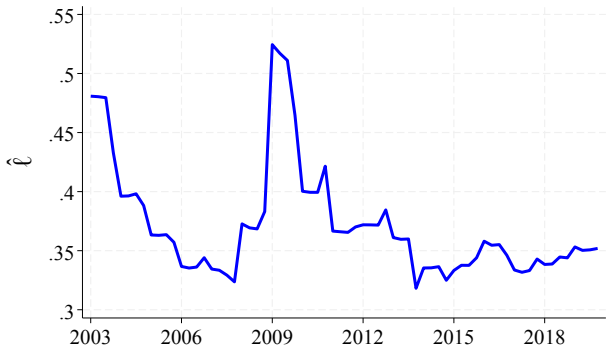
Average Q is distinct from the marginal q entering the capital Euler equation; the two need not coincide, particularly under decreasing returns. When bonds trade close to par, $P_t^L \approx 1$, so $\hat{\ell}_{j,t} \approx B_{j,t}/(Q_{j,t}K_{j,t})$. This construction measures the market value of debt relative to the market value of productive assets, with $Q_{j,t}$ incorporating forward-looking expectations about profitability. When $Q_{j,t} \approx 1$ and bonds trade close to par, $\hat{\ell}_{j,t}$ approximately coincides with model leverage, $B_{j,t}/K_{j,t}$. Because average Q need not equal one even in steady state, and bond prices can differ from par, I treat $\hat{\ell}_{j,t}$ as an empirical proxy for model leverage. When cash holdings are zero and bonds trade close to par, it also approximately equals one minus the market capital ratio, the preferred empirical measure of distance from financial constraints.

For each quarter, I construct the firm-level $\hat{\ell}_{j,t}$, and aggregate to a time series, with firm weights given by bonds outstanding. The time series is plotted in Figure F.1, and the summary statistics are reported in Table F.1. During the Great Recession, $\hat{\ell}_t$ was substantially elevated, particularly from late 2008 through 2010.

Table F.1: Market Leverage Statistics

	Mean	SD	p10	p50	p90
$\hat{\ell}$	0.372	0.048	0.333	0.359	0.465

Figure F.1: Market Leverage Time Series



F.4 Untargeted Model Moments

I evaluate the model's untargeted fit with time-series data by estimating multivariate time-series regressions. These regressions are not causal, but test whether the calibrated model captures conditional covariances between key model objects. Industrial production in the model is defined as $Y = AK^{\alpha}$, while in the data I use the industrial production series from the Board of Governors. I measure the bond issuance rate in both the model and the data as $\text{BI}_t = \frac{B_t - B_{t-1}}{K_t}$, where K_t denotes assets. I then compare whether bond issuance and equilibrium yields exhibit similar conditional covariation with observables in the model and the data.

Table F.2: Untargeted Comovement in Data and Model

	BI_t		$y_t^{(10)}$	
	Data	Model	Data	Model
$y_t^{(10)}$	-0.051^{***}	-0.081^{***}		
	(0.015)	(0.015)		
$\log Y_t$	-0.518^{*}	-1.528^{***}	-9.745^{***}	-16.228^{***}
	(0.273)	(0.228)	(3.175)	(0.767)
$\Delta \log \left(P_t^{(10)} B_t \right)$			-14.440^{***}	-13.620^{***}
			(4.492)	(1.116)

Notes. Comovement of bond issuance and equilibrium yields with the aggregate state in the model and in data. The bond issuance rate is measured as $\text{BI}_t = \frac{B_t - B_{t-1}}{K_t}$. In the model $Y_t \equiv AK_t^{\alpha}$. The long-term bond yields are measured or calibrated to be for 10-year maturity. Newey-West standard errors with 12 lags are reported in parentheses. Statistical significance is denoted by $^{*}p < 0.10$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

Table F.2 reports untargeted, contemporaneous regressions in the data and in the sim-

ulated model. The table shows that the model captures the main qualitative comovement between bond issuance, long-term yields, and aggregate production. The first two columns study bond issuance. In both the data and the model, higher long-term yields are associated with lower issuance. This reflects that when long-term bond prices are low, issuing debt raises fewer resources today. Conditional on yields, higher output is also associated with lower issuance rates. This does not imply that debt is lower in high-output states. Rather, it reflects that firms are further from financial constraints and therefore adjust bond issuance less aggressively.

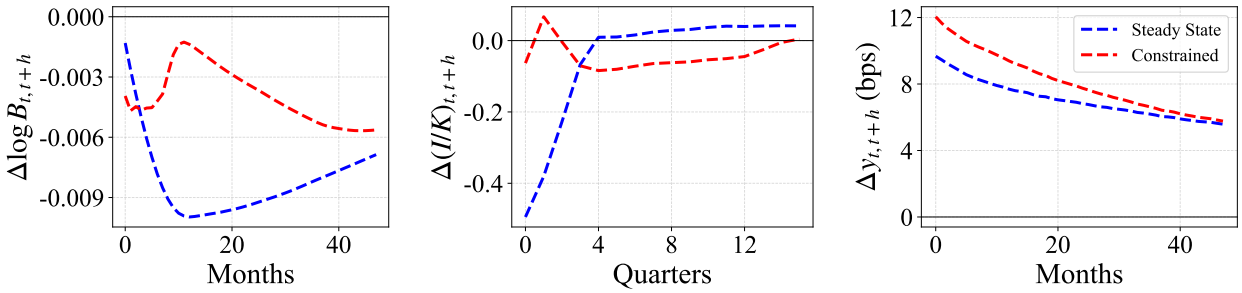
The last two columns study long-term yield comovement. In both the data and the model, higher output is associated with lower long-term yields, consistent with bond prices being higher in good aggregate states. The coefficient on $\Delta \log(P_t^{(10)} B_t)$ is negative, and closely matches the empirical conditional correlation. The negative coefficients reflect that states with rising market values of long-term debt are also states with rising bond prices and falling yields. This is consistent with the model's equilibrium comovement, but it should be interpreted as comovement in the market value of long-term debt rather than a pure supply elasticity.

F.5 Additional Quantitative Results

A 25 bps rate hike. I perform an analogous experiment to Section 6.2 by hiking the short-term interest rate 25 bps and studying the model impulse responses. The IRFs to the rate hike are plotted in Figure F.2. Broadly, the dynamics of the model are symmetric, especially with investment responses. However, there are some notable asymmetries for bond issuance and the monetary effects on yields.

Due to a rate hike, bond issuances decline for unconstrained firms. However, the magnitude of this reduction in bonds outstanding is more limited than in the case of a rate cut. In response to the rate hike, the constrained firms deleverage more aggressively than they issue debt as in the rate cut experiment. Consequently, while there is significant state dependence in investment and equilibrium yields due to the monetary shock, the state-dependence is not quite as extreme. The rationale for this is that rate hikes cause bond prices to decline, which according to (27) causes firms to reduce their bond issuance levels ceteris paribus. When firms are unconstrained, they will reduce their debt levels, but these firms are well capitalized and near their steady state levels and therefore do not cut issuance as aggressively as when there is an unexpected positive shock to bond prices. For the constrained firms, they are more responsive in this region because the binding financial constraints are inherently asymmetric. While firms face hard caps on their debt levels, this binds when firms

Figure F.2: State-Dependent IRFs to Monetary Contraction

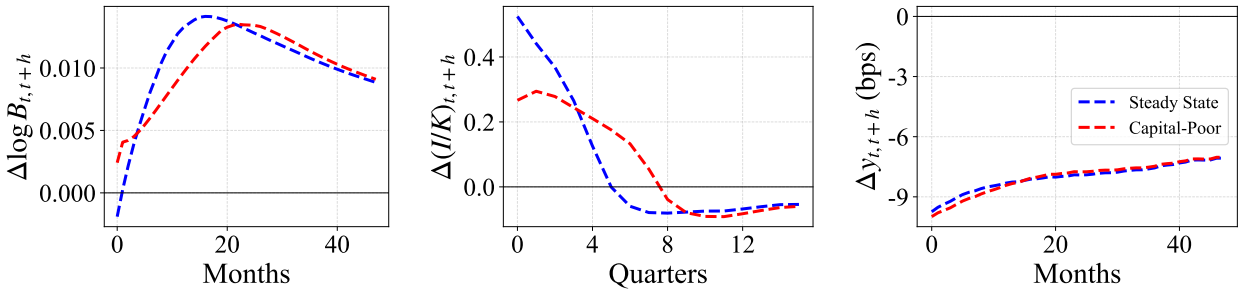


(a) $\Delta \log B_{t,t+h}$ **(b)** $\Delta \left(\frac{I}{K}\right)_{t,t+h}$ **(c)** $\Delta y^{(10)}_{t,t+h}$

Notes: Generalized IRFs of an annualized 25 bps hike in the 1-year rate starting from an initial rate of $\bar{r}$ annualized, generated from Monte Carlo Simulation. Panel (a) plots the log face value IRF, Panel (b) plots the investment rate IRF (p.p.), and Panel (c) plots the $y^{(10)}$ IRF (bps). Blue line is response given an initial state of SS capital and debt burden. Red line is 97.5% of SS capital level with 133% of SS debt burden.

wish to increase leverage. When there is a rate hike, the constrained firms are not subject to the same additional friction. As a result, the yield effects of rate hikes feature less state dependence in this economy.

Figure F.3: Amplification of Monetary Responses without Binding Constraints



(a) $\Delta \log B_{t,t+h}$ **(b)** $\Delta \left(\frac{I}{K}\right)_{t,t+h}$ **(c)** $\Delta y^{(10)}_{t,t+h}$

Notes: Generalized IRFs of an annualized 25 bps cut in the 1-year rate starting from an initial rate of $r_{t+1} = \bar{r}$ annualized, generated from Monte Carlo Simulation. Panel (a) plots the log face value IRF, Panel (b) plots the investment rate IRF (p.p.), and Panel (c) plots the $y^{(10)}$ IRF (bps). Blue lines are responses given an initial state of SS capital and debt burden. Red lines are responses for the capital-poor economy with 95% of SS capital level with SS debt burden.

Amplification without Binding Constraints. The model does not strictly rely on binding financial constraints to generate state dependence of real and financial responses to monetary policy. I test the quantitative magnitude of amplification when the only friction is the bond issuance cost by studying the impulse responses of two unconstrained economies. In this exercise, I study model dynamics to a 25 bps rate cut, when both economies begin with the same steady state debt burden, B^*_{t-1}. The first economy remains the *steady-state*

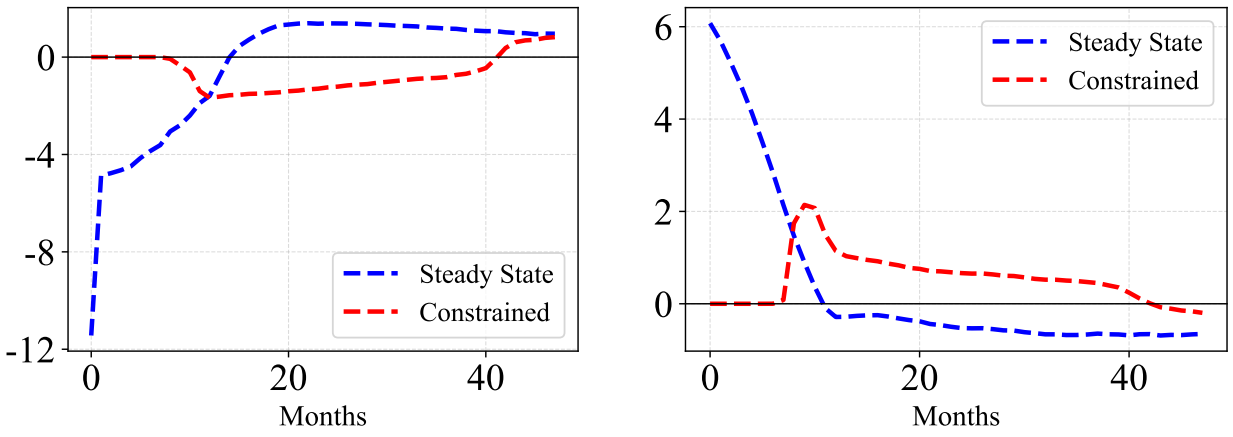
economy, calibrated to the steady state. I also study the dynamics of an economy with 95% of the steady state capital level, which I denote the *capital-poor* economy.

Figure F.3 plots dynamics of these two economies. The steady state economy has larger peak investment and bond issuance responses. Bond issuance is higher in the steady state relative to the capital-poor economy because additional capital lowers the issuance costs of corporate bonds. Investment responses to a rate cut are larger in the steady state relative to the capital-poor economy, but the deleveraging of capital in the capital-poor economy is more gradual. Finally, the larger bond issuance responses in the steady state economy do attenuate yield pass-through to monetary policy relative to the capital-poor economy.[12]

The amplification effects of having additional capital are small in magnitude when firms do not face additional potentially binding constraints. This exercise confirms that binding financial constraints are not required to generate state dependence of monetary responses. However, in order to replicate the stark state-dependence of bond supply and yields of Figure 6, the leverage and dividend constraints play an important role in terms of matching the magnitudes and nonlinearities of bond issuance and yield state-dependence.

Dividend payout dynamics. For both 25 bps rate cut and rate hike, Figure F.4 displays the firms' dividend responses for the unconstrained and constrained economies.

Figure F.4: Dividend State-Dependent IRFs to Monetary Policy

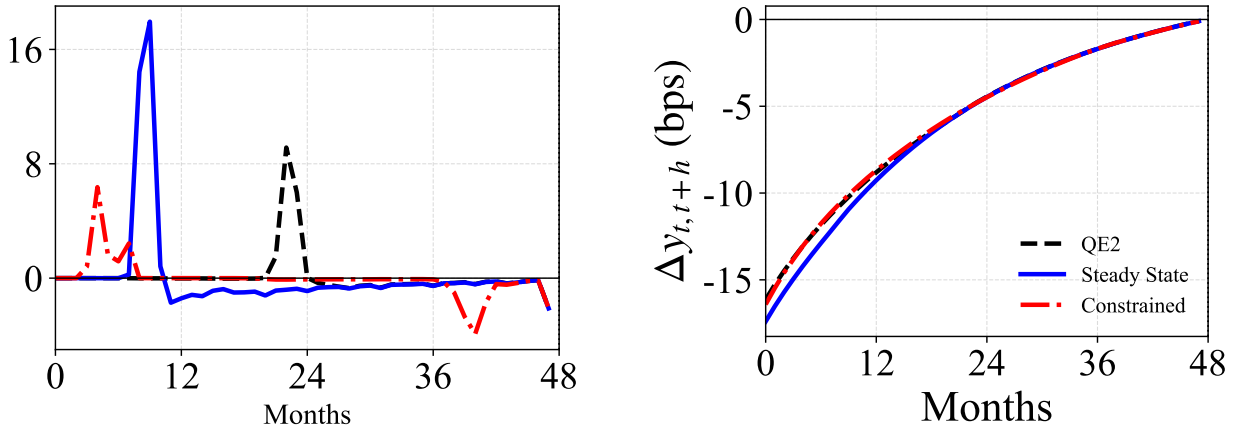


(a) Rate cut: $\Delta d_{t,t+h}$ **(b)** Rate hike: $\Delta d_{t,t+h}$

Notes: Generalized IRFs of an annualized 25 bps monetary shock in the 1-year rate starting from an initial rate of $\bar{r}$ annualized, generated from Monte Carlo Simulation. The x-axis denotes months after the monetary shock. The y-axis scale is change in dividends. Blue line is response given an initial state of SS capital and debt burden. Red line is 97.5% of SS capital level with 133% of SS debt burden..

[12] While there is more debt issuance initially in the capital-poor economy, all agents in the model are forward-looking and have rational expectations. Therefore the bond market investors anticipate that they will hold more duration in the steady state economy, and the yield state-dependence follows.

Figure F.5: QE2 Experiment: Dividends and Full Yield Responses



(a) Dividends: $\Delta d_{t,t+h}$ **(b)** Long-term yield: $\Delta y_{t,t+h}$

Notes: Generalized impulse responses to an announced QE2 intervention that raises the preferred-habitat demand intercept, θ_0, by 25% on impact. The increase decays geometrically at a monthly persistence of 0.95 and is set exactly to zero after 48 months. Each response is the difference between the QE and no-QE economies simulated using identical short-rate histories. The solid blue line begins at the steady state, $(K_t, B_{t-1}) = (K^*, B^*)$. The dashed black line begins at the QE2-calibrated state, $(K_t, B_{t-1}) = (0.98K^*, 1.12B^*)$. The red dash-dot line begins at the adverse constrained state, $(K_t, B_{t-1}) = (0.975K^*, 1.33B^*)$. The short rate is initialized at 1% annualized in all three simulations; the dashed black specification matches the bond-issuer and aggregate states in 2010Q4, when QE2 was implemented. The horizontal axis denotes months after the asset purchases. Panel a) reports the response of dividends, and Panel b) reports the annualized long-term yield response in basis points over the full 48-month horizon.

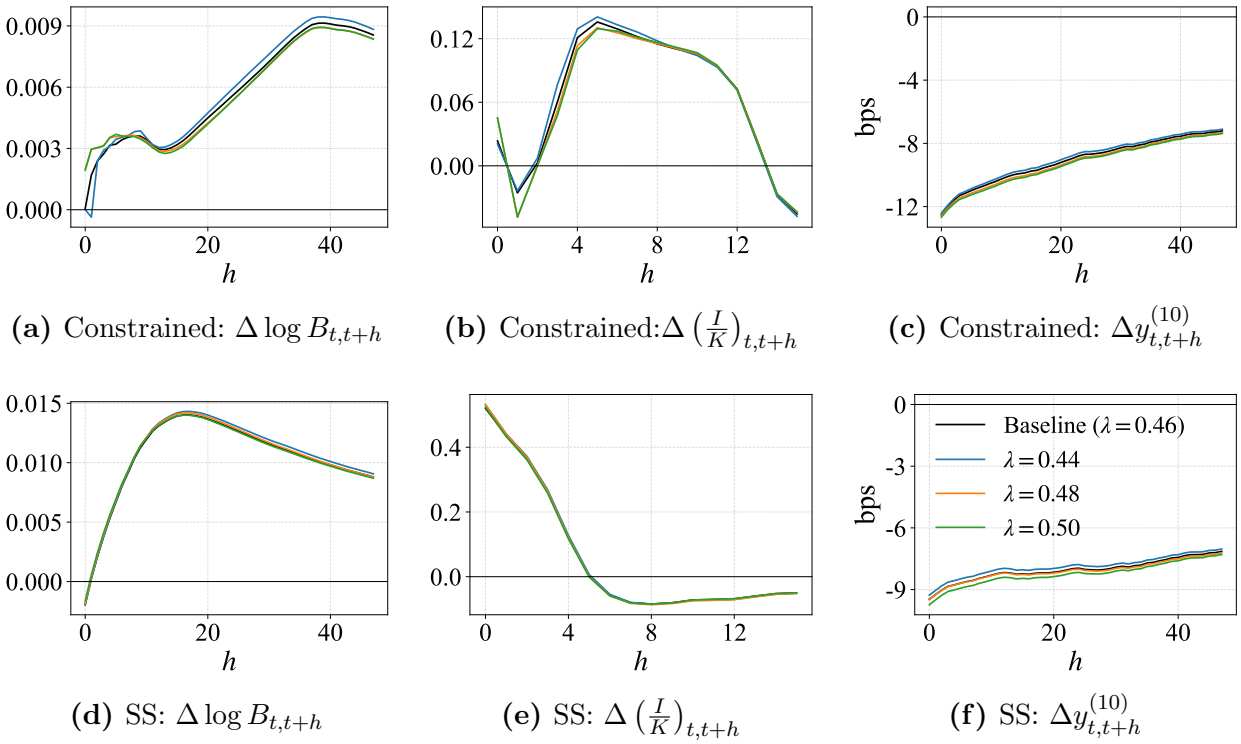
F.6 Model under Alternative Leverage Constraints

In the calibration, $\lambda = .465$, which reflects that firms more than one standard deviation above the empirically observed leverage cannot issue additional bonds. This appears consistent with the regime-switching time series evidence presented in Section 3.3. I find that whenever the aggregate market capital ratio is below its time series median, there is no statistically significant aggregate bond issuance, and the point estimates are close to zero. However, as this parameter only affects policies away from the steady state, it is not internally calibrated.

To test how sensitive the model's results are to λ, I re-estimate the model under a variety of alternative values of λ. Because all the calibration targets are for firms in their steady state, I do not recalibrate the other parameters in the model for this exercise. To test whether this is sensible, I do estimate IRFs for the steady state with alternative λ values to ensure that this choice is quantitatively reasonable.

Figure F.6 plots the IRFs for constrained firms and steady state firms in response to a 25 bps rate cut under alternative values of leverage constraints λ. I include the calibrated value

Figure F.6: State-Dependent IRFs under Alternative λ Constraints



(a) Constrained: $\Delta \log B_{t,t+h}$ **(b)** Constrained:$\Delta \left(\frac{I}{K}\right)_{t,t+h}$ **(c)** Constrained: $\Delta y^{(10)}_{t,t+h}$

(d) SS: $\Delta \log B_{t,t+h}$ **(e)** SS: $\Delta \left(\frac{I}{K}\right)_{t,t+h}$ **(f)** SS: $\Delta y^{(10)}_{t,t+h}$

Notes: Generalized IRFs of an annualized 25 bps cut in the 1-year rate starting from an initial rate of $r_{t+1} = \bar{r}$ annualized, generated from Monte Carlo Simulation. Panels (a) and (d) plot the log face value IRFs, Panels (b) and (e) plot the investment rate IRFs (p.p.), and Panels (c) and (f) plot the $y^{(10)}$ IRFs (bps). The investment panels have their x-axis quarterly, all others are months after the monetary shock. The steady state IRFs use an initial firm state of (K^*, B^*). The constrained IRFs use an initial state of $(0.975K^*, 1.33B^*)$.

of $\lambda = 0.465$, and then consider a range of other values: $\lambda \in \{0.44, 0.48, 0.50\}$, representing alternative calibrations with tighter or looser constraints. Panels (d)-(f) plot the IRFs for firms whose initial state is the ergodic steady state for capital and debt burdens. Reassuringly, varying λ has no quantitative effect on these responses to a monetary shock.

For the constrained-state IRFs, I initialize firms with capital equal to 97.5% of its steady-state level and lagged debt equal to 133% of steady-state debt,B_{-}. Varying λ changes the response to an expansionary monetary shock, but the quantitative effects on equilibrium yields are small. The reason is that, in this constrained region of the state space, the stock of outstanding bonds is largely predetermined at impact. As a result, changing the leverage limit has limited scope to alter the bond-supply channel that dampens the pass-through of monetary policy to yields. The remaining differences appear mainly in firms' real choices. With a looser constraint, $\lambda = 0.50$, firms initially issue fewer bonds and yields are somewhat more attenuated. This lower debt issuance is accompanied by earlier capital accumulation, followed by a sharper subsequent decline in investment.

The alternative calibrations show that the model's main qualitative and quantitative conclusions are insensitive to reasonable variation in λ.

F.7 Risk Neutral Monetary Transmission

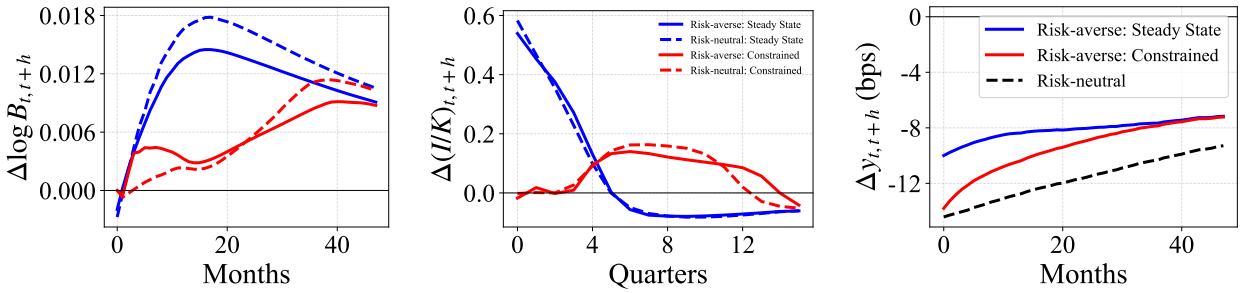
In this Appendix, I study how a risk-neutral intermediary changes conventional monetary transmission relative to the calibrated economy where long-term bonds are priced in partially segmented bond markets. To implement risk-neutral pricing of bonds, I replace the preferred habitat and arbitrageur blocks of the economy with an Euler equation in prices which holds with a risk-neutral intermediary

$$P_t^L = \mathbb{E}_t \left[M_{t,t+1} \left(c + \delta_B + (1 - \delta_B) P_{t+1}^L \right) \right] . \tag{F.13}$$

I then simulate the generalized IRFs to a 25 bps cut in the short-term interest rate, r_{t+1}, and plot the responses in Figure F.7. In implementing this counterfactual, all calibrated parameters are left unchanged, with the bond-pricing parameters $\{W, \gamma, \theta_0, \theta_y\}$ becoming irrelevant. To facilitate comparison, the IRFs generated with the risk-averse asset pricing blocks are plotted using solid lines, and the risk-neutral responses are plotted using dashed lines. I compare, across different issuer states, how risk-neutral intermediaries change the implications for monetary transmission.

The bond market transmission responses, Panel (a) and (c), highlight the starkest differences when bonds are priced by a risk-neutral intermediary. Panel (a) plots the bond

Figure F.7: Conventional Policy with Risk-Neutral Intermediary



(a) $\Delta \log B_{t,t+h}$ **(b)** $\Delta \left(\frac{I}{K}\right)_{t,t+h}$ **(c)** $\Delta y^{(10)}_{t,t+h}$

Notes: Generalized IRFs of an annualized 25 bps cut in the 1-year rate starting from an initial rate of $r_{t+1} = \bar{r}$ annualized, generated from Monte Carlo Simulation. Panel (a) plots the log face value IRF, Panel (b) plots the investment rate IRF (p.p.), and Panel (c) plots the $y^{(10)}$ IRF (bps). The x-axis denotes months after the monetary shock for face value and yield responses, and quarters for investment responses. Blue lines are responses given an initial state of SS capital and debt burden. Red lines are responses for 97.5% of SS capital level with 133% of SS debt burden. The solid lines plot the steady-state IRFs for the calibrated risk-averse arbitrageur discussed in Section 6.2, and the dashed lines are for a risk-neutral intermediary.

issuance IRFs across economies. When firms are unconstrained near the steady state, risk-neutral bond pricing causes bond issuance to become more elastic, with peak issuance response nearly 0.5 percentage points larger than in the baseline risk-averse pricing scenario. The most obvious difference between pricing scenarios relates to the yield responses in panel (c). Risk-neutral pricing implies that there is no state-dependence in yield responses when bonds are priced at (F.13). This result is driven by the fact that the intermediary does not care about the level of duration risk in bond markets, and instead arbitrages the term premia such that bond prices today are equal to properly discounted future prices.

Finally, Panel (b) of Figure F.7 quantifies the investment transmission results when investors are risk-neutral. Investment responses differ under risk-neutral and risk-averse bond pricing. Near the steady state, the peak investment-rate response under risk-neutral pricing is 0.58 percentage points, 8.4% larger than under baseline risk-averse pricing. Similar differences arise in the constrained state, where investment responses under risk-neutral pricing are notably larger two years after the rate cut. These results suggest that risk-neutral pricing of firm debt can overestimate the external financing resources available to firms after an aggregate shock, which causes investment responses to be larger than in an economy with risk-averse pricing of firm bonds.