Inflation risk and the finance-growth nexus

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When firms finance using long-term nominal debt issued by financial intermediaries, changes in expected inflation lead to a wealth transfer across sectors. Higher expected inflation decreases firms' real liabilities and default risk, which helps reduce debt overhang. However, it hurts intermediaries' real assets, leading to a contraction in credit supply. We theoretically demonstrate that intermediary financing conditions play a key role in the transmission of nominal shocks, influencing the premium investors require for bearing inflation risk. We provide empirical evidence supporting our novel inflation transmission mechanism and connect our findings to the banking stress of 2023. We also show that Taylor rules responding to both financial and real variables can help stabilize our economy.

Keywords: Inflation, inflation risk premium, asset prices, credit risk, debt deflation, financial intermediation, monetary policy, general equilibrium model, recursive preferences.

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1 Introduction

Firm financing is crucial for economic activity, as investment, output, and default risk are all influenced by credit frictions (Gertler and Kiyotaki (2010)). Firms typically secure funding from financial intermediaries through long-term nominal debt contracts, whose real value is influenced by changes in both current and expected inflation (Fisher (1933)). A surprise increase in expected inflation reduces a firm's real debt burden, benefiting debtors like non-financial firms. However, financial intermediaries suffer adverse effects as corporate loans, being assets, devalue in real terms. While this lump-sum wealth transfer is non-distortionary in a frictionless economy, the presence of credit frictions complicates its impact. In this paper, we explore – both theoretically and empirically – how this redistribution affects the transmission of nominal shocks and its implications for economic activity and asset prices.

The key theoretical result of our paper is to show that in the presence of long-term nominal liabilities, financing frictions play a pivotal role in shaping the impact of changes in expected inflation. Specifically, we demonstrate that those effects depend on two primary (and opposing) forces. Firstly, as highlighted in Bhamra et al. (2011) and Gomes et al. (2016), higher expected inflation triggers a debt inflation effect, reducing firms' debt overhang and enabling financially constrained firms to increase investment and production (Myers (1977)). We call this the *debt overhang effect* of nominal shocks. However, simultaneously, inflation adversely affects the balance sheets of financial intermediaries, compelling them to raise the cost of debt and curtail credit supply, thereby deterring investment. We call this second opposing force, the *cost of capital effect* of nominal shocks. In short, the transmission of nominal shocks through long-term nominal debt and its impact on the economy and asset prices critically depend on financing frictions.

The intuition for this tradeoff is first formalized in a simple model with analytical solutions. In this model, producers finance through a combination of debt and equity, weighing the costs and benefits of debt. They face profit shocks, which lead some firms to default and render corporate debt risky. Producers invest in capital and produce output with time-to-build. As a result, they account for their probability of survival when choosing investment, resulting in a debt overhang. Debt financing is obtained from financial intermediaries in competitive credit markets in the form of nominal long-term debt. Intermediaries face liquidity shocks, prompting some to seek costly short-term financing to cover liquidity needs. The magnitude of these costs determines the severity of intermediary financing constraints. Importantly, credit markets clear, implying that the equilibrium cost of debt reflects a compensation for both default risk and inflation, as well as the intermediary's cost of capital.

We investigate the impact of an unpredictable MIT shock on expected inflation in the steady-state industry equilibrium (Boppart et al. (2018)). We emphasize how the sign and magnitude of the effects of the shock depend explicitly on financing constraints in the intermediary sector. Specifically, consider an increase in expected inflation. When financing costs are low, financial intermediaries are able to absorb the nominal shock without raising the cost of debt, resulting in the debt overhang effect dominating. However, as credit frictions intensify, intermediaries start reducing credit supply and raising the cost of debt. This dampens the expansionary effects of higher expected inflation and can even lead to a recession when constraints are tight enough and the cost of capital effect dominates. We also demonstrate that the presence of both long-term nominal debt and credit frictions is necessary for our results. When debt is real or short-term, the economy remains neutral to changes in expected inflation. Furthermore, in the absence of financial intermediation frictions, positive nominal shocks are always good news for the economy.

Our mechanism relies on the premise that changes in expected inflation create a wealth transfer between the financial and non-financial sectors. We find supporting evidence for this transfer in the data. Using a panel of publicly traded firms, we demonstrate that financial firms' stock returns exhibit a negative exposure to expected inflation surprises (the inflation beta), relative to non-financial firms. Furthermore, the magnitude of the inflation beta increases with long-term leverage for non-financial firms but decreases with the maturity of assets for financial firms. Overall, these results underscore the importance of long-term nominal debt as a mechanism through which inflation transfers wealth between financial intermediaries and non-financial firms.

The model generates unique empirical predictions on how financing frictions affect the relationship between expected inflation and economic activity. To test this, we compute the rolling covariance between expected inflation and future economic activity, i.e., the "Nominal Real Covariance", or NRC. The NRC changes signs over time, as demonstrated by Campbell et al. (2017). A positive NRC indicates that higher expected inflation forecasts increased economic activity, while a negative NRC suggests the opposite. Consistent with the model, we document a large and significant negative relation between the tightness of intermediary financing constraints and the NRC.

These findings also have important implications for asset pricing. We demonstrate that financing frictions influence the impact of nominal shocks on consumption and investors' marginal utility, thereby predicting the inflation risk premium (IRP). The IRP measures the premium investors are willing to pay to hedge against changes in future inflation. As documented in Boons et al. (2020), the IRP displays substantial variation over time. Our objective is to test whether financing frictions have predictive power over the IRP. We measure the IRP using a Fama and MacBeth (1973) cross-sectional approach, allowing us to extract the IRP from the cross-section of stock returns. We find that financing constraints strongly predict the IRP across various proxies for financing constraints. Overall, empirical evidence from both macroeconomic variables and asset prices strongly supports our main conjecture that financing frictions play a key role in the transmission of nominal shocks.

To quantify our mechanism, we integrate the core elements of the simple model into a New Keynesian framework with sticky prices à la Rotemberg (1982) and a short-rate rule for monetary policy that endogenizes expected inflation dynamics. Notably, we assume a representative household with recursive preferences, which helps generate a sizable risk premium in both stock and credit markets, and allow banks to also collect deposits from households. The quantitative model is calibrated to match salient features of credit markets, asset prices, and macroeconomic fluctuations. Using Jordà (2005) local projections, we verify that the model's responses to an exogenous monetary shock, used to proxy for a change in expected inflation, quantitatively match their empirical counterparts. In short, our model adequately captures the unconditional propagation of nominal shocks.

To directly test our mechanism, we estimate the model's responses to a monetary shock, conditioned on credit frictions, defined as times when financing costs are one standard deviation above their mean. These responses serve as an important external validation of our channel, as they are not matched in the calibration. Although an expansionary policy shock unconditionally leads to increased output and consumption and decreased credit spreads, we find that when financing frictions are high, these relationships are significantly dampened and sometimes even reversed. For instance, a surprise one-standard deviation cut in the short rate causes an increase in consumption of about 0.3 standard deviations, unconditionally. When financial frictions are high, this response is reduced to zero. We estimate the same responses in the data and find similar results. Importantly, all model responses are within the error bands of empirical estimates, suggesting that our channel can quantitatively explain a significant portion of the responses to nominal shocks in the data. These results provide further evidence that financing frictions have a first-order effect on the transmission of expected inflation shocks.

These results have important policy implications. Monetary authorities should pay close attention to financing conditions when formulating inflationary policies because the welfare consequences of such policies critically depend on the inflation wealth transfer. Consequently, we conduct a welfare analysis within a class of linear Taylor rules for monetary policy and find that the optimal policy rule always adapts its inflation policy to financing conditions. Particularly, during periods of heightened financing frictions, monetary policy should restrain from implementing expansionary measures that generate inflation. This can be achieved by adopting a more hawkish stance against inflation or by reducing the monetary response to the output gap. Alternatively, these policies should be complemented with programs aimed at strengthening the financial sector.

The recent inflationary episode following the COVID-19 pandemic provides a compelling case study for our mechanism. In response to large-scale fiscal and monetary stimulus, several mid-sized banks increased their exposure to long-term securities, primarily financed by short-term, uninsured deposits, thereby heightening their balance sheet vulnerability to expected inflation risk. As inflation rose and interest rates followed, these banks faced mounting balance sheet pressures, triggering depositor runs and an effective increase in their cost of capital. Consequently, three regional banks failed in the first half of 2023, with the crisis spilling over to other financial institutions.[1] To prevent broader financial contagion, policymakers implemented emergency liquidity measures aimed at supporting the financial sector. This episode illustrates how rising expected inflation, while initially expansionary for the economy, can destabilize financial intermediaries by eroding balance sheets, restricting credit supply, and ultimately weakening real economic activity. More broadly, it underscores the importance of considering financial sector conditions when assessing the broader macroeconomic effects of inflation and designing monetary policy interventions.

Our paper relates to the literature linking inflation to firm decisions and asset prices through long-term nominal debt. Kang and Pflueger (2015), Bhamra et al. (2011), and Gomes et al. (2016) study the effect of inflation on default risk but do not consider risk for equity and abstract from financial intermediation. Our work complements these studies by investigating – both theoretically and empirically – the asset pricing implications of the sticky leverage channel and highlights a new feedback channel that arises in the presence of constrained financial intermediaries.[2] Bhamra et al. (2018) also study the asset pricing implications of the deflation risk, but do not consider investment

[1]Specifically, First Republic Bank failed on May 1, while Silicon Valley Bank and Signature Bank collapsed on March 12. These were the second-, third-, and fourth-largest bank failures in U.S. history, respectively. Additionally, the S&P Regional Bank Index declined by more than 20% between March 8 and March 13, 2023. For a detailed account of the banking stress of 2023, see Acharya et al. (2023).

[2]Other relevant studies on debt deflation risk in mortgage markets include Doepke and Schneider (2006) and Garriga et al. (2017).

and debt overhang. Two recent studies, contemporaneous with our work, empirically support the main transmission mechanism of the paper. Brunnermeier et al. (2023) provides evidence of the debt overhang effect in the context of the German inflation of 1919-1923. Agarwal and Baron (2023) finds that banks, that were more exposed to inflation, reduced lending more during the 1977 inflation shock. To the best of our knowledge, our paper is the first to explore the asset pricing implications of nominal corporate debt in a model with financial intermediaries. Also related are papers studying inflation risk. Boons et al. (2020) show that inflation risk is priced in stock returns, while Campbell et al. (2014) and Song (2017) focus on government bonds. These papers note that the inflation risk premium varies substantially over time. Our paper provides a micro-foundation for this time-variation attributed to financing conditions in the intermediary sector.

We also contribute to the large literature that recognizes the importance of financial intermediation in business cycle analysis and for the transmission of monetary policy shocks (e.g., Bernanke and Gertler (1995), Gertler and Kiyotaki (2010), Drechsler et al. (2017), Wang et al. (2020), Brunnermeier and Krishnamurthy (2020)). Acharya et al. (2020) show empirically that higher bank risk impairs the transmission of monetary policy. They conclude that effective monetary policy during a financial crisis should be accompanied by a policy that strengthens the banking sector's health. We reach a similar conclusion but through a different monetary policy tool – inflation. Also, we provide a quantitative model in which we conduct a welfare analysis. Additionally, our paper is related to the papers that quantitatively examine transmission channels for policy interventions in production based models and its implications for asset prices, such as, Croce et al. (2012), Croce et al. (2012), Elenev et al. (2018), Begenau and Landvoigt (2018) and Liu et al. (2020). Our paper documents a distinct role for inflation that affects firms' and intermediaries' balance sheets in opposite ways, which has important implications for the conduct of optimal monetary policy.

Finally, this paper builds on the literature in economics and finance embedding dynamic capital structure decisions into equilibrium asset pricing models. Successful attempts at jointly explaining corporate debt prices and business cycle variations include Bhamra et al. (2010a), Gourio (2013), Chen (2010), Gomes and Schmid (2016), and Kuehn and Schmid (2014). The importance of labor frictions for credit risk is studied in Favilukis et al. (2020). Corhay (2016) and Chen et al. (2020) highlight the importance of imperfect competition for credit risk. In contrast to these papers, our study explicitly considers financial intermediaries and nominal rigidities. Methodologically, our paper builds on the framework of Croce (2014) in which the productivity process features a non-stationary component. This allows the model to generate long-run risk à la Bansal and Yaron (2004) in a production-based asset pricing model with a sizeable equity risk premium. In addition, we build on the numerical approach of Gomes et al. (2016) that allows solving for time-consistent optimal policies for long-term debt with perturbation techniques.

The paper is organized as follows. Section 2 presents the simple model that highlights our main mechanism. Section 3 provides empirical support for four main predictions of the simple model. Sections 4 and 5 embed our mechanism into a quantitative New Keynesian model. Section 6 provides a quantitative assessment of our channel and studies the welfare implications of various short-rate rules. Finally, Section 7 concludes.

2 Simple Model

This section builds a simple model to illustrate how expected inflation shocks are transmitted through nominal debt contracts in a production economy with a financial sector. We study the impact of an unpredictable one-time shock to expected inflation in the steady-state equilibrium of an economy without aggregate shocks, also known as a MIT shock (see, e.g., Boppart et al. (2018)). Notably, we emphasize the importance of intermediary financing constraints in the transmission of this shock.

2.1 Economic environment

The economy consists of two sectors, each with a continuum of firms of measure one. The financial sector has banks that issue long-term nominal claims to risky firms. The production sector consists of firms that produce consumption goods, hereafter referred to as producers. Producers are owned by equity holders, but partially financed by debt supplied by banks facing financial frictions. All banks and producers are owned by a representative household.[3]

Time is infinite but divided into cycles of three periods, indexed by $t = 0, 1, 2$. At the beginning of each cycle ($t = 0$), banks and producers are established, each with a lifespan of two periods. During this phase, producers obtain two-period debt from banks and invest in capital that becomes productive in the next period. No shocks occur during this initial period. The objective of period

[3]Throughout the paper, we denote nominal variables with a \$-superscript and the associated real counterpart with the same letter, but without the \$-superscript, e.g., $x^{\$} = xP_t$, where P_t is the aggregate price level. Following the convention, all variables are deflated by the contemporaneous price level, P_t. In addition, we use a b- and a f-superscript to differentiate between bank and producing firm variables, when necessary.

$t = 0$, is to ensure that both banks and producers have outstanding debt when entering period $t = 1$. As we demonstrate later, having legacy debt is crucial for the impact of expected inflation shocks on our economy. However, our results generally hold for any positive value of legacy debt. Therefore, to maintain clarity, we focus on the optimization problems of banks and firms in period $t = 1$ and relegate the details of period $t = 0$ optimization to Appendix A.

In period $t = 1$, producers repay a portion of their long-term debt and produce using the capital accumulated in the previous period. They also have the option to change their capital structure by obtaining new one-period debt from banks and to invest in new capital for the next period. Both producers and banks are subject to idiosyncratic i.i.d. shocks, which lead some firms to default and cause some banks to become financially constrained. At the end of the cycle ($t = 2$), producers produce and sell their output, repay all their debt to banks, and are hit again by i.i.d. shocks that cause some firms to default. All surviving producers and banks are then liquidated, initiating a new cycle. To maintain a consistent measure of producers and banks across cycles, we assume that defaulting firms are replaced with new firms at the beginning of each new cycle.

Agents have perfect foresight regarding the future path of aggregate shocks but do not observe idiosyncratic shocks until they materialize. However, the distribution of these shocks is common knowledge. In the following sections, we describe the optimization problem faced by banks and producers in period $t = 1$ and then examine the impact of an unanticipated increase in expected inflation on the model equilibrium.

2.2 Financial intermediaries

The intermediary sector consists of a continuum of small, competitive banks. These banks conduct maturity transformation, financing short-term and providing long-term nominal loans to firms. We first describe the characteristics of loan contracts and bank financing that are key to generating the mechanism elucidated in the paper. We then summarize the bank's optimization problem and derive the optimal policies. All derivation details are relegated to Appendix A.1.

Lending. Banks enter the first period ($t = 1$) with a portfolio of legacy debt issued in the previous period. This debt, denoted as $\{\bar{B}_{i0}^{b\$}\}$, is supplied to the continuum of producers indexed by $i \in [0, 1]$. Loan contracts have three key features: they are (i) long-term, (ii) denominated in nominal terms, and (iii) risky. Specifically, debt is considered long-term in that \$1 of principal issued at $t = 0$ is repaid over two periods: a proportion λ at $t = 1$ and the remaining portion,

$(1-\lambda)$, in the second period. This specification allows long-term debt to be modeled in a tractable manner while accommodating the particular case of one-period debt when $\lambda = 1$. Debt contracts are subject to credit risk, with certain producers defaulting on their debt obligations in each period. In the event of default, creditors recover nothing.

After collecting the proceeds from the existing loan portfolio, the bank determines the new principal of one-period debt to extend to each producer i, $B_{i1}^{b\$}$. The price of debt per \$1 of face value is denoted by q_{i1}. Since banks are competitive and lend to a diversified pool of infinitesimal producers, they regard the price of debt as given when making lending decisions.

The net cash flow from lending to producer i in period 1 is equal to the proceeds from existing loans minus new lending:

$$\mathbb{1}_{i1}^{\text{ND}} \times \Big(\left(\lambda + (1-\lambda) q_{i1}\right) \bar{B}_{i0}^{b\$} - B_{i1}^{b\$} q_{i1} \Big), \tag{1}$$

where $\mathbb{1}_{i1}^{\text{ND}}$ is an indicator function equal to one if producer i doesn't default and pays its debt in $t = 1$. Given that producers and banks are liquidated after two periods, the bank's net cash flow in period $t = 2$ only consists of collecting the proceeds on existing one-period debt:

$$\mathbb{1}_{i1}^{\text{ND}} \times \mathbb{1}_{i2}^{\text{ND}} \times B_{i1}^{b\$}, \tag{2}$$

where $\mathbb{1}_{i2}^{\text{ND}}$ is an indicator function equal to one if producer i does not default in $t = 2$. Banks have no residual value at liquidation.[4]

The bank is subject to i.i.d. liquidity shocks in period 1, summarized by a random variable η_1, which are observed *after* all other decisions have been made. These shocks force certain banks to seek external financing when the realized proceeds from the loan portfolio are insufficient to cover their liquidity needs. The shock, η_1, follows a uniform distribution over a support interval $[0, \overline{\eta}]$, with probability and cumulative density functions denoted by $g(.)$ and $G(.)$, respectively.[5]

Consequently, the (real) total cash flow obtained from the portfolio of all existing loans in periods 1 and 2 is expressed as:

$$\text{CF}_1^b(\eta_1) \quad = \quad \int_0^1 \mathbb{1}_{i1}^{\text{ND}} \times \left(\left(\lambda + (1-\lambda) q_{i1}\right) \bar{B}_{i0}^b \frac{P_0}{P_1} - B_{i1}^b q_{i1} - \eta_1 + \frac{\overline{\eta}}{2} \right) di \tag{3}$$

[4]This happens due to banks being perfectly competitive and exhibiting constant returns to scale.

[5]We focus on scenarios where banks have a positive probability of needing external financing in period 1. Specifically, we ensure that the range of η_1 is wide enough so that internal financing from existing assets are not sufficient to withstand the liquidity shock, leading to the following parameter restriction: $\overline{\eta} > \left(\lambda + (1-\lambda) q_1\right) \bar{B}_0^b$.

$$\mathrm{CF}_2^b = \int_0^1 \left(\mathbb{1}_{i1}^{\mathrm{ND}} \times \mathbb{1}_{i2}^{\mathrm{ND}} \times B_{i1}^b \frac{P_1}{P_2} \right) di, \tag{4}$$

where B_{it}^b represents the real (i.e., normalized by P_t) quantity of debt issued in period t, and the constant term, $\frac{\bar{\eta}}{2}$, ensures that liquidity shocks have zero effect, on average.

Financing. In period 1, the bank has access to internal and external financing sources. Acquiring funds from external capital markets (e.g., through seasoned equity issuance or the interbank market) incurs costs. Specifically, for every dollar of external financing obtained, the bank only receives $(1-\varrho)$ of new capital. Thus, $\varrho \geq 0$ represents the extent of financing frictions and directly impacts the bank cost of capital. In contrast, internal financing is free. This disparity between internal and external funding constrains the bank's ability to rely on equity issuance to meet its financing needs. It serves as the primary source of financing friction in the model. External financing is unnecessary in period 2 since there is no liquidity shock occurring at that time.

Bank value. Banks operate competitively and determine the optimal lending allocation to each firm i to maximize the bank's value, defined as the present value of future expected real dividends. Since banks do not extend new loans in period 2, we focus on the optimization problem in period 1 but provide a detailed derivation for each period in Appendix A.1. Dividends from period 2 are discounted using the stochastic discount factor, denoted as M_2. The bank's problem is formulated as:

$$\begin{aligned} V_1^b \left(\{\bar{B}_{i0}^b\}_{i\in[0,1]} \right) &= \max_{\left\{B_{i1}^b\right\}_{i\in[0,1]}} \mathbb{E} \left\{ \int_0^{\bar{\eta}} D_1^b(\eta_1)\, dG(\eta_1) + M_2 \mathbb{E}_i \left[\mathrm{CF}_2^b \right] \right\}, \\ \text{where } D_1^b(\eta_1) &= \mathrm{CF}_1^b(\eta_1) + \varrho \min(0, D_1^b(\eta_1)), \end{aligned} \tag{5}$$

where the expectation operator $\mathbb{E}$ is taken with respect to the unobserved firm-specific producer shocks, which we define later.

Financing policy. The bank-specific shock η_1 directly influences the bank's financing needs. When η_1 surpasses a certain threshold, the bank requires external financing. This happens when the dividend becomes negative. Thus, we can define the bank's policy for external financing as follows:

$$\begin{cases} \text{no external financing} & \text{if } \eta_1 \leq \eta_1^\star \\ \text{external financing} & \text{if } \eta_1 > \eta_1^\star, \end{cases} \tag{6}$$

where $\eta_1^\star$ denotes the external financing threshold, obtained as

$$\eta_1^\star = \frac{\int_0^1 \mathbb{1}_{i1}^{\text{ND}} \times \left((\lambda + (1-\lambda) q_{i1}) \, \bar{B}_{i0}^b \frac{P_0}{P_1} - B_{i1}^b q_{i1} + \frac{\bar{\eta}}{2} \right) di}{\int_0^1 \mathbb{1}_{i1}^{\text{ND}} di}. \tag{7}$$

Obtaining \$1 of financing externally costs $\$\frac{1}{1-\varrho}$ compared to \$1 internally. Denoting the conditional probability of not requiring external financing as $G_1 \equiv P(\eta_1 \leq \eta_1^\star)$, we define the expected cost of financing, θ_1, as follows:

$$\theta_1 = 1 + (1 - G_1) \frac{\varrho}{1-\varrho} \geq 1 \tag{8}$$

As demonstrated later, θ_1 limits the bank's ability to fund its lending activities and plays a crucial role in determining the optimal bank credit supply and the cost of debt.

Debt pricing. Next, we derive the optimal supply of one-period debt, which is obtained by taking the first-order condition with respect to B_{i1}^b. This condition determines the equilibrium price of debt offered to firm i:

$$q_{i1} = \frac{M_2}{\Pi_2} \times \Phi_{i2} \times \frac{1}{\theta_1}, \tag{9}$$

where $\Phi_{i2} \equiv \mathbb{E}[\mathbb{1}_{i2}^{\text{ND}}]$ is the conditional probability of survival of producer i, and $\Pi_2 \equiv \frac{P_2}{P_1}$ is the inflation rate between period 1 and period 2.

Expression (9) reveals that banks price the debt to break-even on each loan. Specifically, the equilibrium debt price compensates banks for three factors. The first term accounts for the time-value of money, as represented by M_2 and future inflation, Π_2. The second term adjusts for the expected credit risk due to the probability of default, $(1 - \Phi_{i2})$. The last term accounts for banks' cost of capital. When the expected marginal cost of external financing increases (θ_1 higher), banks pass this increase on to lenders. We show that this effect can lead to cuts in credit supply and an increase in the cost of debt, significantly altering the impact of nominal shocks.

2.3 Producers

Producers enter the first period with two state variables: a stock of productive capital $\bar{K}_{i0}$ and a face value of outstanding, nominal debt $\bar{B}_{i0}^{f\$}$ issued by banks. Given that all producers face the same maximization problem, we remove the i subscript.

Production. Firms produce output Y_t using capital K_{t-1} accumulated in the previous period. The stock of capital fully depreciates at the end of the period, implying that investment today equals the stock of capital in the next period. The production function is:

$$Y_t = K_{t-1}^{\alpha}, \tag{10}$$

where we set $\alpha < 1$ is a decreasing return to scale parameter. The production function deliberately abstracts from total factor productivity since we focus on shocks to future inflation. This assumption is relaxed in the quantitative model of Section 4.

Financing. The optimal debt/equity mix is determined by a standard trade-off between the bankruptcy costs and tax benefits of debt. Debt is obtained from the intermediary sector. Because debt markets are perfectly competitive, the firm chooses the total amount of debt it issues in period 1 and its allocation to a particular bank is irrelevant. Thus, we omit the bank identifier and assume a representative bank.

Equity is directly sourced from households and features limited liability. Equity holders can choose to default on their debt obligations when the equity value turns negative. Default, however, entails bankruptcy costs as the entire firm value is wiped out in case of bankruptcy. The presence of bankruptcy cost makes debt unattractive as a source of financing. To obtain an interior solution for the debt/equity mix, we assume that debt also brings benefits to shareholders. For example, interest rate expenses are tax deductible, and debt helps mitigate agency frictions between managers and shareholders. We capture all these benefits by assuming that the firm gets a subsidy equal to a proportion $(1-\chi)$ of each \$1 of principal paid. To ensure that debt is optimal in the steady state, we require that the benefit of debt, net of financing cost is positive, that is, $\chi\theta_1 < 1$.[6]

In period 1, the firm issues new debt B_1^f at a unit price of q_1 and is left with $(1-\lambda)\bar{B}_0^f$ of outstanding debt from the last period. Given that this legacy debt is now one-period debt, its price is also q_1. Therefore the net (real) cash-flow from financing activities in period 1 is:

$$-\chi\lambda\frac{\bar{B}_0^f}{\Pi_1} + q_1\left(B_1^f - (1-\lambda)\frac{\bar{B}_0^f}{\Pi_1}\right), \tag{11}$$

where $\Pi_1 \equiv P_1/P_0$ is the inflation rate between period 0 and period 1. The first term captures the

[6] One also needs to impose a lower bound on $\chi\theta_1$ to ensure a local maximum. If $\chi\theta_1$ is too low, debt is too attractive, and the firm takes an infinite leverage. More details can be found in Appendix A.

repayment of the existing debt, adjusted for the tax subsidy. The second term in parentheses is the net cash-flow obtained from changing the firm's debt structure.

There is no new debt issue in period 2, therefore the cash-flow from financing activities only consists of the repayment on the existing one-period debt portfolio, adjusted for the debt benefits:

$$-\chi \frac{B_1^f}{\Pi_2}. \tag{12}$$

Equity value. The producer's dividend in each period is the cash-flow obtained from production plus the net proceeds from financing activities:

$$D_1^f(z_1) = \bar{K}_0^\alpha - \chi\lambda \frac{\bar{B}_0^f}{\Pi_1} - K_1 + q_1 \left(B_1^f - \frac{\bar{B}_0^f}{\Pi_1}(1-\lambda) \right) - z_1 \tag{13}$$

$$D_2^f(z_2) = K_1^\alpha - \chi \frac{B_1^f}{\Pi_2} + \bar{V}_0^f - z_2, \tag{14}$$

where z_t, for $t = 1, 2$, are i.i.d. profit shocks that follow a uniform distribution over a support $[0, \bar{z}]$. These shocks are the main driver of credit risk in the cross-section of firms and are observed at the beginning of the period. We denote the corresponding cumulative and probability density functions of z_t by $\Phi(.)$ and $\phi(.)$, respectively.[7] $\bar{V}_0^f$ is the net liquidation payment paid to the producer. In particular, we assume that the firm is bought by a new producer at the end of the cycle who will optimally lever using two period debt and invest in capital at the beginning of the next cycle. As such, $\bar{V}_0^f$ is equal to the value of an unlevered firm in period 0.

The objective of the producer is to maximize the market value of equity by making three decisions: (i) whether to default, and if no default occurs (ii) what quantity of debt to issue and (iii) how much to invest in capital. The maximization problem is:

$$V_1^f\left(\bar{K}_0, \bar{B}_0^f, z_1\right) = \max \left\{ 0, \max_{B_1^f, K_1} \left\{ D_1^f(z_1) + M_2 \int_0^{\bar{z}} D_2^f(z_2) d\Phi(z_2) \right\} \right\} \tag{15}$$

The first max operator accounts for the limited liability of equity holders, while the second operator captures the optimality of decisions. It is important to note that the market value of debt is endogenous and depends on the firm's choices of investment and debt position, i.e. $q_1 = q_1(K_1, B_1^f)$. Consequently, when making decisions, the firm recognizes that its actions also affect the value of debt to creditors, as the supply of bank debt must satisfy the bank break-

[7] To ensure that debt is risky, we require that the upper bound $\bar{z}$ is large enough so that $\bar{z} > z_2^\star$.

even condition defined in Equation (9). However, the firm treats the bank cost of capital, θ_1, as exogenous because banks are perfectly diversified, and each firm constitutes a small portion of the bank's loan portfolio.

Default Equity holders have limited liability and will default once equity becomes negative. This leads to a threshold decision where a firm chooses to default when $z > z_t^\star$ and not to default otherwise. The default threshold in each period is:

$$z_1^\star = \bar{K}_0^\alpha - \chi\lambda\frac{\bar{B}_0^f}{\Pi_1} - K_1 + q_1\left(B_1^f - \frac{\bar{B}_0^f}{\Pi_1}(1-\lambda)\right) + M_2\int_0^{\bar{z}} D_2^f(z_2)d\Phi(z_2) \tag{16}$$

$$z_2^\star = K_1^\alpha - \chi\frac{B_1^f}{\Pi_2} + \bar{V}_0^f \tag{17}$$

When the firm defaults, shareholders and creditors leave with a zero cash-flow. The (endogenous) probability of default of a firm is defined as $\text{Def}_t = \int_{z_t^\star}^{\bar{z}} d\Phi(z_t) = 1 - \Phi(z_t^\star)$.

Optimal capital structure The optimal capital structure decision of the firm is obtained after taking the first order condition for B_1^f (see Appendix A.2 for details):

$$\frac{\partial q_1}{\partial B_1^f}\left(B_1^f - \frac{\bar{B}_0^f}{\Pi_1}(1-\lambda)\right) + q_1 = \frac{M_2}{\Pi_2}\Phi(z_2^\star)\chi. \tag{18}$$

Equation (18) says that the firm will choose to issue debt up until the point where the proceeds from issuing a marginal unit of debt (left-hand-side) exactly equal the present value of the expected future costs of debt to the firm (right-hand-side). When making decisions, equity holders take into account the fact that changing leverage affects the debt value ($\partial q_1/\partial B_1^f < 0$) – for both newly issued and outstanding debts. Notably, the higher the stock of existing long-term debt, the higher the firm's incentive to maintain high leverage, causing leverage choices to be persistent (e.g., see Admati et al. (2018)).

Optimal investment The optimal investment condition equates the marginal costs of increasing the firm's capital by one unit (left-hand side) to the marginal benefits of having one more unit of capital in the firm (right-hand side). Benefits of accumulating an extra unit of capital include the additional debt capacity that can be secured by reducing the probability of default next period,

$\frac{\partial q_1}{\partial K_1} > 0$ (first term), and the return on capital (second term):

$$1 = \frac{\partial q_1}{\partial K_1} \left(B_1^f - \frac{\bar{B}_0^f}{\Pi_1}(1-\lambda) \right) + M_2 \Phi(z_2^\star) \alpha \frac{Y_1}{K_1} \tag{19}$$

Note that the marginal benefits of investment are affected by default and the stock of long-term debt. This creates a debt overhang problem that distorts the investment decision. In addition and importantly, the financing conditions of the intermediary sector affect the bank cost of capital, which also affects investment decisions through the equilibrium prices of debt, q_1.

2.4 Aggregation and equilibrium

Banks differ by the realization of their respective liquidity shocks η_1. Since these shocks are i.i.d. and are observed after lending decisions, bank policies remain unaffected by specific realizations of η_1, except for their decision to seek external financing. Consequently, the model admits a representative bank, and the distribution of banks can be tracked by the measure of banks requiring external financing, $(1 - G(\eta_1^\star))$. Using a similar argument for producers where z_t shocks enter as fixed cost, the heterogeneity among producers can be captured by the proportion of firms that default each period, denoted as $\Phi(z_t^\star)$, and the model admits a representative producer.

The perfect foresight equilibrium is defined as a sequence of prices q_t and decision rules B_t and K_t such that in each period t:

(i) Decision rules jointly solve the optimization problems of producers and banks.

(ii) Debt prices clear credit markets.

(iii) The aggregate price level P_t follows a deterministic path known by all economic agents.

We examine two equilibrium variants to analyze the effects of an unexpected change in future inflation on the economy. In the partial equilibrium variant, we assume a constant pricing kernel across all periods, enabling us to derive analytical solutions. In the general equilibrium variant, we relax the assumption of an exogenous pricing kernel and introduce a representative household that derives utility from consumption. We solve this second variant numerically.

2.5 Shock to expected inflation.

In this section, we explore the impact of a MIT shock on expected inflation in our perfect foresight equilibrium. We assume that the economy is in the steady state in period 0 and expect the price level to remain at its steady-state level, $P_t = 1$, indefinitely. In period 1, agents suddenly learn that the price level in period 2 will increase from $P_2 = 1$ to $P_2 = 1 + \Delta\pi^e$, and will remain at that level indefinitely. In effect, $\Delta\pi^e$ represents a one-time shock to expected inflation as of period 1. To obtain analytical solutions, we set the decreasing returns to scale parameter α to 1/2, an assumption that we relax in the quantitative model.

2.5.1 Partial Equilibrium

The partial equilibrium case assumes a constant pricing kernel across all periods, that is, $M_t = 1$ for $t = 1, 2$. To elucidate the main mechanisms at play, we report below the Euler equation governing the optimal capital (and thus output) allocation of the firm obtained by combining the two FOCs defined in Equations (18) and (19):

$$1 \quad = \quad \Phi(z_2^\star)\frac{\text{MPK}_2}{\theta(\eta_1^\star)\chi}, \tag{20}$$

where $\text{MPK}_2 \equiv \frac{1}{2}\frac{Y_2}{K_1}$ represents the marginal product of capital.

This equation says that the marginal cost of an additional unit of capital equals the expected marginal product of capital, discounted for two reasons. First, the firm might default next period, limiting shareholders' willingness to invest, i.e., there is a *debt overhang effect*, captured by the survival probability $\Phi(z_2^\star)$. Second, investing in capital necessitates acquiring an additional dollar of financing, incurring a net cost of $\theta(\eta_1^\star)\chi$. We term this the *cost of capital effect*. As shown later, nominal shocks affect the debt overhang and cost of capital effects in opposite directions.

The first proposition summarizes the impact of an exogenous change in expected inflation on the producer's optimal choices. We approximate the policy functions through a first-order approximation around the steady state. Steady state variables are denoted with an upper bar, and variales in deviation from the steady state with Δ. Detailed proofs are available in Appendix A.3.

Proposition 1. *Assume the partial industry equilibrium defined in Section 2.4 holds, the producer's optimal default threshold and investment responses to a MIT shock $\Delta\pi^e$ are given by:*

$$\frac{\Delta z_2^\star}{\bar{z}_2^\star} \quad = \quad \frac{\chi\bar{B}_0(1-\lambda)}{\left(\bar{V}_0^f - \chi\bar{B}_0(1-\lambda)\right)} \times \Delta\pi^e - \gamma_z \times \frac{\Delta\theta_1}{\bar{\theta}_1}, \tag{21}$$

$$\frac{\Delta K_1}{K_1} \quad = \quad \frac{2\chi\bar{B}_0(1-\lambda)}{\left(\bar{V}_0^f - \chi\bar{B}_0(1-\lambda)\right)} \times \Delta\pi^e - 2\gamma_y \times \frac{\Delta\theta_1}{\bar{\theta}_1}, \tag{22}$$

where $\gamma_y > 0$, $\frac{\chi \bar{B}_0(1-\lambda)}{\left(\bar{V}_0^f - \chi \bar{B}_0(1-\lambda)\right)} \geq 0$, *and the sign of* γ_z *is undefined.*

The cost of capital effect, $\Delta\theta_1$*, is given by:*

$$\Delta\theta_1 \quad = \quad \frac{\varrho}{1-\varrho}(1-\lambda)\bar{B}_0\gamma_\theta \times \Delta\pi^e, \tag{23}$$

where $\gamma_\theta > 0$*.*

To better understand the effects of a change in expected inflation, we first examine the special case where there are no financing frictions in the banking sector, i.e., $\varrho = 0$, implying $\Delta\theta_1 = 0$. In this scenario, only the debt overhang effect is at work, and an increase in expected inflation erodes the proportion of legacy debt due in period 2, $\chi\bar{B}_0(1-\lambda)$, which decreases the probability of default. The reduction in debt overhang stimulates investment. Without frictions in the financial sector, higher expected inflation is expansionary as in Gomes et al. (2016).

However, allowing for external financing costs ($\varrho > 0$) introduces a *feedback* from the financial sector to the producing sector, potentially offsetting the expansionary effect of inflation. In response to positive inflation shocks, real bank assets depreciate, causing them to seek expensive external financing and increasing the cost of capital $\Delta\theta_1$. As seen in Equation (20), investment is negatively related to θ_1, and the capital cost feedback diminishes the expansionary impact of inflation on capital, as demonstrated in Equation (22). It is worth noting that the effect of $\Delta\theta_1$ on the default threshold is uncertain because higher capital costs discourage investment and restrict the firm's borrowing capacity. Proposition 1 also underscores the importance of long-term nominal debt, $\bar{B}_0(1-\lambda) > 0$. In the absence of long-term debt ($\lambda = 1$), expected inflation shocks have no effect. Conversely, legacy debt is sufficient to break nominal neutrality, even without traditional nominal frictions, such as sticky prices.

Drawing from the insights of Proposition 1 and noting that $Y_t = K_{t-1}^{1/2}$, we formulate our first empirical prediction regarding the relationship between expected inflation shocks, real aggregates, and intermediary financing frictions:

Prediction 1. *Tighter financing frictions in the intermediary sector have a negative impact on the relationship between expected inflation and future output.*

One crucial mechanism for our results is the wealth transfer of inflation between financial and non-financial firms. We summarize the effects of an expected inflation shock on each firm's stock price in Proposition 2.

Proposition 2. *Assuming the partial industry equilibrium defined in Section 2.4 holds, the response function of an average producer's market value to a MIT shock* $\Delta\pi^e$ *is given by:*

$$\Delta EV_1^f \;\; = \;\; \bar{\Phi}_1 \left(\bar{q}_1 \bar{B}_0 (1-\lambda) \times \Delta\pi^e - \bar{q}_1 \left(\bar{B}_1 - \bar{B}_0(1-\lambda) \right) \times \frac{\Delta\theta_1}{\bar{\theta}_1} \right). \tag{24}$$

The response function of the bank's market value is:

$$\Delta EV_1^b \;\; = \;\; \bar{V}_1^b \times \frac{\Delta\Phi_1}{\bar{\Phi}_1} - \gamma_{vb} \bar{\Phi}_1 \bar{\Phi}_2 (1-\lambda) \bar{B}_0 \left(\Delta\pi^e - \frac{\Delta\Phi_2}{\bar{\Phi}_2} \right), \tag{25}$$

where $\gamma_{vb} > 0$*.*

To better understand the results of Proposition 2, assume $\varrho = 0$. We obtain:

$$\Delta EV_1^f \;\; = \;\; \bar{\Phi}_1 \bar{q}_1 \bar{B}_0 (1-\lambda) \times \Delta\pi^e \tag{26}$$

$$\Delta EV_1^b \;\; = \;\; -\bar{\Phi}_1 \bar{q}_1 \bar{B}_0 (1-\lambda) \times \Delta\pi^e + \left(\bar{V}_1^b \times \frac{\Delta\Phi_1}{\bar{\Phi}_1} + \bar{\Phi}_1 \bar{\Phi}_2 (1-\lambda) \bar{B}_0 \frac{\Delta\Phi_2}{\bar{\Phi}_2} \right) \tag{27}$$

The first term in each response captures the redistribution effect of inflation across sectors. With higher expected inflation, the real value of legacy debt depreciates. This boosts the equity value of producers, where debt is a liability, while simultaneously diminishing the value of banks, where debt is an asset. The bank value includes two additional terms that reflect the impact of inflation on the probability of survival of producers in each period, denoted by $\Delta\Phi_t$, $t = 1, 2$. These terms only emerge in the bank value because although firms pay ex-ante for the expected credit risk (via lower debt value at issuance), once default materializes, creditors suffer the losses. Since higher expected inflation increases the producers' probability of survival, these effects alleviate the losses suffered by the bank. Quantitatively, we find that the debt inflation effect consistently dominates, resulting in higher expected inflation adversely impacting financial intermediaries. This conclusion is further supported by empirical evidence in Section 3.

Financing frictions ($\varrho > 0$) have a detrimental effect on the value of both producers and banks. This occurs because higher expected inflation increases the cost of financing for banks, resulting in losses. Banks then pass on this increased cost to producers, resulting in producers receiving less for each dollar of new debt issued (as evidenced by the second term in Equation (24)), which exerts a negative impact on the producer's value. It is important to note that despite this shared negative impact, the wealth transfer caused by debt inflation persists. We derive a second empirical prediction regarding the wealth transfer of inflation:

Prediction 2. *Stock returns of financial firms are more negatively exposed to expected inflation news than stock returns of non-financial firms.*

The magnitude of the effects of expected inflation shocks on valuations, crucially depends on the amount of long-term legacy debt on the balance sheet of producers and banks, as shown in Equations (24) and (25). This leads to a third empirical prediction:

Prediction 3. *(i) Non-financial firms with more long-term debt are more positively exposed to expected inflation news. (ii) Financial firms with more long-term assets are more negatively exposed to expected inflation news.*

2.5.2 GE Model Extension

The general equilibrium model retains all elements of the partial equilibrium but assumes a representative household with Epstein-Zin preferences for consumption, holding all claims to banks and producers. Recursive preferences ensure that utility is affected by both realized and future consumption growth. The resulting Stochastic Discount Factor (SDF), M_t, is defined as the intertemporal marginal rate of substitution between time $t-1$ and t:

$$M_t \;=\; \beta\left(\frac{C_{t-1}}{C_t}\right)\left(\frac{U_t^{1-\gamma}}{E_{t-1}\left[U_t^{1-\gamma}\right]}\right), \tag{28}$$

where $\beta < 1$ is the subjective discount factor, $\gamma > 1$ is a parameter reflecting risk aversion, and the IES is set to one for illustration purposes. We retain the expectation operator to underscore that agents make decisions in period 0 before observing the unexpected MIT inflation shock that occurs in period 1. In that sense, there is unknown risk materializing in period 1 that can potentially affect the agent's intertemporal choices.

The general equilibrium model does not admit closed-form solutions; thus, we calculate the response functions numerically. In Appendix A.4, we verify that the responses of future consumption largely mirror those of investment and output as derived in Proposition 1.[8] In short, while higher expected inflation increases consumption, this relationship is mitigated by financing constraints. This also affects the agent's SDF, which is an inverse function of consumption growth. Specifically, higher expected inflation is seen as positive news by investors when financing constraints are low, that is, the SDF drops. However, this relationship is dampened by financing constraints.

[8] We also confirm that Predictions 2 and 3 from the partial equilibrium model continue to hold in the general equilibrium model (see Figure A.2 in the Appendix).

These results have important implications for the inflation risk premium. Indeed, the price an investor would be willing to pay to avoid an upcoming shock to expected inflation, before learning about its magnitude is given by:

$$\lambda_1^{\pi} = -\text{Cov}\left(\Delta M_1, \Delta \pi^e\right). \tag{29}$$

Our model predicts that increased financing constraints worsen the impact of higher expected inflation on the real economy. This leads investors to demand a lower premium for inflation risk, meaning securities that load positively on inflation are perceived as hedges for the representative investor. In short, our paper provides a microeconomic foundation for the time-varying inflation risk documented in the existing literature (e.g., Boons et al. (2020)). This motivates a fourth prediction:

Prediction 4. *The inflation risk premium decreases with the magnitude of intermediary financing constraints.*

3 Empirical results

3.1 Data description

Expected inflation. We measure expected inflation using the median of consumers' expected price change over the next year, obtained from the University of Michigan Surveys of Consumers, available monthly from 1978 to 2022. This measure offers two main advantages. First, as demonstrated in Ang et al. (2007), survey-based measures of expected inflation outperform model-based forecasts. Secondly, the extensive sample size provides enough statistical power to estimate stock-based and macroeconomic quantity exposures to expected inflation.

Financing constraints. We use three proxies to assess financing constraints. The first measure is the TED spread, that is, the difference between the 3-month LIBOR and Treasury Bill rates. It captures the premium charged on short-term loans in the interbank market and is a standard measure of liquidity strains on the banking system (e.g., see Cornett et al. (2011)). The TED series is available monthly from 1986 to 2022. The second measure is the Chicago Fed's National Financial Conditions Index (FC), developped by Brave and Butters (2011), which aggregates 105 measures of financial activity across money, debt, and equity markets.[9] Positive values of the index indicate tighter financial conditions. The FC series is available monthly since 1971. Notably, the FC exhibits a high correlation with the TED spread (0.75). We propose a third measure to capture the *relative* financing constraint between financial and non-financial firms. Specifically, we estimate the cost of capital, net of expected growth, for each sector using the Gordon Growth formula (e.g., see Farhi and Gourio (2018)), which implies $\frac{D_t}{P_t} = E_t[R_{t+1} - G_{t+1}]$, where D_t is a measure of cash-flows paid to equity and P_t is the market value of equity. High $\frac{D_t}{P_t}$ is an indication of tighter financing constraints because either the cost of capital is high, or the expected future growth rate of cash flows is low.

Using this intuition, we define a measure of relative financing constraints as follows:

$$\Delta EP \;=\; \frac{D_t^{\text{Fin}}}{P_t^{\text{Fin}}} - \frac{D_t^{\text{Non-Fin}}}{P_t^{\text{Non-Fin}}},$$

where we proxy for D_t using a three-year moving average of the sector's past earnings.[10] Firm-level variables are aggregated at the sector level by summing across all firms in a month. The resulting measure of relative constraint has a first-difference correlation of 0.61 and 0.26 with the FC and TED measures, respectively. This suggests ΔEP captures similar variations in financing conditions, although obtained from very different data inputs. It is available for our benchmark sample period, i.e., from 1978 to 2022.

Firm stock returns and debt/asset characteristics. Monthly stock returns and annual firms' characteristics are obtained from the merged CRSP-Compustat database. Firms are classified into financial and non-financial sectors based on their 4-digit SIC industry codes. We define financial firms as those with SIC codes ranging from 6000 to 6999. This category includes various types of banks, insurance companies, etc. The remaining firms are classified as non-financial.[11]

When testing the impact of long-term debt on exposure to inflation, we measure non-financial firms' debt maturity structure as long-term debt to total asset ratio. We measure financial firms'

[9]More information about the index can be found on https://www.chicagofed.org/research/data/nfci/about. Recent studies using this index to measure financing conditions includes Beaudry et al. (2020). Note that we obtain similar results using alternative proxies for financial conditions, including the VIX index, the Volatility Financial Conditions Index (Adrian et al. (2023)), the Financial Conditions Impulse on Growth index (Ajello et al. (2023)), and the first principal component from a principal component analysis on all financial condition measures.

[10]Using a moving average helps correct for potential seasonality, similar to the approach taken with the Cyclically Adjusted Price Earnings (CAPE) Ratio by Bob Shiller.

[11]Firm-year observations with missing or negative total assets, market capitalization, or long-term debt are excluded from the sample.

asset maturity structure using the U.S. Call Reports data available on Philipp Schnabl's website.[12] Following Drechsler et al. (2021), we construct a proxy for asset duration using the repricing maturity. Repricing maturity is the minimum of (i) the time until the underlying asset's interest rate resets and (ii) the time until the asset matures. Each bank's average repricing maturity is calculated by computing the weighted average of the repricing maturities of its asset categories, net of the average repricing maturities of its liabilities, divided by total assets. The U.S. Call Reports data is available quarterly from 1997 to 2021 for bank holding companies. We merge the U.S. Call Reports information with Compustat and identify matched firms as banks.

Macroeconomic quantities. We measure economic activity using two monthly time series: consumption and output. Consumption is defined as the sum of real nondurable and services consumption divided by the total population. The series is published by the Bureau of Economic Analysis (BEA). Output is measured using the industrial production index, published by the Board of Governors of the Federal Reserve System.

In summary, our benchmark sample period spans 1978–2022. When using the TED spread, our sample period is limited to 1986–2022. Finally, our sample period runs from 1997 to 2021 for tests involving bank balance sheet data. All subsequent analyses are conducted at a monthly frequency.

3.2 Empirical tests

In this section, we formally test the model's predictions. We first examine the second empirical prediction, where we introduce our measure of exposure to expected inflation risk. These measures will form the basis for subsequent empirical tests.

Inflation wealth transfer. The model predicts that stock returns of financial firms react more negatively to changes in expected inflation. Accordingly, we measure the firm-level sensitivity to changes in expected inflation as follows:

$$r_{it} - r_{mt} = \alpha_{it} + \beta_{it}^{\pi} \Delta\pi_t^e + \varepsilon_{i,t}, \tag{30}$$

where $\Delta\pi_t^e$ is the change in one-year expected inflation, and α_{it} denotes the time-varying intercept. $r_{it} - r_{mt}$ is the monthly (or quarterly in the model) stock return for firm i, in excess of the market return at time t, also known as the "market-adjusted-return" (e.g., Campbell and Taksler (2003)).

[12]More information can be found on https://pages.stern.nyu.edu/~pschnabl/data/data_callreport.htm.

This approach enables us to control for any systematic component of inflation that affects all firms in the economy but is unrelated to the wealth transfer effect (e.g., demand shocks, discount rates, etc.). It has the advantage of avoiding the estimation of CAPM market betas and facilitates the interpretation of the inflation beta as one that is relative to the overall market. Regressions are estimated at a monthly frequency using five-year rolling windows for each firm i in our sample, with a minimum of 10 observations. The results are adjusted using the Vasicek (1973) method, following Boons et al. (2020).

The coefficients β_{it}^{π} capture the sensitivity of firms' returns to inflation news. We run the following panel regression to test the wealth transfer prediction, where we expect $\Psi_{\beta} < 0$:

$$\beta_{it}^{\pi} = \Psi_{\beta} \times \mathbb{1}_i^{\text{Fin}} + \varepsilon_{it}, \tag{31}$$

where $\mathbb{1}_i^{\text{Fin}}$ is a dummy variable equal to one if firm i is categorized as a financial firm and zero otherwise.

Panel A of Table 1 presents the results. Consistent with the simple model, financial firms exhibit a relative decline compared to non-financial firms following an uptick in inflation forecasts. This difference is both statistically and economically significant. A one percentage point increase in expected inflation results in an average wealth transfer of approximately 40 basis points. Overall, these findings underscore the key role of expected inflation shocks in redistributing wealth between the financial and non-financial sectors.

Inflation sensitivity and debt/asset maturity. The third prediction of the model posits that banks with a larger asset maturity mismatch are more negatively exposed to inflation shocks. Conversely, firms with longer debt maturity exhibit higher inflation exposures. To test this, we run the following panel regression model separately for financial and non-financial firms:

$$\beta_{it}^{\pi} = \Psi_{LT} \times \log(\text{LT}_{it}) + \gamma_{it} X_{t-1} + \varepsilon_{it}, \tag{32}$$

where X_t is a vector of controls that can include firm characteristics, as well as time and industry fixed effects. LT_{it} is equal to the long-term debt ratio for non-financial firms and the asset maturity for financial firms. Both measures are normalized to facilitate interpretation.

Prediction 3 implies that $\Psi_{LT} < 0$ for financial firms and $\Psi_{LT} > 0$ for non-financial firms. Panel B of Table 1 reports the results. Column (1) shows that in a given year, banks with a longer

Table 1: Expected Inflation Stock Sensitivity

Panel A: Inflation Wealth Transfer

	Financial	Non-Financial	Difference (Ψ_β)
E[β^π]	-0.273	0.128	-0.400
	(0.024)	(0.026)	(0.035)

Panel B: Long-Term Debt Transmission

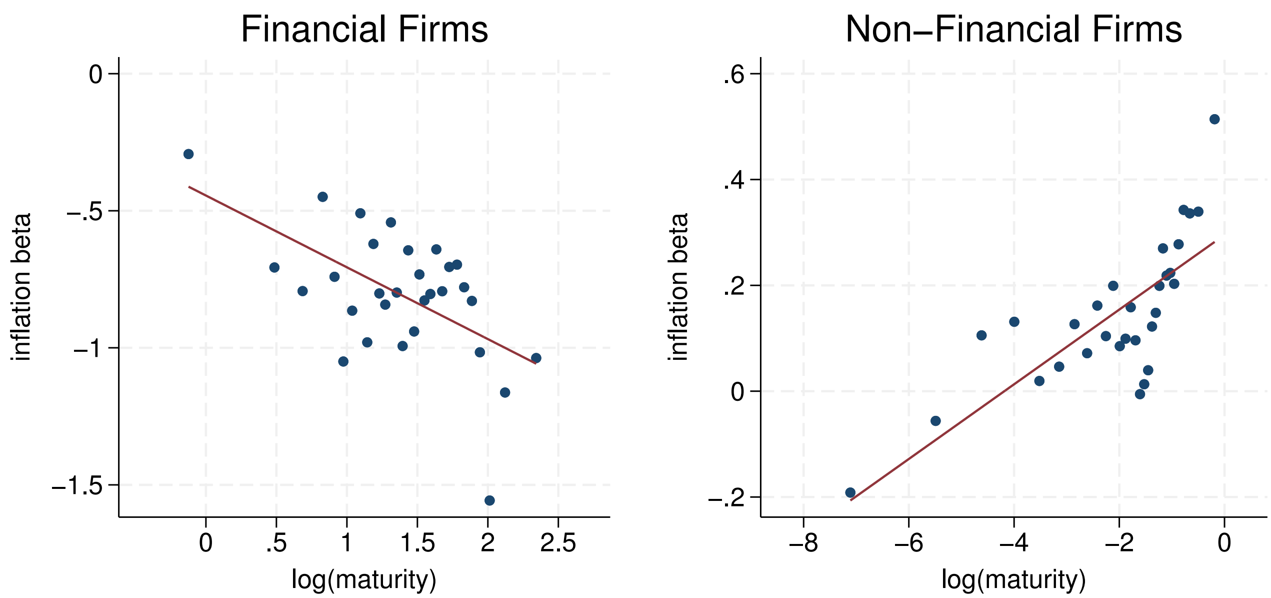
	Financial			Non-Financial		
	(1)	(2)	(3)	(4)	(5)	(6)
Ψ_{LT}	-0.144	-0.141	-0.096	0.111	0.122	0.073
	(0.057)	(0.057)	(0.054)	(0.025)	(0.025)	(0.026)
Controls		X	X		X	X
Time FE	X	X	X	X	X	X
Ind. FE			X			X
N	76,186	76,096	76,096	1,733,410	1,662,043	1,662,043
R^2	0.351	0.354	0.370	0.048	0.047	0.056

This table investigates the factors influencing expected inflation betas (β^π) across firms. Expected inflation betas are estimated using Equation (30). The panel data is structured at the firm-month level and covers the period from 1978 to 2022. Panel A compares the average inflation betas between financial and non-financial firms, presenting the average difference between the two. Panel B displays the coefficient estimates derived from the panel regression model specified in (32). Industry fixed effects are defined at the two-digit SIC level, and controls include the book-to-market ratio and the logarithm of market capitalization. Financial firms are identified by four-digit SIC codes ranging from 6000 to 6999, while the rest are categorized as non-financial firms. Standard errors, clustered at the firm level, are presented in parentheses below the corresponding coefficient estimates.

asset maturity are more negatively exposed to news about expected inflation. A one standard deviation increase in the average asset maturity reduces the inflation beta by 0.144, representing an amplification of 53%, relative to the average inflation beta reported in Panel A. This relationship is statistically significant at conventional levels and remains robust to the inclusion of both industry fixed effects and controls, as demonstrated in columns (2) and (3). Next, we conduct the same analysis for non-financial firms in column (4). On average, firms with longer debt maturity are more sensitive to expected inflation changes than those with shorter maturities, as indicated by the positive coefficient estimate. The economic significance is also substantial. A one standard deviation increase in the long-term debt to asset ratio results in a 87% rise in expected inflation exposure. These findings remain robust when including controls and industry fixed effects. In short, we document strong empirical support for long-term debt playing a key role in the transmission of expected inflation shocks across sectors.

Figure 1 visually represents the impact of balance sheet exposures to long-term debt on the

Figure 1: Inflation Sensitivity and debt/asset maturity



This figure compares the relationship between the exposure to long-term debt on the balance sheet and the exposure to expected inflation for financial (left) and non-financial (right) firms.

exposure to expected inflation shocks. Using binned scatter plots, we show that, on average, (i) banks are more negatively exposed to expected inflation shocks, and (ii) this exposure decreases with the maturity of assets (left graph). Conversely, this relationship is reversed for non-financial firms (right graph). In short, we find that nominal rigidities in long-term nominal debt, expose the real and financial sectors differently to inflation risk. As we show next, this has important implications for macroeconomic quantities and asset prices.

Shocks to expected inflation and the economy. A key implication of the model is that tighter intermediary financing frictions have a negative effect on the connection between expected inflation and future economic activity, such as output and consumption. We test this prediction in two steps. First, we compute a time-varying measure of the covariance between expected inflation and future economic activity (e.g., see Song (2017), Boons et al. (2020)), i.e., the "Nominal Real Covariance" (NRC):

$$NRC_t^{\Delta Z} = \text{Cov}_t\left(\frac{\Delta Z_{t+12}}{Z_t}, E_t\left[\frac{\Delta P_{t+12}}{P_t}\right]\right), \tag{33}$$

where Z_t represents a measure of economic activity such as output (Y_t) or consumption (C_t), $\Delta Z_{t+12} \equiv Z_{t+12} - Z_t$, and $E_t[\Delta P_{t+12}/P_t]$ is the expected inflation rate at time t over the next 12 months. The NRC is computed over rolling 12-month windows, using the Michigan Expected Inflation series to proxy for $E_t[\Delta P_{t+12}/P_t]$.

The NRC becomes positive when higher expected inflation forecasts an economic boom. Conversely, it turns negative when higher expected inflation is bad news for real aggregates. The model predicts that the effect of expected inflation on output and consumption is diminished when financing constraints tighten. Accordingly, we conduct the following test, anticipating $\Lambda_\theta^\pi < 0$:

$$NRC_t^{\Delta Z} = \Lambda_\theta^\pi \times \overline{\text{FinCon}}_t + \beta X_{t-1} + \varepsilon_t, \tag{34}$$

where $\overline{\text{FinCon}}_t$ is the average measure of financial constraints over the same sample period as the NRC, and X_t is a vector of controls.

Panel A of Table 2 presents the regression results using future output to measure economic conditions. All variables are normalized and each of the three columns employs a different proxy for intermediary financial constraints. The coefficient estimates are consistently negative and statistically significant, confirming the model prediction that tighter constraints diminish the expansionary effect of expected inflation. The economic magnitude is sizable. A one-standard deviation increase in financial constraints is associated with a reduction in the NRC ranging from 0.41 to 0.67 standard deviations, depending on the financing constraints proxy used. This relationship persists when employing both direct measures of intermediary cost of capital (TED and FC) and measures based on the valuation ratio gap between the two sectors (ΔEP). Panel B repeats the analysis using future consumption instead. Consistent with Panel A, the coefficient estimates remain negative and significant. These results confirm that intermediary financing constraints play a key role in determining the effects of expected inflation shocks on the economy.

Financing constraints also influence the compensation investors demand for bearing inflation risk. To test this hypothesis, we compute a time-varying measure of the inflation risk premium using a Fama and MacBeth (1973) cross-sectional approach for individual stocks. Specifically, we identify the month-t inflation risk premium, denoted as λ_t^π, by regressing a stock's future return in excess of the risk-free rate on the expected stock-level inflation exposure $\hat{\beta}_{it}^\pi$, controlling for various

Table 2: Financial Constraints and Inflation Price of Risk

	A. $NRC^{\Delta Y}$			B. $NRC^{\Delta C}$			C. λ^{π}		
	TED	FC	ΔEP	TED	FC	ΔEP	TED	FC	ΔEP
Λ^{π}_{θ}	-0.673	-0.511	-0.409	-0.335	-0.632	-0.242	-0.113	-0.187	-0.084
	(0.340)	(0.270)	(0.268)	(0.131)	(0.143)	(0.126)	(0.069)	(0.068)	(0.036)
N	421	505	505	421	505	505	432	527	527
R^2	0.277	0.174	0.145	0.150	0.257	0.079	0.017	0.026	0.010

This table examines how financial constraints affect the propagation of inflation shocks on future economic activity (Panels A and B) and the inflation risk premium (Panel C). Panel A and B are the results of the following time series regression using 12-month overlapping data $NRC_t = \Lambda^{\pi}_{\theta} \times \overline{\text{FinCon}_t} + \beta X_{t-1} + \varepsilon_t$, where NRC_t is a 12-month rolling covariance for future output ($NRC^{\Delta Y}$) and future consumption ($NRC^{\Delta C}$), and $\overline{\text{FinCon}_t}$ is the 12-month contemporaneous moving average of a financial constraint measure. Panel C is the results of the following monthly time series regression $\lambda^{\pi}_t = \Lambda^{\pi}_{\theta} \times \Delta\text{FinCon}_{t-1} + \varepsilon_t$, where λ^{π}_t is the inflation risk premium in month t and ΔFinCon_t is a measure of change in financial constraints. X_t is a vector of controls comprising (i) a constant, (ii) a trend to accommodate potential secular trends in the variable of interest, and (iii) a 12-month lag of the independent variable. We consider three measures of financial constraints: the TED spread, the Chicago Fed Financial constraint index (FC), and the difference in the earnings-to-price ratio between financial and non-financial firms (ΔEP). The construction of each time series is described in Section 3.1. Newey-West standard errors are reported in parentheses below the coefficient estimates.

stock characteristics X_t:[13]

$$r_{it+1} - r_{ft+1} = \lambda_{0t} + \lambda^{\pi}_t \times \hat{\beta}^{\pi}_{it} + \lambda_t X_{it} + \varepsilon_{it},$$

where $\hat{\beta}^{\pi}_{it}$ is obtained from Equation (31).

The model predicts that financing frictions negatively impact λ^{π}_t. Indeed, tighter financing constraints exacerbate the impact of high expected inflation on the real economy, causing investors to prefer securities that positively correlate with inflation, perceiving them as inflation hedges. Consequently, the inflation risk premium decreases. To test this hypothesis, we conduct the following regression, expecting $\Lambda^{\pi}_{\theta} < 0$:

$$\lambda^{\pi}_t = \alpha + \Lambda^{\pi}_{\theta} \times \Delta\text{FinCon}_{t-1} + \varepsilon_t,$$

where ΔFinCon_t is the monthly change in financial constraints.

Panel C of Table 2 presents the results. An increase in financing constraints forecasts a reduced inflation risk premium. Specifically, a one-standard-deviation increase in the ΔTED spread cor-

[13] Controls include standard drivers of the cross-section of expected stock returns such as the log-size, the book-to-market ratio, the return on assets, momentum, and log-asset growth (e.g., see Bessembinder et al. (2019)). Note that following standard practice, we winsorize each firm characteristic at the upper and lower 1% level in each month and exclude firm months with missing characteristics.

responds to a 11% decrease in the monthly inflation risk premium. These conclusions are further strengthened when using the Financial Condition Index measure, revealing a 19% decrease in the IRP. Interestingly, the results using ΔEP exhibit slightly lower magnitudes, consistent with the model, as demonstrated later in Table 3.

Overall, these empirical tests confirm the significant redistributive role of nominal shocks and validate the model's main prediction: the impact of expected inflation on economic activity depends critically on intermediary financial conditions. When financing conditions deteriorate, higher inflation can adversely affect the economy and result in a lower inflation risk premium.

4 Quantitative Model

This section integrates the insights of the simple model within a New Keynesian framework to quantify our new channel. The intermediary, producer, and household sectors maintain similar structures to the simple model. However, we augment the model with a retail sector to introduce nominal rigidities through sticky prices and a Taylor rule for monetary policy, thereby endogenizing inflation dynamics.

4.1 Retailers

Traditional channels for monetary policy require two main ingredients (e.g., see Galí (2015)): (i) imperfect competition in product markets and (ii) costly price adjustments. To depart from perfect competition, we assume that, before being consumed, the firms' products are first packaged by retailers using a CES aggregator. Solving the cost minimization problem of the final goods producer yields an inverse demand function $\mathcal{Y}_{kt}$ for the retailer's k product:

$$\mathcal{Y}_{kt} = \mathcal{Y}_t \mathcal{P}_{kt}^{-\nu}, \tag{35}$$

where $\mathcal{P}_{kt}$ is the price charged by the retailer, normalized by the aggregate price index $\mathcal{P}_t$ and ν is the elasticity of demand.[14]

Retailers charge $\mathcal{P}_{kt}$ per unit sold and buy products from the continuum of producers $i \in [0, 1]$ at a unit price of P_{it}^f. Producers compete in perfectly competitive markets and thus take the competitive price P_t^f as given (we can omit the i subscript). Retailers also face quadratic

[14] Note that we use the aggregate price index as our numeraire, i.e., $\mathcal{P}_t \equiv \left(\int_0^1 \mathcal{P}_{kt}^{1-\nu} dk\right)^{1/(1-\nu)} = 1$.

adjustment costs when adjusting their nominal price as in Rotemberg (1982):

$$\frac{\Phi_P}{2}\left(\frac{\mathcal{P}_{kt}}{\mathcal{P}_{kt-1}\bar{\Pi}}-1\right)^2\mathcal{Y}_t, \tag{36}$$

where Φ_P captures the magnitude of the price adjustment cost, $\mathcal{Y}_t$ is aggregate output, and $\bar{\Pi}$ is the inflation rate in the steady state. Solving the retailer problem determines the equilibrium producer output price P_t^f:

$$P_t^f \quad = \quad \frac{\nu-1}{\nu}+\frac{\Phi_P}{\nu}\left(\frac{\Pi_t}{\bar{\Pi}}-1\right)\frac{\Pi_t}{\bar{\Pi}}-\frac{\Phi_P}{\nu}E_t\left(M_{t+1}\Delta\mathcal{Y}_{t+1}\left(\frac{\Pi_{t+1}}{\bar{\Pi}}-1\right)\frac{\Pi_{t+1}}{\bar{\Pi}}\right), \tag{37}$$

where we used the fact that all retailers face a symmetric problem.

P_t^f can be mapped to the inverse of the price markup.[15] While the price markup remains constant under flexible prices (i.e., $\Phi_P = 0$), it becomes time-varying when prices are sticky. This highlights the main New-Keynesian transmission mechanism. In the presence of sticky prices, firms cannot adjust their prices quickly enough in response to an increase in inflation, leading them to charge a lower markup than desired, thus stimulating demand. Therefore, in New-Keynesian models, monetary policy shocks cause an increase in expected inflation and are expansionary. However, our paper demonstrates that this effect can be significantly dampened when considering constraints in the financial sector.

4.2 Financial intermediaries

The intermediary sector consists of a continuum of infinitely-lived competitive intermediaries that channel funds from households to firms through long-term loans. The nominal debt contract issued by the bank pays a fixed coupon rate of C per period and repays the principal in a geometrically declining fashion (Cochrane (2001)). Specifically, the loan repays a portion $\lambda \leq 1$ of the outstanding principal each period, while the remaining portion $(1-\lambda)$ remains outstanding.

When a default occurs, the bank seizes the producer's assets and restructures the firm. In restructuring, the bank only recovers a portion $0 < \xi < 1$ of the firm value. The remaining $(1-\xi)$ represents bankruptcy costs (e.g., legal fees, loss of customers, etc.). Denoting the market value of the unlevered producer i by ${}^uV_{it}^{f\$}$, the cash-flow available to all creditors in case of default is given by $\text{Recov}_{it}^{\$} = \xi \times {}^uV_{it}^{f\$}$. The proceeds from the restructuring are shared across creditors following

[15] Indeed, the price markup is defined as the price charged by retailers ($\mathcal{P}_{kt}$) over the marginal cost P_t^f. In the symmetric equilibrium, $\mathcal{P}_{kt} = 1$, making the price markup equal to the inverse of P_t^f.

a pro-rata rule. Specifically, if the total debt issued by the firm is $B_{it-1}^{f\$}$, the bank only obtains a share $B_{it-1}^{b\$}/B_{it-1}^{f\$}$ of the total payoff in bankruptcy.

The real cash flow obtained from the portfolio of all loans in period t is expressed as:

$$\mathrm{CF}_t^b = \int_0^1 \left(\mathbb{1}_{it}^{ND} \times (C + \lambda + (1-\lambda)q_{it}) \frac{B_{it-1}^b}{\Pi_t} + (1 - \mathbb{1}_{it}^{ND}) \times \mathrm{Recov}_{it}^{\$} \times \frac{B_{it-1}^b}{B_{it-1}^f} - B_{it}^b q_{it} \right) di, \quad (38)$$

where q_{it} is the price of a unit of debt issued by firm i and $\Pi_t = P_t/P_{t-1}$ is the gross inflation rate.

The bank has access to two sources of external financing: (i) external equity financing from capital markets (referred to as external financing) and (ii) deposits. As in the simple model, for each dollar of external financing issued, the bank only receives $(1 - \varrho_t)$ of new capital. We allow ϱ_t to vary over time to capture different financing conditions in the intermediary sector. When ϱ_t is high, external financing is costly, indicating tighter constraints on banks.

The marginal cost of external financing depends on the amount of external financing raised (e_t) as well as an aggregate exogenous financing shock $x_{\varrho t}$, as in Gomes (2001) and Eisfeldt and Muir (2016). Specifically,

$$\varrho_t = \varrho_1 \, e_t \, e^{x_{\varrho,t}}, \quad (39)$$

where $\varrho_1 > 0$ is a parameter driving the average cost of external financing, and $x_{\varrho t} = \rho_\varrho x_{\varrho t-1} + \sigma_\varrho \epsilon_{\varrho t}$ is a persistent aggregate financing shock that is uncorrelated with productivity.

The second source of financing is short-term deposits, which are collected from households and pay a riskless interest rate of R_t^S. The nominal amount of deposits outstanding at the beginning of period t is denoted by $S_{t-1}^{\$}$. At the end of each period, banks collect an additional $S_t^{\$}$ in new deposits due in the next period. To prevent banks from solely relying on deposits to avoid paying the premium on external financing, we assume that banks have a target level of deposits, and deviating from this target incurs costs that include, for example, the operating expenses and regulatory constraints associated with deposit collection (e.g., Flannery (1982)). We model these costs in a reduced form using a quadratic function Ψ_t:

$$\Psi_t = \frac{\psi_s}{2} (s_t - \bar{s})^2 \bar{K}_{t-1}, \quad (40)$$

where $\bar{K}_t$ is the aggregate stock of capital in the economy, $s_t \equiv S_t/\bar{K}_t$ represents the ratio of deposits to capital, and $\bar{s}$ is the target ratio of deposits to capital. The parameter $\psi_s > 0$ determines the magnitude of deposit adjustment costs. We scale all variables by the stock of capital because the model is non-stationary, as explained later.

Bank's problem. Banks operate competitively and determine loans extended to each firm i and the quantity of deposits to collect from households to maximize the present value (discounted by the SDF M_{t+1}) of future real dividends V_t^b. Expressing the recursive problem in real terms:

$$V_t^b\left(S_{t-1},\{B_{it-1}^b\}_{i\in[0,1]}\right) = \max_{S_t,\left\{B_{it}^b\right\}_{i\in[0,1]}} \left\{\int_{\underline{\eta}}^{\bar{\eta}} D_t^b(\eta)\, dG(\eta) + \mathbb{E}_t M_{t+1} V_{t+1}^b\left(S_t,\{B_{it}^b\}_{i\in[0,1]}\right)\right\} \tag{41}$$

$$D_t^b(\eta) = \bar{Y}_t^b + \mathrm{CF}_t^b - \eta \bar{K}_{t-1} + S_t - \frac{S_{t-1}}{\Pi_t} R_t^S - \Psi_t + \varrho_t \min(0, D_t^b), \text{ and}$$

$$\mathrm{CF}_t^b = \int_0^1 \left(\mathbb{1}_{it}^{ND} \times (C+\lambda+(1-\lambda)q_{it})\,\frac{B_{it-1}^b}{\Pi_t} + (1-\mathbb{1}_{it}^{ND}) \times \mathrm{Recov}_{it}^{\$} \times \frac{B_{it-1}^b}{B_{it-1}^f} - B_{it}^b q_{it}\right) di.$$

η is an i.i.d. idiosyncratic liquidity shock, forcing some banks to seek external financing. We assume that η follows a normal distribution $\eta \sim (0,\sigma_\eta)$, with its cumulative and probability density functions denoted by $G(.)$ and $g(.)$. The variable $\bar{Y}_t^b$ is exogenous and captures the bank's profit from activities other than competitive lending (e.g., rents from market power, additional financial services, etc.). $\bar{Y}_t^b > 0$ ensures that the competitive bank generates positive profits in the steady state and has a well-defined market value. The bank's profit is assumed to be proportional to the size of the balance sheet, i.e., $\bar{Y}_t^b = \bar{y}^b B_{t-1}^b$, where $\bar{y}^b > 0$.

Optimal policies. The external financing decision follows a threshold decision where a bank chooses to obtain new equity when $\eta > \eta_t^\star$ and not to issue equity otherwise. The refinancing threshold solves $\bar{K}_{t-1}\eta_t^\star = \bar{Y}_t^b + \mathrm{CF}_t^b + S_t - \frac{S_{t-1}}{\Pi_t} R_t^S - \Psi_t$. In addition, the optimal debt supply decision determines the equilibrium price of debt, q_{it}:

$$q_{it} B_{it}^b = \mathbb{E}_t M_{t+1}^\star \left[\Phi_{it+1}\left(C+\lambda+(1-\lambda)q_{it+1}\right)\frac{B_{it}^b}{\Pi_{t+1}} + (1-\Phi_{it+1}) \times \mathrm{Recov}_{it+1}\right], \tag{42}$$

$$M_{t+1}^\star = M_{t+1}\frac{\theta_{t+1}}{\theta_t} \tag{43}$$

$$\theta_t = G_t + (1-G_t)\frac{1}{1-\varrho_t}, \tag{44}$$

where θ_t is the time-varying expected cost of financing, which depends on both the marginal cost of external funds ϱ_t and the endogenous need for external financing, G_t. Note that in the presence of external financing costs, the bank's effective discount rate, $M_{t+1}^\star$, will differ from that of the representative agent, M_{t+1}. In particular, if the external cost of financing θ_t increases, the bank will become more reluctant to lend to firms, leading to a drop in the quantity and price of debt.

Finally, the demand for deposits determines the equilibrium rates on deposits:

$$1 - \Psi'_t = \mathbb{E}_t \frac{M^\star_{t+1}}{\Pi_{t+1}} R^S_{t+1}, \tag{45}$$

where $\Psi'_t = \partial \Psi_t / \partial S_t$. This expression implies that the bank will collect deposits until the net amount collected from a marginal \$1 (left-hand side) equals the present value of the marginal cost (right-hand side). Appendix B.2 provides further derivation details.

4.3 Producers

Firms produce using labor L_t and predetermined capital K_{t-1} and are subject to an aggregate productivity shock A_t. The production technology is:

$$Y_t = (A_t \, L_t)^{1-\alpha} K^{\alpha}_{t-1}, \tag{46}$$

where α is the share of capital in production. The productivity process features long-run risk:

$$\log(A_{t+1}/A_t) = E_t[\Delta a_{t+1}] + \sigma_a \epsilon_{at+1} \tag{47}$$

$$E_t[\Delta a_{t+1}] = \mu + x_t + \rho_{\text{defr}} \times \mathbb{E}_t[\widehat{\text{defr}}_{t+1}] \tag{48}$$

$$x_t = \rho_x x_{t-1} + \sigma_x \varepsilon_{xt} \tag{49}$$

where ϵ_a and ϵ_x are standard normal random variables, and $\widehat{\text{defr}}_t$ is the aggregate proportion of firms that default, in deviation from the steady state.

The presence of persistent productivity growth processes generates low-frequency components that contribute to long-run risks (Bansal and Yaron (2004)). When the representative investor is averse to long-run risks, this specification yields a substantial risk premium for financial claims and improves the model's quantitative fit. Although we model the persistent process as exogenous (e.g., see Croce (2014)), we allow aggregate default rates to negatively influence expected productivity, that is, $\rho_{\text{defr}} < 0$. This type of process can be justified in a model with endogenous growth and entry/exit (e.g., see Corhay et al. (2020)) where a debt overhang would also affect the accumulation of intangible capital and thus trend growth. In Section 5.1, we calibrate ρ_{defr} to align with the empirical relationship between expected default rates and expected productivity.

Labor is obtained in competitive markets at a wage rate of W_t, which the producer takes as given. Producers accumulate capital for production in the next period through investment I_t. The stock of productive capital accumulates according to

$$K_t = (1 - \delta_k)K_{t-1} + \Gamma\left(\frac{I_t}{K_{t-1}}\right)K_{t-1} \tag{50}$$

where δ_k is the depreciation rate of capital, and $\Gamma(\cdot)$ captures capital adjustment costs. These costs are crucial for quantitatively matching investment dynamics jointly with asset prices (e.g., see Jermann (1998)).[16]

The firm chooses the optimal debt/equity mix to finance its operations. Long-term debt is obtained from the intermediary sector. Equity is directly obtained from households and enjoys a limited liability option. As discussed earlier, default incurs bankruptcy costs paid by the creditors. To ensure an interior solution for the debt/equity mix, we assume that debt provides benefits such that the net cost of debt to the firm is χC, where $\chi < 1$.

The (real) dividend paid by a firm in the absence of new debt issue and investment is given by:

$$D_t^f(z) \quad = \quad P_t^f \text{MPK}_t K_{t-1} - zK_{t-1} - FK_{t-1} - (\chi C + \lambda)\frac{B_{t-1}^f}{\Pi_t}, \tag{51}$$

where F represents a fixed cost of production and MPK_t denotes the marginal product of capital.[17]

As in the simple model, the producer is hit, each period, with an i.i.d. profit shock z. This shock is the key driver of heterogeneity across producers in our economy.[18] The firm's idiosyncratic profit shocks z follow a truncated normal distribution with a mean of zero, standard deviation σ_z, and a truncation bound $|z| < \bar{z}$. The truncated normal distribution offers two advantages: it bounds the profit shock, ensuring that the limited liability condition is not violated when creditors seize the firm in bankruptcy, and it allows for a significant mass of firms to accumulate around the default threshold due to fat tails.

Equity and debt value. The objective of equityholders is to maximize the market value of equity by making three decisions: (i) whether to default, and if no default occurs, (ii) what

[16] The capital adjustment cost function, $\Gamma(.)$, follows the model of Jermann (1998), i.e., $\Gamma(x) = \frac{\alpha_1}{1-1/\zeta}x^{1-1/\zeta} + \alpha_2$, where α_1 and α_2 are determined such that there are no adjustment costs in the deterministic steady state.

[17] Since labor decisions are static and labor markets are competitive, we can substitute the optimal labor demand using the first-order condition with respect to labor. This enables us to replace the production function, net of labor costs, with the marginal product of capital, yielding $P_t^f Y_t - W_t L_t = P_t^f MPK_t K_{t-1}$.

[18] We multiply z by the firm's size, K_t, to ensure that heterogeneity still matters along the balanced growth path.

quantity of debt to issue, and (iii) how much to invest. The maximization problem writes:

$$V_t^f\left(K_{t-1}, B_{t-1}^f, z\right) = \max\left\{0, D_t^f(z) + J_t^f(K_{t-1}, B_{t-1}^f)\right\} \tag{52}$$
$$J_t^f\left(K_{t-1}, B_{t-1}^f\right) = \max_{B_t^f, K_t, I_t}\left\{q_t\left(B_t^f - \frac{B_{t-1}^f}{\Pi_t}(1-\lambda)\right) - I_t + \mathbb{E}_t M_{t+1}\int_{\underline{z}}^{\bar{z}} V_{t+1}^f\left(K_t, B_t^f, z'\right) d\Phi(z')\right\},$$

subject to the capital accumulation constraint defined in Equation (50) and the debt valuation that is consistent with the optimal loan supply decision of the bank in Equation (42).

Specifically, the debt valuation equals the present value of future cash-flows. If the firm defaults, which happens with probability $(1-\Phi_t)$[19], debt holders inherit an unlevered firm subject to restructuring costs. Replacing for ${}^uV_t^{f\$}$, the total market value of debt is:

$$\begin{aligned} B_t^f q_t = \mathbb{E}_t\Bigg[M_{t+1}^\star\Bigg[&\Phi_{t+1}\left(C+\lambda+q_{t+1}(1-\lambda)\right)\frac{B_t^f}{\Pi_{t+1}} \\ &+\xi\int_{z_{t+1}^\star}^{\bar{z}}\left(\text{MPK}_{t+1} - F + \frac{J_{t+1}^f}{K_t} - z'\right) d\Phi(z')K_t\Bigg]\Bigg], \end{aligned} \tag{53}$$

where $M_{t+1}^\star$ is the one-period bank SDF, defined in Equation (43).

Optimal policies. The default decision follows a threshold rule where a firm chooses to default when $z > z_t^\star$ and not to default otherwise. The default threshold is defined as:

$$z_t^\star = \text{MPK}_t - F - (\chi C + \lambda)\frac{B_{t-1}^f}{K_{t-1}\Pi_t} + \frac{J_t^f}{K_{t-1}}. \tag{54}$$

The optimal capital structure and investment decisions are derived by taking the first-order conditions (see Section B.3 for details). The economic intuition behind these conditions are the same as the equivalent conditions in the simple model (see Equations (18) and (19)):

$$\frac{\partial q_t}{\partial B_t^f}\left(B_t^f - \frac{B_{t-1}^f}{\Pi_t}(1-\lambda)\right) + q_t = \mathbb{E}_t\left[\frac{M_{t+1}}{\Pi_{t+1}}\Phi_{t+1}\left[(1-\lambda)q_{t+1} + (\chi C+\lambda)\right]\right] \tag{55}$$
$$(\Gamma_t')^{-1} = \frac{B_t^f}{K_t}q_t + \mathbb{E}_t\left[M_{t+1}\int_{\underline{z}}^{z_{t+1}^*}\frac{V_{t+1}^f(B_t^f, z')}{K_t}d\Phi(z')\right], \tag{56}$$

where $\Gamma_t' = \frac{\partial\Gamma(I_t/K_{t-1})}{\partial(I_t/K_{t-1})}$.

[19]With some abuse of notation, we denote by $\Phi_t \equiv \Phi(z_t^\star)$, the surviving probability of the firm.

4.4 Households

The representative household has lifetime utility given by Epstein-Zin recursive preferences defined over aggregate consumption, C_t:

$$U_t = u\left(C_t\right) + \beta\left(E_t[U_{t+1}^{1-\tau}]\right)^{\frac{1}{1-\tau}}, \tag{57}$$

where $\tau \equiv 1 - \frac{1-\gamma}{1-1/\psi}$, γ captures relative risk aversion, ψ is the elasticity of intertemporal substitution, and β is the subjective discount rate. The utility kernel is additively separable: $u\left(C_t, L_t\right) = \frac{C_t^{1-1/\psi}}{1-1/\psi}$. We assume that $\psi > \frac{1}{\gamma}$, indicating a preference for early resolution of uncertainty following the long-run risks literature (e.g., Bansal and Yaron (2004)). The household supplies her labor endowment (normalized to 1) every period since she has no disutility for labor.

Solving the intertemporal household decision yields the equilibrium one-period pricing kernel:

$$M_{t+1} = \beta\left(\frac{U_{t+1}}{E_t(U_{t+1}^{1-\theta})^{\frac{1}{1-\theta}}}\right)^{-\theta}\left(\frac{C_{t+1}}{C_t}\right)^{-\frac{1}{\psi}}, \tag{58}$$

where the continuation utility term captures sensitivity to uncertainty about long-run risks.

Imposing the symmetry across firms, banks and retailers and noting that the only cross-sectional difference comes from the measure of producers that default and the measure of banks that require external financing, we can derive the aggregate resource constraint:

$$\begin{aligned} C_t \;=\; & Y_t - I_t - FK_{t-1} - \Psi_t - \overbrace{\frac{\varrho_t}{1-\varrho_t}K_{t-1}\int_{\eta_t^\star}^{+\infty}\left(\eta-\eta_t^\star\right)dG(\eta)}^{\text{External financing costs}} \\ & - \underbrace{(1-\Phi_t)\frac{1-\xi}{\xi}\mathbb{E}[\text{Recov}_t(z)|z>z_t^\star]}_{\text{Loss from bankruptcies}} - \underbrace{\frac{\Phi_P}{2}\left(\frac{\Pi_t}{\bar{\Pi}}-1\right)^2 Y_t}_{\text{Loss from sticky prices}}. \end{aligned} \tag{59}$$

All derivation details are in Appendix B.4.

4.5 Monetary and fiscal policy

Monetary policy is governed by a Taylor rule that responds to inflation and output deviations:

$$\hat{r}_{t+1}^{\$} \;=\; \rho_\pi\left(\pi_t - \pi^\star\right) + \rho_y \hat{y}_t + x_{rt} \tag{60}$$

where $\pi^\star$ is the inflation target, and $\hat{y}_t$ denote output deviations from the unconditional mean. The process $x_{rt} = \rho_{xr} x_{rt-1} + \sigma_{xr} \varepsilon_{rt}$ accounts for policy deviations from the standard Taylor rule. In subsequent sections, we will use monetary policy shocks ε_{rt} to induce exogenous changes in expected inflation, enabling us to assess the quantitative significance of our channel.

The fiscal government's role in the economy is minimal. It collects lump-sum taxes from households to fund the interest rate deductibility subsidy firms enjoy. Since this transfer occurs via a lump sum, it has no distortionary effects.

5 Parametrization

This section describes the benchmark calibration. The objective is to create a model that captures salient features of the finance-growth nexus to assess the quantitative importance of our channel in the next section. The model is solved using a second-order approximation about the steady state after normalizing all non-stationary variables by the aggregate stock of capital K_{t-1}. Normalized variables are denoted with lowercase letters.

While perturbation methods help save on computing time, the presence of long-term debt necessitates computing higher-order derivatives of the optimal debt policy $b_t^\star(b_{t-1})$ to fully account for the debt dilution effect. We adopt the solution strategy proposed in Gomes et al. (2016), assuming a functional form for higher-order terms of the policy function. Note that this approximation is exclusively used to approximate higher-order derivatives of the policy function and not the policy function itself. Further details on the solution method are provided in Appendix C.

5.1 Calibration

The preference parameters are set according to standard practices in the long-run risks literature, e.g., Bansal and Yaron (2004), Croce (2014). Specifically, the IES (ψ) is set to 2, while the coefficient of risk aversion (γ) is set to 10. These values implies a preference for early resolution of uncertainty, consistent with Ai et al. (2019). The subjective discount factor (β) is calibrated to 0.996 to align with the level of the real risk-free rate. The production sector parameters are chosen as follows. α is set to 0.36. The quarterly capital depreciation rate δ_k is set to 2.5%. The elasticity of capital adjustment costs (ζ) is set to 2.25 to match the relative investment volatility. We choose the fix cost parameter F to generate an aggregate unlevered market to book ratio of 1.10 as in Hall (2001). The volatility of firm-specific shock is set to 20.69% per quarter to target the Moody's Investors Service (2022) average annual default rate of 1.18%.

We next outline the calibration of parameters governing corporate debt. The coupon payment C is determined to ensure that the price of default-free debt equals 1 in the steady state. The average maturity of debt is fixed at 5 years ($\lambda = 0.05$) as in Gomes et al. (2016). The firm recovery rate in default (ξ) is 0.63 to align with a debt recovery rate of 37%. The benefit of debt parameter (χ) is chosen as 0.65 to achieve an average book leverage of 40%. The average cost of external financing in the steady state, ϱ_1, is set to 0.10. This value falls within the range of estimates used in the literature. For instance, Cooley and Quadrini (2001), Gomes (2001), and Eisfeldt and Muir (2016) use a value of 0.30, 0.10, and 0.02, respectively. The volatility of η determines how frequently banks require external financing and influences the average cost of intermediation for the financial intermediary as captured by θ_t. We select σ_η to yield an average cost of intermediation of 4% per annum, consistent with the estimates of Ajello (2016). The bank profitability parameter is chosen to produce a return on assets (ROA) of 4%. Additionally, we set $\bar{s}$ to achieve a deposits-to-assets ratio of 87% as in the data.

The aggregate productivity process parameters are calibrated as follows. μ implies a steady state growth rate of 1.80% per annum. The persistence of the non-stationary components is 0.925. The conditional volatility of the transitory component, $\sigma_a = 1\%$ and that of permanent component $\sigma_x = 0.10\sigma_a$, similar to Croce (2014). The impact of expected default on long-run productivity (ρ_{defr}), is a new parameter that we discipline to align with the data. Our approach follows the methodology in Bansal et al. (2007) and Croce (2014). Specifically, we first identify the long-run component in productivity, $E_t[\Delta a_{t+1}]$, by regressing one-year-ahead productivity growth, Δa_{t+1}, on a vector of financial predictors. We then identify the empirical relation between long-run productivity and expected default rates:

$$\widetilde{x}_{at} = \gamma_0 + (1 - \rho_a)\gamma_{\text{defr}}\, E_t[\widetilde{\text{defr}}_{t+1}] + \rho_a\, \widetilde{x}_{at-1} + \varepsilon_t, \tag{61}$$

where $\widetilde{x}_{at}$ represents our empirical estimates of $E_t[\Delta a_{t+1}]$ obtained in the first stage, and $E_t[\widetilde{\text{defr}}_{t+1}]$ is a measure of expected default probability.[20] The coefficient estimate is $\gamma_{\text{defr}} = -0.40$ (Newey-West t-stat is -3.61). We set ρ_{defr} in the model to replicate the empirical relation between expected

[20] Productivity is measured as the annual business sector Total Factor Productivity (TFP) provided by Fernald (2014). Financial predictors include: (i) the risk-free rate, calculated as the one-year Treasury yield minus realized one-year inflation, and (ii) the log-price dividend ratio, defined as the Cyclically Adjusted Price Earnings Ratio, obtained from Robert Shiller's website (http://www.econ.yale.edu/~shiller/data.htm), and (iii) the BAA-AAA spread. The expected probability of default is obtained by predicting total default using lagged default from the Moody's default file and the BAA-AAA spread.

default and productivity, resulting in a value of $\rho_{\text{defr}} = -0.25$.

The external finance process $x_{\varrho t}$ captures time-variations in the cost of intermediation. To avoid differences in the persistence of different aggregate disturbances driving our results, we set $\rho_{\varrho} = 0.925$. This value falls within the range of estimates provided in Ajello (2016) for the first autocorrelation of the persistent and transitory process driving the cost of financial intermediation. The conditional volatility of the cost shock, σ_{ϱ} is equal to 0.05, in line with evidence on exogenous financial disturbances in DSGE models (e.g., see Christiano et al. (2014) and Ajello (2016)). This calibtration generates a volatility of the cost of intermediation of about 3.2%.

The parameters governing the Taylor rule are $\rho_{\pi} = 2$ and $\rho_y = 0.075$ (e.g., see Smets and Wouters (2007)). The inflation target $\pi^{\star}$ is chosen to yield an average inflation rate in line with the data. The autocorrelation and volatility of the monetary policy shock are set to 0.85 and 0.75%, respectively, to match the quarterly volatility and persistence of the inflation rate. In our model, two parameters determine the magnitude of traditional New Keynesian frictions. The elasticity of substitution, $\nu = 4$, implies a markup in the steady state of 33%. The magnitude of price adjustment cost, $\Phi_P = 5$, is set to match the cumulative response of consumption to a one-standard deviation monetary policy shock (more detail on this in the quantitative analysis section). Table A.1 in the Appendix summarizes the calibrated parameter values.

5.2 Quantitative fit

To assess the quantitative fit of the calibrated model, we compare model-simulated moments to their empirical counterparts. The results are reported in Table 3. Panel I.A shows that the model provides a good fit of macroeconomic dynamics targeted in the calibration – both for real and nominal aggregates. Importantly, Panel I.B reveals that the model also matches well key variables from the financing cycle. For instance, the average firm leverage is around 40%. The average corporate default rate is low at about 1.17%, and the dynamics of bank deposits are broadly consistent with their empirical targets.

Panel I.C reports a series of asset pricing statistics, which, for the most part, were not targeted in the calibration. The model generates a sizable equity premium – both for intermediaries and producers – and a low and smooth risk-free rate. The quantitative success of the model for asset prices is mainly due to the combination of long-run risk in productivity and a preference for early resolution of uncertainty. Because a firm's equity value positively loads on (risky) productivity, investors require a premium to invest in a firm's stock, resulting in a high equity risk premium.

Furthermore, the average credit spread is sizable (125bps), despite a low average probability of default. This substantial credit risk premium arises from two primary channels. Firstly, default rates and creditors' losses in default are endogenously countercyclical, prompting investors to demand a risk premium for holding corporate debt (e.g., see Bhamra et al. (2010b) and Chen (2010)). Secondly, credit is provided by intermediaries subject to time-varying constraints, as captured by the cost of intermediation θ_t. Intermediaries are more likely to face constraints during economic downturns, intensifying the procyclicality of debt value and further amplifying the risk premium (e.g., see He and Krishnamurthy (2013) and He et al. (2017)).[21]

In conclusion, our calibrated model provides a strong quantitative fit to macroeconomic and asset price dynamics. Next, we use the model to quantify the significance of the cost of capital channel in influencing the transmission of expected inflation shocks.

6 Inflation risk and the finance-growth nexus

6.1 Simulation results

We first verify that the quantitative model generates response functions in line with those of the simple model. Figure A.3 reports the impulse-response functions to a surprise increase in expected inflation induced by an expansionary monetary policy shock. We compute these responses for three different levels of financing conditions: mean, medium, and high, which are obtained by conditioning the response based on θ_t when the shock occurs.[22] The conclusions from the responses echo those of the simple model. Specifically, an increase in expected inflation leads to a wealth transfer between producers and banks, reducing debt overhang for producers but increasing the cost of capital in the economy. When financing frictions are at their average level (dashed blue line), this shock leads to an expansion in output of about 80bps over the next 4 years.[23]

However, as intermediary financing conditions worsen, the influence of the cost of capital effect intensifies, substantially dampening the expansionary effects of monetary policy shocks driven by New Keynesian sticky prices and debt overhang. In fact, it can become so potent that it

[21] We decompose the contribution of each component to the credit risk premium, we find that the first accounts for 58bps, while the second explains 14bps.

[22] The mean response case is obtained by averaging the impulse-response functions across all values of θ_t; the medium (high) case averages the responses when θ_t is at least one (two) standard deviation(s) above the mean.

[23] This magnitude is consistent with related studies estimating the impact of monetary policy shocks (e.g., Christiano et al. (1999) and Smets and Wouters (2007)). One notable difference is that, although our responses are less potent initially, their effects are more persistent due to the endogenous default-growth relation in productivity.

Table 3: Business cycle, financing, and asset pricing moments

Panel I. Business Cycle and Asset Prices

Moment	Data	S.E.	Model	Moment	Data	S.E.	Model
A. Business cycle							
$E(C/Y)$	65.24%	(0.25)	73.12%	$\sigma(\Delta c)$	1.72%	(0.02)	1.93%
$E(\Delta c)$	1.89%	(0.18)	1.80%	$\sigma(\Delta c)/\sigma(\Delta y)$	0.68	(0.01)	1.02
$E(\Delta y)$	1.95%	(0.26)	1.80%	$\sigma(\Delta i)/\sigma(\Delta y)$	4.39	(0.03)	5.31
$E(\pi)$	3.12%	(0.43)	3.27%	$\sigma(\pi)$	1.79%	(0.02)	2.22%
B. Firm leverage and intermediaries							
Book leverage	41.35%	(0.74)	39.85%	ROA Intermediaries	5.31%	(0.17)	5.28%
Deposit/Debt	86.67%	(1.31)	90.24%	$\sigma(\Delta\text{Deposits})$	2.76%	(0.03)	2.81%
Default	1.18%	(0.13)	1.08%	$\rho_{\text{defr,prod}}$	-0.40	(0.08)	-0.36
C. Asset prices							
$E(r_f^\$)$	4.68%	(0.61)	5.02%	$\sigma(r_f^\$)$	3.28%	(0.02)	2.57%
$E(r_f)$	1.56%	(0.41)	1.99%	$\sigma(r_f)$	2.42%	(0.03)	0.96%
$E(r_{\text{firm}} - r_f)$	7.31%	(1.65)	3.55%	$\sigma(r_{\text{firm}} - r_f)$	20.32%	(0.20)	12.88%
$E(r_{\text{bank}} - r_f)$	8.42%	(1.83)	3.16%	$\sigma(r_{\text{bank}} - r_f))$	21.52%	(0.16)	7.86%
E(Credit spread)	192bps	(4.50)	124bps				

Panel II: Inflation Wealth Transfer

	Financial	Non-Financial	Difference
$E[\beta^\pi]$	-1.644	0.386	-2.030

Panel III. Inflation Risk Premium and Financial Constraints

	A. $NRC^{\Delta Y}$		B. $NRC^{\Delta C}$		C. λ^π	
	θ	ΔEP	θ	ΔEP	θ	ΔEP
Λ_θ^π	-0.631	-0.290	-0.628	-0.294	-0.036	-0.032

This table reports aggregate macroeconomics, financing, and asset pricing moments from the model and the data. Δy, Δc, Δi, and π denote output growth, consumption growth, investment growth, and inflation respectively. C/Y is the consumption-to-output ratio, r_f ($r_f^\$$) is the risk-free real (nominal) interest rate. Model moments are calculated by computing the time-series average from a long simulation with 100,000 periods. Growth rates and returns moments are annualized percentages; credit spreads are in annualized basis point units. The bank's levered return is obtained by multiplying the bank's return by 4. We estimate the inflation risk exposures (β^π), the nominal-real covariance ($NRC^{\Delta Y}$ and $NRC^{\Delta C}$) using the same procedure as in the empirical estimation. We compute inflation risk premium λ^π as the negative covariance between the pricing kernel and shocks to expected inflation. As in the data, we regress inflation risk prices to lagged changes in financial conditions to obtain Λ_θ^π. Standard errors are Newey-West corrected. Standard errors of second moments are computed with bootstrapping.

dominates these effects entirely. When financing constraints are tight enough (red solid line), positive expected inflation news can even lead to a recessionary outcome. In our calibration, the output response can turn negative, reaching -30 basis points over 4 years. This underscores the quantitative importance of the cost of capital effect in impeding the effectiveness of monetary policy. In summary, the quantitative model confirms all the conclusions drawn from the simple model and demonstrates their significant quantitative magnitude.

Next, we verify whether the model generates variations in the price of inflation risk consistent with the empirical evidence outlined in Section 3.2. Specifically, we simulate the model and compute the NRC as detailed in Equation (33). Subsequently, we regress the NRC on two measures of financial conditions akin to those used in the data, namely θ_t and ΔEP. The results are presented in Panels III.A and III.B of Table 3. Both measures are strong predictors of the NRC, with coefficient estimates aligning with their empirical counterparts.[24] Similarly, we calculate the model-implied IRP as $\lambda_t^\pi = -\text{Cov}_t(\Delta M_{t+1}, \Delta E_t[\pi_{t+1}])$, and test the role of financing conditions as a driver of the inflation risk premium. The results are reported in Panel III.C of Table 3. In summary, the quantitative model replicates significant variations in inflation risk that are consistent with the empirical evidence.

6.2 Evidence from monetary policy shocks

In this section, we verify that our model is able to explain the empirical responses to a monetary policy shock. Specifically, we compute the *estimated* impulse response to an exogenous monetary policy shock (MPS), conditioned on financing conditions, both in the model and the data. We define MPS as the orthogonalized, high-frequency changes in interest rates around policy announcements, following Bauer and Swanson (2023b). This measure offers two main advantages. First, it excludes the predictable component of high-frequency interest rate changes, minimizing potential endogeneity issues associated with monetary policy surprises (e.g., see Cieslak (2018) and Bauer and Swanson (2023a)). Second, the series is available at the monthly frequency from 1988 to 2019, enabling us to increase the number of observations in the estimation.[25]

We estimate the unconditional dynamic effects of a monetary policy shock using Jordà (2005) local projections. The idea is to regress future values of macroeconomic variables on the MPS,

[24]Note that the lower estimates in the data compared to the model can be attributed to differences in frequency and the fact that the empirical estimates include firm-specific risk, which is absent in the model.

[25]The MPS series is available on Michael Bauer's website: https://www.openicpsr.org/openicpsr/project/181661/version/V1/view.

controlling for lags. Denoting the time t monetary policy shock by MPS_t, we estimate:

$$\Delta z_{t+h} = \alpha_h + \beta_h \times \text{MPS}_t + \gamma X_t + \epsilon_{t+h} \tag{62}$$

Here, X_t represents a vector of controls that includes four lags of z_t, and $\Delta z_{t+h} \equiv z_{t+h} - z_t$. We examine three values for z_t: log-consumption, log-output (measured by industrial production in the data), and the Moody's BAA-AAA spread. Parameter β_h captures the effect of MPS_t on the variable of interest, h periods ahead.[26]

We also examine the dynamic effect of monetary policy shocks, *conditional* on financing conditions. Following Ottonello and Winberry (2020), we extend our local projections model as follows:

$$\Delta z_{t+h} = \alpha_h + \beta_{\text{FC},h} \times \text{MPS}_t \times \mathbb{1}_{\text{FC},t} + \gamma \tilde{X}_t + \epsilon_{t+h}, \tag{63}$$

where $\mathbb{1}_{\text{FC},t}$ is an indicator function equal to 1 if the economy experiences high financial constraints at the time of the MPS, and zero otherwise. High financial constraint states are defined as times when financing conditions, as measured by θ_t (TED) in the model (data), are one standard deviation higher than their historical mean.[27] $\tilde{X}_t$ is a vector of controls that includes four lags of the variable of interest in addition to the usual interactive control terms. The key parameter of interest is $\beta_{\text{FC},h}$, which captures the *additional* effect of financing constraints on the transmission of a monetary policy shock to the variable of interest at time $t+h$. For easier comparability between the model and data, we standardize all variables.

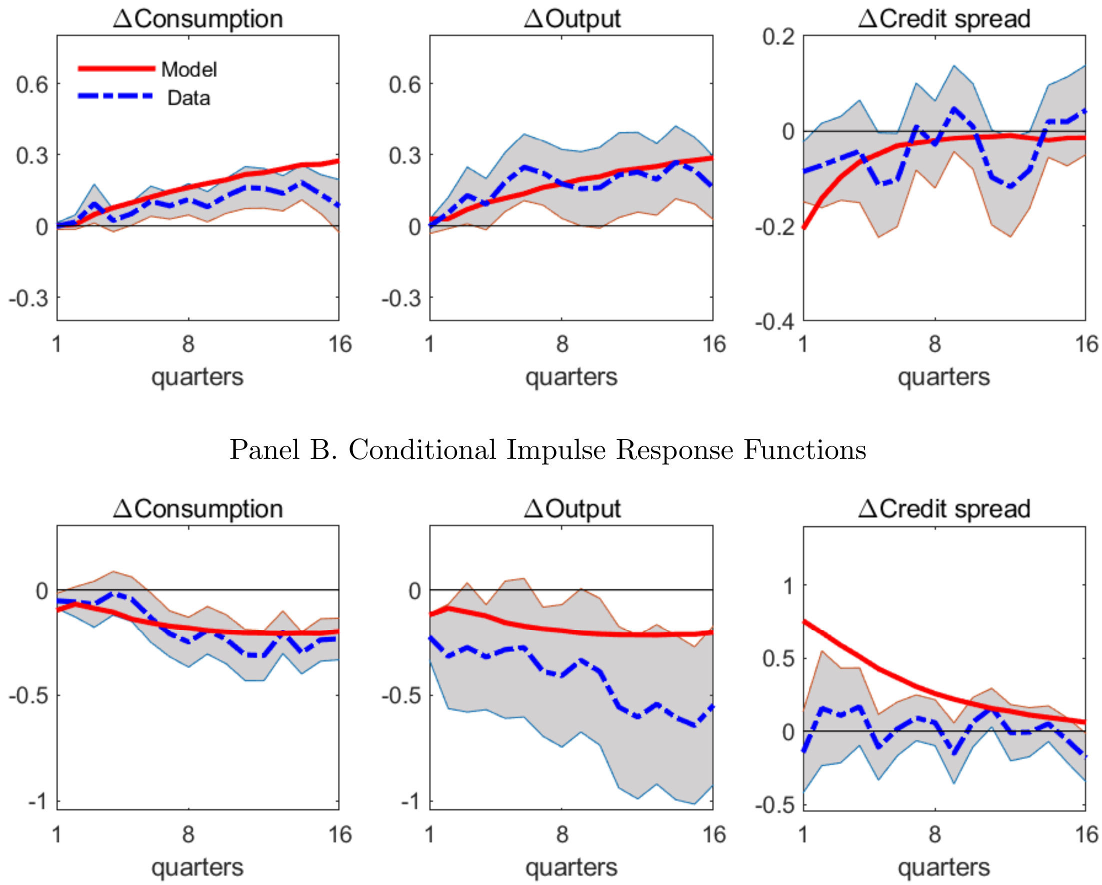
In Figure 2, we present the estimated responses to a one-standard deviation monetary policy shock for both the model (solid red line) and the data (dashed blue line). Panel A depicts the unconditional responses, showing that a monetary expansion stimulates output and consumption while decreasing credit spreads. Importantly, the model responses closely align with their empirical counterparts, indicating that the model accurately captures the average effects of monetary policy shocks. Panel B illustrates the conditional responses, directly testing our cost of capital channel. We find robust empirical evidence that financing conditions in the financial sector significantly influence the transmission of monetary policy shocks in the data. Specifically, when financing

[26] For additional details on these data sources, please refer to Section 3.1. Focusing on the BAA-AAA spread allows us to eliminate potential convenience yields not accounted for in the model. In the model, this spread is defined as the yield difference between the risky corporate debt held by the bank and a hypothetical risk-free bond held by the same bank. Finally, due to the difference in data frequency between the model and the empirical data, we use three-month average estimates of $\widehat{\beta}_h$ within a quarter when comparing model-implied and empirical responses.

[27] Note that results are robust to various thresholds for financial constraints.

Figure 2: Unconditional and Conditional IRF: Model vs. Data

Panel A. Unconditional Impulse Response Functions



This figure compares the Jordà (2005) local projections estimated in the data (dashed blue line) with those of the model (solid red line). Panel A illustrates the unconditional responses, while Panel B focuses on responses conditional on tight financing conditions in the financial sector. The shaded grey area represents the empirical confidence interval of +/- one standard deviation.

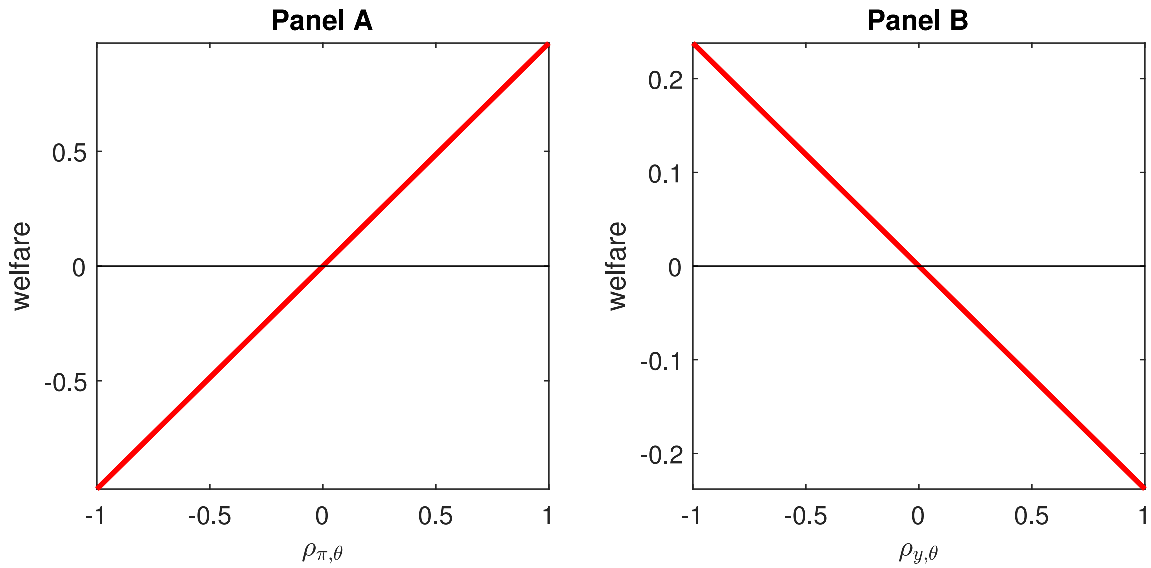
conditions are tight, the impact of monetary policy is noticeably dampened, with negative effects on output and consumption, along with an increase in credit spreads. Notably, the model captures a substantial portion of the cost of capital effect observed in the data.

6.3 Policy experiment

The preceding results have important policy implications, as the efficacy of monetary policy critically depends on intermediary financing conditions. In this section, we undertake a welfare analysis within a class of linear Taylor rules for monetary policy, demonstrating that the optimal policy rule consistently adjusts its inflation policy to financing conditions.

We compute welfare benefits following the methodology of Croce et al. (2012) and Croce (2021).

Figure 3: Welfare Analysis



This figure reports the welfare benefits for different values of Taylor rule parameters that adapt to financing conditions. Panel A focuses on the inflation response parameter, while Panel B focuses on the output gap response parameter. Units are in percentages.

Specifically, we compare the consumption processes of an economy following a specific policy, denoted as $\{C^*\}$, with that of a benchmark economy without such policy, denoted as $\{C^0\}$. The welfare benefits (or costs) of a policy can be approximated by the difference in lifetime utility associated with the two consumption streams, expressed as $\mathbb{E}\left[\ln\left(U_t\{C^*\}\right)\right]-\mathbb{E}\left[\ln\left(U_t\{C^0\}\right)\right]$, where $\mathbb{E}$ denotes the unconditional average. A policy is considered welfare-improving when the agent achieves higher lifetime utility than the benchmark case.

We modify the Taylor rule, defined in Equation (60), to allow the policy response parameters to depend on financing conditions, θ_t:

$$\hat{r}^{\$}_{t+1} = \left(\rho_\pi + \rho_{\pi,\theta}\,\hat{\theta}_t\right)\left(\pi_t - \pi^\star\right) + \left(\rho_y + \rho_{y,\theta}\hat{\theta}_t\right)\hat{y}_t + x_{rt}, \tag{64}$$

where $\hat{\theta}_t$ is normalized to have a mean of zero and a standard deviation of one. The welfare benefits of a specific policy are obtained by varying the policy parameters $\rho_{\pi,\theta}$ and $\rho_{y,\theta}$, while keeping the other parameters at their benchmark values.

The results, presented in Figure 3, indicate that adapting monetary policy to θ_t enhances welfare. Specifically, when financing conditions deteriorate, the optimal response is to adopt a more hawkish stance on inflation (i.e., $\rho_{\pi,\theta} > 0$) while reducing the policy's sensitivity to the output gap (i.e., $\rho_{y,\theta} < 0$). In other words, during periods of heightened financial frictions, monetary policy should avoid expansionary measures that could amplify inflationary pressures and further increase the cost of capital. Conversely, these results suggest that during stagflationary periods, the government should implement policies that support the financial sector (akin to decreasing θ) to promote credit supply and enhance the positive effects of monetary policy.

7 Conclusion

This paper investigates the implications of inflation risk in the finance-growth nexus. We develop a model where the production sector obtains financing from the financial sector in the form of long-term nominal debt, which exposes the real value of debt to changes in expected inflation. Consequently, the economy can be exposed to substantial inflation-driven wealth transfers between the production and the financial sectors. Using a simple model with analytical solutions, we show that the impact of changes in expected inflation on macroeconomic variables depends on two main factors. On the one hand, inflation triggers a debt inflation effect, reducing debt overhang for firms and stimulating investment. On the other hand, inflation adversely affects the balance sheets of financial intermediaries, leading to higher costs of financing and reduced credit supply, thereby deterring investment.

Our new mechanism has important implications for asset pricing as financing conditions determine the impact of nominal shocks on consumption and investors' marginal utility, thus driving the inflation risk premium. We find strong evidence of these effects in the data – both in macroeconomic quantities and asset prices – providing a microfoundation for the documented time-varying inflation risk (Campbell et al. (2017)). To assess the importance of this channel, we develop and calibrate a general equilibrium model that captures key aspects of the finance-growth relationship. We then investigate the implications of these redistributive effects for aggregate credit supply, investment, and monetary policy. Our model is able to quantitatively replicate variations in inflation risk in line with the data. Importantly, the model predicts that the effect of monetary policy shocks crucially depends on intermediary financing conditions. While expansionary monetary policy stimulates economic activity under normal conditions, its impact is significantly muted and may even be reversed when financing is constrained. We directly test this prediction in the data using local projection methods and confirm our predictions. Overall, these results support the existence of significant inflation risks within the finance-growth nexus, which have first-order effects on the economy.

Our findings on the dual effect of inflation are closely linked to the banking stress of 2023. While large-scale fiscal and monetary stimulus helped sustain the economy during the pandemic, it also encouraged many regional banks to take on greater risk by investing in long-term securities financed by short-term, uninsured deposits. As inflationary pressures mounted and interest rates rose, these banks incurred significant balance sheet losses, sharply increasing their cost of capital and triggering financial market turmoil. To prevent broader disruptions, policymakers implemented emergency liquidity measures in 2023, successfully restoring financing conditions to pre-COVID levels.[28] This stabilization allowed monetary authorities to combat inflation more effectively without exacerbating the adverse effects of financial sector constraints. The episode highlights the importance of accounting for financing conditions in monetary policy decisions, particularly during periods of heightened financial frictions. Our welfare analysis suggests that in such environments, policymakers should either avoid expansionary measures that fuel inflation or complement them with initiatives to strengthen financial intermediaries. More broadly, the findings underscore the need for regulatory safeguards that ensure banks maintain sufficient capital buffers to withstand periods of stagflationary pressures.

8 Data Availability Statement

The data and code underlying this research is available on Zenodo at https://dx.doi.org/10.5281/zenodo.15161002

[28]For instance, as of December 2024, the Chicago Fed's National Financial Conditions Index stood at -0.576 (negative values indicate looser financial constraints), closely aligning with its one-year pre-COVID average of -0.560. Other measures of financial conditions, such as the VIX index, the Volatility Financial Conditions Index (Adrian et al. (2023)), and the Financial Conditions Impulse on Growth index (Ajello et al. (2023)), also returned to pre-COVID levels.

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