Government Debt and the Transmission of Monetary Policy to Credit

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January 2026

Abstract

This paper shows that government debt weakens the transmission of monetary policy to credit. Using high-frequency monetary policy shocks and bank-level data, I find that contractionary policy has significantly smaller effects on lending and capital accumulation when debt-to-GDP is high. I explain this using a model with financial intermediaries in a fiscal theory framework with active fiscal and passive monetary policy. Higher debt raises expected inflation, dampening the response of real interest rates to policy tightening and attenuating its effects on credit. The model matches the empirical evidence and implies that sufficiently high debt can even reverse the transmission mechanism, generating expansionary credit responses to contractionary policy.

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1 Introduction

In the first half of 2024, the value of the United States' federal interests costs eclipsed military spending, making it the second largest source of federal outlays behind social security. Federal debt as a percent of GDP surpassed 100 for the first time in the nation's history in Q4 of 2012. The latest estimates put the federal debt-to-GDP in excess of 120%. As a result, economists have become increasingly concerned about the consequences of the U.S. fiscal trajectory. Mankiw (2025) delineated five ways out of the mounting debt: rapid growth, cutting spending, raising taxes, printing money, and default. Although AI and other technological advancements might generate significant growth, it's unlikely to generate the amount of resources necessary to get the debt under control. Cutting spending is nearly politically impossible. He cites the politically radioactive effects of even mentioning cuts to social security and medicare; this will dis-incentivize legislators from making the necessary changes. Raising taxes was cited as the most politically feasible and least costly option between priting money and default.

However, history shows that countries that face high debt burdens have a tendency to experience frequent bursts of inflation. Under a healthy arrangement, the status quo will be for a central bank to predetermine the growth of base money. The central government's spending is constrained will then be constrained by the public's willingness to purchase its debt, predetermined seigniorage, and tax revenue. The government adjusts its spending to the surrounding environment. The state of affairs is very different when the government determines how much it is going to spend irrespective of constraints. In this scenario, the central bank must finance, via money printing, the shortfall in government revenues from bond sales and taxes needed to cover its spending. This is precisely the point made in Sargent and Wallace (1981) when they say that, under some circumstances, monetary policy might not be able to control inflation, even in the long run.

These two regimes correspond to what is commonly referred to as active-monetary/passive-fiscal policy, and active-fiscal/passive-monetary environments, respectively. This verbiage originally comes from Leeper (1991). Countries that have high debt and consistently high inflation fall under the latter designation. In the case of the U.S., the concern is that our economy is becoming increasingly characterized by fiscal dominance [1], which will continue to exert inflationary pressure, even over the long run, unless something is done to reverse course.

Consequently, the fiscal theory of the price level (FTPL) has become an increasingly relevant framework for understanding the dynamics of the macroeconomy under mounting public debt. The purpose of this paper is to use FTPL to analyze the joint effects of monetary policy and fiscal policy, in an environment of fiscal dominance, upon credit issuance and capital accumulation. Much of the focus in FTPL modeling has revolved around macroaggregates, such as output, inflation, policy rates, discount rates, and government surpluses. However, very few papers have incorporated financial frictions into this model, and none, so far, have analyzed how monetary policy interacts with debt-to-GDP to shape the dynamics of credit.

In terms of macro aggregates, my results mirror those in Caramp and Feilich (2024) and Brandao-Marques et al. (2024) who find a negative joint effect between monetary policy and government debt, meaning that as the debt burden rises, the macro economy becomes less responsive to a given monetary policy shock. In my model, as the economy's indebtedness rises, the sensitivity of lending to a given monetary policy shock is dampened. The primary mechanism producing this result is future inflation expectations. Although falls in current inflation reduce lending, as indebtedness rises, inflation expectations also rise, which counteracts the contractionary effects of a fall in current inflation, muting the impact of a monetary policy contraction. Firms' capital accumulation, which depends upon access to credit, follows the same dynamics as lending – a muted response to any given monetary shock as debt grows.

This intuition is consistent with findings in Bonfim et al. (2025) that show how the Portugese government's procurement cuts during the 2010-2011 European sovereign debt crisis adversely affected firms that previously held government contracts, the majority of which were in construction. These cuts created a proliferation of non-performing loans (NPLs) that forced credit contractions. The converse of this behavior, where budget deficits

[1] A term for the scenario when fiscal policy "dominates" monetary policy, or a active-fiscal/passive monetary regime.

persist, creating mounting debt, can sustain lending even in the face of large losses on bank balance sheets due to the re-pricing of its debt holdings. Bottero et al. (2020) show that as bank balance sheets become increasingly exposed to sovereign debt, a given "sovereign shock"[2] generates ever larger contractions in credit. Therefore, the muted response in credit to debt shocks that I observed in the data and reproduce in the model suggest that U.S. debt still carries a fairly low risk premium, which leads inflation expectations to dominate the dynamics of credit and macro aggregates.

The empirical design is simple. I use Bauer and Swanson (2023) high-frequency monetary policy shocks to identify monetary policy surprises. I'm particularly interested in the responses of variables to contractions, which will be the focus of this paper. After purging the effects of macroeconomic news releases from the identified shocks, I split the data for U.S. federal debt into two categories: high debt versus low debt, which corresponds to periods when debt is above the 90th percentile and below the 10th percentile, respectively, for all observations. I then split the observations into the pre-QE and post-QE[3] time frames.

Using the method from Jordà (2005) to estimate local projections (LPs), I estimate the response of lending, controlling for various balance sheet variables and macro aggregates, to the Bauer and Swanson (2023) monetary policy shock in a state dependent fashion, where the states are high versus low debt in the pre and post-QE samples. The IRFs show that lending's response to monetary policy shocks under high debt are consistently lower than their response under low debt at every horizon over which the LPs are estimated; this is true for both the pre and post-QE samples. In both cases the difference in lending under high versus low debt is as much as 6% at later horizons; meaning monetary policy is 6% less effective under high debt than low debt 8 - 12 quarters in the future.

To explain my findings, I build a medium-scale model with financial frictions that has active fiscal policy and passive monetary policy. The fiscal block and calibrations for the Taylor rule are borrowed from Cochrane (2022a) and Cochrane (2022b). The financial block ties firm capital accumulation to its ability to obtain credit; that is, firms borrow from banks to accumulate additional capital. Then, I follow a similar pattern in developing the

[2]A perceived increase in the riskiness of holding the sovereign's debt.

[3]Pre-QE: September 2008; Post-QE: March 2009 onward, where QE stands for Quantitative Easing

financial side of the economy Balloch and Koby (2023), where bank loans and deposits are differentiated products sold by banks. Banks also hold government debt on their balance sheets and are therefore exposed to duration risk.

The predictions of the model are consistent with the empirical findings: for every 1% monetary policy contraction, each 1% rise in debt-to-GDP ratio reduces the impact of monetary tightening on lending by 0.05%. Given that firms finance capital accumulation via loans, the fall in capital accumulation in capital is also dampened by rising debt. Counterfactual exercises show that as debt-to-GDP grows, a threshold is eventually reached where, even in the face of the monetary policy shock, lending and output increase as real interest rates begin to fall. For a 1% monetary policy shock, this threshold corresponds to about a 30% rise in debt-to-GDP

Related Literature

This paper sits at the intersection public and macro finance. A broad literature exists that explores the effects of sovereign debt on the banking system. The Eurozone sovereign debt crisis of the 2010s was quite enlightening on this head. Altavilla et al. (2017); Bottero et al. (2020); Bonfim et al. (2025) are examples of work that map out the impact of sovereign debt risk on bank credit creation. A common thread is the classic doom-loop where risk of sovereign default generated a risk premium on the debt that pushed down bond prices. Banks that were exposed to this incurred capital losses and contracted credit, which generated further sovereign default risk.

Arellano et al. (2026) show that, in emerging markets, inflation expectations are highly sensitive to default risk and nearly 50% of inflation volatility in these countries is explained by default risk. Nakamura and Steinsson (2014); Auerbach et al. (2020) both argue that expansionary fiscal policy can have quite large effects on the real economy. The Auerbach et al. paper argues that this is also true of credit and that, in fact, we see the exact opposite of the crowding out effect. The mechanism is that fiscal expansions are income for firms, which raises their equity. When firm equity rises, default risk falls. As a result, the banks that lend to these firms experience asset quality improvement and they become better capitalized. Thus, credit expands, which pushes down borrowing costs. However, it is important to note that this paper is limited to the U.S. experience. Kosekova et al. (2025) show that there are fundamental differences across countries in terms of firm-bank relationships and that these relationships alter the transmission of policy shocks. Therefore, heterogeneous firm-bank relations across countries will likely lead to heterogeneous effects of debt on credit.

Very much related to my work is a paper by Cantero-Saiz et al. (2014) that uses evidence from Europe to conclude that monetary tightening is much more contractionary in high-sovereign-risk environments because banks face tighter funding constraints and cut lending more. As we shall see, my findings for the U.S. are almost the opposite. My explanation for this difference will point to the differences in maturity structure between the U.S. and the European countries.

My paper is also related to a large literature on government policy, both fiscal and monetary, and its transmission to credit through the banking system Gennaioli et al. (2014); Krishnamurthy and Muir (2017); Gennaioli et al. (2018). This is relevant because credit is intimitaely linked to investment. Cingano et al. (2016) show that a 10pp credit crunch reduces investment by 8-14%.

Finally, my model uses the FTPL framework. Its roots can be traced back to Sargent and Wallace (1981) and has been steadily developed over time Leeper (1991); Sims (2011); Bianchi et al. (2023); Cochrane (2023). As the U.S. debt burden becomes more of a concern, this framework will become more relevant. My contribution to this literature is to incorporate financial frictions into the model and exploit it to analyze the negative consequences that a rising debt burden has for monetary policy.

The remainder of the paper is structured as follows. In the next section (2.1) I lay out the empirical design. Then, in section (2.2) I discuss the results from the empirical analysis. In section (3.1) I turn to the quantitative model, providing a detailed overview of its ingredients. Section (3.2) displays the results of the simulation that are consistent with the empirical findings. Then, section (3.3) performs counterfactual analyses. Finally, section (4) concludes.

2 Data

2.1 Monetary Policy Shocks

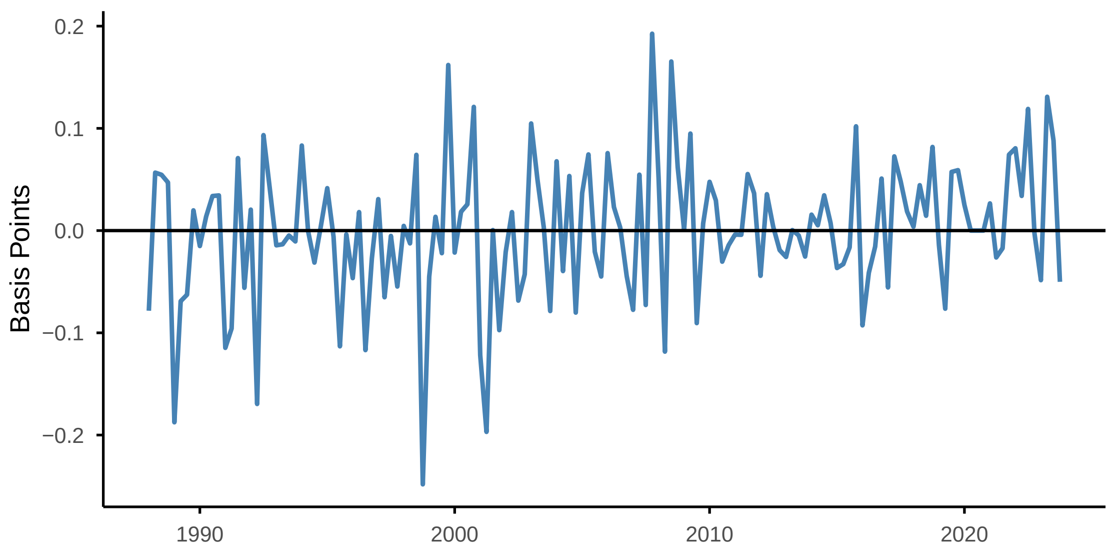

Figure 1: Quarterly Bauer & Swanson Monetary Policy Shock (Orthoganlized)

The orthogonalized monetary policy shock appears, usually at a bi-quarterly frequency. The above series represents the within-quarter sum of the shocks.

I begin with the identification of the monetary policy shock. The data for this shock is available through the San Francisco Federal Reserve Bank's Center for Monetary Research under the heading *Monetary Policy Surprises* (MPS). Figure 1 provides a visual of the series at quarterly intervals. A positive and negative values represent expansionary and contractionary policy shocks, respectively.

The MPS shocks are constructed following the methodology of Bauer and Swanson (2023). This method builds upon the work of Gurkaynak et al. (2005), where MPS is identified by following changes in the prices of futures contracts in a 30-minute window around FOMC meetings. Specifically, in the method employed here, the authors follow the changes in Eurodollar futures contracts 10 minutes prior to each FOMC meeting and 20 minutes after in order to measure the "surprise" behind FOMC announcements. Consequently, this data only extends to 2023 with the end of LIBOR. However, sources exist that use a variety of alternative securities to keep this series up to date[4] The data begins in 1988Q1, and reaches its terminus at 2023Q4 with a total of 432 observations.

The final dataset that I use in the empirical analysis terminates in 2019Q4 due to the turbulence that followed in the wake of COVID-19. However, as a side note, the large increase in government debt and the inflationary impact that ensued is what inspired this research. However, to be safe, I've chosen to omit this period.

The authors follow Nakamura and Steinsson (2018) in extracting a single principal component from this data that covers shocks to both the current federal funds rate target, as well as shocks to the future path of monetary policy (forward guidance). The shock is "orthogonalized" to various confounding factors, which means that the effects of macroeconomic news and other variables associated with changes in the futures contracts are regressed out of the shock measure, leaving us with a clean and well-identified monetary policy shock.

2.2 Bank Data

The data on commercial bank was gathered using the entire universe of FFIEC Call Reports lending data available through Wharton Research Data Services (WRDS) spanning 1995Q3 - 2019Q4. The data occurs at quarterly frequency and contains about 643,000 observations on about 11,000 individual units over that interval. Some of the individual units do not span the entire time series, however, as some banks went out or in to business over that time. The same source allows me to also gather data on bank assets, tier 1 risk-based capital ratios, risk-weighted assets, deposits, and accumulated other comprehensive income (AOCI).

Given that my bank data is quarterly, while the MPS data is a higher frequency, I have to aggregate the shock to a quarterly measure. As other papers have noted Miranda-Agrippino (2016); Bauer and Swanson (2021), without controlling for the effects of macroeconomic news, this approach can lead to issues with endogeneity. I find that sticking with the controls[5] employed by Bauer and Swanson (2023) that orthogonalize the shock are sufficient for the

[4] SOFR futures have replaced Eurodollar futures for the purpose of updating this MPS series.

[5] There are six predictors of monetary surprises: nonfarm payrolls surprise, employment growth, S&P 500 index data, change in the yield curve's slope, Bloomberg commodity spot price index, and treasury skewness.

purposes of quarterly aggregation of the shock. To verify that other sources of macro news don't contaminate the shock data, I regressed the quarterly-aggregated orthogonalized-MPS shock on a variety of macro news releases that precede each FOMC meeting, including, but not limited to: consumer sentiment, core inflation, retail sales (ex autos), and housing prices. This regression generated an $R^2 = 0.007$. Additionally, a joint F-test fails to reject that the macro news variables have no explanatory power for the already orthogonalized MPS shock ($F = 0.47,\ p \approx 0.80$), consistent with the interpretation of these shocks as orthogonal to standard macroeconomic news.

2.3 Public Debt Data

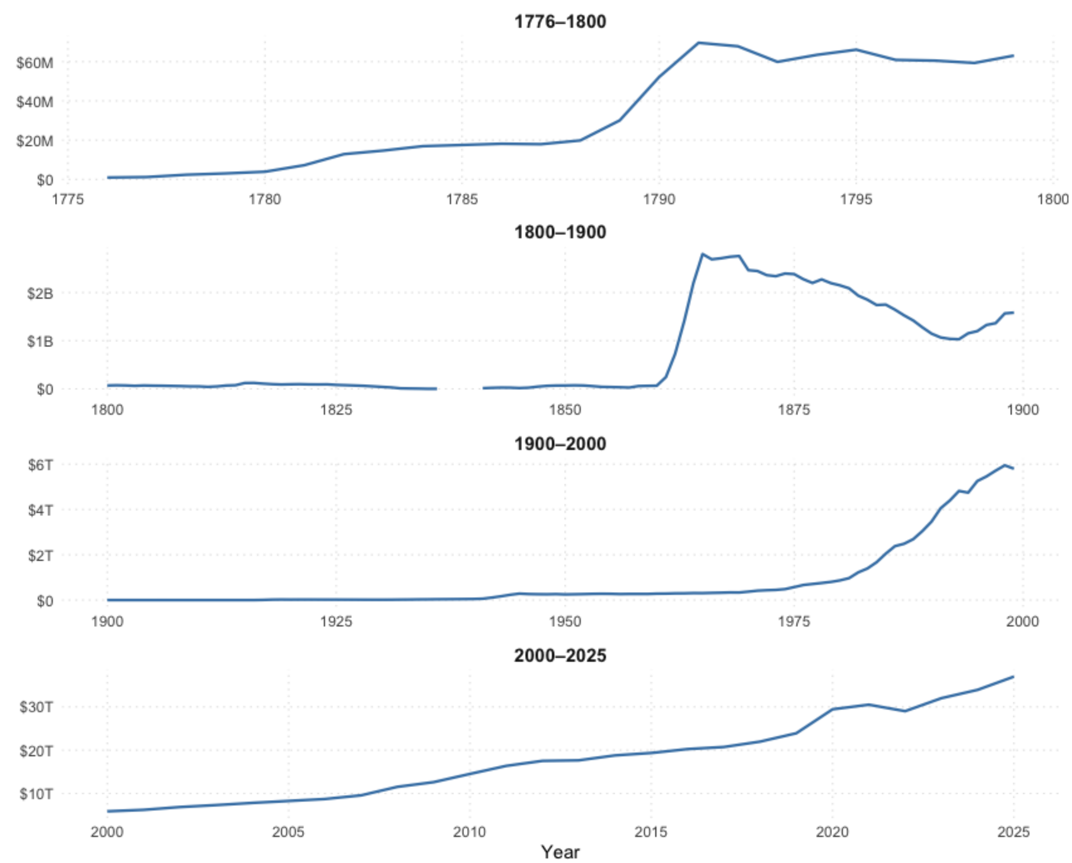

Figure 2: Gross Market Value of U.S. Treasury Debt (1776 - 2025)

Data from Hall and Sargent (2018). This plot displays the gross market value of U.S. treasury debt as of the beginning of December of each year from 1776 to 2025. Note the changes in the scale of the y-axis for each of the four intervals.

Figure 2 shows the evolution of U.S. treasury debt from the inception of the country to December 2025. This data, courtesy of George Hall's website, will provide us with our measure of debt that we will use to construct our measure of debt-to-GDP. This measure is purged of its time trend before use in our analysis.

The remaining data pertains to publicly available data obtained through the St. Louis Federal Reserve's Economic Data (FRED). This is comprised of quarterly data on Moody's Corporate Bond Yields (BAA10Y), GDP Deflator, and a measure of the unemployment gap constructed by subtracting the natural rate of unemployment from the actual unemployment rate over time.

3 Bank Lending, Debt, and Monetary Surprises

This section lays out the methodology used to generate the empirical results that shed light on the underlying question: how does credit respond to any given monetary policy shock as debt-to-GDP grows?

3.1 Methodology

When working with time-series data with the intention of analyzing how a macroeconomic variable of interest responds to shocks to other variables, one dominant approach follows the recommendations of Sims (1980) in using vector autoregression (VAR) models to generate impulse response functions (IRFs) of variables that are jointly determined. Although this is a standard approach in the macroeconomic literature, the appropriate way to tackle our question is by using Jordà's local projections (LPs) Jordà (2005). The reason is that we already have a well-identified exogenous shock already pre-specified: our orthogonalized MPS shock. Given this external source of identification, the VAR framework is not required to recover structural shocks, and LPs provide a direct and flexible way to estimate impulse responses by projecting future outcomes on the shock of interest.

Under standard conditions, LPs and VAR-based impulse responses are asymptotically equivalent when the VAR is correctly specified. In practice, however, the two methodologies tend to differ in finite samples. VARs may be more statistically efficient when correctly specified (greater precision), while LPs are more robust to misspecification and more easily accommodate nonlinearities and state dependence. One tradeoff is that LP estimates tend to be less smooth and exhibit greater sampling variability at longer horizons Hansen (2022).

To analyze the dynamics of bank credit to monetary policy shocks at varying level of national indebtedness, I therefore use a state-dependent LP framework. The model that I estimate in order to produce the IRFs is the following:
For each forecast horizon $h = 0, \ldots, H$, I estimate local projections of the form:

$$\Delta y_{i,t+h} = \alpha_i + \delta^h \text{MPS}_t + \gamma^h D_t + \beta^h (\text{MPS}_t \cdot D_t) + \Gamma^h X_{i,t} + \varepsilon_{i,t+h} \tag{1}$$

Where $\Delta y_{i,t+h} = \ln y_{i,t+h} - \ln y_{i,t-1}$ is the log difference of bank lending for bank i, where the monetary policy shock enters through MPS_t at time t. X_t represents the control variables, which includes bank-level controls: assets, tier 1 risk-based capital ratio, risk-weighted assets relative to total assets, deposits relative to total assets, and AOCI relative to equity. I also include macro aggregates in the controls: unemployment gap, BAA10Y, and GDP Deflator. I also include four lags of loan growth and a linear time trend.

I denote bank level fixed-effects with α_i. The coefficients $\delta^h, \gamma^h, \beta^h$, and Γ^h are estimated horizon by horizon h, which simply denotes which period the coefficient estimate corresponds to.

I separate observations into high- and low-debt categories based on the empirical distribution of d_t.[6] Let $q_{0.35}$ and $q_{0.65}$ denote the 35th and 65th percentiles of d_t, respectively. D_t, therefore, is an indicator defined as:

$$D_t = \begin{cases} 1 & \text{if } d_t \geq q_{0.65}, \\ 0 & \text{if } d_t \leq q_{0.35}. \end{cases} \tag{2}$$

Observations with $d_t \in (q_{0.35}, q_{0.65})$ are excluded from the estimation sample. The variable d_t represents detrended debt, which is obtained by projecting out a linear time trend from log debt-to-GDP and using the residual as our state variable. In other words, I removed the long-run increase in debt and isolated the component that reflects deviations from trend,

[6] "Debt", here, always means debt-to-GDP.

which is the relevant variation for identifying high- and low-debt regimes.

One might wonder about the chosen percentile categories for debt. The explanation has to do with availability of data. As I use more exclusive percentiles, data becomes more sparse and the IRFs behave more erratically. In the appendix, I show that the results still hold when I increase the percentiles to 85th for high debt and 15th for low debt. However, confidence bands become unreasonably tight as I further separate percentiles. The reason for this is that we have a very large number of bank observations for ever fewer quarterly observations of the policy shock and debt. I proceed under the assumption the chose percentiles above are sufficient for the delineation of high versus low debt.

The impulse response functions are evaluated in terms of the marginal effect of a given monetary policy shock (one standard deviation shock to MPS), interacted with an indicator variable for the debt state. When we are in the high-debt state, therefore, the marginal effect of a monetary policy shock upon lending is:

$$\text{IRF}^h(D_{\text{high}}) = \delta^h + \beta^h \tag{3}$$

Whereas in the low-debt state we have:

$$\text{IRF}^h(D_{\text{low}}) = \delta^h$$

The differential effect that a monetary policy shock has in the high-debt versus low-debt state is therefore:

$$\text{IRF}^h_{diff} = \text{IRF}^h(D_{\text{high}}) - \text{IRF}^h(D_{\text{low}}) = \beta^h$$

The LPs that I generate are further split into two time periods: before and after the period of quantitative easing (QE). I demarcate the “Pre-QE” period as the start of the sample until October of 2008. The “Post-QE” sample runs from April 2009 until the end of the sample, with the interim period omitted from estimation. I apply a slight smoothing penalty to the IRFs using the splines following Barnichon and Brownlees (2019).

3.2 Results

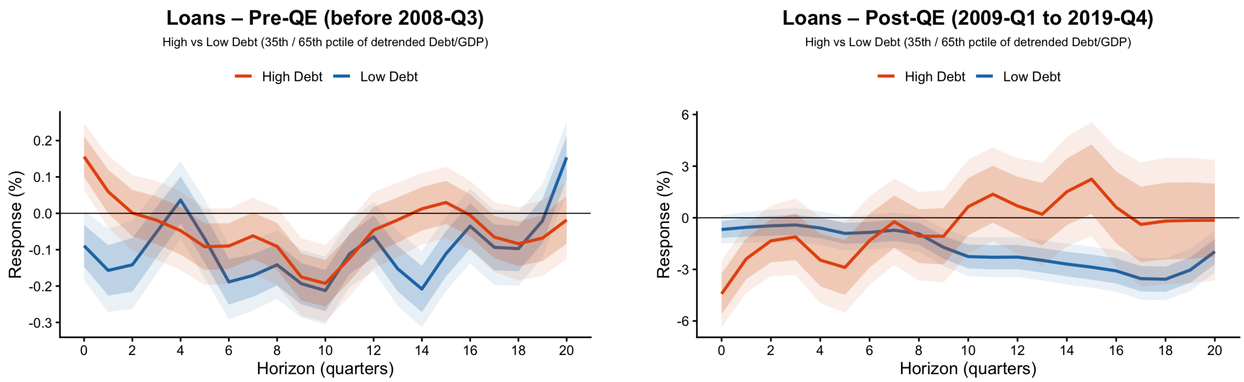

Figure 3: State-dependent IRFs of Loan Growth

Figure 3 shows the resulting IRFs of lending in response to a contractionary monetary policy shock under the high-debt state and low-debt state. The left panel corresponds to the period preceding QE and the right panel is post-QE. The orange IRFs are high-debt and the blue is low-debt.

These IRFs represent the percentage change in lending at each horizon h relative to the baseline trend at time $t-1$ in the wake of a contractionary monetary policy shock at time t. As I discussed above, we can also plot IRFs that represent the difference between the IRFs at each horizon. The IRFs in Figure 4 show the result of this exercise. The left panel plots the difference of the response of lending to a monetary policy contraction in the high-debt state versus the low-debt state for the period preceding QE. The right pane does the same thing for the post-QE period.

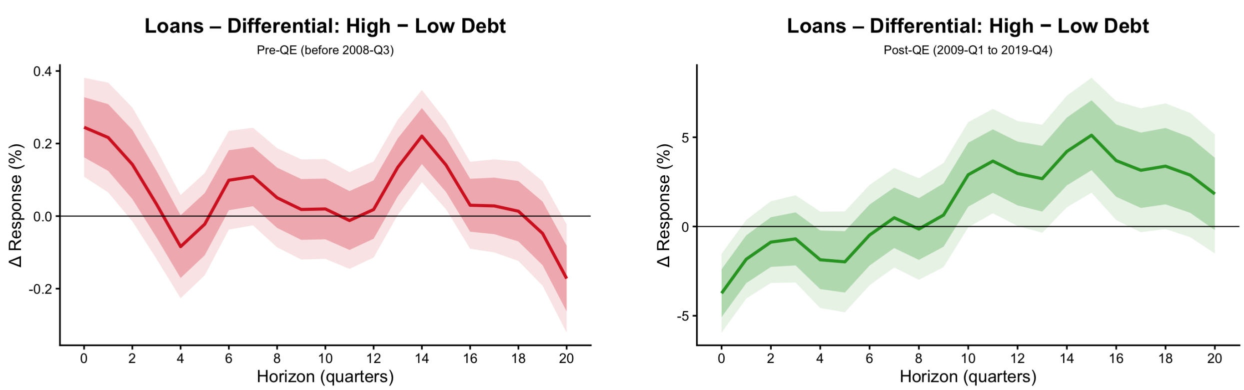

Figure 4: State-dependent IRFs of Loan Growth (Differential)

A consistent pattern emerges between the two plots: over medium to long-term horizons, the effect of a monetary policy contraction is smaller under a state of high indebtedness than under a state of low indebtedness. In fact, over most horizons, lending is less sensitive to the policy shock under high versus low debt. An obvious difference between the two plots is that, before QE, lending jumped positively on impact before finally contracting. Ater QE, the immediate effect reverses: lending falls more sharply under high debt than low debt. In either case, the immediate effect is short-lived, a few quarters, before a long-term trend appears of a persistently smaller response of lending to the policy shock under high debt.

Therefore, my findings are consistent with Caramp and Feilich (2024) where I find a dampened effect on monetary policy as federal debt-to-GDP rises. Their results apply to macro aggregates, and my findings uncover a similar patterns with regards to credit. This contrasts with the findings of Cantero-Saiz et al. (2014) with respect to Europe. They find the opposite pattern: high debt entails greater contractionary effects on lending in wake of a contractinary monetary policy shock.

One major difference that could serve as at least as one explanation for this disparity is the maturity structure of the debt for various European countries and the sovereign risk tied to that debt. For instance, in Europe, around the time of the 2010 sovereign debt crisis, nearly 60% of debt had residual maturity under five years.[7]

Another important fact is that, in the run up to the 2010 sovereign debt crisis in Europe, about 70% of Greece's foreign debt was owned by non-residents Lojsch et al. (2011) — especially German and French financial institutions. In the U.S. about two thirds of public debt are domestically held.[8] While sovereign risk became more of a concern for countries like Greece, who, unlike the U.S., cannot print off money to finance debt payments., the value of their debt instruments experienced larger oscillations than American debt. The disruptions this causes to holders of this kind of high-risk debt, which includes European creditors, may well explain the disparate findings between my results, those of Caramp and Feilich (2024) and the findings of Cantero-Saiz et al. (2014).

[7]The United States faces similar magnitudes of debt with residual maturity under five years Hall and Sargent (2018)

[8]U.S. Department of the Treasury, Bureau of the Fiscal Service. 2025. *Treasury Bulletin: Current Issue*. (September 2025).

4 Fiscal Theory and Credit Model

The model operates in discrete time with an economy characterized by households with CRRA utility, final goods producers, and a bank that operates much like a final goods firm with CES aggregation of intermediate inputs. The firm side is standard, with one caveat: they use capital and labor to produce their good, while financing capital accumulation via loans from the bank. Banks operate in a fashion similar to the canonical intermediate-final goods pipeline in standard new-keynesian models.

The setup of the financial block largely follows Balloch and Koby (2023) in specifying loans and deposits as CES aggregates. There is a loan-services firm that aggregates intermediate bank loans according to a CES technology. Similarly, a savings product is sold by this firm in the form of a CES aggregate of bank deposits offered by the intermediate banks. Then, using Calvo frictions, I derive the rates at which loans and deposits are remunerated, which gives us spreads between the lending, deposit, and policy rates.

Finally, the model is characterized by active-fiscal/passive-monetary policy Leeper (1991). The skeleton of this block of the model is imported from Cochrane (2022a,b). The final model can ultimately be broken down into six equations and, in the appendix, I discuss the determinacy condition and how it contrasts with that of the log-linear three-equation NK model from Woodford (2003).

4.1 Households

Households preferences given by:

$$\max_{C_t,N_t} \mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\phi}}{1+\phi} + \psi \Phi\left(\frac{D_t}{P_t}\right) \right]$$

The household gets utility from consumption C_t and disutility from supplying labor N_t. They also receive some small utility from the liquidity services that deposits supply D_t with $\Phi'(\cdot) > 0$, $\Phi''(\cdot) < 0$. They maximize this utility, subject to the budget constraint:

$$P_tC_t+D_t+B^H_{s,t}+Q_tB^H_{\ell,t} = (1+i_t)B^H_{s,t}+(1+i^D_t)D_{t-1}+(1-\omega Q_t)B^H_{\ell,t}+W_tN_t+\Pi_{f,t}+\Pi_{b,t}+P_tT_t$$

Where $B^H_{s,t}$ is household holdings of short-term debt, which are remunerated at the policy rate i_t. The household also holds a portion of the government's issue of long-term debt $B^H_{\ell,t}$, priced at Q_t, with maturity structure governed by ω. They also receive government transfers T_t and, as owners of the bank and goods firm, they receive profits $\Pi_{f,t}$, $\Pi_{b,t}$.

4.2 Firms

The final good firm produces output that is a CES aggregate of intermediate goods:

$$Y_t = \left(\int_0^1 Y_t(j)^{\frac{\nu-1}{\nu}}dj\right)^{\frac{\nu}{\nu-1}}$$

Where $\nu > 1$ is the elasticity of substitution between intermediate goods. The final good firm's problem is therefore:

$$\max_{Y_t(j)} P_t\left(\int_0^1 Y_t(j)^{\frac{\nu-1}{\nu}}dj\right)^{\frac{\nu}{\nu-1}} - \int_0^1 P_t(j)Y_t(j)dj$$

Which, after taking the FOC and rearranging terms, eventually gives us:

$$Y_t(j) = \left(\frac{P_t(j)}{P_t}\right)^{-\nu} Y_t$$

We also have a continuum of intermediate goods firms $j \in [0,1]$. Each firm produces a differentiated variety of output $Y_t(j)$ using capital K and labor N:

$$Y_t(j) = A_tK_t(j)^{\alpha}N_t(j)^{1-\alpha}, \qquad \alpha \in (0,1)$$

where P_t is the output price, Y_t output, W_t the wage, N_t labor, K_t capital, L_t loans, i_t^L the gross nominal loan rate minus one, and δ the depreciation rate. Firms must finance their capital by borrowing from banks. Let $L_t(j)$ denote loans and $R_t^L \equiv 1 + i_t^L$ the loan rate. Firms are constrained in their ability to accumulate capital by how much they can borrow:

$$K_t(j) \leq L_t(j),$$

Firm j's nominal profit, therefore, is:

$$\Pi_t(j) = P_t(j)Y_t(j) - W_tN_t(j) - R_t^L L_t(j) + (1-\delta)K_t(j).$$

Assuming the borrowing constraint binds, profits become:

$$\Pi_t(j) = P_t(j)Y_t(j) - W_tN_t(j) - R_t^K K_t(j).$$

where

$$R_t^K \equiv R_t^L - (1-\delta) = i_t^L + \delta,$$

Given output $Y_t(j)$, the intermediate firms will seek to minimize total cost:

$$\min_{K_t(j),N_t(j)} W_tN_t(j) + R_t^K K_t(j) \quad \text{s.t.} \quad Y_t(j) = A_tK_t(j)^\alpha N_t(j)^{1-\alpha}.$$

Each period, a firm can reset its price with probability $1-\theta$. If not, its price remains fixed. A firm that can reset at time t chooses P_t^* to maximize expected discounted profits:

$$\max_{P_t^*} \sum_{k=0}^{\infty} (\beta\theta)^k \mathbb{E}_t \left[\Lambda_{t,t+k} \big(P_t^* Y_{t+k|t} - MC_{t+k} Y_{t+k|t} \big) \right], \tag{4}$$

where $\Lambda_{t,t+k}$ is the stochastic discount factor and

$$Y_{t+k|t} = \left(\frac{P_t^*}{P_{t+k}} \right)^{-\nu} Y_{t+k}.$$

Which comes from the solution to the final goods producer's problem. $Y_{t+k|t}$ is the output of the firm k periods ahead of the last time they reset their price at time t. The first-order condition of (4) yields the optimal reset price:

$$P_t^* = \frac{\nu}{\nu - 1} \frac{\sum_{k=0}^{\infty} (\beta\theta)^k \mathbb{E}_t \left[\Lambda_{t,t+k} P_{t+k}^{\nu} MC_{t+k} Y_{t+k}\right]}{\sum_{k=0}^{\infty} (\beta\theta)^k \mathbb{E}_t \left[\Lambda_{t,t+k} P_{t+k}^{\nu-1} Y_{t+k}\right]}.$$

Under Calvo pricing, log-linearization around a steady state yields the New Keynesian Phillips Curve (NKPC):

$$\pi_t = \beta \mathbb{E}_t[\pi_{t+1}] + \kappa\, mc_t, \tag{5}$$

4.3 Banks

Total lending is a CES aggregate of a continuum of banks:

$$L_t = \left(\int_0^1 L_t(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}}$$

That is, a competitive loan-services firm aggregates intermediate bank loans according to a CES technology, much like the Calvo setup for final goods firms. The idea is that loans are differentiated products sold by banks and ε is the elasticity of substitution between loans as in Balloch and Koby (2023). The profit maximization problem of the loan-services firm is:

$$\max_{L_t(j)} R_t^L \left(\int_0^1 L_t(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}} - \int_0^1 R_t^L(j) L_t(j) dj$$

Taking FOCs and simplifying, we get the demand for each intermediate (i), which is proportionate to total loans, L_t:

$$L_t(j) = \left(\frac{R_t^L(j)}{R_t^L} \right)^{-\varepsilon} L_t$$

We also get an expression for the aggregate lending rate:

$$R_t^L = \left(\int_0^1 R_t^L(j)^{1-\epsilon} dj \right)^{\frac{1}{1-\varepsilon}}$$

Intermediate banks experience nominal profits:

$$\Pi_t(j) = R_t^L(j)L_t(j) + R_{t+1}^n Q_t B_t - R_t^D(j)D_t(j)$$

Where they are remunerated for their loans at rate $R_t^L(j)$. They also hold government debt B_t with a market price Q_t and expected period-by-period return R_{t+1}. Banks remunerate deposits at rate $R_t^D(j)$ and, along with equity $E_t(j)$, use these deposits to finance the accumulation of loans and government debt. Banks are also subject to the capital constraint:

$$L_t(j) \leq \eta E_t(j)$$

and they are also subject to the following budget constraint:

$$L_t(j) + Q_t B_t(j) = D_t(j) + E_t(j)$$

When banks set $R_t^L(j)$ so as to maximize profits, and after simplifying and rearranging conditions, we end up with the following condition for the loan rate:

$$R_t^L(j) = \underbrace{\frac{\varepsilon}{\varepsilon - 1}\left(1 - \frac{1}{\eta}\right)}_{\text{markup}} R_t^D(j).$$

Where, ε and $\eta > 1$. Therefore, we have a wedge between the loan and deposit rates that represents the markup banks charge for their loans over and above what they remunerate their depositors.

4.4 Government and Central Bank

Following the notation of Cochrane (2022a), the government, at each period t, faces nominal market value of debt V_t, which is defined as:

$$V_t = M_t + \sum_{j=0}^{\infty} Q_t^{t+1+j} B_t^{t+1+j}$$

Where M_t is nominal money balances in the economy at time t. The component of debt that drives the dynamics of the model is the term $Q_t^{t+1+j} B_t^{t+1+j}$, where B_t^{t+j} is the nominal amount of zero-coupon debt at period t that matures at period $t+j$. Q_t^{t+j} is the corresponding price of this debt.

Earlier, in the bank's problem, we saw that government bonds earn an expected nominal return R_{t+1}^n. This is entirely determined by the difference in the price of bonds Q_t overnight:

$$R_{t+1}^n = \frac{M_t + \sum_{j=1}^{\infty} Q_{t+1}^{t+j} B_t^{t+j}}{M_t + \sum_{j=1}^{\infty} Q_t^{t+j} B_t^{t+j}}$$

Bonds have a geometric maturity structure determined by 0 ¡ ω ¡ 1, which gives $B_t^{t+j} = \omega^{j-1} B_t$. As ω increases, the maturity structure is characterized by more long-term debt. As we shall see in our experimentation with the model, as we shorten the duration of debt, negative surplus shocks (or positive debt shocks), generate more inflation. The idea is that, with more short-term debt, the government is more exposed to rollover risk, which affects discounts rates today and, furthermore, inflation.

The government's fiscal policy is set so as to raise surpluses to, at least partially, repay accumulated debts:

$$s_t = \theta_{s\pi} \pi_t + \theta_{sx} y_t + \alpha_v v_t + u_t^s \tag{6}$$

Where lowercase v_t is log market value of debt-to-GDP and u_t^s is an exogenous disturbance term. That surpluses don't simply respond one-to-one to unexpected changes in inflation will give us "active" fiscal policy. The central bank has a policy rule that simply follows the standard Taylor rule:

$$i_t = \theta_{i\pi}\,\pi_t + \theta_{iy}\,y_t + u_t^i \tag{7}$$

Where u_t^i is an exogenous disturbance. Unlike the standard new-keyensian setup, we will set $\theta_{i\pi} < 1$, so that interest rates respond less than one-to-one to inflation, hence the "passive" monetary policy. The remaining details of the model are laid out in the appendix, including the calibration of parameters, which can be found in Table 1 The calibration of the monetary and fiscal policy rules are taken from Cochrane (2022b), with banking parameters calibrated to match interest rate spreads.

4.5 Monetary Policy Shocks and Debt

The question of interest is how credit responds to a given monetary policy shock as a country becomes more indebted. To be clear, the kind of economy I am interested in simulating is one that borrows in its own currency and, therefore, has the ability to inflate away debt at will. Our model operates under that exact framework. Our model has a government that issues long-term debt that it partially repays with future surpluses, thereby generating transitory inflation when debt deviates from trend.

We can use our model to simulate the dynamics of credit in the wake of a monetary policy, given varying deviations of debt-to-GDP from its long-term trend. The monetary policy shock represents a one percentage point increase in i_t (MP contraction), which enters through the Taylor rule (7). I simultaneously force surpluses to deviate from trend by four different degrees, from smallest to largest: 1 pp, 5 pp, 10 pp, and 20 pp.

One might wonder why I'm introducing shocks to surpluses instead of debt directly. Recall that the valuation equation specifies the following relation:[9]

$$\frac{M_{t-1} + \sum_{j=0}^{\infty} Q_t^{t+j} B_{t-1}^{t+j}}{P_t} = \mathbb{E}_t \sum_{j=0}^{\infty} \beta^j s_{t+j} \tag{8}$$

[9]See Cochrane (2023), page 53.

Here, the price level adjusts so that real value of nominal government debt (LHS) equals the present value of future surpluses (RHS). Consider an exogenous rise in the value of debt (LHS) through B_{t-1}. Barring a corresponding rise in surpluses, the price level must rise or bond prices Q_t must fall, or both, to reestablish equality. Likewise, if surpluses fall relative to the LHS, then prices must rise or bond prices fall or both. A negative surplus shock gives us large deficits, which raise the value of debt.

Below, in Figure 5, we see that, in response to an exogenous one percentage point increase in interest rates, lending contracts less and less as future surpluses fall ever further from trend and, therefore, debt-to-GDP rises above trend. Therefore, lending becomes less sensitive to a given monetary policy contraction as indebtedness rises.

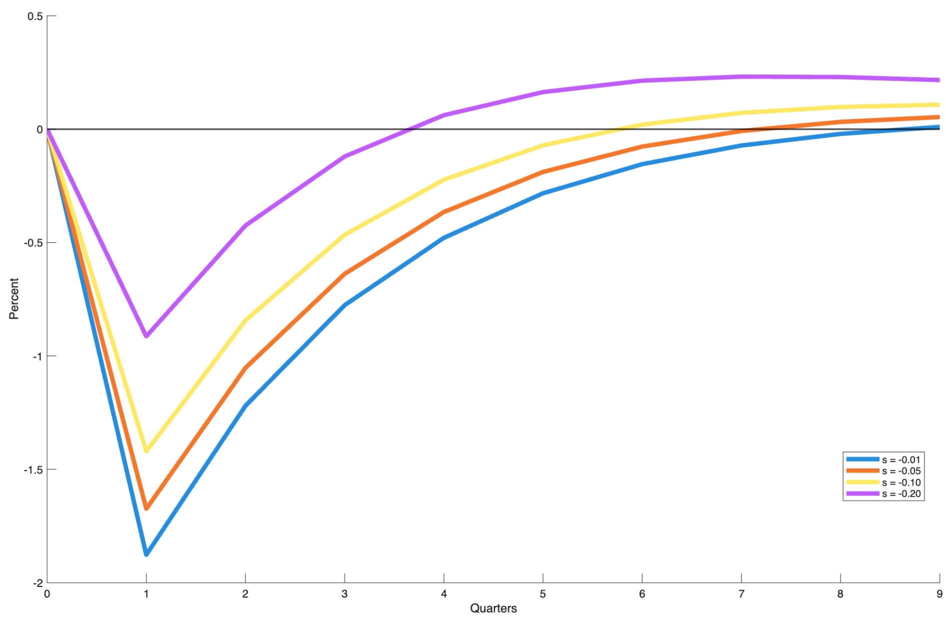

Figure 5: Credit Response to a 1pp MP Shock at Varying Debt/GDP Levels

Contractionary MP shock's effect on credit at four different deviations of debt from trend. The variable "s" represents a decline in future surpluses of the following magnitudes: 1 percent, 5 percent, 10 percent, and 20 percent.

The reason for this is fairly straightforward. A surplus shock generates inflation that, while partly offset by fluctuations in bond prices, spurs economic activity. The sign of inflation, as debt rises, continues to trend in the positive direction, despite the monetary contraction. As debt-to-GDP deviates far enough from trend, real interest rates rise less and less for a given monetary policy shock.

In the model, by the time expected future surpluses fall 10% below trend, inflation actually begins to increase in the face of a 1 percent monetary policy contraction. As monetary policy has generates an ever smaller impact on real interest rates ($r = i - \pi$), lending likewise responds by less. This can be observed in the two panels of Figure 6.

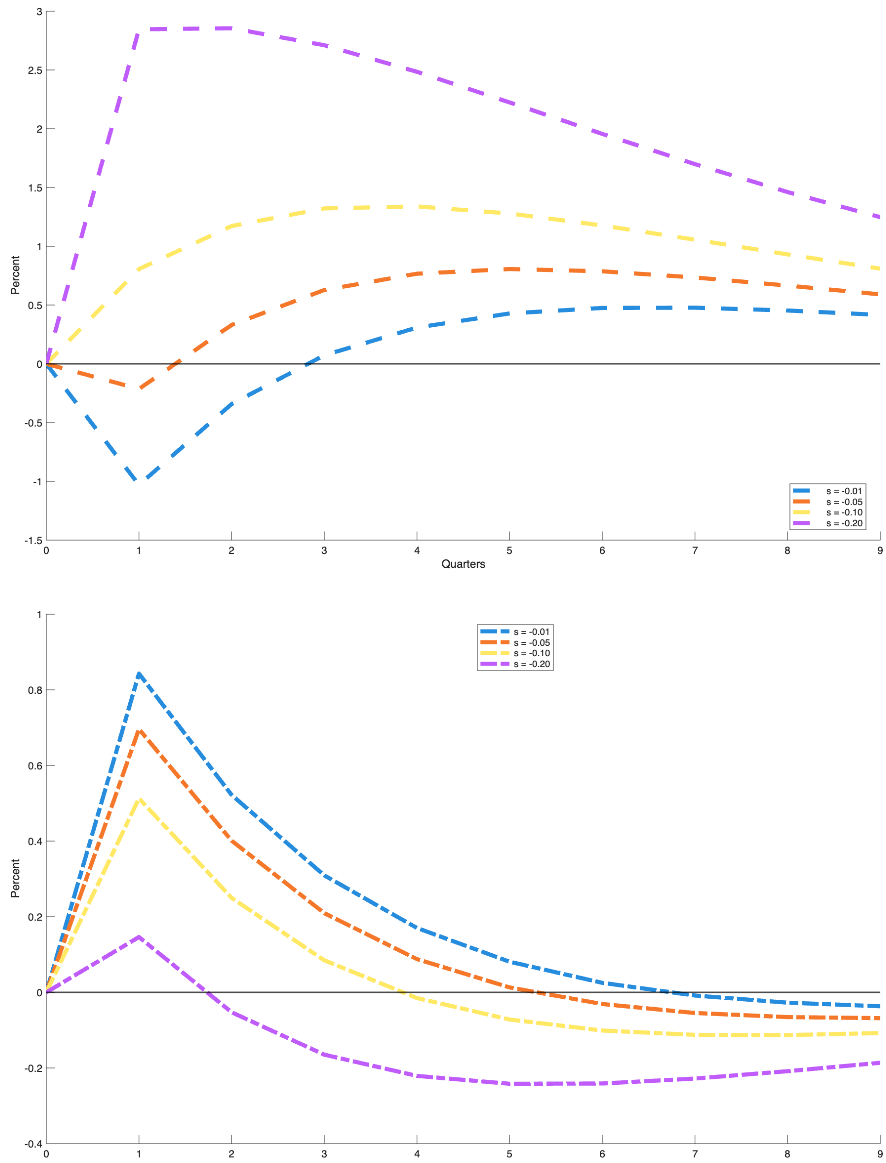

Figure 6: State-Dependent IRFs of Inflation π and Real Interest Rates r

Top panel represents contractionary MP shock's effects on inflation π and bottom panel represents the same shock's effects on real interest rates r at four different deviations of debt from trend. Real interest rates are $r = i - \pi$, with i as the policy rate.

As indebtedness rises, it creates additional inflationary pressure, which pushes down real interest rates, thus offsetting the effects of the monetary contraction. Specifically, for every 5% deviation of surpluses below trend, we see real interest rates r rise by 0.15% less after the 1% monetary policy shock. In the extreme, the monetary policy shock only slightly dampens what is otherwise a large inflationary spike in the wake of the rise in debt; reaching 3% as surpluses fall 20% below trend, even though nominal interest rates are held 1% above trend. Therefore, in order to achieve the same desired fall in economic activity, monetary policy will have to become more contractionary as debt-to-GDP rises.

It would seem, at first pass, the solution to this problem would be for the monetary authority to simply react more strongly to inflation as debt rises and that this will resolve the problem. In reality, although this approach will generate a larger contraction in the immediate term, it will generate very substantial inflation over the long run. The reason is that the value of debt increases in interest rates. As the monetary authority pushes up rates, the government's borrowing costs also rise. Therefore, although responding more strongly to inflation by pushing interest rates even higher to meet a given inflation target will generate the desired result in the near term, this will result in substantial and drawn-out inflation over the medium and long term.

Figure 7 illustrates precisely what the problem is and, conveniently, helps shed light on why my results, along with those of Caramp and Feilich (2024) differ from studies of the European experience Cantero-Saiz et al. (2014). Notice the consequences of ramping up the policy rate as debt grows. As the monetary policy contraction gets larger jointly with debt-to-GDP, both lending and inflation contract by more over near-term horizons. At the extreme end — 20% increase in policy rates jointly with a 20% decline in future surpluses — we see as much as a 37.5% drop in total lending and 20.5% fall in inflation. Clearly this is extreme, but it illustrates the point: if monetary policy contracts more strongly, in step with rising indebtedness, it can generate strong near-term contractions in both inflation and lending.

However, and this is the key point, this policy prescription comes at the expense of massive and persistent inflation as soon as one year into the future. Observe the dashed lines. Over the immediate term, within a year, inflation falls below trend. However, since the freshly accumulated debt is only partially repaid with future surpluses, our valuation equation (8) dictates that bond prices and inflation have to absorb the residual. Although long-term debt acts as a shock absorber Cochrane (2022a); Leeper and Leith (2016), the joint effects of a contractionary monetary policy shock and negative surplus shock is to generate larger inflation in the future.

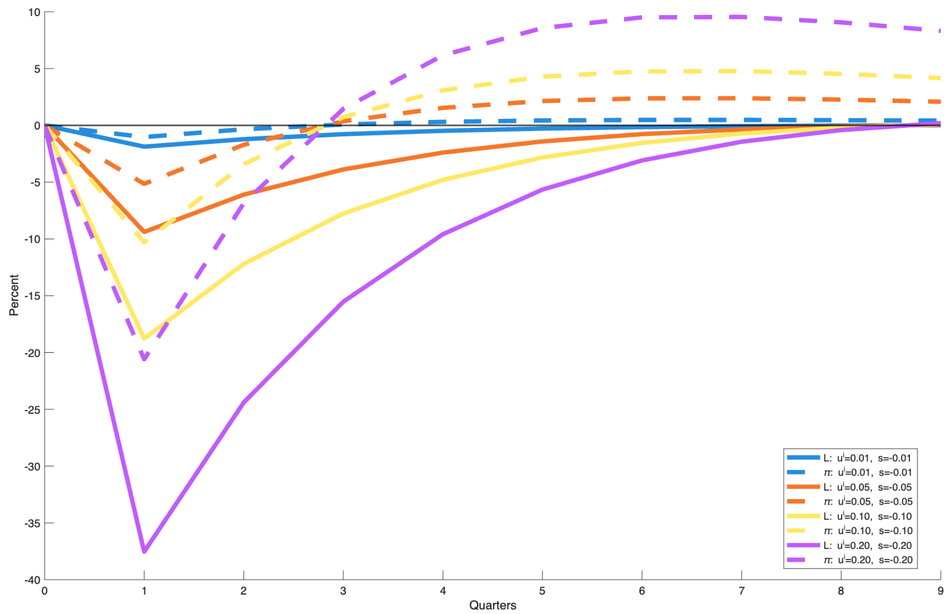

Figure 7: Lock-Step MP + FP Shocks

Dashed lines represent inflation π. Solid lines represent lending L. Each line is the response of a given variable to a joint contractionary monetary policy shock and negative fiscal shock (fall in surpluses) of the same magnitude.

The mechanism is familiar. In an environment of fiscal dominance where the government issues nominal debt,[10] Sims (1994); Leeper and Leith (2016) explain how monetary and fiscal policy jointly determine the price level. Higher interest rates generate higher debt service costs for the government. If the fiscal authority does not adjust surpluses appropriately, then in order to ensure government solvency, the price level adjusts so that the valuation equation (8) is satisfied. This works through a wealth effect channel. If the government has to offer increasingly higher interest to bond holders, barring a future tax increase to finance these interest payments, households (bond holders) receive a windfall in income that translates into additional demand and, thus, prices. Hence the sense in which people understand FTPL to be "non-Ricardian."

[10]Fiscal dominance — Active Fiscal/Passive Monetary Policy

In addition to the wealth effects of an active fiscal regime, inflation expectations also play a key role in determining the path of realized inflation. Chen et al. (2015) explain that inflation expectations are anchored only partially by monetary policy — they are also anchored by expected fiscal backing and regime credibility. They work with a model where firm marginal costs depends positively on tax rates. If people expect the government will raise distortionary taxes in the future, they expect firms' costs to rise, so they expect inflation. That expectation feeds into current inflation. To counteract that, the fiscal authority cuts taxes today, but doing so increases debt, which makes future tax hikes even more likely, creating a destabilizing loop.

These mechanisms, taken together explain the dynamics of credit in Figure 5 and Figure 7. In the former case, monetary policy responds highly passively to each successive increase in debt-to-GDP. That is, we observe how the dynamics of credit evolve over time when, at each successively higher level of indebtedness, the monetary authority's response to inflation at any given state is the same (1% interest rate hike). In the latter case, as monetary policy responds more aggressively to each successive deterioration in fiscal backing, inflation falls by more in the immediate horizon, pushing down credit accumulation, but at the expense of greater future inflation.

These two cases help cast light on the differences between the U.S. and European experiences in terms of how monetary and fiscal policy jointly determine credit dynamics. In the run up to the sovereign debt crisis of the 2010s, high sovereign-risk countries saw credit contract more strongly to a given monetary policy shock than low sovereign-risk countries. This is related to the deterioration of bank balance sheets in those countries who held substantial quantities of these high risk securities. Figure 7 shows the effects of a joint monetary contraction and fiscal deterioration. What is not visible on this plot are the massive increases in debt-to-GDP that result from every tightening monetary policy jointly with deteriorating fiscal backing. Although this model assumes that the home country can inflate away its debt (print the currency in which its nominal debt is denominated), this experiment models the effects of tremendous increases in debt generated by tight monetary policy along with poor fiscal outlook, which is precisely the situation faced by countries like Greece and Spain in the run up to the 2010 sovereign debt crisis. This explains why these countries experienced disproportionately large credit contractions in the wake of policy tightenings.

The U.S., on the other hand, borrows in nominal debt denominated in its own currency. The expectation is that the monetary authority will not permit the central government to default and will accommodate the budgets it sets in advance via seignorage. This has immediate inflationary impacts as fiscal backing deteriorates, which has expansionary effects on the entire economy, including credit.

5 Conclusion

This paper set out to analyze the joint effects of monetary and fiscal policy in the United States. The data shows that as the country becomes more indebted relative to its available resources, a given monetary policy shock contracts credit growth by less. This operates through inflation expectations and, furthermore, real interest rates. As a countries fiscal outlook deteriorates, individuals expect the government to respond by inflating away at least a portion of the debt. As the debt grows, with no change in expected future fiscal backing, the contractionary effects of monetary policy on real interest rates is dampened, which, furthermore, causes credit to contract by less.

Using a model with active fiscal and passive monetary policy, I show why policymakers at central banks should be wary of responding to this dampened efficacy of monetary policy by responding with greater aggression when hiking interest rates. Although this route might have the desired effect in the short run of contracting credit and inflation to intended levels, in the long run it will generate even more inflation than if the monetary authority had simply not responded at all.

The implications of this are clear: in an environment of fiscal dominance, fiscal policy has at least as much a role to play in determining the path of credit and inflation over the short and long term as monetary policy.

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Appendix

A Households

Households preferences given by:

$$\max_{C_t,N_t} \mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\phi}}{1+\phi} + \psi \Phi\left(\frac{D_t}{P_t}\right) \right]$$

Subject to the budget constraint:

$$P_t C_t + D_t + B_{s,t}^H + Q_t B_{\ell,t}^H = (1+i_t) B_{s,t}^H + (1+i_t^D) D_{t-1} + (1-\omega Q_t) B_{\ell,t}^H + W_t N_t + \Pi_{f,t} + \Pi_{b,t} + P_t T_t$$

Where $B_{s,t}^H$ is household holdings of short-term debt. $B_{\ell,t}^H$ are household holdings of long-term debt priced at Q_t with maturity structure governed by ω. D_t represent deposits with $\Phi'(\cdot) > 0$, $\Phi''(\cdot) < 0$.

Starting with a definition of inflation:

$$\Pi_{t+1} \equiv \frac{P_{t+1}}{P_t}$$

Goods market clearance will yield:

$$C_t = Y_t$$

From the FOC for consumption we get:

$$\lambda_t = \frac{C_t^{-\sigma}}{P_t} = \frac{Y_t^{-\sigma}}{P_t}$$

Assume Φ takes on a CRRA functional form, then we obtain the following real deposit demand condition:

$$d_t = \left(\frac{\psi}{Y_t^{-\sigma} - \beta \mathbb{E}_t \left[Y_{t+1}^{-\sigma} \frac{1+i_{t+1}^D}{\Pi_{t+1}} \right]} \right)^{\frac{1}{\nu}}$$

Where nominal deposits are defined as:

$$D_t = P_t d_t$$

B Firms

B.1 Final Good Producer

A representative final good firm produces output as a CES aggregate of intermediate goods:

$$Y_t = \left(\int_0^1 Y_t(j)^{\frac{\nu-1}{\nu}} dj \right)^{\frac{\nu}{\nu-1}}, \quad \nu > 1.$$

The firm chooses $\{Y_t(j)\}_{j \in [0,1]}$ to maximize profits:

$$\max_{Y_t(j)} \quad P_t Y_t - \int_0^1 P_t(j) Y_t(j) dj.$$

The first-order condition implies the demand for each intermediate good:

$$Y_t(j) = \left(\frac{P_t(j)}{P_t} \right)^{-\nu} Y_t.$$

The aggregate price index is:

$$P_t = \left(\int_0^1 P_t(j)^{1-\nu} dj \right)^{\frac{1}{1-\nu}}.$$

B.2 Intermediate Goods Firms

There is a continuum of intermediate firms $j \in [0, 1]$. Each firm produces using Cobb–Douglas technology:

$$Y_t(j) = A_t K_t(j)^\alpha N_t(j)^{1-\alpha}, \quad \alpha \in (0, 1).$$

B.3 Financing Constraint and Profits

Firms must finance capital through borrowing. Let $L_t(j)$ denote loans and define:

$$R_t^L \equiv 1 + i_t^L.$$

Capital is constrained by borrowing:

$$K_t(j) \leq L_t(j).$$

Since borrowing is costly and only used to finance capital, the constraint binds:

$$L_t(j) = K_t(j).$$

Nominal profits are:

$$\Pi_t(j) = P_t(j)Y_t(j) - W_t N_t(j) - R_t^L L_t(j) + (1 - \delta)K_t(j).$$

Substituting the constraint:

$$\Pi_t(j) = P_t(j)Y_t(j) - W_t N_t(j) - R_t^K K_t(j),$$

where the cost of capital is:

$$R_t^K \equiv R_t^L - (1 - \delta) = i_t^L + \delta.$$

B.4 Cost Minimization and Marginal Cost

Given output $Y_t(j)$, firms minimize cost:

$$\min_{K_t(j),N_t(j)} \quad W_t N_t(j) + R_t^K K_t(j) \quad \text{s.t.} \quad Y_t(j) = A_t K_t(j)^\alpha N_t(j)^{1-\alpha}.$$

This yields nominal marginal cost:

$$MC_t = \frac{1}{A_t} W_t^{1-\alpha} (R_t^K)^\alpha (1-\alpha)^{-(1-\alpha)} \alpha^{-\alpha}.$$

Define real marginal cost:

$$mc_t = \frac{MC_t}{P_t}.$$

Log-linearizing:

$$mc_t = (1-\alpha)(w_t - p_t) + \alpha R_t^K - a_t.$$

Using $R_t^K = i_t^L + \delta$, we obtain:

$$mc_t = (1-\alpha)(w_t - p_t) + \alpha \xi \hat{i}_t^L - a_t,$$

where $\xi = \frac{\bar{i}^L}{\bar{i}^L + \delta}$.

B.5 Price Setting

Firms face Calvo price rigidity. Each period, a firm can reset its price with probability $1-\theta$.

A firm resetting at time t chooses P_t^* to maximize:

$$\max_{P_t^*} \sum_{k=0}^{\infty} (\beta\theta)^k \mathbb{E}_t \left[\Lambda_{t,t+k} \left(P_t^* Y_{t+k|t} - MC_{t+k} Y_{t+k|t} \right) \right],$$

where demand is:

$$Y_{t+k|t} = \left(\frac{P_t^*}{P_{t+k}}\right)^{-\nu} Y_{t+k}.$$

The optimal reset price is:

$$P_t^* = \frac{\nu}{\nu-1} \frac{\sum_{k=0}^{\infty}(\beta\theta)^k \mathbb{E}_t\left[\Lambda_{t,t+k} P_{t+k}^{\nu} MC_{t+k} Y_{t+k}\right]}{\sum_{k=0}^{\infty}(\beta\theta)^k \mathbb{E}_t\left[\Lambda_{t,t+k} P_{t+k}^{\nu-1} Y_{t+k}\right]}.$$

B.6 New Keynesian Phillips Curve

Log-linearizing yields:

$$\pi_t = \beta \mathbb{E}_t[\pi_{t+1}] + \kappa\, mc_t.$$

C Banks

Loan-Services Banks

Total lending is a CES aggregate of a continuum of banks:

$$L_t = \left(\int_0^1 L_t(j)^{\frac{\varepsilon-1}{\varepsilon}} dj\right)^{\frac{\varepsilon}{\varepsilon-1}} \tag{C.1}$$

That is, a competitive loan-services firm aggregates intermediate bank loans according to a CES technology.

The profit maximization problem of the loan-services firm is:

$$\max_{L_t(j)} R_t^L \left(\int_0^1 L_t(j)^{\frac{\varepsilon-1}{\varepsilon}} dj\right)^{\frac{\varepsilon}{\varepsilon-1}} - \int_0^1 R_t^L(j) L_t(j) dj \tag{C.2}$$

Taking FOCs and simplifying, we get the demand for each intermediate (i), which is proportionate to total loans, L_t:

$$L_t(j) = \left(\frac{R_t^L(j)}{R_t^L}\right)^{-\varepsilon} L_t \tag{C.3}$$

We also get an expression for the aggregate lending rate:

$$R_t^L = \left(\int_0^1 R_t^L(j)^{1-\epsilon} dj \right)^{\frac{1}{1-\varepsilon}} \tag{C.4}$$

Intermediate Banks

Intermediate banks experience nominal profits:

$$\Pi_t(j) = R_t^L(j) L_t(j) + R_{t+1}^n Q_t B_t - R_t^D(j) D_t(j) \tag{C.5}$$

subject to the capital constraint:

$$L_t(j) \leq \eta E_t(j) \tag{C.6}$$

and the budget constraint:

$$L_t(j) + Q_t B_t(j) = D_t(j) + E_t(j) \tag{C.7}$$

Plugging (53) in for $E_t(j)$ in (54) and then plugging (54) into (52), we get:

$$\Pi_t(j) = R_t^L(j) L_t(j) + [R_{t+1}^n Q_t - R_t^D(j)] B_t - \left(1 - \frac{1}{\eta}\right) R_t^D(j) L_t(j) \tag{C.8}$$

Plugging in the definition of $L_t(j)$ from (50) in to (55), we get:

$$\Pi_{t+1}(j) = R_t^L(j) \left(\frac{R_t^L(j)}{R_t^L} \right)^{-\varepsilon} L_t + [R_{t+1}^n Q_t - R_t^D(j)] B_t - \left(1 - \frac{1}{\eta}\right) R_t^D(j) \left(\frac{R_t^L(j)}{R_t^L} \right)^{-\varepsilon} L_t \tag{C.9}$$

Which simplifies to:

$$\Pi_t(j) = \left(R_t^L(j)^{1-\varepsilon} R_t^{L\,\varepsilon} - \left(1 - \frac{1}{\eta}\right) R_t^D(j) R_t^L(j)^{-\varepsilon} R_t^{L\,\varepsilon} \right) L_t + [R_{t+1}^n Q_t - R_t^D(j)] B_t \tag{C.10}$$

Taking the derivative with respect to $R_t^L(j)$:

$$\frac{\partial \Pi_t(j)}{\partial R_t^L(j)} = L_t R_t^{L\,\varepsilon} \left[(1-\varepsilon) R_t^L(j)^{-\varepsilon} + \varepsilon \left(1 - \frac{1}{\eta}\right) R_t^D(j) R_t^L(j)^{-\varepsilon-1} \right]. \tag{C.11}$$

Setting the FOC equal to zero:

$$(1-\varepsilon) R_t^L(j)^{-\varepsilon} + \varepsilon \left(1 - \frac{1}{\eta}\right) R_t^D(j) R_t^L(j)^{-\varepsilon-1} = 0. \tag{C.12}$$

Multiply both sides by $R_t^L(j)^{\varepsilon+1}$:

$$(1-\varepsilon) R_t^L(j) + \varepsilon \left(1 - \frac{1}{\eta}\right) R_t^D(j) = 0. \tag{C.13}$$

Therefore, the optimal lending rate is:

$$R_t^L(j) = \underbrace{\frac{\varepsilon}{\varepsilon - 1}}_{\text{markup}} \left(1 - \frac{1}{\eta}\right) R_t^D(j). \tag{C.14}$$

Deposits

Similarly, savings products sold by banks and form an aggregate bank deposit D_t:

$$D_t = \left(\int_0^1 D_t(j)^{\frac{\varepsilon^D - 1}{\varepsilon^D}} \right)^{\frac{\varepsilon^D}{\varepsilon^D - 1}} \tag{C.15}$$

Then the problem is similar to the loan problem above, except, for loans you subtract payments to banks, for deposits you add receipts from banks:

$$\max_{\{D_t(j)\}} \quad \int_0^1 R_t^D(j)\, D_t(j)\, dj \; - \; R_t^D \left(\int_0^1 D_t(j)^{\frac{\varepsilon_D - 1}{\varepsilon_D}}\, dj \right)^{\frac{\varepsilon_D}{\varepsilon_D - 1}} \tag{C.16}$$

Similar to the process above of the firm that provides loan services, we end up with an expression for deposits in the form of:

$$D_t(j) = \left(\frac{R_t^D(j)}{R_t^D}\right)^{\varepsilon^D} D_t \tag{C.17}$$

$$\tag{C.18}$$

Now, using (54) to eliminate $Q_tB_t(j)$ in (52), we get:

$$\Pi_{t+1}(j) = R_t^L(j)L_t(j) + R_{t+1}^n(D_t(j) + E_t(j) - L_t(j)) - R_t^D(j)D_t(j) \tag{C.19}$$

Collecting terms:

$$\Pi_{t+1}(j) = [R_t^L(j) - R_{t+1}^n]L_t(j) + [R_{t+1}^n - R_t^D(j)]D_t(j) + R_{t+1}^n E_t(j) \tag{C.20}$$

Plugging in (64) into (67):

$$\Pi_{t+1}(j) = [R_t^L(j) - R_{t+1}^n]L_t(j) + [R_{t+1}^n - R_t^D(j)]\left(\frac{R_t^D(j)}{R_t^D}\right)^{\varepsilon^D} D_t + R_{t+1}^n E_t(j) \tag{C.21}$$

Simplifying:

$$\Pi_{t+1}(j) = [R_t^L(j) - R_{t+1}^n]L_t(j) + R_{t+1}^n R_t^D(j)^{\varepsilon^D} R_t^{D\ -\varepsilon^D} D_t - R_t^D(j)^{1+\varepsilon^D} R_t^{D\ -\varepsilon^D} D_t + R_{t+1}^n E_t(j) \tag{C.22}$$

Taking the derivative with respect to $R_t^D(j)$:

$$\frac{\partial \Pi_{t+1}(j)}{\partial R_t^D(j)} = \varepsilon_D R_{t+1}^n R_t^D(j)^{\varepsilon_D - 1} R_t^{D\,-\varepsilon_D} D_t - (1+\varepsilon_D) R_t^D(j)^{\varepsilon_D} R_t^{D\,-\varepsilon_D} D_t \tag{C.23}$$

Factor out common terms:

$$\frac{\partial \Pi_{t+1}(j)}{\partial R_t^D(j)} = R_t^{D\,-\varepsilon_D} D_t \left[\varepsilon_D R_{t+1}^n R_t^D(j)^{\varepsilon_D - 1} - (1+\varepsilon_D) R_t^D(j)^{\varepsilon_D}\right] \tag{C.24}$$

Setting the FOC equal to zero:

$$\varepsilon_D R_{t+1}^n R_t^D(j)^{\varepsilon_D - 1} - (1+\varepsilon_D) R_t^D(j)^{\varepsilon_D} = 0 \tag{C.25}$$

Factor $R_t^D(j)^{\varepsilon_D - 1}$:

$$R_t^D(j)^{\varepsilon_D - 1}\left[\varepsilon_D R_{t+1}^n - (1+\varepsilon_D) R_t^D(j)\right] = 0 \tag{C.26}$$

Solving for the optimal deposit rate:

$$R_t^D(j) = \frac{\varepsilon_D}{1+\varepsilon_D} R_{t+1}^n \tag{C.27}$$

If $E_t[R_{t+1}^n] = 1 + i_t$, then

$$R_t^D(j) = \frac{\varepsilon_D}{\varepsilon_D + 1}(1 + i_t) \tag{C.28}$$

Which does not depend on j. Therefore, our optimal deposit rate is:

$$R_t^{D^*} = \frac{\varepsilon_D}{\varepsilon_D + 1}(1 + i_t) \tag{C.29}$$

D Calibration of Parameters

D.1 Basic Parameters:

Table 1 reports the baseline calibration. The discount factor $\beta = 0.99$ corresponds to a standard quarterly frequency. The relative risk aversion $\sigma = 3$ and inverse Frisch elasticity $\phi = 1$ are within the range commonly used in the New Keynesian literature. The slope of the Phillips curve $\kappa = 0.5$ implies moderate price stickiness. Bank leverage $\eta = 10$ is consistent with typical pre-crisis US commercial bank balance sheets. The loan-market elasticity $\varepsilon = 7$ and deposit-market elasticity $\varepsilon_D = 1$ are calibrated to match a US loan-deposit spread of approximately 300 basis points. The weight on loan-rate pass-through $\xi = 0.75$ is tentative and subject to revision.[11]

Table 1: Basic Parameter Calibration

Parameter	**Value**	**Parameter**	**Value**
Households & Firms			
β	0.99	α	0.33
σ	1.5	ψ	1
ϕ	1	κ	0.50
Banks			
ε	7	ε_D	1
η	10	ξ	0.75†
Monetary & Fiscal Policy Rules			
$\theta_{i\pi}$	0.80	$\theta_{s\pi}$	0.25
θ_{ix}	0.50	θ_{sx}	1.00
Asset Pricing			
ω	0.70	α_v	0.20
γ	0.80		
Shock Processes			
ρ_a	0.90	ρ^s	0.40
ρ^i	0.70		

†Tentative.

[11] $\xi \equiv \bar{i}^L/(\bar{i}^L + \delta)$ is pinned down by the steady-state loan rate and depreciation rate; the value reported here is an approximation pending full steady-state calibration.

D.2 Composite Parameters

The composite parameters reported in Table 2 are computed analytically from the basic calibration above. Θ_L summarizes the net markup applied to the policy rate in the loan rate equation (100); Λ_π rescales the forward inflation term in the New Keynesian Phillips Curve once loan-financed capital is accounted for; and Γ_π, Ω_y, Ω_a, Γ_u are the reduced-form coefficients on lagged inflation, output, productivity, and the monetary shock, respectively, in the Phillips Curve (111).

Table 2: Composite Parameters

Parameter	**Value**
Θ_L	0.525
Λ_π	1.185
Γ_π	1.019
Ω_y	-1.023
Ω_a	1.008
Γ_u	0.099

E Solving the Model

E.1 Combining Conditions

The purpose of this section is to solve the model laid out in the previous section. The model can be expressed in the following form:

$$Ay_{t+1} = By_t + C\varepsilon_{t+1} + D\delta_{t+1}$$

Start with the IS equation:

$$y_{t+1} + \sigma\pi_{t+1} = y_t + \sigma(\theta_{i\pi}\pi_t + \theta_{ix}y_t + u_t^i) + \delta_{t+1}^y + \sigma\delta_{t+1}^\pi \tag{E.1}$$

Then the NKPC:

$$\pi_{t+1} = \frac{1}{\beta}\pi_t - \frac{\kappa}{\beta}mc_t + \delta^{\pi}_{t+1}$$

Which can be decomposed as follows:

$$\pi_{t+1} = \frac{1}{\beta}\pi_t - \frac{\kappa}{\beta}[(1-\alpha)(\sigma y_t + \phi n_t) + \alpha\xi\, r^L_{t+1} - a_t] + \delta^{\pi}_{t+1}$$

From equation (90), call $\frac{\varepsilon}{\varepsilon-1}\left(1-\frac{1}{\eta}\right)\frac{\varepsilon_D}{\varepsilon_D+1} \equiv \Theta_L$. Then we have:

$$\pi_{t+1} = \frac{1}{\beta}\pi_t - \frac{\kappa}{\beta}\left[(1-\alpha)\left(\left(\sigma + \frac{\phi}{1-\alpha}\right)y_t - \frac{\phi\alpha}{1-\alpha}k_t\right) + \alpha\xi\left(\Theta_L i_t - \pi_{t+1}\right) - \left(1+\frac{\phi}{1-\alpha}\right)a_t\right] + \delta^{\pi}_{t+1}$$

Then this expands to:

$$\pi_{t+1} = \frac{1}{1+\alpha\xi}\left\{\left(\frac{1+\kappa(1-\alpha)\alpha\xi\Theta_L\theta_{i\pi}}{\beta}\right)\pi_t - \frac{\kappa}{\beta}\left[(1-\alpha)\left(\left(\sigma + \frac{\phi}{1-\alpha} + \alpha\xi\Theta_L\theta_{ix}\right)y_t - \frac{\phi\alpha}{1-\alpha}k_t\right)\right.\right.$$
$$\left.\left. + \alpha\xi\,\Theta_L u^i_t - \left(1+\frac{\phi}{1-\alpha}\right)a_t\right] + \delta^{\pi}_{t+1}\right\} \quad \text{(E.2)}$$

Then our equation for k_t:

$$\begin{aligned}
k_t &= n_t + w_t - r^K_t \\
&= n_t + \sigma y_t + \phi n_t - r^K_t \\
&= \frac{1+\phi}{1-\alpha}\left(y - a_t - \alpha k_t\right) + \sigma y_t - r^K_t \\
&= \left(\frac{1+\phi}{1-\alpha} + \sigma\right)y_t - \frac{1+\phi}{1-\alpha}a_t - \frac{\alpha(1+\phi)}{1-\alpha}k_t - r^K_t \\
\left(1+\frac{\alpha(1+\phi)}{1-\alpha}\right)k_t &= \left(\frac{1+\phi}{1-\alpha} + \sigma\right)y_t - \frac{1+\phi}{1-\alpha}a_t - \xi[\Theta_L(\theta_{i\pi}\pi_t + \theta_{ix}y_t + u^i_t) - \pi_{t+1}]
\end{aligned}$$

Which yields our expanded condition for k_t:

$$\left(1+\frac{\alpha(1+\phi)}{1-\alpha}\right)k_t + \xi\pi_{t+1} = \left(\frac{1+\phi}{1-\alpha} + \sigma + \xi\Theta_L\theta_{ix}\right)y_t - \frac{1+\phi}{1-\alpha}a_t - \xi[\Theta_L(\theta_{i\pi}\pi_t + u^i_t)]$$

Rearranging:

$$k_t = \frac{1}{\left(1+\frac{\alpha(1+\phi)}{1-\alpha}\right)}\left[\left(\frac{1+\phi}{1-\alpha}+\sigma+\xi\Theta_L\theta_{ix}\right)y_t - \frac{1+\phi}{1-\alpha}a_t - \xi[\Theta_L(\theta_{i\pi}\pi_t+u_t^i)-\pi_{t+1}]\right] \quad \text{(E.3)}$$

We can plug this in for k_t in equation (99), which gives us:

$$\pi_{t+1} = \frac{1}{1+\alpha\xi}\Bigg\{\left(\frac{1+\kappa(1-\alpha)\alpha\xi\Theta_L\theta_{i\pi}}{\beta}\right)\pi_t$$
$$-\frac{\kappa}{\beta}\Bigg[(1-\alpha)\Bigg(\left(\sigma+\frac{\phi}{1-\alpha}+\alpha\xi\Theta_L\theta_{ix}\right)y_t - \frac{\phi\alpha}{1-\alpha}\frac{1}{\left(1+\frac{\alpha(1+\phi)}{1-\alpha}\right)}\left[\left(\frac{1+\phi}{1-\alpha}+\sigma+\xi\Theta_L\theta_{ix}\right)y_t - \frac{1+\phi}{1-\alpha}a_t - \xi[\Theta_L(\theta_{i\pi}\pi_t+u_t^i)-\pi_{t+1}]\right]\Bigg)$$
$$+\alpha\xi\,\Theta_L u_t^i - \left(1+\frac{\phi}{1-\alpha}\right)a_t\Bigg] + \delta_{t+1}^{\pi}\Bigg\}$$

Collecting terms we have:

$$\left[(1+\alpha\xi) - \frac{\kappa\phi\alpha\xi}{\beta\left(1+\frac{\alpha(1+\phi)}{1-\alpha}\right)}\right]\pi_{t+1} = \left[\frac{1+\kappa(1-\alpha)\alpha\xi\Theta_L\theta_{i\pi}}{\beta} - \frac{\kappa\phi\alpha\xi\Theta_L\theta_{i\pi}}{\beta\left(1+\frac{\alpha(1+\phi)}{1-\alpha}\right)}\right]\pi_t$$
$$+\left[-\frac{\kappa}{\beta}(1-\alpha)\left(\sigma+\frac{\phi}{1-\alpha}+\alpha\xi\Theta_L\theta_{ix}\right) + \frac{\kappa\phi\alpha}{\beta\left(1+\frac{\alpha(1+\phi)}{1-\alpha}\right)}\left(\frac{1+\phi}{1-\alpha}+\sigma+\xi\Theta_L\theta_{ix}\right)\right]y_t$$
$$+\left[-\frac{\kappa\phi\alpha}{\beta\left(1+\frac{\alpha(1+\phi)}{1-\alpha}\right)}\left(\frac{1+\phi}{1-\alpha}\right) + \frac{\kappa}{\beta}\left(1+\frac{\phi}{1-\alpha}\right)\right]a_t$$
$$-\left[\frac{\kappa\phi\alpha\xi\Theta_L}{\beta\left(1+\frac{\alpha(1+\phi)}{1-\alpha}\right)} + \frac{\kappa\alpha\xi\Theta_L}{\beta}\right]u_t^i + \frac{1}{1+\alpha\xi}\delta_{t+1}^{\pi}$$

Consolidating the parameter blocks into single parameters:

$$\Lambda_\pi \equiv \left[(1+\alpha\xi) - \frac{\kappa\phi\alpha\xi}{\beta\left(1+\frac{\alpha(1+\phi)}{1-\alpha}\right)}\right]$$

$$\Gamma_\pi \equiv \left[\frac{1+\kappa(1-\alpha)\alpha\xi\Theta_L\theta_{i\pi}}{\beta} - \frac{\kappa\phi\alpha\xi\Theta_L\theta_{i\pi}}{\beta\left(1+\frac{\alpha(1+\phi)}{1-\alpha}\right)}\right]$$

$$\Omega_y \equiv \left[-\frac{\kappa}{\beta}(1-\alpha)\left(\sigma+\frac{\phi}{1-\alpha}+\alpha\xi\Theta_L\theta_{ix}\right) + \frac{\kappa\phi\alpha}{\beta\left(1+\frac{\alpha(1+\phi)}{1-\alpha}\right)}\left(\frac{1+\phi}{1-\alpha}+\sigma+\xi\Theta_L\theta_{ix}\right)\right]$$

$$\Omega_a \equiv \left[-\frac{\kappa\phi\alpha}{\beta\left(1+\frac{\alpha(1+\phi)}{1-\alpha}\right)}\left(\frac{1+\phi}{1-\alpha}\right) + \frac{\kappa}{\beta}\left(1+\frac{\phi}{1-\alpha}\right)\right]$$

$$\Gamma_u \equiv \left[\frac{\kappa\phi\alpha\xi\Theta_L}{\beta\left(1 + \frac{\alpha(1+\phi)}{1-\alpha}\right)} + \frac{\kappa\alpha\xi\Theta_L}{\beta} \right]$$

We end up with a simpler equation for π_{t+1}:

$$\Lambda_\pi \pi_{t+1} = \Gamma_\pi \pi_t + \Omega_y y_t + \Omega_a a_t - \Gamma_u u_t^i + \frac{1}{1+\alpha\xi}\delta_{t+1}^\pi \tag{E.4}$$

From (92) and (93) we get our expression for bonds:

$$\omega q_{t+1} = \theta_{ix} y_t + \theta_{i\pi} \pi_t + q_t + u_t^i + \omega \delta_{t+1}^q \tag{E.5}$$

From equation (94)-(96) and (101) we get:

$$\theta_{sx} y_{t+1} + \theta_{s\pi} \pi_{t+1} + \left(1 + \frac{\alpha_v}{\gamma}\right) v_{t+1}^* + u_{t+1}^s = \left(\theta_{i\pi} - \frac{\Gamma_\pi}{\Lambda_\pi}\right) \pi_t + \left(\theta_{ix} - \frac{\Omega_y}{\Lambda_\pi}\right) y_t + \left(1 + \frac{\Gamma_u}{\Lambda_\pi}\right) u_t^i - \Omega_a a_t + v_t^* \tag{E.6}$$

Then we also get, from equation (96):

$$\theta_{sx} y_{t+1} + (1 + \theta_{s\pi}) \pi_{t+1} + \alpha v_{t+1}^* + v_{t+1} - \omega q_{t+1} + u_{t+1}^s = v_t - q_t \tag{E.7}$$

We also have our evolution of TFP:

$$a_{t+1} = \rho_a a_t + \epsilon_{t+1}^\alpha \tag{E.8}$$

Equations (98) - (104) are, therefore, the equations that will comprise our system.

Now we can proceed with solving the model as in the matrix notation above.

E.2 Determinacy Condition

The model is written as

$$\underbrace{\mathbf{A}}_{6\times 6} \mathbf{z}_{t+1} = \underbrace{\mathbf{B}}_{6\times 6} \mathbf{z}_t + \underbrace{\mathbf{C}}_{6\times 3} \boldsymbol{\varepsilon}_{t+1} + \underbrace{\mathbf{D}}_{6\times 3} \boldsymbol{\eta}_{t+1}.$$

Therefore, we have:

$$
\begin{bmatrix} 1 & \sigma & 0 & 0 & 0 & 0 \\ 0 & \Lambda_\pi & 0 & 0 & 0 & 0 \\ 0 & 0 & \omega & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} y_{t+1} \\ \pi_{t+1} \\ q_{t+1} \\ a_{t+1} \\ u^i_{t+1} \\ u^s_{t+1} \end{bmatrix}
$$

$$
= \begin{bmatrix} 1+\sigma\theta_{ix} & \sigma\theta_{i\pi} & 0 & 0 & \sigma & 0 \\ \Omega_y & \Gamma_\pi & 0 & \Omega_a & -\Gamma_u & 0 \\ \theta_{ix} & \theta_{i\pi} & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & \rho_a & 0 & 0 \\ 0 & 0 & 0 & 0 & \rho_i & 0 \\ 0 & 0 & 0 & 0 & 0 & \rho_s \end{bmatrix} \begin{bmatrix} y_t \\ \pi_t \\ q_t \\ a_t \\ u^i_t \\ u^s_t \end{bmatrix}
$$

$$
+ \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \varepsilon^a_{t+1} \\ \varepsilon^i_{t+1} \\ \varepsilon^s_{t+1} \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & \omega \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} \delta^y_{t+1} \\ \delta^q_{t+1} \end{bmatrix}
$$

Inverting the A matrix and moving to the RHS, we end up with:

$$
z_{t+1} = A^{-1}B\, z_t + A^{-1}C\, \varepsilon_{t+1} + A^{-1}D\, \eta_{t+1}
$$

Where:

$$A^{-1}B = \begin{bmatrix} \frac{\Lambda_\pi - \Omega_y \sigma + \Lambda_\pi \sigma \theta_{ix}}{\Lambda_\pi} & -\frac{\sigma(\Gamma_\pi - \Lambda_\pi \theta_{i\pi})}{\Lambda_\pi} & 0 & -\frac{\Omega_a \sigma}{\Lambda_\pi} & \frac{\sigma(\Gamma_u + \Lambda_\pi)}{\Lambda_\pi} & 0 \\ \frac{\Omega_y}{\Lambda_\pi} & \frac{\Gamma_\pi}{\Lambda_\pi} & 0 & \frac{\Omega_a}{\Lambda_\pi} & -\frac{\Gamma_u}{\Lambda_\pi} & 0 \\ \frac{\theta_{ix}}{\omega} & \frac{\theta_{i\pi}}{\omega} & \frac{1}{\omega} & 0 & \frac{1}{\omega} & 0 \\ 0 & 0 & 0 & \rho_a & 0 & 0 \\ 0 & 0 & 0 & 0 & \rho_i & 0 \\ 0 & 0 & 0 & 0 & 0 & \rho_s \end{bmatrix}$$

The eigenvalues of $A^{-1}B$ are as follows: 1.1111, 0.8250, 3.0799, 0.90, 0.70, 0.50, which confirms that we have two explosive roots for two forward looking variables.

It is instructive to examine the determinacy condition a little more closely. To find the conditions for determinacy, I follow the procedure laid out in Woodford (2001). First, let's say $A^{-1}B \equiv \Theta$. Then, an eigenvalue satisfies:

$$\det(\mu I - \Theta) = 0$$

The factorization of the characteristic polynomial yields:

$$\det(\mu I - \Theta) = \frac{(\mu\omega - 1)(\mu - \rho_a)(\mu - \rho_i)(\mu - \rho_s)}{\Lambda_\pi \, \omega} \cdot \left[\Gamma_\pi - \Gamma_\pi \mu - \Lambda_\pi \mu + \Lambda_\pi \mu^2 + \Gamma_\pi \sigma \theta_{ix} + \Omega_y \mu \sigma - \Omega_y \sigma \theta_{i\pi} - \Lambda_\pi \mu \sigma \theta_{ix}\right]$$

Evaluating the characteristic polynomial at $\mu = 1$, we get:

$$p(1) \equiv \det(I - \Theta) = -\frac{\sigma(\omega - 1)(\rho_a - 1)(\rho_i - 1)(\rho_s - 1)}{\Lambda_\pi \, \omega} \cdot \left[\Omega_y + \Gamma_\pi \theta_{ix} - \Lambda_\pi \theta_{ix} - \Omega_y \theta_{i\pi}\right]$$

Given our calibration, $-\frac{\sigma(\omega-1)(\rho_a-1)(\rho_i-1)(\rho_s-1)}{\Lambda_\pi \, \omega}$ turns out to be negative as a whole. We have two forward looking variables and we know that the NKPC gives us an eigenvalue greater than 1. Therefore, in order to obtain determinacy, we must have $p(1) > 0$. Hence, the determinacy condition becomes:

$$\boxed{\Omega_y(1-\theta_{i\pi})+\theta_{ix}(\Gamma_\pi-\Lambda_\pi)<0}$$

Which, given our calibrations, becomes:

$$-1.023(1-0.8)+0.5(1.019-1.185)=-0.2876<0$$

Satisfying the determinacy condition.