The Macroeconomic Effects of Sovereign Risk: New Evidence from U.S. Debt Ceiling Episodes[*]

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Abstract

This paper provides new evidence on the macroeconomic consequences of sovereign risk. Exploiting high-frequency movements in Treasury prices around U.S. debt ceiling episodes, I construct a novel instrument to identify exogenous shocks to government repayment risk. These shocks generate immediate financial market disruptions and lead to persistent contractions in real economic activity, even in the absence of an actual default. The key transmission operates through the bank-lending channel: valuation losses on government securities erode bank capital and induce a contraction in credit supply. Investment declines in response, particularly among financially constrained firms, and labor demand falls in capital-intensive sectors, compressing household income and weakening aggregate demand. I interpret these findings through the lens of a DSGE model with nominal rigidities and financial frictions, and use the framework to characterize optimal monetary policy in the presence of sovereign risk.

JEL classification: C32, C36, E32, E44, E52, E61, H63

Keywords: Sovereign risk, high-frequency identification, internal instrument, VAR, financial frictions, optimal monetary policy, welfare implications

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One thing is clear: [I]f left unattended, concerns about sovereign risk in advanced economies can undermine the [economy] and jeopardize [...] financial stability. The high levels of debt and related vulnerabilities, and the financial system implications, are being priced in market assessments of sovereign risk.

—IMF Managing Director Dominique Strauss-Kahn, March 18, 2011
"Financial Crisis and Sovereign Risk: Implications for Financial Stability"

1 Introduction

Sovereign default is commonly viewed as a concern limited to emerging or developing economies. Yet recent episodes such as the Euro Area debt crisis, recurrent U.S. debt ceiling impasses, and a series of sovereign credit rating downgrades demonstrate that sovereign *risk* can emerge even in advanced economies. Although outright default remains improbable, such events can nonetheless erode investor confidence, elevate borrowing costs, and undermine broader financial stability. While the financial market implications of sovereign risk are well documented, systematic empirical evidence on its short-run effects on households, firms, and real economic activity remains scarce.

This paper develops a novel empirical approach to quantify the macroeconomic effects of shocks to sovereign repayment risk. The identification strategy leverages debt ceiling episodes, a distinctive feature of the U.S. fiscal system that periodically restricts the Treasury's capacity to issue new debt unless authorized through an act of Congress. In the absence of legislative action, a binding debt limit may force the Treasury to delay or miss scheduled payments, increasing the risk of a technical default. Although no default has occurred to date, repeated political impasses and last-minute resolutions have made the statutory debt limit a credible source of sovereign risk.

Using Congressional records and official communications, I identify 196 institutional developments related to the debt limit from the 1980s to the present. I then exploit high-frequency movements in Treasury futures prices within narrow windows around each event to construct a new series of sovereign risk surprises. The short window helps ensure that the observed price movements reflect plausibly exogenous revisions in default expectations, ruling out concerns about simultaneity. The resulting surprise series is then used as an instrument in a structural vector autoregression (VAR) to estimate the dynamic causal effects of a sovereign risk shock.

I find that increases in expected sovereign risk generate immediate disruptions in financial markets and persistent effects on real activity even if default does not materialize.

Treasury prices fall on impact, leading to a broader repricing across asset classes: corporate bond prices decline sharply and continue to underperform for more than a year, while equity markets register a one percent loss in market value within six months. As financial conditions deteriorate, industrial production contracts by nearly 0.3 percent, and hours worked fall steadily. These effects lead to a significant decline in labor income and contribute to a modest rise in inflation.

The transmission operates through multiple channels. I document that valuation losses on government securities weaken bank capital positions and reduce intermediaries' capacity to absorb risk. In response, banks restrict exposure to non-Treasury securities and business loans, while maintaining relatively stable holdings of Treasuries and household credit. This portfolio adjustment tightens credit conditions for firms and depresses capital expenditure, with particularly strong effects among highly leveraged firms. The resulting contraction in credit supply and investment reduces labor demand, especially in capital-intensive sectors. These effects compress household disposable income through a combination of lower profits and diminished labor earnings, dampening aggregate demand and reinforcing the contraction in real activity.

Although the United States is not typically viewed as vulnerable to sovereign default, I find that debt ceiling episodes generate sizable sovereign risk shocks and pose a material threat to financial stability. These episodes are not isolated anomalies but reflect a recurring source of fiscal risk embedded in the institutional framework of U.S. public finance. To interpret these empirical findings and assess policy implications, I develop a medium-scale New Keynesian model with sovereign risk and financial frictions. I use the model to formalize the mechanism at the core of the transmission process, demonstrating that sovereign risk constrains investment through a market wedge that raises the effective cost of capital.

Nominal interest rate adjustments that stabilize the external cost of finance can significantly reduce the pass-through of sovereign risk to the broader economy. These gains, however, come at the cost of increased nominal distortions, revealing a trade-off between financial and price stability. In this context, a standard Taylor rule proves insufficient to resolve the tension. In contrast, an augmented rule that responds to sovereign risk through government bond returns closely approximates the optimal allocation, yielding a welfare gain of 0.31 percent in consumption-equivalent terms relative to the conventional rule. These results remain robust under a binding zero lower bound, with asset purchases providing an effective substitute for nominal rate adjustments.

Related Literature and Contribution. Observable signals of sovereign default are rare and often difficult to interpret in real time, complicating empirical efforts to measure sovereign risk.

Recent studies attempt to address these challenges using text-based indicators. Dim et al. (2021), for instance, construct a sovereign risk index using natural language processing applied to a broad collection of political, economic, and financial news articles. Related work develops fiscal sentiment indices using textual analysis (Latifi et al., 2024; Staffa and von Schweinitz, 2023). While these methods provide systematic ways to extract information relevant to sovereign risk, the resulting indices often reflect a broad set of narratives, ranging from political developments to realized defaults, making it difficult to disentangle revisions in expectations from shifts in macroeconomic fundamentals.

This paper, in contrast, adopts a more targeted approach, using U.S. debt ceiling crises as a novel source of variation to identify changes in sovereign risk expectations. The statutory limit imposes a binding legal constraint on the Treasury's authority to issue new debt, directly affecting its ability to service existing obligations. As a result, institutional developments related to the debt ceiling offer a well-defined setting for identifying changes in market expectations regarding the likelihood and timing of a potential U.S. sovereign default. In this respect, the analysis also departs from broader indicators of economic or political uncertainty, such as the Economic Policy Uncertainty Index (Baker et al., 2016) and the Partisan Conflict Index (Azzimonti, 2018), which reflect a wider array of concerns not specific to sovereign risk.

Identifying changes in expectations, however, presents its own challenges. Legislative decisions to raise or suspend the debt ceiling may reflect political or macroeconomic considerations, introducing potential endogeneity. These concerns are well-documented in theoretical models that emphasize the role of expectations and self-fulfilling prophecies in sovereign debt crises (Zabai 2014, among others). To address this issue, I propose a novel high-frequency identification strategy that exploits variation in Treasury prices. The approach involves isolating market surprises within narrow windows around institutional developments tied to the debt ceiling. Focusing on tight windows helps ensure that observed price changes only reflect information specific to default risk.

This strategy builds on a broader literature that uses high-frequency identification to estimate the impact of policy news (Kerssenfischer and Schmeling, 2024). Earlier applications focus on monetary policy surprises around FOMC announcements (Kuttner, 2001; Gertler and Karadi, 2015; Nakamura and Steinsson, 2018; Bauer and Swanson, 2023, among others), and more recent studies extend the methodology to settings including OPEC announcements (Känzig, 2021), climate policy (Känzig, 2023), and Treasury auctions (Pal Mustafi, 2024; Phillot, 2025). I apply high-frequency identification to the context of sovereign debt repayment, leading to a novel, market-based measure of sovereign risk.

An additional challenge in the empirical analysis of sovereign risk is the limited number of relevant episodes. Existing research often focuses on single events using reduced-form designs. Almeida et al. (2017), for example, exploit credit rating downgrades to estimate firm-level effects within a difference-in-differences framework. Related works conduct similar analyses in the contexts of the Greek government-debt crisis (Augustin et al., 2018) and the 2011 U.S. debt ceiling crisis (Gori, 2019). While offering valuable insights into the micro-level transmission of sovereign risk, these contributions remain confined to isolated episodes and cross-sectional settings. In contrast, this paper provides evidence on the *macroeconomic dynamics* of sovereign risk, taking potential general equilibrium effects into account.

Related work on the aggregate effects of sovereign risk relies on narrative identification strategies based on the events of the European sovereign debt crisis (Brutti and Sauré, 2015; Bahaj, 2020). These approaches draw on a broad range of political and policy developments (e.g., bailout negotiations, electoral cycles, and episodes of civil unrest), complicating efforts to isolate changes in default expectations from broader dimensions of political instability (Balduzzi et al., 2023). Furthermore, the focus on single historical episodes restricts the temporal coverage of any instrument series. I address these limitations by proposing a more systematic identification strategy based on a consistent set of institutional developments (e.g., legislative acts) concerning the statutory borrowing limit. The resulting series spans nearly four decades, allowing for the identification of sovereign risk shocks across a wide range of historical contexts.

There is growing recognition among policymakers that investors' concerns about repayment of public debt can impose significant economic pressures, even in the absence of an actual default. To the best of my knowledge, this paper provides the first empirical quantification of these effects. The analysis identifies the banking sector as a key transmission channel, in line with existing theories of the sovereign-bank nexus (Gennaioli et al., 2014; Sosa-Padilla, 2018; Bocola, 2016). However, I also document a pronounced asymmetry in banks' portfolio responses: financial institutions maintain exposure to Treasuries and household credit while tightening lending to firms.

These disruptions in firm financing generate substantial real effects. Firms more reliant on external borrowing exhibit larger declines in capital expenditure, and labor demand contracts most in capital-intensive sectors, consistent with models featuring firm heterogeneity (Arellano et al., 2024; Moretti, 2021). In addition, I present new empirical evidence that employment losses and reduced profits erode household disposable income and contribute to a decline in aggregate demand (see Roldán, 2025). Importantly, my empirical approach identifies these effects under substantially weaker structural assumptions.

Motivated by these findings, I develop a dynamic stochastic general equilibrium (DSGE) model to evaluate the policy implications of sovereign risk. The model integrates two distinct strands of the literature. It extends New Keynesian frameworks with financial frictions (e.g., Gertler and Karadi, 2011; Carlstrom et al., 2017) to incorporate sovereign default risk à la Bocola (2016), allowing risk to arise exogenously and independently of macroeconomic fundamentals. At the same time, it embeds nominal rigidities into sovereign risk models, in turn enabling a systematic role for monetary policy.

In contrast to existing frameworks that abstract from financial frictions (Arellano et al., 2020), the model demonstrates that effective stabilization requires jointly considering sovereign risk, nominal rigidities, *and* credit market distortions. Focusing on a single distortion can understate the full cost of stabilization, as the optimal policy response to sovereign risk involves a significant trade-off between price stability and credit market conditions. I demonstrate that an augmented interest rate rule that responds to government financing conditions closely replicates the Ramsey allocation and is welfare-improving.

Roadmap. The paper proceeds as follows. Section 2 provides institutional background on the U.S. debt limit and outlines the identification strategy used to construct the sovereign risk surprise series. Section 3 describes the econometric framework. Section 4 presents the core empirical findings, detailing the aggregate effects of sovereign risk shocks, the propagation channels, and the historical incidence of sovereign risk in the U.S. Section 5 introduces a New Keynesian model with sovereign risk and financial frictions. Section 6 uses the model to interpret the empirical evidence and to assess the optimal policy response. Section 7 concludes.

2 Institutional Background and Identification

> *The debt limit is the total amount of money that the United States government is authorized to borrow to meet its existing legal obligations, including Social Security and Medicare benefits, military salaries, interest on the national debt, tax refunds, and other payments.*
>
> –U.S. Department of the Treasury

The U.S. Debt Limit: History and Legislation. The statutory debt ceiling was first established in 1917 under the Second Liberty Bond Act, which imposed an overall cap on federal borrowing alongside limits on specific categories of debt. In 1939, the Public Debt Act consolidated these individual limits with a single unified ceiling, granting the Treasury greater operational flexibility while preserving congressional oversight. A 1941 amendment introduced the formal legislative procedure for revising the ceiling, forming the institutional basis still in use today. The "modern" debt limit applies to nearly 99.5 percent of total federal debt, including both publicly held debt and intragovernmental holdings.[1]

Since the late 1950s, borrowing from the public has increased each fiscal year, with exceptions in 1969 and from 1998 to 2001, while the accumulation of assets in federal trust funds has steadily raised the level of intragovernmental debt subject to the limit. Together, these trends have necessitated over 100 debt ceiling increases or suspensions since World War II (see Figure 1).

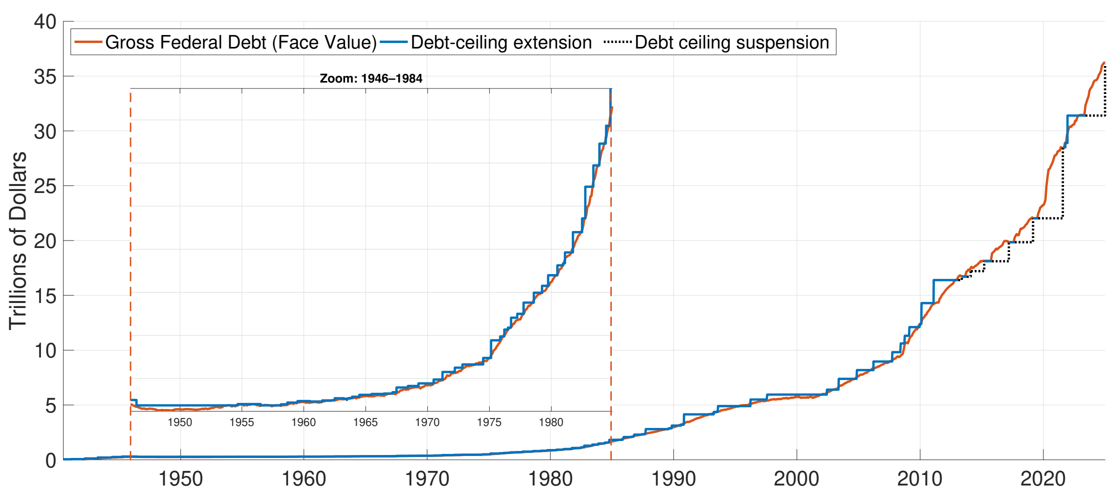


Figure 1: Historical debt ceiling levels

Sources: Gross federal debt data are provided by the Federal Reserve Bank of Dallas. Debt ceiling levels are obtained from the Congressional Record.

When the limit is reached, the Treasury initiates a "debt issuance suspension period," during which it is unable to issue new debt. At the same time, it deploys "extraordinary measures" to manage cash flows and service existing obligations, temporarily allowing the government to continue operations, and creating a limited window for Congress to revise the statutory limit. Any revision must begin with a bill introduced in either cham-

[1] Examples of intragovernmental holdings include federal trust funds for mandatory spending programs (e.g., Social Security and Medicare), while excluded from the statutory limit are unamortized discounts on Treasury bills and zero-coupon bonds, debt issued prior to 1917 (i.e., United States Notes), debt held by the Federal Financing Bank, and federally guaranteed debt.

ber of Congress.[2] After committee review, the bill proceeds to floor debate and vote; if approved, it moves to the other chamber, where it may be amended or passed. Once both chambers reach an agreement, the bill is sent to the President for approval, at which point the debt limit is formally revised and the Treasury can resume borrowing operations.

Debt Limit Negotiations: Consequences of Delay or Inaction. The duration of extraordinary measures is inherently uncertain, depending on a range of fiscal and economic factors. If the debt ceiling is not raised or suspended before the so-called "X-date" –the point at which these measures are exhausted– the government may be unable to meet legally mandated payments, risking a technical default.[3] Such an event could have unprecedented effects, with implications that extend beyond domestic markets to the global financial system (U.S. GAO, 2011). Although Congress has consistently acted to avert default, debt ceiling negotiations have historically been contentious, with partisan disagreements often extending until the Treasury resources are nearly exhausted.

This procedural uncertainty contributes to market volatility and erodes confidence in the institutional credibility of the United States government. In 2011, following a protracted impasse, Standard & Poor's downgraded the U.S. credit rating from AAA to AA+, citing "political brinkmanship" and declining confidence in fiscal governance (Standard & Poor's, 2011). In 2023, after another major crisis, Fitch issued a similar downgrade, emphasizing that repeated debt ceiling standoffs had "eroded trust in the government's ability to manage its finances" (Fitch Ratings, 2023). That same year, Moody's revised its outlook on U.S. sovereign debt to negative, ultimately proceeding with a formal downgrade in 2025, marking the third among the major rating agencies to lower its assessment of U.S. creditworthiness.

Measuring Sovereign Risk around Debt Ceiling Episodes. Prolonged debt ceiling standoffs elevate sovereign risk and often attract significant attention from financial markets and the media (see Figure 2). These episodes generally unfold through a sequence of institutional developments, including congressional action on debt ceiling legislation, Treasury communications regarding the status of extraordinary measures, and updated pro-

[2]In general, the debt ceiling may be either extended or suspended. An extension raises the statutory borrowing limit to a new level, allowing the Treasury to issue additional debt up to that revised ceiling. A suspension, by contrast, temporarily lifts the borrowing limit altogether for a specified period, permitting unrestricted issuance until the suspension expires.

[3]U.S. Treasury securities do not contain explicit default clauses, leading third parties to adopt their own definitions to monitor compliance with payment obligations. However, in October 2015, the U.S. Treasury warned that "(f)ailing to increase the debt limit [...] would cause the government to default on its legal obligations," reflecting growing concern over how default is understood in practice.

jections of the time remaining before the X-date. Each development typically introduces new, unanticipated information that prompts investors to revise their expectations about the likelihood and timing of a potential U.S. default. For instance, the enactment of legislation to raise or suspend the ceiling tends to reduce sovereign risk, as it reaffirms the Treasury's authority to issue new debt.[4] In contrast, downward revisions in the projected duration of extraordinary measures may intensify concerns about default, particularly in the absence of a clear legislative path to resolution.

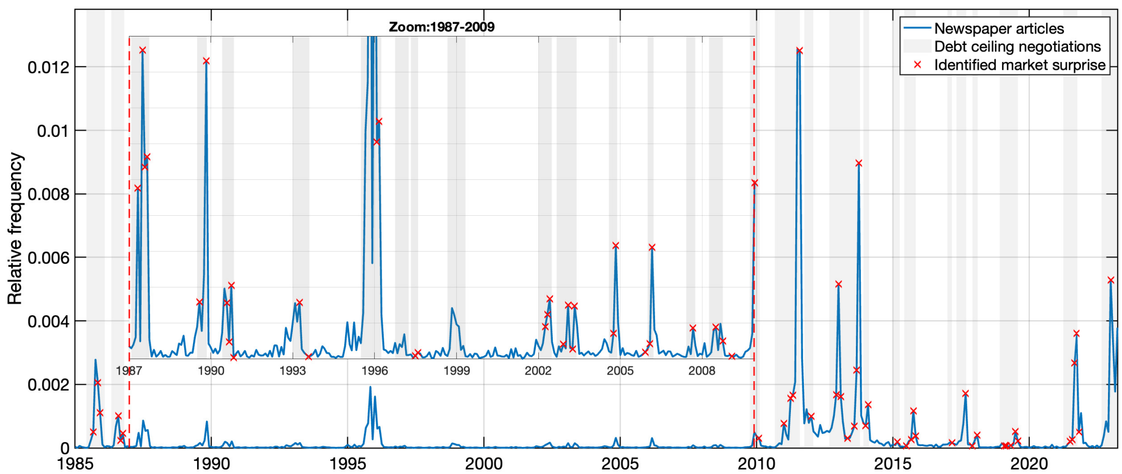


Figure 2: Debt ceiling in the news

Note: The blue solid line plots the debt ceiling sub-index of the Economic Policy Uncertainty index (Baker et al., 2016), constructed by identifying newspaper articles that include terms related to economics, policy, and uncertainty, along with a categorical reference to the "debt ceiling." Shaded areas denote periods of debt ceiling negotiations, spanning from the start of each episode to its resolution. The red crosses indicate days with market reactions to institutional developments concerning the debt ceiling, as detailed in Table A.1.

To systematically identify these episodes, I construct a dataset of debt ceiling–related events from 1982 to 2023. Drawing on the Congressional Record and official Treasury communications, I document 196 institutional actions associated with the statutory debt limit. To isolate changes in expected sovereign risk, I exclude observations that coincide with major macroeconomic data releases, monetary policy announcements, or other significant legislative actions that could confound the interpretation of market responses. The resulting sample contains 119 relevant episodes, detailed in Appendix Table A.1.

U.S. Treasury Futures Market. To capture market responses around debt ceiling episodes, I focus on U.S. Treasury futures. These standardized contracts allow traders to buy or sell Treasury securities at a predetermined price on a future date. As forward-looking instruments, Treasury futures reflect expectations about fiscal developments, and their

[4]These events are frequently preceded by failed legislative proposals and protracted political standoffs, making any resolution difficult to predict.

prices serve as a real-time, market-based measure of shifts in sovereign risk expectations. These contracts are traded primarily on the Chicago Board of Trade (CBOT), the central hub for U.S. Treasury derivatives, with an average daily volume of 40.7 million contracts. This high level of liquidity ensures that prices respond swiftly and efficiently to new information.

2.1 High-Frequency Identification

Debt ceiling revisions often reflect prevailing political and economic considerations, raising concerns about potential endogeneity in the observed macroeconomic responses. To address this challenge, I employ a high-frequency identification strategy designed to isolate market reactions within narrow time windows surrounding events related to the statutory limit.

The core assumption is that, over a sufficiently tight window, reverse causality becomes implausible, as other relevant information is assumed to be priced in advance and unlikely to change meaningfully during the event window. The depth and liquidity of the U.S. Treasury futures market further support this approach, allowing asset prices to incorporate new information rapidly and with minimal noise.

To capture these reactions, I construct a sovereign risk surprise series based on changes in the Treasury futures prices. Letting $F_{t,d}$ denote the (log) settlement price on day d of month t, the corresponding daily surprise is defined as

$$Surprise_{t,d} = F_{t,d} - F_{t,d-1}, \tag{1}$$

which measures the revision in market expectations on the event day relative to the previous trading day, under the assumption that risk premia remain constant over such a short horizon.[5]

Daily surprises are then aggregated to the monthly frequency, consistent with the existing literature. In months with a single relevant event, the monthly surprise equals the corresponding daily value. If multiple events occur in the same month, the monthly surprise is defined as the sum of the daily values. In the absence of relevant events, the monthly surprise is set to zero.

The resulting sovereign risk surprise series is presented in Figure 3. Overall, the series aligns closely with historical accounts of debt ceiling episodes. These episodes occur with

[5] Piazzesi and Swanson (2008) provide evidence that risk premia tend to vary primarily at business-cycle frequencies, indicating that one-day changes in near-dated futures can effectively "difference them out." See Känzig (2021,2) for further discussion.

some regularity and often generate sizable market responses, including several instances in which price changes exceeded one percent.[6] The sign of the surprise also conveys important information about the nature of the policy action and the degree of associated uncertainty. Negative surprises are typically associated with temporary measures or communications that elevate expected default risk. In contrast, positive surprises tend to follow more resolutive actions, such as large increases or multi-year suspensions of the debt ceiling, which alleviate near-term default concerns.

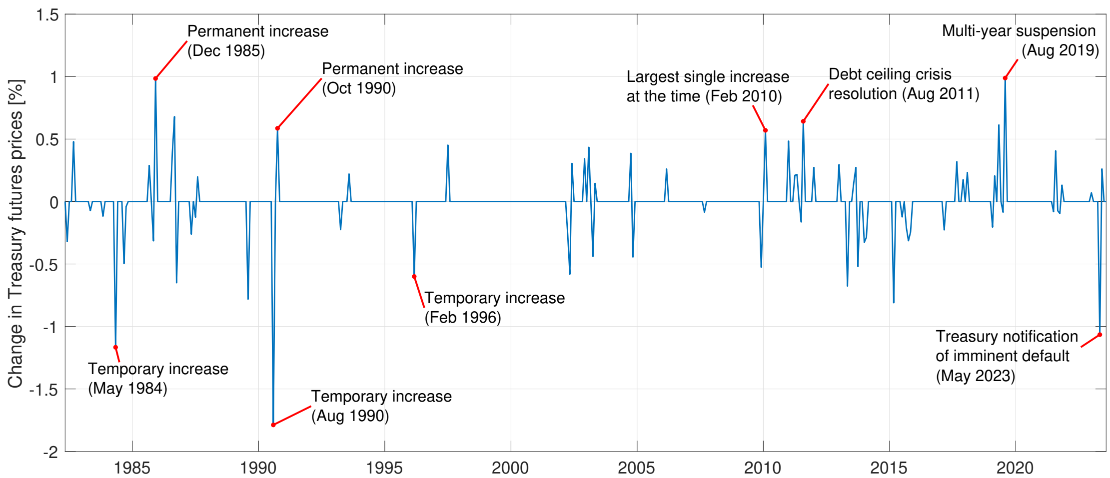


Figure 3: Sovereign risk surprise series

Note: Monthly sovereign risk surprise series constructed by aggregating daily surprises, computed as in (1) from Treasury futures price changes around institutional developments related to the U.S. debt ceiling (see Appendix A.1).

For example, in May 1984 and August 1990, Congress passed legislation that extended the debt ceiling for only a few weeks amid escalating default pressures. These last-minute measures temporarily averted default but failed to address broader concerns surrounding the statutory limit. Their limited scope, combined with persistent political divisions, signaled the likelihood of another imminent standoff, reinforcing investors' concerns about sovereign risk and contributing to negative market reactions. A similar pattern emerged in May 2023, when a formal warning from Secretary Yellen that the Treasury was approaching cash exhaustion intensified default concerns and triggered a sharp decline in futures prices. In contrast, the $1.9 trillion increase approved in February 2010 –the largest at the time– and the two-year suspension passed in August 2019 represented more durable policy responses to sovereign risk concerns and prompted positive revaluations in sovereign bond markets.

[6] A notable exception is the period between the late 1990s and early 2000s, when sustained budget surpluses eliminated the need for frequent increases in the statutory limit.

Construction Choices and Surprise Series Diagnostics. An important choice in constructing the sovereign risk surprise series concerns the selection of the appropriate futures contract. The baseline specification uses the ten-year Treasury Note futures contract, which offers one of the longest continuous trading histories and remains the most actively traded among Treasury futures.[7] Moreover, I use the front contract (i.e., the one closest to expiration) which tends to be the most liquid and helps minimize exposure to time-varying risk premia (Nakamura and Steinsson, 2018).[8]

A second consideration involves the choice of event window. A window that is excessively wide risks contamination from unrelated news, while an overly narrow one may fail to capture the full market response. Since debt ceiling developments do not follow scheduled release times and often unfold without advance notice, I adopt a one-day window, consistent with the literature using high-frequency identification around unscheduled institutional events (e.g., carbon policy in Känzig, 2023). This choice accommodates the irregular timing of debt limit announcements and also addresses potential concerns of reverse causality.[9]

Last, I validate the surprise series through a series of diagnostic tests adapted from Ramey (2016) and Känzig (2021,2). To assess whether the series reflects unanticipated information, I first examine its predictability using Granger causality tests. None of the macroeconomic or financial variables considered predict the series at conventional significance levels, and the joint test yields a p-value of 0.66. To further support the interpretation of exogeneity, I examine correlations with a range of externally identified structural shocks –including oil, monetary, and fiscal policy shocks– and find no significant relationships. Full diagnostics are reported in Appendix A.3.

3 Econometric Framework

The surprise series aligns closely with narrative accounts and exhibits desirable empirical properties. However, it does not constitute a direct measure of the underlying structural shock. In particular, the series may contain measurement error or fail to capture some episodes of elevated sovereign risk. I therefore use the series as an instrument for the

[7]The 10-year Treasury futures contract has been traded continuously since 1982, second only to the 30-year T-Bond futures, which began trading earlier, in 1977, but with declining trading volumes since then. As of 2024, it recorded an average volume of 1.65 million contracts per day (Figure A.1).

[8]Appendix B presents several robustness exercises based on contracts of other maturities. Reassuringly, these produce similar results.

[9]Unlike scheduled events, such as FOMC announcements, congressional sessions, for instance, can extend late into the evening or conclude abruptly, complicating efforts to align market reactions with narrow intra-day windows.

structural shock, provided that it is sufficiently correlated with the shock of interest and orthogonal to all other structural innovations.

Specifically, I adopt the internal instrument approach of Plagborg-Møller and Wolf (2021), which involves estimating a vector autoregression (VAR) with the instrument included as the first variable in the system. A key advantage of this framework is that it does not require invertibility of the moving average representation, an assumption that is often violated in the presence of "news" about future fundamentals or policy decisions, potentially biasing structural estimates (Plagborg-Møller and Wolf, 2022).[10] As such, the internal instrument approach provides a more robust alternative to identification strategies that rely on invertibility, including external instrument (proxy) VARs (e.g., Stock and Watson, 2012; Mertens and Ravn, 2013).

3.1 Empirical Model

Let $\mathbf{y}_t = [z_t, \bar{\mathbf{y}}_t']'$ be a $(1+n)$-dimensional vector, where the instrument z_t appears as the first element and $\bar{\mathbf{y}}_t$ collects the n endogenous variables of interest. Assume also that the joint dynamics of these variables follow a reduced-form vector autoregression (VAR) of order p:

$$\mathbf{y}_t = \mathbf{b} + \mathbf{B}_1 \mathbf{y}_{t-1} + \ldots + \mathbf{B}_p \mathbf{y}_{t-p} + \mathbf{u}_t, \tag{2}$$

where $\mathbf{b}$ is a $(1+n)$-dimensional vector of intercepts, $\mathbf{B}_i$, $i = 1, \ldots, p$, is a $(1+n) \times (1+n)$ matrix of autoregressive coefficients, and $\mathbf{u}_t$ denotes the vector of reduced-form innovations. These innovations have covariance matrix $\mathbf{\Sigma} = \text{Var}(\mathbf{u}_t)$ and are assumed to be linear combinations of orthogonal structural disturbances:

$$\mathbf{u}_t = \mathbf{S} \boldsymbol{\varepsilon}_t, \tag{3}$$

where $\boldsymbol{\varepsilon}_t$ is a vector of mutually orthogonal structural shocks with unit variance, and $\mathbf{S}$ is the matrix of contemporaneous responses.

The objective is to identify the causal effect of a single structural shock. Letting the sovereign risk shock correspond to the first element of the structural disturbance vector $\boldsymbol{\varepsilon}_t$, the identification problem reduces to recovering the first column of $\mathbf{S}$. Stock and Watson (2018) show that this vector, denoted $\mathbf{s}_1 \in \mathbf{S}$, is point-identified up to sign and scale, provided the instrument z_t satisfies the following conditions:

(1) Relevance: $E(z_t, \varepsilon_{1,t}) = \alpha \neq 0$,

[10] As emphasized by the authors, "rational expectations equilibria create noninvertible SVMA representations, and so SVARs cannot correctly recover the structural shocks."

(2) Exogeneity: $E\left(z_t, \varepsilon_{j,\tau}\right) = 0$ for all $\tau \neq t,$ and all $j \neq 1.$

Under these conditions, s_1 is proportional to the first column of the unique lower-triangular Cholesky factor of $\mathbf{\Sigma}$:

$$\mathbf{s}_1 \propto \left[chol\left(\mathbf{\Sigma}\right)\right]_{\cdot,1} \tag{4}$$

Importantly, this identification strategy yields consistent impulse response estimates even if the instrument is contaminated by measurement error, provided that the error is uncorrelated with the structural shock of interest.

3.2 Model Specification

The baseline specification consists of eight variables selected to capture key dimensions of U.S. financial and macroeconomic conditions. On the financial side, the model includes the level factor of the yield curve and the market value of outstanding marketable Treasury securities.[11] These variables reflect the stance of government borrowing conditions and the dynamics of publicly held federal debt. The financial block also incorporates a broad equity market index and a corporate bond return index, which jointly capture investor sentiment, firm profitability, and corporate credit risk. On the macroeconomic side, the model includes industrial production to represent aggregate output, the consumer price index (CPI) to measure price dynamics, and two labor market indicators –average weekly hours worked and total wages and salaries– to summarize employment conditions and household income. A constant term is included as the only deterministic component. All variables are expressed in log levels, with the exception of Treasury yields. Additional information on the data and sources is presented in Appendix A.2.

The VAR is estimated over the period from May 1982 through December 2019, to avoid the influence of extreme outliers during the COVID-19 pandemic. The lag order is set to six, based on standard model selection criteria, and confidence bands are constructed using a residual-based moving block bootstrap (Jentsch and Lunsford, 2019). Importantly, the results are robust to alternative sample periods, different lag specifications, and the inclusion of additional deterministic terms (see Appendix B).

[11]The level of the yield curve is measured as the first principal component of Treasury yields with maturities from one to thirty years. Shorter maturities are excluded to avoid distortions associated with the zero lower bound (ZLB). As documented in Appendix B.2, the results are robust to alternative specifications.

4 The Macroeconomic Effects of Sovereign Risk

A necessary condition for the validity of the empirical analysis is that the instrument satisfies the relevance condition. A weak correlation between the instrument and the endogenous variable could lead to biased estimates, undermining the credibility of the identification strategy.

The first-stage results confirm a strong statistical relationship between the instrument and the endogenous variable. The conventional F-statistic is 18.48, while the heteroskedasticity- and autocorrelation-robust F-statistic is 17.27. Both statistics exceed the standard threshold of 10 commonly used to rule out weak instruments, supporting the interpretation of the identified surprise series as a valid proxy for sovereign risk shocks.

4.1 Baseline Effects on Financial and Aggregate Conditions

To begin, I examine the broad effects of sovereign risk shocks on financial and economic conditions, as identified in the baseline VAR model in (2). Figure 4 reports the corresponding impulse responses, with solid black lines indicating point estimates and shaded areas denoting 68 and 90 percent confidence bands constructed from 10,000 bootstrap replications.

A one standard deviation increase in expected default risk leads to a broad repricing in the Treasury market. Yields rise across maturities as investors reassess the likelihood of delayed or missed government payments. At the same time, the market value of Treasuries declines, in line with a reduction in demand for government debt.

These effects are not confined to sovereign bonds. Corporate bond prices decline on impact and remain below baseline over the medium term, consistent with price arbitrage across fixed-income markets. Equity prices also exhibit a significant and persistent response, with valuations falling by more than one percent within two quarters and continuing to underperform throughout the horizon. This broad-based repricing across asset classes indicates a strong and significant pass-through from the government bond market to broader financial markets. I return to this mechanism in the next section, where I analyze the role of bank portfolio adjustments in transmitting sovereign risk.

As financial conditions deteriorate, the shock gradually transmits to the broader economy. Industrial production contracts steadily, reaching a cumulative decline of nearly 0.3 percent by the end of the second year. Labor market indicators follow a similar trajectory, with hours worked falling to a trough of about 0.15 percent. These effects extend to households through a decline in aggregate wages and salaries, and inflation rises modestly in the near term, but remains contained overall.

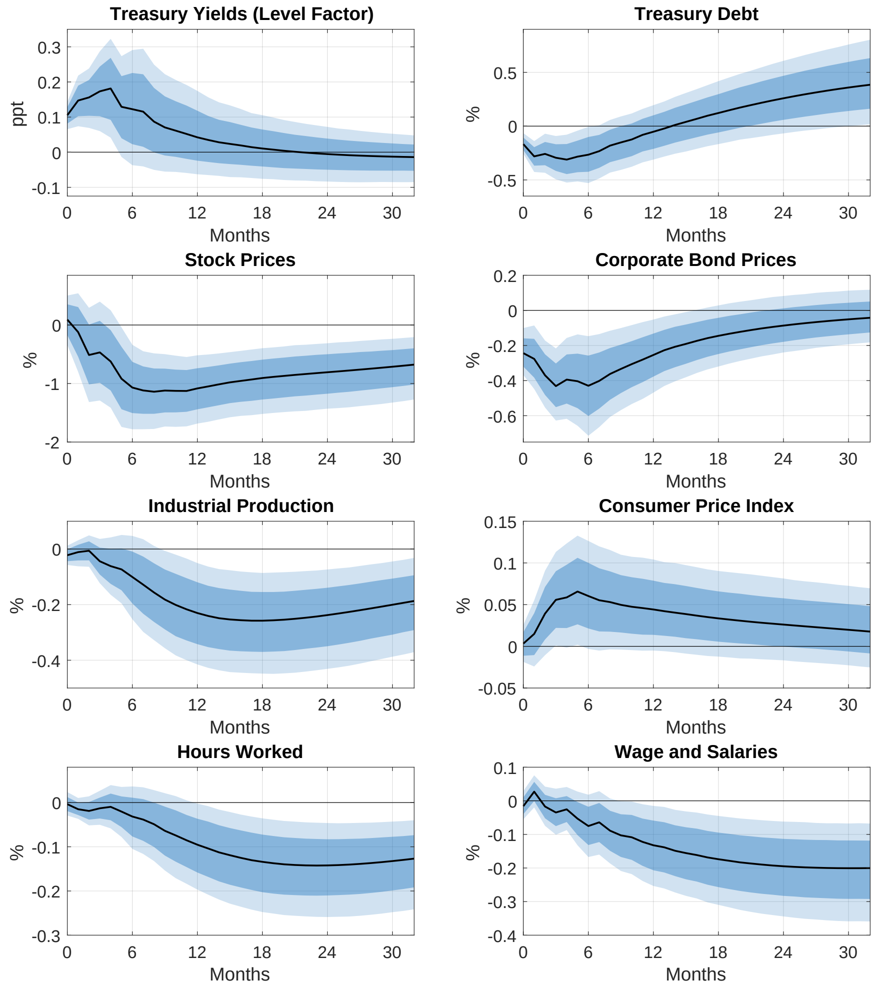


Figure 4: Impulse Responses to a Sovereign Risk Shock

Note: Impulse responses to a one-standard deviation sovereign risk shock are estimated from the VAR model in (2), using the sovereign risk surprise series in Figure 3 as an instrument. Solid black lines denote point estimates, while shaded regions indicate 68% and 90% confidence intervals based on 10,000 replications of the residual-based moving block bootstrap (Jentsch and Lunsford, 2019). Table A.2 in the Appendix provides further details on the variables used.

Qualitatively, these dynamics are consistent with the empirical evidence on sovereign risk (see e.g. Bahaj, 2020). Quantitatively, however, the results indicate that sovereign risk can induce significant and persistent disruptions, in contrast to the more limited and less precisely estimated effects typically reported. In addition, the analysis extends beyond financial markets to real economic outcomes, in this respect complementing the findings of Brutti and Sauré (2015). The remainder of the empirical section provides a detailed account of the underlying transmission channels.

4.2 Inspecting the Propagation Channels

The evidence presented thus far demonstrates that sovereign risk can trigger widespread disruptions across financial markets and the broader economy, even in the absence of an actual default. A systematic investigation of the underlying transmission channels is therefore essential to identify the sources of amplification and persistence, and to inform the design of effective policy responses.

To this end, I augment the baseline VAR with additional macro-financial indicators, introduced one at a time following Gertler and Karadi (2015) and Känzig (2021). For outcomes observed at quarterly frequency, I estimate impulse responses using local projections (Jordà, 2005):

$$y_{t+h}^{i} = \alpha_{h,0}^{i} + \beta_{h}^{i} Shock_{t} + \alpha_{h,1}^{i} y_{t-1}^{i} + \ldots + \alpha_{h,l}^{i} y_{t-l}^{i} + \zeta_{h,t}^{i} \tag{5}$$

where y_{t+h}^{i} denotes outcome variable i at horizon h, and $Shock_t = \sum_{k=0}^{2} \mathbf{s_1}'\Sigma^{-1}\mathbf{u}_{t,k}$ is the cumulative sovereign risk shock over quarter t, constructed from monthly innovations $\mathbf{u}_{t,k}$ identified in the baseline VAR in (2).[12] The coefficient β_h^i traces the response of variable i at horizon h.

Each specification includes three lags of the dependent variable and, for non-stationary series, incorporates a linear time trend to improve statistical precision given the short sample size (Känzig, 2023).[13] Confidence intervals are constructed using the lag-augmentation method of Montiel Olea and Plagborg-Møller (2021).

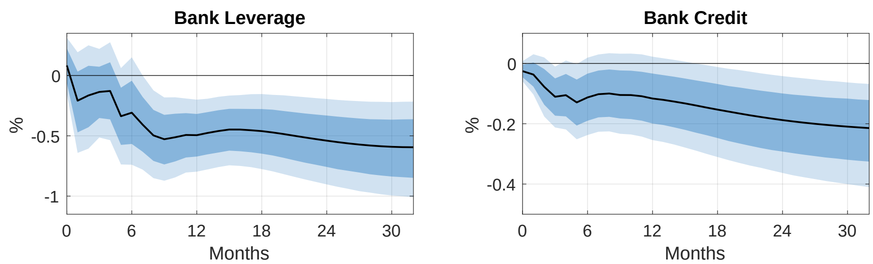
Banking Sector. A growing literature emphasizes the importance of the banking sector in the transmission of sovereign risk (Bocola, 2016; Gennaioli et al., 2014; Sosa-Padilla, 2018). The core mechanism rests on banks' dual role as major holders of government debt and key intermediaries in credit markets. Mark-to-market losses on sovereign securities can significantly erode bank capital and tighten credit provision. Although firmly established in theoretical work, direct empirical evidence on the resulting adjustment dynamics remains limited.

Figure 5 provides a quantitative assessment of the banking channel. As an initial step, the analysis characterizes the response of book leverage, defined as the ratio of total assets to equity, and total bank credit to a sovereign risk shock. These indicators are routinely

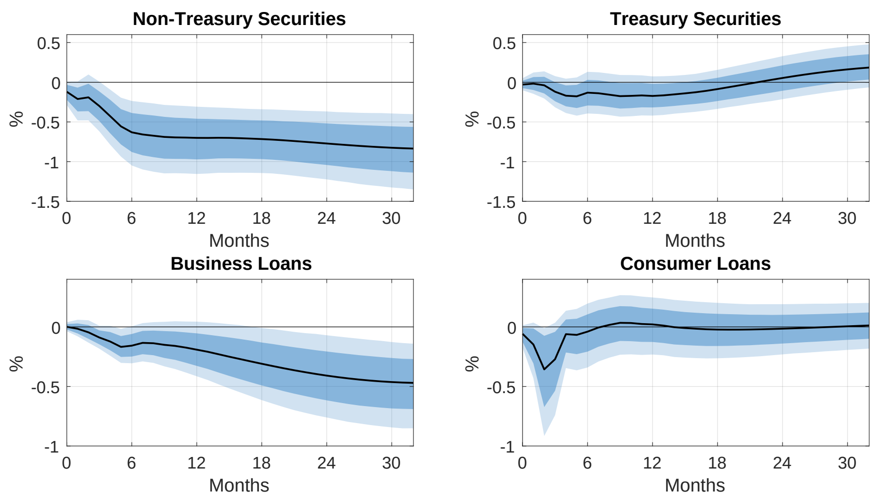
[12] To be precise, point identification of structural shocks additionally requires that the shock be recoverable. As discussed in Plagborg-Møller and Wolf (2022), this is a meaningfully weaker condition than invertibility, and holds in many models with news or noise shocks.

[13] Appendix B.7 confirms that including a deterministic trend has no material effect on the point estimates.

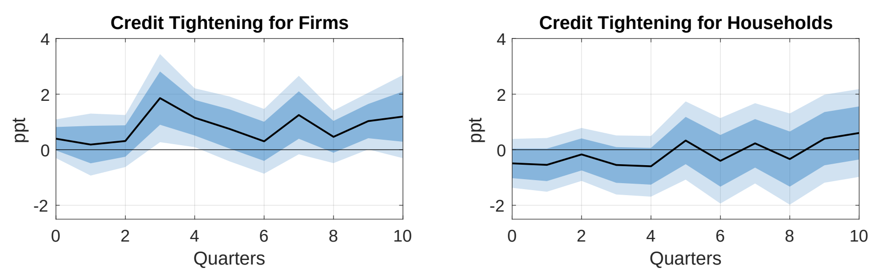
used to monitor financial conditions and jointly offer a broad overview of banks' capital exposure and lending capacity.



(a) Bank Leverage and Credit Supply



(b) Composition of Bank Credit



(c) Lending Standards: Firms vs. Households

Figure 5: Effects on the Banking Sector

Note: Panels (a) and (b) display impulse responses to a one-standard deviation sovereign risk shock estimated from the augmented VAR model in (2), using the sovereign risk surprise series in Figure 3 as an instrument. Solid black lines denote point estimates, and shaded regions indicate 68% and 90% confidence intervals based on 10,000 replications of the residual-based moving block bootstrap (Jentsch and Lunsford, 2019). Panel (c) shows impulse responses to a one-standard deviation sovereign risk shock estimated using local projections as specified in (5), with the cumulative sovereign risk shock over the quarter identified in the baseline VAR model in (2). Solid black lines denote point estimates, and shaded regions indicate 68% and 90% confidence intervals based on 10,000 replications of the lag-augmented bootstrap procedure of Montiel Olea and Plagborg-Møller (2021). Table A.2 in the Appendix provides further details on the variables used.

The shock leads to a persistent decline in bank leverage (Figure 5a), consistent with a balance sheet contraction in response to heightened portfolio risk. Importantly, the adjustment appears concentrated in bank credit, as other asset categories exhibit no statistically significant change (see Figure C.1a in the Appendix). Quantitatively, the reductions in leverage and credit amount to approximately 0.5 and 0.2 percent, respectively, pointing to a direct and economically significant transmission channel from sovereign debt repricing to the broader economy (see also Brutti and Sauré, 2015).

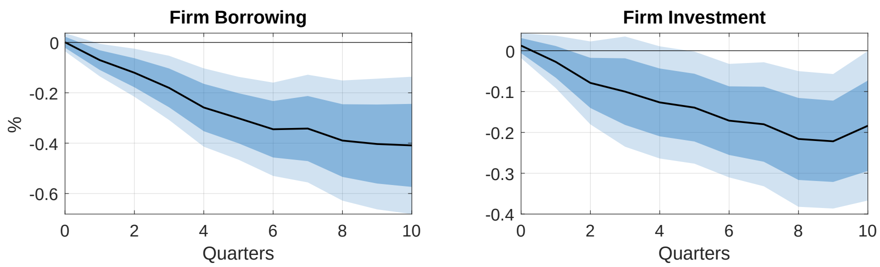
A more granular decomposition of bank credit further reveals that the observed decline primarily reflects adjustments in non-Treasury securities (Figure 5b, upper left panel), consistent with the interpretation that banks under balance sheet stress prioritize the sale of riskier or less liquid assets (e.g., corporate bonds). Interestingly, this response coincides with the broader reduction in private asset valuations reported in the baseline estimates, indicating a strong pass-through from the banking sector to asset prices. In contrast, holdings of Treasury securities (right panel) remain largely stable, reflecting the comparatively safer and more liquid position of these assets within bank portfolios.

A similar asymmetry emerges in direct lending activity (Figure 5b, bottom panel). Business loans decline significantly and remain below baseline levels for several quarters, with a peak contraction of nearly 0.5 percent. Consumer credit, instead, shows no meaningful response. Survey-based evidence on lending standards reinforces this interpretation. Although estimates are less precise due to the shorter sample length, Figure 5c indicates that a greater share of banks report tightening standards for commercial and industrial loans, with no comparable change in standards for consumer credit.

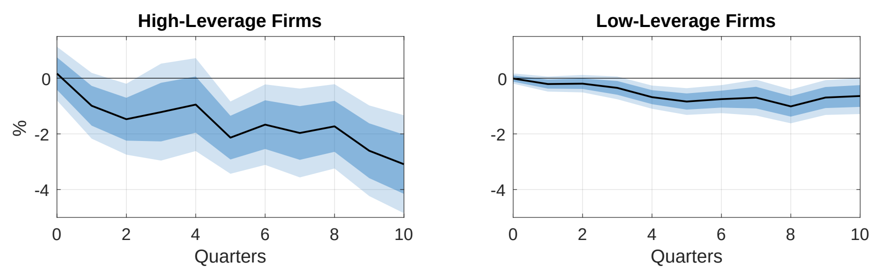
To summarize, these findings offer novel empirical evidence on the role of the banking sector in the pass-through of sovereign risk. The observed contraction in credit reflects a targeted withdrawal from private-sector exposures, as seen in both reduced holdings of non-Treasury securities and a decline in business lending, and establishes a direct channel through which sovereign debt repricing transmits to the real economy.

Production Sector. A substantial share of firms relies on external finance to support operations and fund investment. A reduction in intermediated lending can therefore constrain firms' ability to finance new capital projects, potentially limiting future productive capacity.

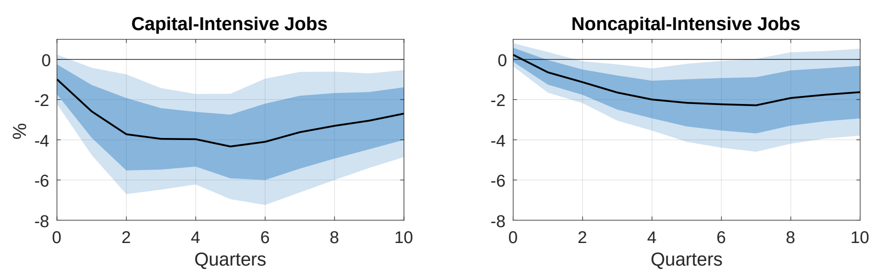
Figure 6a provides initial evidence of these dynamics. The left panel shows aggregate firm borrowing, a composite measure that includes both bank lending and market-based debt (see Table A.2 for further details). Consistent with the previously documented contraction in bank credit, a sovereign risk shock leads to a steady and persistent decline in firm borrowing, reaching a trough of approximately 0.4 percent below baseline. As expected, aggregate firm investment (right panel) exhibits a similar decline, falling to 0.2 percent below baseline after two years.[14] These dynamics are qualitatively consistent with the predictions of general equilibrium models of sovereign risk (e.g., Bocola, 2016), in which tighter financial conditions lead to weaker investment and, ultimately, slower capital accumulation.



(a) Aggregate Borrowing and Investment



(b) Capital Expenditure: High- vs. Low-Leverage Firms



(c) Labor Demand: Capital-Intensive vs. Noncapital-Intensive Jobs

Figure 6: Effects on the Production Sector

Note: Impulse responses to a one-standard deviation sovereign risk shock are estimated using local projections as specified in (5), with the cumulative sovereign risk shock over the quarter identified in the baseline VAR model in (2). Solid black lines denote point estimates, and shaded regions indicate 68% and 90% confidence intervals based on 10,000 replications of the lag-augmented bootstrap procedure of Montiel Olea and Plagborg-Møller (2021). Table A.2 in the Appendix provides further details on the variables used.

To assess the causal relationship between borrowing and investment more directly, I examine whether firms' financing needs systematically influence the strength of the in-

[14]Disaggregated results across corporate and noncorporate businesses reveal similar patterns, underscoring the joint role of direct lending and capital markets in supporting firm financing (see Figure C.2).

vestment response. Using firm-level data from Compustat, I construct two disaggregated investment series in the spirit of Arellano et al. (2024), employing firm leverage as a proxy for reliance on external finance. The premise is that firms with higher leverage may be more sensitive to deteriorating credit conditions. Building on this intuition, I create separate investment series for high- and low-leverage firms (see Appendix A.2 for further details). The corresponding dynamics are shown in Figure 6b. Among highly leveraged firms (right panel), capital expenditure declines significantly, reaching a peak contraction of more than 3 percent. These effects are over three times larger than the decline observed for low-leverage firms (left panel), revealing a pronounced asymmetry in the pass-through of sovereign risk and highlighting the importance of borrowing constraints in shaping the investment response (see e.g. Moretti, 2021).

These declines in investment also have important implications for hiring decisions, particularly in sectors where capital and labor are strong complements. I provide evidence of these effects by constructing separate measures of labor demand for capital-intensive and noncapital-intensive sectors. Figure 6c presents the results. In capital-intensive sectors (left panel), job openings decline sharply and persistently, falling by approximately 4 percent and remaining below baseline throughout the horizon. In contrast, job openings in noncapital-intensive sectors (right panel) exhibit a smaller and less precisely estimated decline, suggesting a more indirect response of labor demand. These patterns align with the general equilibrium mechanisms emphasized by Arellano et al. (2024), in which sovereign risk affects labor demand both through its *direct* impact on financially constrained firms and through *indirect* effects transmitted across sectors.

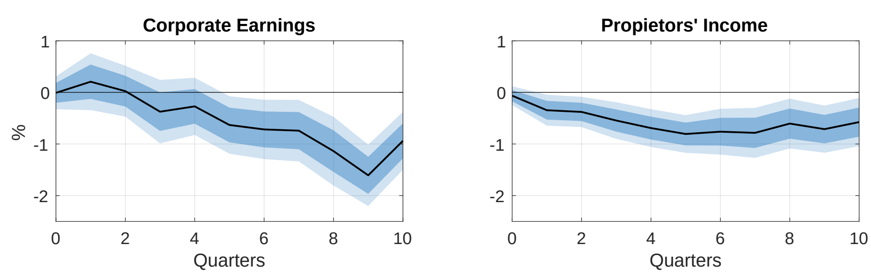
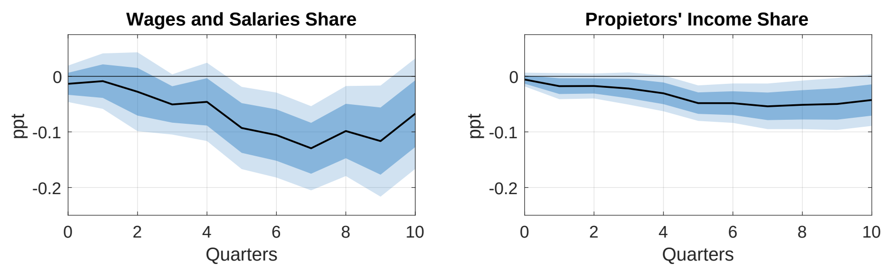


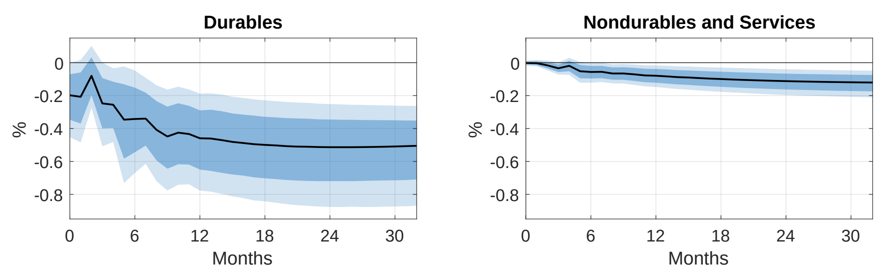
Figure 7: Firm Earnings

Note: Impulse responses to a one-standard deviation sovereign risk shock are estimated using local projections as specified in (5), with the cumulative sovereign risk shock over the quarter identified in the baseline VAR model in (2). Solid black lines denote point estimates, and shaded regions indicate 68% and 90% confidence intervals based on 10,000 replications of the lag-augmented bootstrap procedure of Montiel Olea and Plagborg-Møller (2021). Table A.2 in the Appendix provides further details on the variables used.

Firm Profitability. Earnings serve as a core indicator of financial health and are instrumental in determining firms' credit access over both short and medium horizons (Drechsel, 2023). Examining the response of firm profitability to sovereign risk is therefore essential for understanding potential amplification dynamics. To this end, Figure 7 presents the responses of business earnings across corporate and noncorporate sectors to a sovereign risk shock. Among corporate firms, earnings before interest and taxes (EBIT) decline gradually and persistently, reaching roughly 1.5 percent below baseline after two years. Proprietors' income, a measure of noncorporate business earnings, also contracts immediately and remains nearly one percent below baseline throughout the horizon, indicating a sustained deterioration in revenues for self-employed and unincorporated businesses. These findings highlight the potential for a two-way feedback loop between bank balance sheets and corporate risk, in which an initial tightening in lending conditions weakens firm fundamentals and further amplifies financial stress in the banking sector (Bernanke et al., 1999; Gertler and Karadi, 2011; Moretti, 2021).



(a) Household Income Shares



(b) Consumption Expenditure

Figure 8: Effects on the Household Sector

Note: Panel (a) shows impulse responses to a one-standard deviation sovereign risk shock estimated using local projections as specified in (5), with the cumulative sovereign risk shock over the quarter identified in the baseline VAR model in (2). Solid black lines denote point estimates, and shaded regions indicate 68% and 90% confidence intervals based on 10,000 replications of the lag-augmented bootstrap procedure of Montiel Olea and Plagborg-Møller (2021). Table A.2 in the Appendix provides further details on the variables used. Panel (b) displays impulse responses to a one-standard deviation sovereign risk shock estimated from the augmented VAR model in (2), using the sovereign risk surprise series in Figure (3) as an instrument. Solid black lines denote point estimates, and shaded regions indicate 68% and 90% confidence intervals based on 10,000 replications of the residual-based moving block bootstrap (Jentsch and Lunsford, 2019).

Household Income and Spending. The effects of sovereign risk ultimately extend to households through both direct reductions in business revenues and indirect transmission via labor market conditions.

To assess the strength of these channels, I examine the responses of wage compensation and proprietors' income as shares of aggregate disposable income. Figure 8a shows that both components decline in statistically and economically significant terms in response to a sovereign risk shock. The reduction in the wage share, however, is more than twice the magnitude of the decline in proprietors' income, pointing to indirect labor market effects as the dominant source of pass-through to households.

The compression of household income, in turn, translates into weaker consumption. As shown in the left panel of Figure 8b, spending on durable goods contracts by roughly 0.5 percent within the first few quarters, reflecting the investment-like nature of durable purchases and greater sensitivity to changes in income and credit conditions. In comparison, spending on nondurables and services (right panel) declines more gradually and to a lesser extent, consistent with households' tendency to smooth essential expenditures over time.

Overall, these results highlight significant general equilibrium dynamics operating through household income and aggregate demand (see also Roldán, 2025), underscoring the far-reaching implications of sovereign risk beyond the financial and production sectors.

4.3 The Systemic Nature of U.S. Sovereign Risk

Having examined the transmission channels, another important question concerns the historical incidence and evolution of sovereign risk in the United States. Although U.S. Treasury securities have long been regarded as virtually free from default risk, episodes of fiscal brinkmanship surrounding the statutory debt limit have repeatedly unsettled market expectations regarding the possibility of delayed or missed government payments (see e.g. Bloomberg, 2011; Financial Times, 2023; Reuters, 2013; Wall Street Journal, 2017).

To examine these dynamics more formally, Figure 9 displays the estimated time series of structural sovereign risk shocks derived from the VAR in (2). The results reveal pronounced volatility during periods of debt ceiling negotiations. In particular, episodes of fiscal impasse in the 1980s, early 1990s, and more recent decades consistently coincide with measurable revisions in default expectations. These patterns underscore the central role of investor beliefs in shaping sovereign risk, illustrating that concerns about repayment can intensify even in the absence of any observable deterioration in macroeconomic fundamentals.

Further evidence is provided in the right panel of Figure 9, which presents a comparison of shock distributions based on the presence of active debt ceiling negotiations. The standard deviation of shocks is more than four times higher during negotiation periods, indicating that institutional developments surrounding the debt limit systematically influence expectations of repayment. A Brown–Forsythe test confirms that the difference in variances is statistically significant. In addition, a historical decomposition reveals that sovereign risk shocks have contributed meaningfully to fluctuations in Treasury yields during episodes of heightened debt-ceiling stress (see Figure C.3).

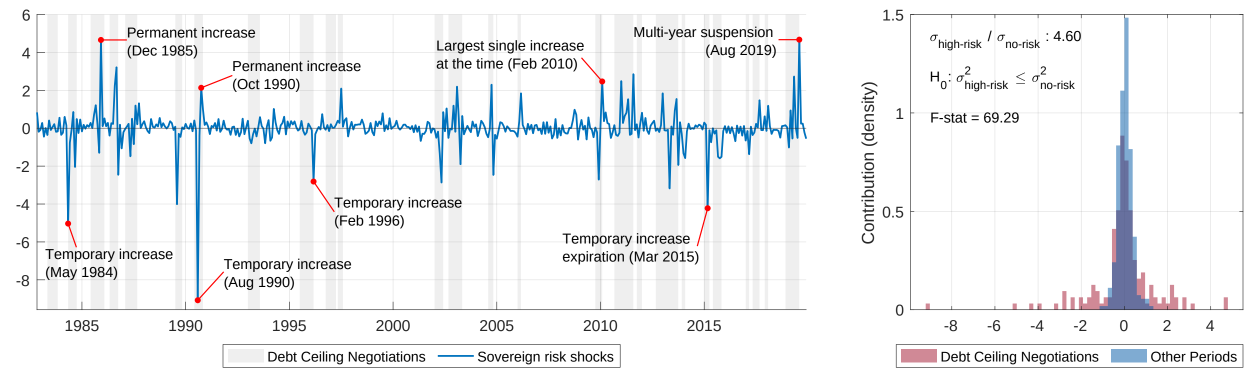


Figure 9: Estimated Sovereign Risk Shocks

Note: (Left panel) Estimated time series of structural sovereign risk shocks obtained from the VAR in (2); shaded areas indicate periods of debt ceiling negotiations, extending from the start of each episode to its resolution. (Right panel) Distribution of structural sovereign risk shocks, shown separately for periods with and without active debt ceiling negotiations.

These findings suggest that debt ceiling episodes are not isolated disruptions but constitute a recurrent and systemic source of sovereign risk embedded in the institutional framework of U.S. fiscal governance. In this context, two fundamental policy questions arise: What instruments are available to mitigate the macroeconomic impact of sovereign risk shocks? And to what extent have debt ceiling impasses impaired macroeconomic performance and welfare? The next section addresses these questions through the lens of a quantitative general equilibrium model of sovereign risk.

5 A New Keynesian Model with Sovereign Default Risk

This section presents a dynamic stochastic general equilibrium (DSGE) model to formally characterize the mechanism through which sovereign risk affects the macroeconomy and to assess its implications for optimal policy. The framework builds on the class of medium-scale New Keynesian models with financial frictions in the spirit of Gertler and Karadi (2013) and Carlstrom et al. (2017), augmented to allow for probabilistic sovereign default à la Bocola (2016). The environment features optimizing households, wage-setting labor unions, a multi-layered production sector, financial intermediaries, a fiscal authority, and a central bank.

Specifically, financial intermediaries manage portfolios of corporate and government long-term bonds on behalf of households. The resulting market segmentation creates an agency problem that constrains financial leverage and increases the sensitivity of portfolio allocations to changes in asset prices. In this setting, sovereign risk is modeled as an exogenous probability of default on government debt, capturing the possibility that repayment may depend on institutional or political constraints unrelated to macroeconomic fundamentals (i.e., the statutory debt limit). An increase in expected default risk lowers the market value of government securities, eroding intermediaries' net worth and tightening funding constraints. The resulting contraction in credit provision propagates to the production sector, where wholesale firms depend on external finance to sustain capital investment.

The remaining elements of the model follow standard formulations. Households choose consumption and leisure, and save through short-term deposits. Labor is supplied to unions that set wages under monopolistic competition subject to nominal rigidity. On the production side, wholesale firms combine capital and aggregated labor to produce intermediate goods, which are then repackaged and sold by monopolistically competitive retailers that adjust prices infrequently. Final goods producers aggregate retail varieties into a homogeneous consumption good, while a competitive capital sector converts unconsumed output into new physical capital. Monetary policy is conducted by a central bank that sets the nominal interest rate according to a standard Taylor-type rule.

The discussion that follows highlights the features of the model that are central to reproducing the empirical transmission of sovereign risk. A complete characterization of the model structure and equilibrium conditions is presented in Appendix D.

5.1 Financial Intermediaries

The model features a continuum of financial intermediaries indexed by i, each operating in segmented financial markets. Intermediaries manage portfolios on behalf of households, allocating funds across corporate bonds $F_{i,t}$, government bonds $B_{i,t}$, and reserves $RE_{i,t}$. These asset positions are financed through a combination of household deposits $D_{i,t}$ and the intermediary's own equity $N_{i,t}$, implying the balance sheet identity:

$$Q_t F_{i,t} + Q_{B,t} B_{i,t} + RE_{i,t} = D_{i,t} + N_{i,t}, \tag{6}$$

where Q_t and $Q_{B,t}$ represent market prices of corporate and government bonds, respectively.

Intermediaries are forward-looking and accumulate net worth from realized asset returns after deducting the cost of deposit funding:

$$N_{i,t} = R^F_t Q_{t-1} F_{i,t-1} + R^B_t Q_{B,t-1} B_{i,t-1} + R^{re}_{t-1} RE_{i,t-1} - R^d_{t-1} D_{i,t-1} \tag{7}$$

where R^F_t, R^B_t, and R^{re}_t denote gross returns on corporate bonds, government bonds, and reserves, respectively, and R^d_t represents the gross interest rate on deposits. To ensure a stationary distribution of net worth, a fraction $1-\sigma$ of intermediaries exits the market exogenously each period. Upon exit, their residual net worth is transferred to households, while an equal mass of new intermediaries enters the market with initial equity X.

Intermediaries select portfolio allocations to maximize the expected present value of real net worth, conditional upon survival:

$$V_{i,t} = \max\left(1-\sigma\right)\mathbb{E}_t \sum_{j=1}^{\infty} \sigma^{j-1} \Lambda_{t,t+j} n_{i,t+j} \tag{8}$$

where $n_{i,t+j} = N_{i,t+j}/P_{t+j}$ is real net worth at period $t+j$, and $\Lambda_{t,t+j}$ is the household stochastic discount factor. An enforcement problem, however, restricts their borrowing capacity against future returns. Specifically, at the end of each period, intermediaries may divert a fraction $\theta_t \in (0,1)$ of their bond portfolios. Anticipating this possibility, depositors impose an incentive compatibility condition:

$$V_{i,t} \geq \theta_t \left(Q_t f_{i,t} + \Delta Q_{B,t} b_{i,t}\right), \tag{9}$$

requiring the continuation value of the intermediary to be no less than the value of assets that can be diverted. In this condition, $\Delta \in (0,1)$ captures the relative enforceability across bonds, indicating that (real) private debt $f_{i,t} \equiv F_{i,t}/P_t$ can be diverted more easily than government bonds $b_{i,t} \equiv B_{i,t}/P_t$.

Optimal Bond Allocation. The optimization problem in Equations (6)-(9) admits a symmetric equilibrium. Of particular relevance are the no-arbitrage optimality conditions for bond holdings:

$$\mathbb{E}_t \tilde{\Lambda}_{t,t+1}\left(R^F_{t+1} - R^d_t\right)\Pi^{-1}_{t+1} = \frac{\lambda_t}{1+\lambda_t}\theta_t \tag{10}$$

$$\mathbb{E}_t \tilde{\Lambda}_{t,t+1}\left(R^B_{t+1} - R^d_t\right)\Pi^{-1}_{t+1} = \frac{\lambda_t}{1+\lambda_t}\theta_t \Delta \tag{11}$$

where λ_t is the Lagrange multiplier associated with the enforcement constraint, Π_t denotes gross inflation, and $\tilde{\Lambda}_{t,t+1}$ represents the intermediary's augmented stochastic discount factor. These conditions show that risk-adjusted excess returns on bonds are positive if and only if the enforcement constraint binds (i.e., $\lambda_t > 0$). In addition, (10) and (11) jointly establish that excess returns co-move across corporate and government bonds, forming a key channel through which changes in government bond pricing propagate to corporate financing conditions.

5.2 Production

The production side of the economy is organized in multiple layers. At its core, a representative wholesale firm utilizes its own capital and hires labor from unions to produce intermediate goods. These goods are then sold to a continuum of retail firms operating under monopolistic competition, which transform and price them as differentiated products. A competitive final-goods producer aggregates these differentiated varieties into a single homogeneous consumption good, while a dedicated capital-goods sector converts unconsumed output into new physical capital. The main departures from standard formulations are introduced in the wholesale sector, which is discussed in detail in the main text, while the remaining elements of the production side are presented in Appendix D.3.

The representative wholesale firm produces intermediate output according to a Cobb-Douglas technology:

$$Y_{m,t} = A_t \left(u_t K_t\right)^{\alpha} L_{d,t}^{1-\alpha}, \tag{12}$$

where K_t represents the firm's capital stock, $L_{d,t}$ its labor demand, u_t the capital utilization rate, and A_t an exogenous productivity shock. The parameter $\alpha \in (0,1)$ reflects the capital share in production. Physical capital accumulates through investment, $\hat{I}_t$, according to a standard law of motion:

$$K_{t+1} = \hat{I}_t + \left(1 - \delta\left(u_t\right)\right) K_t, \tag{13}$$

where $\delta\left(u_t\right)$ is a function mapping higher utilization into greater depreciation.

In contrast to frictionless models, the firm must finance a fraction $\psi \in (0,1)$ of investment by issuing long-term corporate bonds (Carlstrom et al., 2017). This assumption imposes a *loan-in-advanc*e constraint that ties the firm's investment capacity to external financing conditions:

$$\psi P_t^k \hat{I}_t \leq Q_t \left(F_{m,t} - \kappa F_{m,t-1}\right) \tag{14}$$

where P_t^k is the nominal price of new capital, and $F_{m,t} - \kappa F_{m,t-1}$ denotes net bond issuance valued at market price Q_t. In this context, corporate bonds are modeled as perpetuities with geometrically decaying coupon payments (Sims and Wu, 2021), where $F_{m,t}$ represents the nominal outstanding bond obligations and $\kappa \in [0,1]$ governs the amortization rate. The holding-period return on these bonds is therefore:

$$R_t^F = \frac{1 + \kappa Q_t}{Q_{t-1}}. \tag{15}$$

Each period, the wholesale firm selects factor inputs, capital utilization, and bond issuance at prevailing market conditions to maximize the expected present value of real dividends:

$$div_t = P_t^{-1} \left[P_{m,t} Y_{m,t} - W_t L_{d,t} - P_t^k \hat{I}_t - F_{m,t-1} + Q_t \left(F_{m,t} - \kappa F_{m,t-1} \right) \right], \tag{16}$$

subject to the constraints detailed above, and discounted using the household's stochastic discount factor.

Optimal Capital Allocation. The optimization problem in Equation (16) yields two equilibrium relationships that are central to the transmission of sovereign risk to the production sector. The first is the intertemporal condition for capital accumulation:

$$p_t^k M_{1,t} = \mathbb{E}_t \Lambda_{t,t+1} \left[\alpha p_{m,t+1} A_{t+1} \left(K_{t+1} \right)^{\alpha - 1} u_{t+1}^{\alpha} L_{d,t+1}^{1-\alpha} + \left(1 - \delta \left(u_{t+1} \right) \right) p_{t+1}^k M_{1,t+1} \right] \tag{17}$$

where $p_t^k \equiv P_t^k / P_t$ and $p_{m,t} \equiv P_{m,t}/P_t$ denote the real prices of capital and intermediate goods, respectively, and $M_{1,t} \geq 1$ is an *investment wedge* that raises the effective cost of capital. The second condition determines the price of private bonds:

$$Q_t M_{2,t} = \mathbb{E}_t \Lambda_{t,t+1} \Pi_{t+1}^{-1} \left[1 + \kappa Q_{t+1} M_{2,t+1} \right], \tag{18}$$

in which $M_{2,t}$, instead, denotes a *financing wedge* due to the loan-in-advance constraint.[15]

An important implication of (17) and (18) is the direct relationship between the two market wedges:

$$M_{1,t} = 1 + \psi \left(M_{2,t} - 1 \right) \tag{19}$$

In economic terms, the investment wedge is proportional, to first order, to the financing wedge; an increase in the external cost of finance (i.e., higher $M_{2,t}$) thus raises the effective cost of capital (via $M_{1,t}$), reducing the firm's incentive to invest and, in turn, constraining its productive capacity.

[15]Formally, $M_{2,t}$ is equal to one plus the Lagrange multiplier on the loan-in-advance constraint.

5.3 Macroeconomic Policy

Consistent with the empirical evidence that repeated debt ceiling episodes generate credible increases in default risk, the model includes a government sector operating under a binding statutory debt limit and subject to exogenous default risk. A monetary authority is also included to assess the effectiveness of monetary policy in stabilizing the economy under these conditions.

Government. In each period, the government conducts public spending G_t, financed through a combination of lump-sum taxes on households T_t, transfers from central bank operations $T_{cb,t}$, and the issuance of nominal bonds $B_{G,t}$. These bonds are modeled as perpetuities with geometrically declining coupon payments and trade at price Q_t^B in secondary markets. Beyond this standard setup, the model incorporates two additional features stemming from the statutory debt ceiling.

The first concerns sovereign repayment risk. A binding debt limit increases the probability of a technical default due to delayed or partial repayment of outstanding obligations, independent of macroeconomic fundamentals. To capture this risk, the model assumes that, in any given period, the government may exogenously default on a fraction $D \in (0,1)$ of its outstanding debt (Bocola, 2016).[16] Denoting p_t^D as the probability of default, the gross return on government bonds is thus defined as:

$$R_t^B = \begin{cases} \left(1 + \kappa Q_t^B\right) / Q_{t-1}^B, & \text{with probability } 1 - p_t^D, \\ (1 - D) \cdot \left(1 + \kappa Q_t^B\right) / Q_{t-1}^B, & \text{with probability } p_t^D, \end{cases} \tag{20}$$

where $\kappa \in (0,1)$ denotes the decay rate of coupon payments.

The second feature concerns the path of debt issuance. Episodes of elevated sovereign risk tend to coincide with periods in which the statutory debt ceiling binds, legally preventing the Treasury from issuing new debt. At the same time, empirical evidence from Section (4) indicates that Treasury holdings in the banking sector remain largely unchanged, in turn motivating the assumption of an exogenous path for government debt.

Together, these assumptions yield the nominal budget constraint:

$$P_t G_t + \left(1 - p_t^D \cdot D\right) B_{G,t-1} = P_t T_t + P_t T_{cb,t} + Q_{B,t} \left(B_{G,t} - \left(1 - p_t^D \cdot D\right) \kappa B_{G,t-1}\right) \tag{21}$$

where taxes adjust residually to satisfy the constraint, conditional on the paths of govern-

[16] This reduced-form specification stands in contrast to canonical models of endogenous default, where sovereign risk arises as a consequence of deteriorating macroeconomic fundamentals (e.g., Aguiar and Gopinath 2006; Eaton and Gersovitz 1981).

ment spending, transfers, and debt. Last, the government block is closed by specifying a process for the probability of default:

$$p_t^D = \left(1 - \rho^D\right) p^D + \rho^D p_{t-1}^D + \varepsilon_t^D \tag{22}$$

where p^D denotes the steady-state default probability, $\rho^D \in (0, 1)$ governs the persistence of the process, and ε_t^D is an i.i.d. mean-zero innovation.

Central Bank. The monetary authority sets the nominal interest rate on reserves according to a standard Taylor-type rule:

$$\ln R_t^{re} = (1 - \rho_r) \ln R^{re} + \rho_r \ln R_{t-1}^{re} + (1 - \rho_r) \left[\phi_\pi \left(\ln \Pi_t - \ln \Pi\right) + \phi_y \left(\ln Y_t - \ln Y\right)\right] + \varepsilon_{r,t} \tag{23}$$

where ϕ_π and ϕ_y are the policy response coefficients to inflation and output, respectively, ρ_r captures the degree of interest rate smoothing, and $\varepsilon_{r,t}$ represents a monetary policy shock. In addition to its interest rate policy, the central bank manages a balance sheet consisting of long-term government bonds and private investment securities, financed through the issuance of reserves. This configuration allows the model to capture the macroeconomic effects of unconventional monetary policy, including large-scale asset purchases and other balance sheet operations, in an environment in which standard nominal rate adjustments are no longer feasible (i.e., binding effective lower bound), as examined in the following section.

6 Quantitative Analysis

This section presents a quantitative evaluation of the model and examines its implications for optimal policy in the presence of sovereign risk. The analysis proceeds in three stages. First, the model is calibrated to replicate the empirical effects of a sovereign risk shock as documented in Section 4. Second, the analysis solves for the optimal policy response under commitment, providing analytical insight into the transmission channels of sovereign risk. Third, it assesses the effectiveness of a simple interest rate rule in approximating the Ramsey-optimal allocation in a decentralized setting.

6.1 Replicating the Empirical Results

The first step in the quantitative analysis involves disciplining the model parameters to match the estimated effects of a sovereign risk shock. The calibration employs, for the most part, parameter values widely used in the literature, with a subset of less standard parameters tailored to the specific features of the model. These are listed in Table 1 and discussed below. All remaining parameters are reported in Appendix D.9.

The calibration of the production and financial sectors is based on Sims and Wu (2021) and Cardamone et al. (2023). A central parameter for production is the share ψ of investment financed externally. In line with these studies, ψ is set to 0.81 to match the ratio of outstanding private debt to nominal GDP in the United States prior to the financial crisis. Similarly, the decay factor for coupon payments is chosen to imply a ten-year duration for long-term corporate bonds, consistent with average maturities observed in U.S. credit markets.[17] As for the financial sector, the survival probability of intermediaries is set to 0.95, consistent with conventional values in the literature, while the enforcement parameter θ and the bond recovery rate Δ are selected to match average excess returns of 300 basis points on corporate bonds and 100 basis points on government bonds relative to the deposit rate.

Parameter	Interpretation	Value or Target	Source or Calibration Strategy
ψ	Share of Investment from Debt	0.81	Sims and Wu (2021)
κ	Coupon Decay Parameter / Bond Duration	$1-40^{-1}$	Sims and Wu (2021)
σ	Intermediary Survival Probability	0.95	Sims and Wu (2021)
θ	Recoverability Parameter / steady state spread	$400\left(R^F-R^d\right)=3$	Sims and Wu (2021)
Δ	Government Bond Recoverability	1/3	Sims and Wu (2021)
D	Haircut	0.15	Cruces and Trebesch (2013)
$\bar{p}_D$	Steady State Probability of Default	0.002	Hur et al. (2018)
σ_D	Std. Sovereign Risk Shock	0.316×10^2	IRF-targeted
ρ_D	AR(1) Coeff. Sovereign Risk	0.85	IRF-targeted
ρ_r	Taylor Rule Smoothing	0.55	IRF-targeted
ϕ_π	Taylor Rule Inflation	1.70	IRF-targeted
ϕ_y	Taylor Rule Output	0.20	IRF-targeted

Table 1: Calibrated Parameters

The calibration of fiscal parameters is comparatively less standard. In particular, the haircut parameter D poses a specific challenge, given that the United States has no historical precedent of sovereign debt restructuring. To inform its selection, the calibration draws on the empirical distribution of investor losses across 180 sovereign debt restructurings with foreign creditors between 1970 and 2010, as reported in Cruces and Trebesch (2013). The modal haircut in the sample lies between 10 and 20 percent, motivating a

[17] For simplicity, the model assumes equal duration for corporate and government bonds, with no material impact on the results.

benchmark value of $D = 0.15$.[18] Similarly, the steady-state default probability on U.S. sovereign debt, $\bar{p}_D$, is set to 0.2%, based on the historical frequency of defaults among 19 advanced economies (including the U.S.) between 1900 and 2015, as documented in Hur et al. (2018).[19] The remaining parameters, governing the volatility and persistence of the default process, as well as monetary policy, are jointly calibrated to match the impulse responses of key macroeconomic and financial variables (see Figure D.1 in the Appendix).

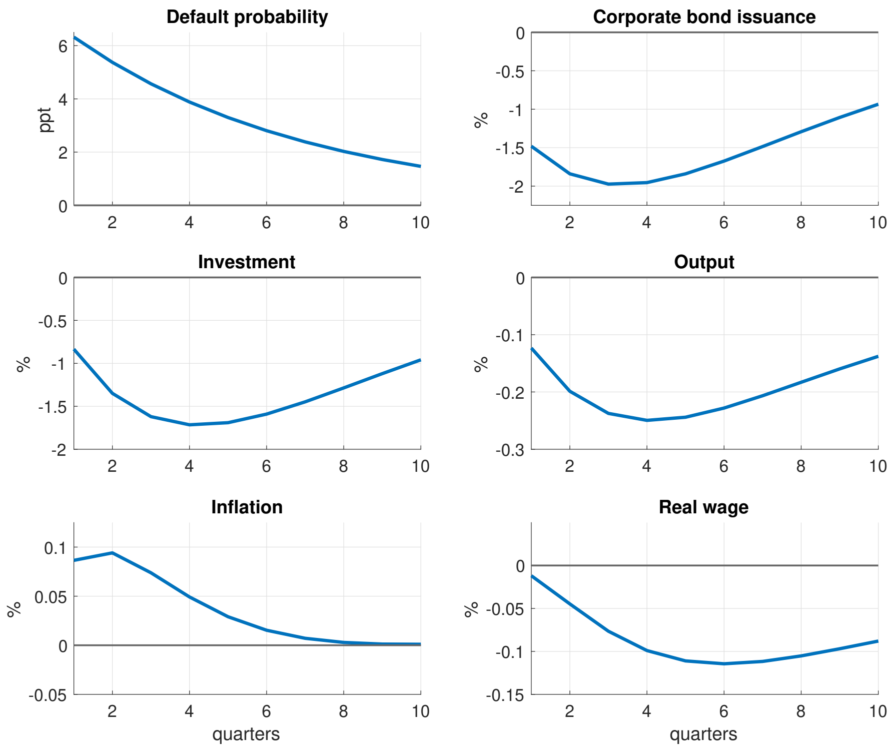


Figure 10: Impulse Responses to a Sovereign Risk Shock

Impulse Responses to a Sovereign Risk Shock. The model is solved using a first-order approximation around the non-stochastic steady state. Baseline impulse responses are reported in Figure 10, with additional results presented in Appendix Figure E.1.

In response to an exogenous increase in sovereign default risk, the model effectively reproduces the core macroeconomic dynamics identified in the empirical analysis. These include a persistent contraction in credit availability and capital investment, a decline in aggregate output and labor earnings, and a moderate increase in inflation. Quantitatively, matching the observed responses requires a six-percentage-point increase in the

[18] The median and mean haircuts – 32.5% and 37.5%, respectively – exceed this value, consistent with the assumption that a potential U.S. restructuring would likely fall at the lower end of the distribution.

[19] This estimate excludes episodes during the world wars and implies an average of one default every 500 years.

default probability, a magnitude well within market-implied estimates documented during recent U.S. debt ceiling episodes (Benzoni et al., 2023).[20] Additionally, the relative magnitudes of the core macroeconomic responses align closely with estimates from other general equilibrium models of sovereign risk (e.g., Bocola, 2016), lending further support to the external validity of the model.

The transmission dynamics are also consistent with empirical evidence. Specifically, the initial shock induces a swift repricing of government securities that erodes bank net worth and amplifies agency frictions, leading to a tightening of lending constraints. The resulting balance sheet adjustments propagate to the real economy through the loan-in-advance constraint, prompting firms to cut investment and, consequently, labor demand. These supply-side pressures ultimately reduce output and labor earnings, and generate a moderate rise in prices.

To summarize, the model successfully captures the main quantitative and qualitative dynamics observed in the data, providing a useful laboratory for optimal policy analysis and for assessing the role of stabilization policies in the presence of sovereign risk.

6.2 Optimal Policy under Sovereign Risk

This section examines the optimal policy response to sovereign risk. The analysis begins by formalizing the transmission mechanism through which elevated default risk disrupts financial conditions and constrains economic activity. It then derives the optimal interest rate path that solves the Ramsey problem, and evaluates the effectiveness of a simple policy rule in replicating the planner's allocation in a decentralized setting.

Transmission Mechanism of Sovereign Risk. Sovereign risk affects the real economy primarily through its impact on the cost of capital formation and investment decisions. To formally illustrate this transmission mechanism, the analysis first establishes the mechanics of investment dynamics, and then explicitly connects these dynamics to prevailing financial market conditions.

The core relationship governing investment decisions is represented by the (log-linearized) Euler equation for capital accumulation (Equation 17):

$$\hat{p}_t^k + \hat{M}_{1,t} = \mathbb{E}_t \left[\hat{\Lambda}_{t,t+1} + \Lambda \left(1 - \delta_0\right) \left(\hat{p}_{t+1}^k + \hat{M}_{1,t+1} \right) + \hat{R}_{K,t+1} \right], \tag{24}$$

[20] Based on credit default swap (CDS) spreads, the authors estimate that default probabilities exceeded 6 percent during the 2011 debt ceiling crisis and reached roughly 4 percent during the 2013 and 2023 episodes. The empirical sovereign risk surprise series used in Section 2.1 captures a broader set of related episodes, supporting this interpretation.

where $\hat{R}_{K,t+1}$ denotes the gross return on capital.[21] Substituting the stochastic discount factor and iterating forward yields an equation relating the marginal cost of capital installation to the present discounted value of expected returns over the real cost of debt:

$$\hat{p}_t^k + \hat{M}_{1,t} = \mathbb{E}_t \sum_{j=0}^{\infty} \left[\Lambda \left(1 - \delta_0\right)\right]^j \left[\hat{R}_{t+j+1}^K - \left(\hat{R}_{t+j}^d - \hat{\Pi}_{t+j+1}\right)\right]. \tag{25}$$

Note that the investment wedge $\hat{M}_{1,t}$ acts analogously to a distortionary tax on new capital, as increases in the wedge raise the effective cost of capital and reduce firms' incentives to invest.

The magnitude of the investment wedge, however, depends on prevailing credit market conditions. To explicitly illustrate this relationship, consider the pricing condition for corporate debt (Equation 18):

$$\hat{M}_{2,t} \approx \mathbb{E}_t \sum_{j=0}^{\infty} \left(\kappa\beta\right)^j \left[\hat{R}_{t+j+1}^F - \hat{R}_{t+j}^d\right] \tag{26}$$

where, due to market segmentation, the financing wedge $\hat{M}_{2,t}$ reflects the discounted sum of expected excess returns on corporate bonds.[22] Importantly, condition (26) can be equivalently stated in terms of $M_{1,t}$, given the proportionality between the two market wedges (Equation 19):

$$\hat{M}_{1,t} \propto \mathbb{E}_t \sum_{j=0}^{\infty} \left(\kappa\beta\right)^j \left[\hat{R}_{t+j+1}^F - \hat{R}_{t+j}^d\right], \tag{27}$$

thus establishing a direct link between changes in borrowing costs and capital accumulation.

In this context, sovereign risk influences investment via financial market repricing. Specifically, an increase in the probability of sovereign default transmits from government to corporate bond markets through the no-arbitrage conditions (Equations 10 and 11), allowing the investment wedge to be expressed directly in terms of government bond returns:

$$\hat{M}_{1,t} \propto \mathbb{E}_t \sum_{j=0}^{\infty} \left(\kappa\beta\right)^j \left[\hat{R}_{t+j+1}^B - \hat{R}_{t+j}^d\right]. \tag{28}$$

This final expression formalizes the core transmission mechanism of sovereign risk, illustrating how sovereign debt repricing distorts investment decisions and, in turn, con-

[21]For notational convenience, $R_{t+1}^K \equiv \alpha p_{m,t+1} A_{t+1} \left(K_{t+1}\right)^{\alpha-1} u_{t+1}^{\alpha} L_{d,t+1}^{1-\alpha}$.

[22]The return on corporate bonds $\hat{R}_{t+j+1}^F \approx \kappa\beta\hat{Q}_{t+j+1} - \hat{Q}_{t+j}$ follows from Equation (15).

strains economic activity.[23] In this setting, an interest rate policy aimed at stabilizing excess returns on government bonds provides an effective instrument for mitigating the broader macroeconomic implications of sovereign risk.

Ramsey Policy as Optimal Interest Rate Response. The Ramsey problem provides a natural benchmark for optimal policy by determining the trajectory of the policy instrument that maximizes household welfare, subject to the constraints of the decentralized economy.

In the presence of sovereign risk, the Ramsey planner optimally adjusts the nominal interest rate to counteract distortions arising from fluctuations in government bond returns. The optimal policy response specifically targets three distinct sources of economic distortion. First, segmented financial markets introduce a financing wedge that elevates the cost of capital and constrains investment. Additionally, nominal rigidities in goods and labor markets produce time-varying markups, resulting in labor and capital wedges that distort the efficient allocation of productive inputs.[24] Optimal policy thus involves balancing the objective of easing financial conditions against the requirement to maintain prices and wages stable.

Figure 11 illustrates this policy trade-off. Relative to the decentralized equilibrium, the Ramsey allocation significantly mitigates the rise in the financing wedge, in turn limiting the contraction in investment and output. Over the medium term, both capital and labor wedges narrow, highlighting the planner's effectiveness in containing the broader economic costs of sovereign risk. Achieving these outcomes, however, requires tolerating persistent financing inefficiencies to avoid exacerbating nominal distortions, as a more aggressive financial stabilization would cause inefficient fluctuations in the labor wedge and result in excessive disinflation.

This fundamental tension between financial and nominal stability is central to the design of implementable policy rules. Specifically, if stabilizing excess returns on government bonds yields meaningful macroeconomic benefits under sovereign risk, a natural question is whether a simple interest rate rule can effectively approximate the Ramsey allocation within a decentralized framework. The next section explores this question.

[23]This mechanism is conceptually related to the economic effects of an increase in the term premium, as defined in Carlstrom et al. (2017).

[24]These distortions are defined in Carlstrom et al. (2017) and consist of a "labor wedge," defined as the gap between the marginal product of labor and the household's marginal rate of substitution, and a "capital wedge," defined as the deviation between the marginal product of capital and its effective user cost.

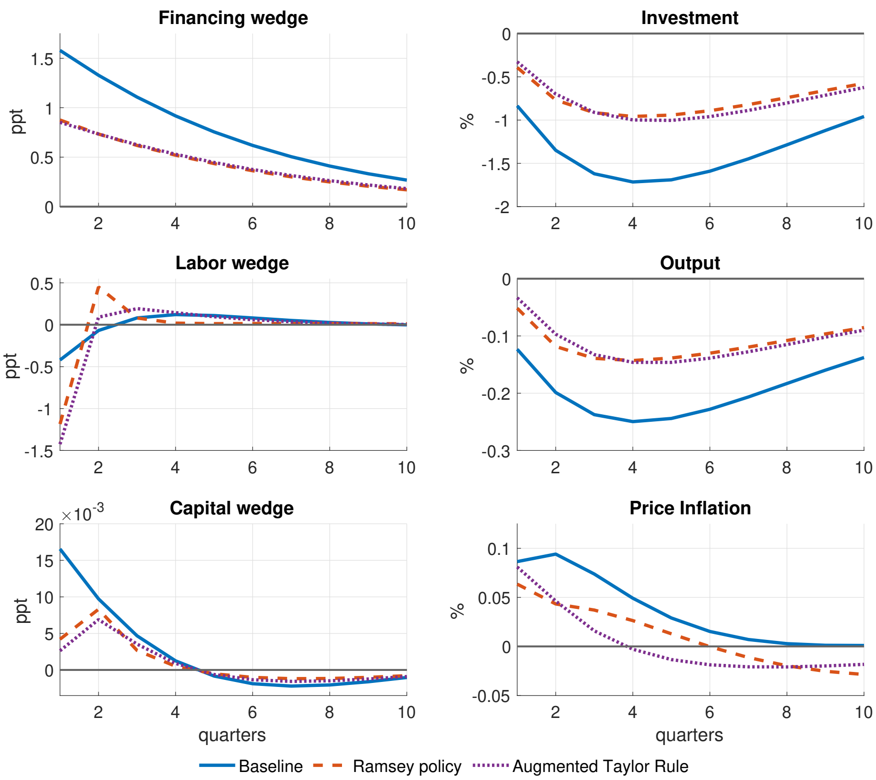


Figure 11: Optimal Policy Response to Sovereign Risk

Welfare Consequences of an Augmented Taylor Rule. Consider an augmented Taylor rule that explicitly incorporates a response to fluctuations in government bond returns:

$$\ln R_t^{re} = (1-\rho_r)\ln R^{re} + \rho_r \ln R_{t-1}^{re} + (1-\rho_r)\left[\phi_\pi \ln\left(\frac{\Pi_t}{\Pi}\right) + \phi_y \ln\left(\frac{Y_t}{Y}\right) + \phi_B \ln\left(\frac{R_t^B}{R^B}\right)\right] + \varepsilon_{r,t} \tag{29}$$

where the parameter ϕ_B captures the sensitivity of the nominal interest rate to deviations in R_t^B from its steady state value. Before assessing welfare implications, the parameters of the augmented rule are estimated using simulated data from the Ramsey economy (see Appendix Table E.1). Of particular interest, the estimated coefficient on government bond returns, $\widehat{\phi}_B \approx 0.12$, indicates a monetary stance that systematically leans against sovereign risk. In economic terms, this implies that during periods of elevated sovereign risk, lower expected returns on public debt prompt the central bank to loosen its policy stance to ease credit conditions and support investment. Vice versa, as bond returns normalize, the policy stance adjusts upward to prevent overheating.

With the estimated parameters in hand, the first step is to evaluate whether the augmented rule can effectively replicate the Ramsey interest rate path. To this end, I simulate the model under both centralized and decentralized monetary policy and examine the empirical fit of alternative Taylor rules relative to the Ramsey policy. The left panel of Figure 12 presents a scatter plot (green crosses) of the fitted policy rates implied by augmented against the Ramsey counterpart. For comparison, the figure also presents the corresponding plot for the standard Taylor rule in Equation (23) (red circles). Against the 45-degree line, the augmented rule provides a substantially closer approximation to the Ramsey path, underscoring the informational value of bond return dynamics for optimal policy. To substantiate this point, the right panel compares correlations for the fully specified augmented rule (green crosses) to a restricted variant with $\phi_B = 0$ (blue circles), further highlighting the importance of systematically responding to financial market conditions in the presence of elevated default risk.

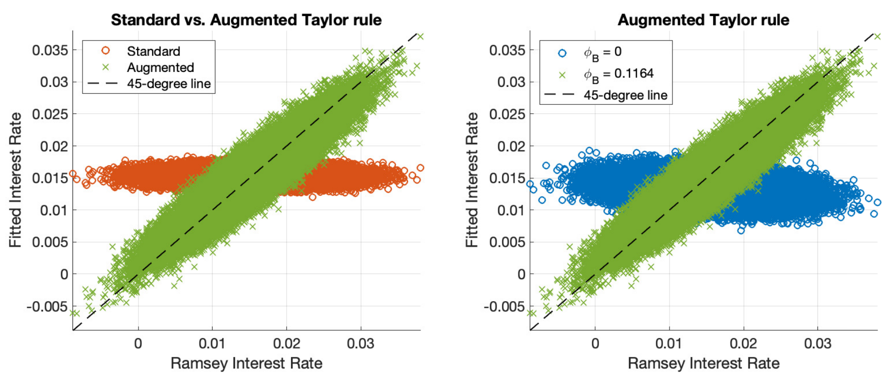


Figure 12: Taylor Rule Comparison: Actual vs. Fitted log Interest Rate

Note: Correlations between interest rate paths from the simulated economies (Ramsey vs decentralized) (100,000 periods) and the fitted interest rate rules in Equations (23) and (29), with parameters estimated in Appendix Table E.1.

Augmented Taylor rule (29):	**Restricted Rule**	**Unrestricted Rule**
Policy Parameters and Outcomes:		
Response to bond return (ϕ_B)	0	0.116
Welfare gain (% CEV)	–	0.31%
Volatility of market distortions:		
Financial segmentation wedge	0.586	0.447
Capital market wedge	0.009	0.007
Labor market wedge	0.164	0.484

Table 2: Welfare Analysis

This empirical assessment forms the basis for the welfare analysis. Table 2 reports the consumption-equivalent welfare gain from adopting the augmented rule, measured relative to the restricted specification. The augmented rule yields a welfare improvement of 0.31, implying that households would require a permanent consumption increase of equivalent magnitude to achieve the same welfare under the restricted rule. This gain is accompanied by reduced volatility in financial and investment-related variables. As in the Ramsey allocation, however, these benefits come at the cost of greater variability in the labor-market wedge. These mechanisms are further illustrated in Figure 11. The impulse responses show that the augmented rule closely tracks the Ramsey allocation along real margins, mitigating the transmission of sovereign risk to private credit markets by stabilizing excess returns on government debt. As a result, the decline in capital formation and output is substantially smaller than under the standard rule. Along nominal margins, however, the augmented rule diverges from the Ramsey allocation, reflecting the mechanical nature of a simple rule compared to the planner's intertemporally coordinated policy.

In summary, a simple interest rate rule augmented with a response to sovereign bond returns can replicate many of the macroeconomic benefits associated with optimal policy. These findings underscore the potential gains from systematically incorporating financial market conditions into monetary policy design in the presence of elevated sovereign risk.

Endogenous Asset Purchases and the Effective Lower Bound. An important question is whether optimal policy remains effective when the effective lower bound (ELB) on the policy rate is binding, under which conventional interest rate adjustments are no longer feasible. In such an environment, the central bank can intervene through balance sheet operations, creating interest-bearing reserves to replace government bonds in the portfolios of financial intermediaries. This reallocation mitigates valuation losses on sovereign assets and helps sustain the flow of credit to firms despite the constraint on the policy rate. Appendix Figure E.2 presents impulse responses under a binding lower bound, where policy accommodation occurs through endogenous balance sheet expansion that stabilizes the financing wedge. The resulting dynamics closely mirror those observed under the unconstrained optimal policy, with reduced distortions across financial, labor, and capital markets and a substantially muted macroeconomic response to sovereign risk. These findings indicate that the transmission mechanism underpinning optimal policy remains effective when implemented through asset purchases rather than conventional interest rate adjustments.

7 Conclusion

This paper provides new empirical evidence on the macroeconomic effects of sovereign risk. Using high-frequency movements in Treasury prices during debt ceiling crises, I construct a novel instrument to identify shocks to default expectations. News of potential sovereign default generates immediate disruptions in financial markets and leads to persistent declines in real economic activity, even if default does not materialize.

I show that the primary transmission mechanism operates through the financial sector and firm balance sheets. Valuation losses on government securities erode bank capital and induce a withdrawal from private lending. The resulting contraction in credit supply reduces investment, particularly among highly leveraged firms, and constrains labor demand in capital-intensive sectors, compressing household disposable income and contributing to a broader decline in aggregate demand.

Although the United States is generally regarded as a safe sovereign borrower, I find evidence that the statutory debt limit has been a recurrent source of volatility in sovereign risk, posing a material threat to financial stability. To interpret these findings, I develop a medium-scale New Keynesian model with sovereign risk and financial frictions, illustrating how the interaction between sovereign debt repricing and credit market distortions transmits sovereign risk to the broader economy. The policy analysis demonstrates that conventional interest rate rules are insufficient to insulate the economy from sovereign risk shocks. In contrast, an augmented rule that responds to returns on government bonds closely replicates the Ramsey allocation and delivers meaningful welfare gains, even in the presence of a binding effective lower bound.

These findings underscore two important lessons. First, sovereign default expectations can exert significant macroeconomic effects regardless of whether default ultimately occurs. Second, the credibility of fiscal institutions and investor sentiment play a central role in shaping sovereign risk dynamics, independent of traditional macroeconomic fundamentals. In future work, it would be interesting to explore the open-economy dimension of these dynamics and analyze the cross-country spillovers of U.S. sovereign risk, given the role of the U.S. dollar as the dominant reserve currency.

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Online Appendix

The Macroeconomic Effects of Sovereign Risk: New Evidence from U.S. Debt Ceiling Episodes

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Contents

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A Data

A.1 Institutional Events

Information on debt ceiling legislation is available from the official Library of Congress website (www.congress.gov). The Journal of the House of Representatives and the Journal of the Senate of the United States provide the precise timing of when a bill is passed. Similarly, official communications from the U.S. Department of the Treasury are available on its website (home.treasury.gov) website. When an event occurs after market hours, it is recorded using the date of the following trading day.

Table A.1: Debt Ceiling Legislative and Advisory Events

	Date	Event Description	Bill Number	Public Law
1	23-Jun-1982	House and Senate Votes Passed	H.J.Res. 519	P.L. 97-204
2	23-Sep-1982	Senate Vote Passed	H.J.Res. 520	P.L. 97-270
3	18-May-1983	House Vote Passed	H.R. 2990	P.L. 98-34
4	17-Nov-1983	Senate Vote Passed	H.J.Res. 308	P.L. 98-161
5	18-Nov-1983	House Vote Passed	H.J.Res. 308	P.L. 98-161
6	24-May-1984	House and Senate Votes Passed	H.R. 5692	P.L. 98-302
7	4-Sep-1984	Statutory Debt Limit Reached		
8	2-Oct-1984	House Vote Passed	H.J.Res. 654	P.L. 98-475
9	3-Sep-1985	Statutory Debt Limit Reached		
10	13-Nov-1985	Senate Vote Passed	H.R. 3721	P.L. 99-155
11	11-Dec-1985	House and Senate Votes Passed	H.J.Res. 372	P.L. 99-177
12	1-Aug-1986	Statutory Debt Limit Reached		
13	15-Aug-1986	House Vote Passed	H.R. 5395	P.L. 99-384
14	18-Aug-1986	Senate Vote Passed	H.R. 5395	P.L. 99-384
15	30-Sep-1986	Statutory Debt Limit Reached		
16	17-Oct-1986	House Vote Passed	H.R. 5300	P.L. 99-509
17	20-Oct-1986	Senate Vote Passed	H.R. 5300	P.L. 99-509
18	13-May-1987	House Vote Passed	H.R. 2360	P.L. 100-40
19	14-May-1987	Senate Vote Passed	H.R. 2360	P.L. 100-40
20	18-Jul-1987	Statutory Debt Limit Reached		
21	29-Jul-1987	House Vote Passed	H.R. 3022	P.L. 100-80
22	30-Jul-1987	Senate Vote Passed	H.R. 3022	P.L. 100-80
23	7-Aug-1987	House and Senate Votes Passed	H.R. 3190	P.L. 100-84
24	1-Aug-1989	House Vote Passed	H.R. 3024	P.L. 101-72
25	4-Aug-1989	Senate Vote Passed	H.R. 3024	P.L. 101-72
26	4-Aug-1990	House and Senate Votes Passed	H.R. 5350	P.L. 101-350
27	30-Sep-1990	House Vote Passed	H.R. 5755	P.L. 101-405
28	9-Oct-1990	House and Senate Votes Passed	H.J.Res. 666	P.L. 101-412
29	19-Oct-1990	House and Senate Votes Passed	H.J.Res. 677	P.L. 101-444
30	25-Oct-1990	House and Senate Votes Passed	H.J.Res. 681	P.L. 101-461
31	2-Apr-1993	House Vote Passed	H.R. 1430	P.L. 103-12

Table A.1: Debt Ceiling Legislative and Advisory Events

	Date	Event Description	Bill Number	Public Law
32	5-Apr-1993	Senate Vote Passed	H.R. 1430	P.L. 103-12
33	7-Aug-1993	Senate Vote Passed	H.R. 2264	P.L. 103-66
34	7-Mar-1996	House and Senate Votes Passed	H.R. 3021	P.L. 104-115
35	28-Mar-1996	House and Senate Votes Passed	H.R. 3136	P.L. 104-121
36	30-Jul-1997	House Vote Passed	H.R. 2015	P.L. 105-33
37	31-Jul-1997	Senate Vote Passed	H.R. 2015	P.L. 105-33
38	17-Apr-2002	Treasury Secretary Sends Letter to Congress		
39	14-May-2002	Treasury Secretary Sends Letter to Congress		
40	11-Jun-2002	Senate Vote Passed	S. 2578	P.L. 107-199
41	18-Jun-2002	Treasury Secretary Sends Letter to Congress		
42	28-Jun-2002	House Vote Passed	S. 2578	P.L. 107-199
43	24-Dec-2002	Treasury Secretary Sends Letter to Congress		
44	19-Feb-2003	Treasury Secretary Sends Letter to Congress		
45	4-Apr-2003	Treasury Secretary Sends Letter to Congress		
46	12-Apr-2003	House Vote Passed	H.J.Res. 51	P.L. 108-24
47	19-May-2003	Treasury Secretary Sends Letter to Congress		
48	23-May-2003	Senate Vote Passed	H.J.Res. 51	P.L. 108-24
49	14-Oct-2004	Treasury Secretary Sends Letter to Congress		
50	18-Nov-2004	Senate Vote Passed	S. 2986	P.L. 108-415
51	19-Nov-2004	House Vote Passed	S. 2986	P.L. 108-415
52	29-Dec-2005	Treasury Secretary Sends Letter to Congress		
53	19-Feb-2006	Treasury Secretary Sends Letter to Congress		
54	6-Mar-2006	Treasury Secretary Sends Letter to Congress		
55	16-Mar-2006	Senate Vote Passed	H.J.Res. 47	P.L. 109-182
56	28-Sep-2007	House and Senate Votes Passed	H.J.Res. 43	P.L. 110-91
57	24-Dec-2009	Senate Vote Passed	H.R. 4314	P.L. 111-123
58	28-Dec-2009	House Vote Passed	H.R. 4314	P.L. 111-123
59	4-Feb-2010	House Vote Passed	H.J.Res. 45	P.L. 111-139
60	6-Jan-2011	Treasury Secretary Sends Letter to Congress		
61	4-Apr-2011	Treasury Secretary Sends Letter to Congress		
62	2-May-2011	Treasury Secretary Sends Letter to Congress		
63	31-May-2011	House Vote Passed	H.R. 1954	
64	31-May-2011	Senate Vote Failed	H.R. 1954	
65	25-Jul-2011	President Speaks to the Nation about Debt Ceiling Crisis		
66	2-Aug-2011	House Vote Passed	S. 365	P.L. 112-25
67	17-Jan-2012	Treasury Secretary Sends Letter to Congress		
68	26-Dec-2012	Treasury Secretary Sends Letter to Congress		
69	31-Dec-2012	Treasury Secretary Sends Letter to Congress		
70	30-Jan-2012	Statutory Debt Limit Reinstated		
71	14-Jan-2013	Treasury Secretary Sends Letter to Congress		
72	15-Jan-2013	Treasury Secretary Sends Letter to Congress		
73	23-Jan-2013	House Vote Passed	H.R. 325	P.L. 113-3
74	17-May-2013	Treasury Secretary Sends Letter to Congress		
75	20-May-2013	Treasury Secretary Sends Letter to Congress		
76	31-May-2013	Treasury Secretary Sends Letter to Congress		

Table A.1: Debt Ceiling Legislative and Advisory Events

	Date	Event Description	Bill Number	Public Law
77	26-Aug-2013	Treasury Secretary Sends Letter to Congress		
78	25-Sep-2013	Treasury Secretary Sends Letter to Congress		
79	1-Oct-2013	Treasury Secretary Sends Letter to Congress		
80	4-Oct-2013	Treasury Secretary Sends Letter to Congress		
81	22-Jan-2014	Treasury Secretary Sends Letter to Congress		
82	10-Feb-2014	Treasury Secretary Sends Letter to Congress		
83	12-Feb-2014	House and Senate Votes Passed	S. 540	P.L. 113-83
84	6-Mar-2015	Treasury Secretary Sends Letter to Congress		
85	13-Mar-2015	Treasury Secretary Sends Letter to Congress		
86	29-Jul-2015	Treasury Secretary Sends Letter to Congress		
87	30-Jul-2015	Treasury Secretary Sends Letter to Congress		
88	10-Sep-2015	Treasury Secretary Sends Letter to Congress		
89	1-Oct-2015	Treasury Secretary Sends Letter to Congress		
90	15-Oct-2015	Treasury Secretary Sends Letter to Congress		
91	2-Nov-2015	Senate Vote Passed	H.R. 1314	P.L. 114-74
92	8-Mar-2017	Treasury Secretary Sends Letter to Congress		
93	7-Sep-2017	House Vote Passed	H.R. 601	P.L. 115-56
94	8-Sep-2017	Senate Vote Passed	H.R. 601	P.L. 115-56
95	6-Dec-2017	Treasury Secretary Sends Letter to Congress		
96	11-Dec-2017	Treasury Secretary Sends Letter to Congress		
97	9-Feb-2018	House and Senate Votes Passed	H.R. 1892	P.L. 115-123
98	21-Feb-2019	Treasury Secretary Sends Letter to Congress		
99	4-Mar-2019	Treasury Secretary Sends Letter to Congress		
100	5-Mar-2019	Treasury Secretary Sends Letter to Congress		
101	23-May-2019	Treasury Secretary Sends Letter to Congress		
102	12-Jul-2019	Treasury Secretary Sends Letter to Congress		
103	25-Jul-2019	Treasury Secretary Sends Letter to Congress		
104	1-Aug-2019	Senate Vote Passed	H.R. 3877	P.L. 116-37
105	13-Oct-2021	House Vote Passed	S. 1301	P.L. 117-50
106	23-Jul-2021	Treasury Secretary Sends Letter to Congress		
107	2-Aug-2021	Treasury Secretary Sends Letter to Congress		
108	8-Sep-2021	Treasury Secretary Sends Letter to Congress		
109	28-Sep-2021	Treasury Secretary Sends Letter to Congress		
110	18-Oct-2021	Treasury Secretary Sends Letter to Congress		
111	16-Nov-2021	Treasury Secretary Sends Letter to Congress		
112	19-Nov-2021	Treasury Secretary Sends Letter to Congress		
113	19-Jan-2023	Treasury Secretary Sends Letter to Congress		
114	24-Jan-2023	Treasury Secretary Sends Letter to Congress		
115	1-May-2023	Treasury Secretary Sends Letter to Congress		
116	15-May-2023	Treasury Secretary Sends Letter to Congress		
117	22-May-2023	Treasury Secretary Sends Letter to Congress		
118	26-May-2023	Treasury Secretary Sends Letter to Congress		
119	1-Jun-2023	House Vote Passed	H.R. 3746	P.L. 118-5

A.2 Data Used in Estimation

Treasury Futures Trading Volume.

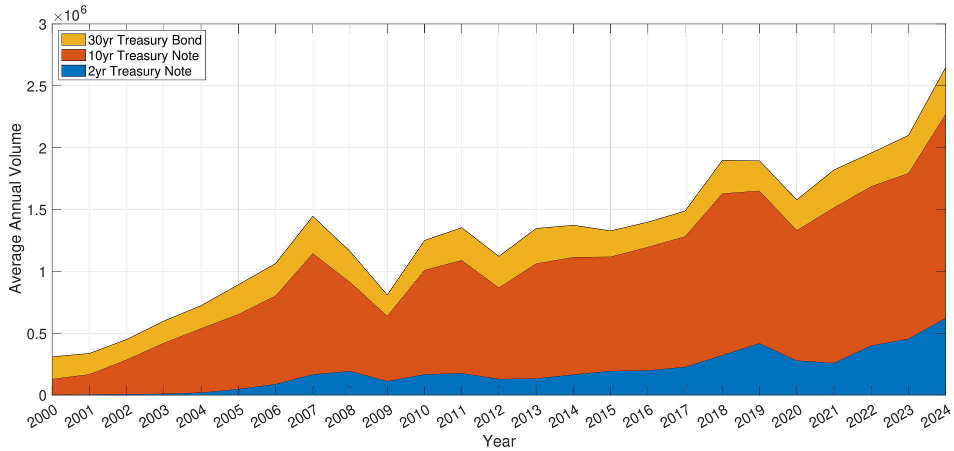


Figure A.1: U.S. Treasury Futures: Trading Volume

Data in the Baseline Model.

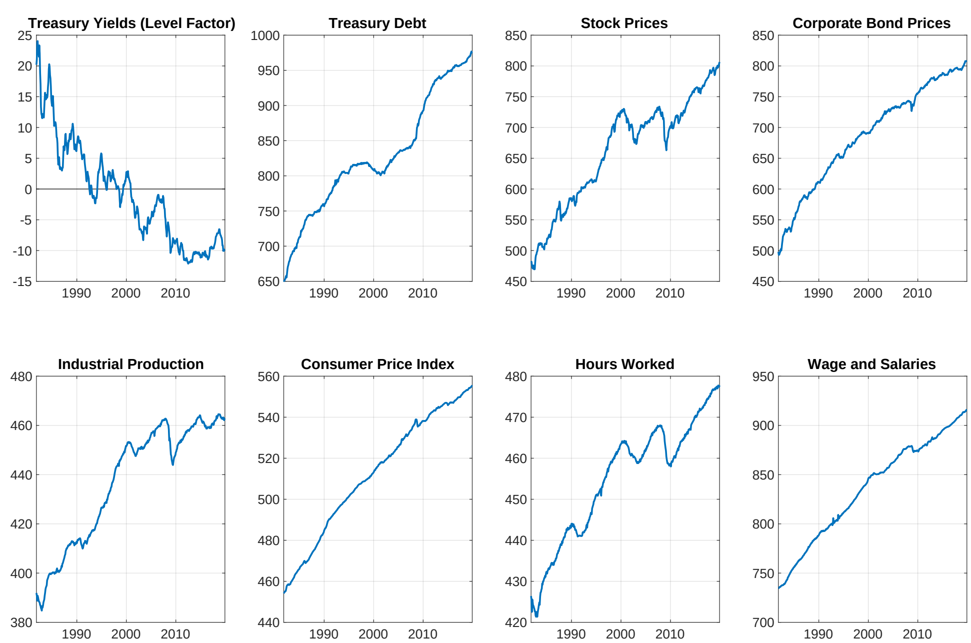


Figure A.2: Data Series Baseline Model

Variable Name	Description	Source	Sample	Transformation
Instrumental Variable				
TY1 Comdty	Generic 1st 10-Year U.S. Treasury Note Future	Bloomberg	05/03/82-08/31/23	$100 \times \Delta log$
Baseline Model				
TLEVEL	Level Factor of Treasury Yields	Own Calculations	1981M11-2019M12	
MVMTD027MNFRBDAL	Treasury Debt	FRED/Seasonal Adjustment	1981M11-2019M12	$100 \times log$
_SPXD	S&P 500	Finaeon	1981M11-2019M12	$100 \times log$
LUACTRUU	US Corporate Total Return Index	Bloomberg	1981M11-2019M12	$100 \times log$
INDPRO	Industrial Production	FRED	1981M11-2019M12	$100 \times log$
CPIAUCSL	CPI Price Index	FRED	1981M11-2019M12	$100 \times log$
AWHI	Hours Worked	FRED	1981M11-2019M12	$100 \times log$
A576RC1	Wages and Salaries	FRED	1981M11-2019M12	$100 \times log$
Additional Variables				
Banking Sector				
BLEVE	Bank Leverage	Own Calculations	1981M11-2019M12	$100 \times log$
TOTBKCR*	Bank Credit	FRED	1981M11-2019M12	$100 \times log$
OTHSEC*	Non-Treasury Securities	FRED	1981M11-2019M12	$100 \times log$
USGSEC*	Treasury Securities	FRED	1981M11-2019M12	$100 \times log$
BUSLOANS*	Business Loans	FRED	1981M11-2019M12	$100 \times log$
CONSUMER*	Consumer Loans	FRED	1981M11-2019M12	$100 \times log$
SUBLPDCILSLGNQ	Lending Standards to Firms	FRED	1990Q2-2019Q4	
SUBLPDCLCSLGNQ	Lending Standards to Consumers	FRED	1996Q2-2019Q4	
Corporate Sector				
FDEBT*	Firm Borrowing	Own Calculations	1983Q1-2019Q4	$100 \times log$
FINV*	Firm Investment	Own Calculations	1983Q1-2019Q4	$100 \times log$
HINV*	Investment: High-Leverage	Own Calculations	1983Q1-2019Q4	$100 \times log$
LINV*	Investment: Low-Leverage	Own Calculations	1983Q1-2019Q4	$100 \times log$
CIJOBS	Job Openings: Capital Intensive	Own Calculations	2001Q1-2019Q4	
NCIJOBS	Job Openings: Noncapital intensive	Own Calculations	2001Q1-2019Q4	
BOGZ1FA106110115Q*	Corporate Earnings	FRED	1983Q1-2019Q4	$100 \times log$
PROPINC*	Proprietors' Income	FRED	1983Q1-2019Q4	$100 \times log$
Household Sector				
WSHARE	Wages and Salaries Share	Own Calculations	1983Q1-2019Q4	
PSHARE	Proprietors' Income Share	Own Calculations	1983Q1-2019Q4	
DUR	Durables	Own Calculations	1981M11-2019M12	$100 \times log$
NDURS	Nondurables and Services	Own Calculations	1981M11-2019M12	$100 \times log$

Table A.2: Variables Used in Estimation

Note: Series marked with an asterisk (*) denote deflated values. Monthly variables are deflated using the Consumer Price Index (CPIAUCSL), while quarterly variables are deflated using the GDP Deflator (GDPDEF).

Variable Name	Raw Variables	Source	Sample	Transformation
Baseline Model				
TLEVEL	DGS1, DGS2, DGS3, DGS5, DGS7, DGS10, DGS30	FRED	1981M11-2019M12	1st Principal Component
Additional Variables				
Banking Sector				
BLEVE	TLAACBW027SBOG, RALACBW027SBOG	FRED	1981M11-2019M12	TLAACBW027SBOG/ RALACBW027SBOG
Corporate Sector				
FDEBT	BCNSDODNS, TCMILBSNNB	FRED	1983Q1-2019Q4	BCNSDODNS + TCMILBSNNB
FINV	BOGZ1FL105020005Q, BOGZ1FL105013265Q, RCSNNWMVBSNNCB, NNBI, NESABSNNB, RCVSNWBSNNB, NNBNIPPCCB, NCBNIPPCCB	FRED	1983Q1-2019Q4	BOGZ1FL105020005Q + BOGZ1FL105013265Q + RCSNNWMVBSNNCB + NNBI + NESABSNNB + RCVSNWBSNNB + NNBNIPPCCB + NCBNIPPCCB
CIJOBS	JTS2300JOL, JTS3000JOL, JTS3200JOL, JTU110099JOL, JTU480099JOL, JTU4200JOL, JTS3400JOL, JTU5100JOL	FRED	2001Q1-2019Q4	JTS2300JOL+ JTS3000JOL+ JTS3200JOL+ JTU110099JOL+ JTU480099JOL+ JTU4200JOL+ JTS3400JOL+ JTU5100JOL
NCIJOBS	JTS6200JOL, JTS4400JOL, JTS7200JOL, JTS7000JOL, JTS7100JOL, JTU6100JOL, JTS540099JOL	FRED	2001Q1-2019Q4	JTS6200JOL+ JTS4400JOL+ JTS7200JOL+ JTS7000JOL+ JTS7100JOL+ JTS6000JOL+ JTU6100JOL+ JTS540099JOL
Household Sector				
WSHARE	A132RC1Q027SBEA, DSPI, A577RC1Q027SBEA	FRED	1983Q1-2019Q4	100*A132RC1Q027SBEA/ (DSPI- A577RC1Q027SBEA)
PSHARE	A045RC1Q027SBEA, DSPI, A577RC1Q027SBEA	FRED	1983Q1-2019Q4	100*A045RC1Q027SBEA/ (DSPI-A577RC1Q027SBEA)
DUR	PCEDG, DDURRG3M086SBEA	FRED	1981M11-2019M12	
NDURS	PCEND, PCES, DNDGRG3M086SBEA, DSERRG3M086SBEA	FRED	1981M11-2019M12	(PCEND/ DNDGRG3M086SBEA) + (PCES/DSERRG3M086SBEA)

Table A.3: Constructed Series

Firm-level data. The construction of the firm-level dataset follows the methodology of Arellano et al. (2024), with adaptations to suit the current context. I use firm-level data from Compustat on U.S. companies, focusing on consolidated reports for active firms.

The initial sample consists of 433,374 firm-quarter observations spanning from 1983Q1 to 2019Q4. To address basic reporting errors, I drop observations with missing or negative values for total assets (`atq`), debt in current liabilities (`dlcq`), property, plant, and equipment (`ppentq`), or inventories (`invtq`). I also exclude firms operating in public administration (NAICS code 92). These steps yield a final sample of 186,241 observations.

Leverage for firm i in quarter t is defined as:

$$\texttt{lev}_{i,t} = \frac{\texttt{dlcq}_{i,t}}{\texttt{atq}_{i,t}}$$

and investment is defined as:

$$\texttt{inv}_{i,t} = \texttt{ppentq}_{i,t} + \texttt{invtq}_{i,t}$$

Firms are classified into high- and low-leverage groups depending on whether their leverage exceeds or falls below the historical sample mean (approximately 0.12). I then aggregate investment by leverage group to construct two time series capturing investment by high- and low-leverage firms, HINV and LINV, respectively. These series are seasonally adjusted using the X-11 filter and deflated using the GDP deflator (GDPDEF) from the Federal Reserve Economic Data (FRED). The resulting series are shown in Figure A.3.

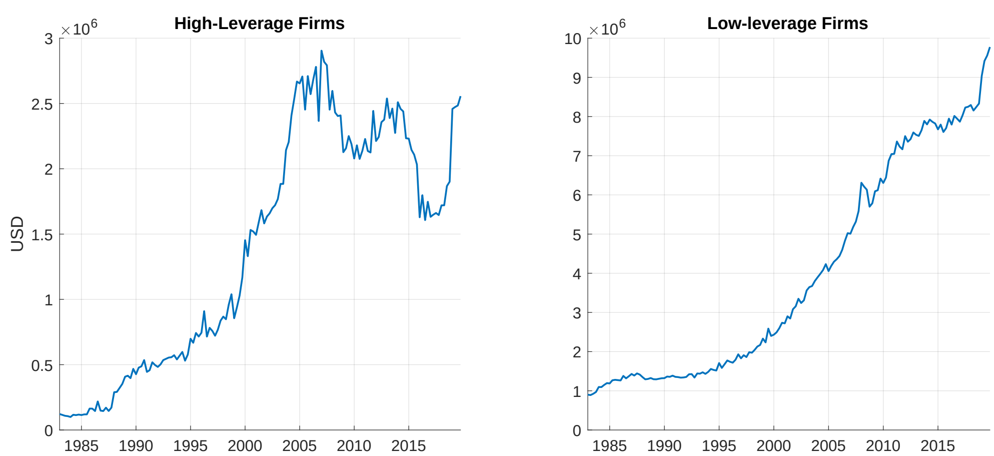


Figure A.3: Investment: High- vs. Low-Leverage Firms

A.3 Instrument Series Diagnostics

Granger Causality Test.

Variables	$p - value$
Level of the yield curve	0.7839
Marketable Treasury debt	0.8857
Stock market index	0.2111
Corporate bond return index	0.8725
Industrial production	0.8045
Consumer price index	0.7416
Weekly hours	0.6718
Wages and salaries	0.7740
Joint	0.6677

Table A.4: Granger Causality test

Correlation with Other Shock Measures.

Name of the Surprise/Shock/Index	**Source**	**Correlation Coefficient**	$p - value$
Carbon policy shocks	Känzig (2021)	-0.0096	0.8803
Oil supply news shocks	Känzig (2023)	-0.0609	0.1992
Debt supply shocks	Phillot (2025)	-0.0234	0.7097
Debt ceiling EPU	Baker et al. (2016)	0.0704	0.1495
Partisan conflict index	Azzimonti (2018)	-0.0077	0.8718
Geopolitical risk	Caldara and Iacoviello (2022)	-0.0663	0.1750
MP surprises (MAR)	Miranda-Agrippino and Ricco (2021)	0.0481	0.4699
MP surprises (BS)	Bauer and Swanson (2023)	0.0341	0.5061
MP surprises (RR)	Romer and Romer (2004), as extended in Miranda-Agrippino and Ricco (2021)	-0.0759	0.1884

Table A.5: Correlation with other shock measures

B Sensitivity Analysis

B.1 Futures Contracts

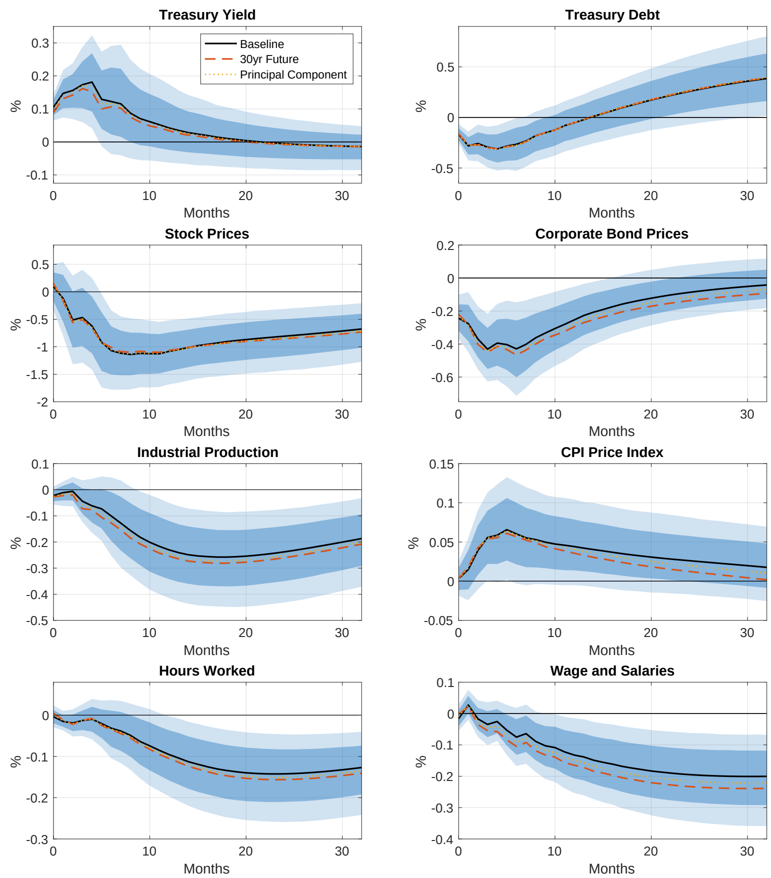


Figure B.1: Sensitivity to different measures of the market surprises

B.2 Sensitivity to Different Yield Curve Constructions

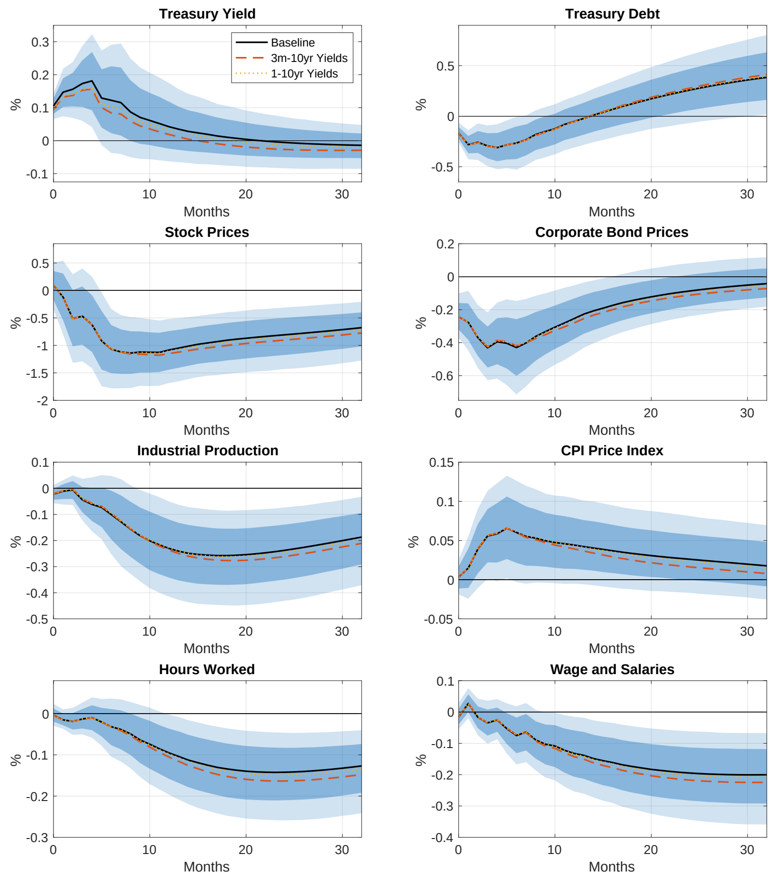


Figure B.2: Sensitivity to different measures of the yield curve level

B.3 Sensitivity to Lag Order

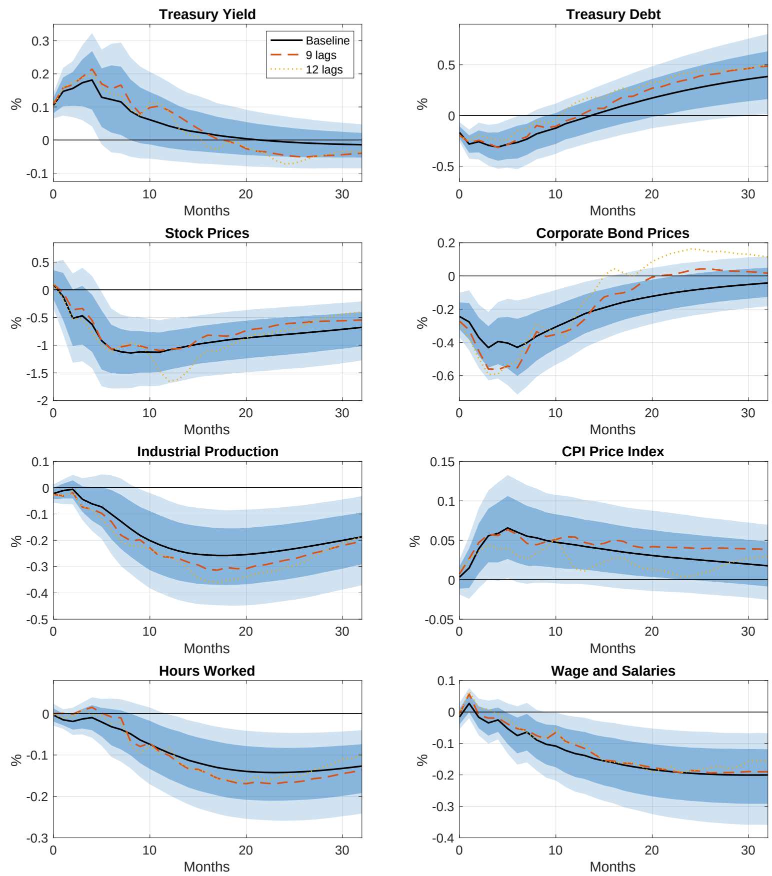


Figure B.3: Sensitivity to Lag Order

B.4 Sensitivity to Deterministic Variables

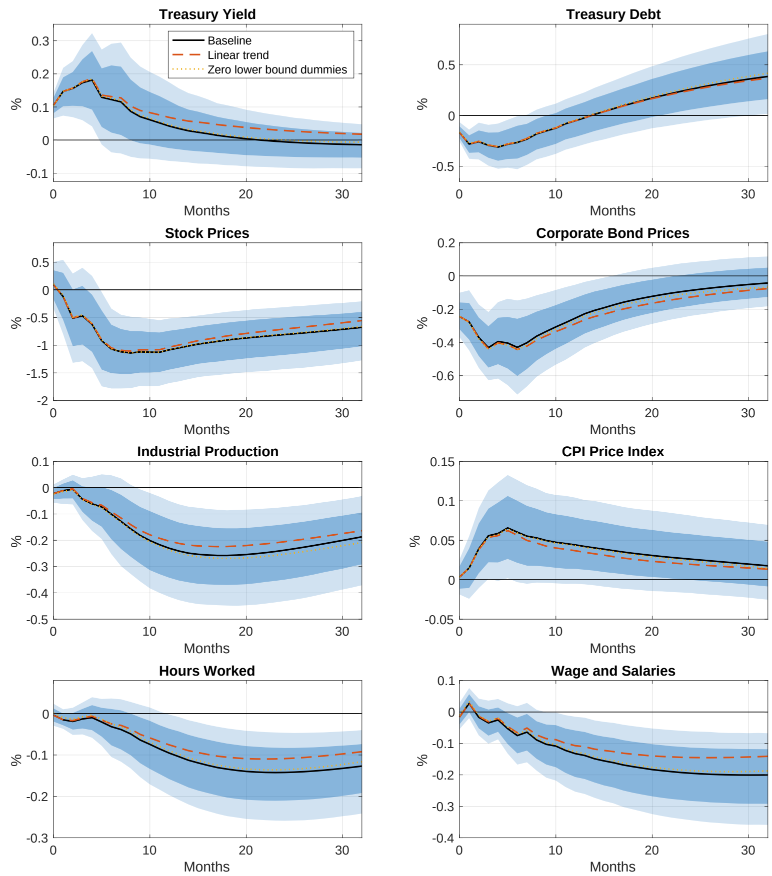


Figure B.4: Sensitivity to Deterministic Variables

B.5 Sensitivity to Sample Specification

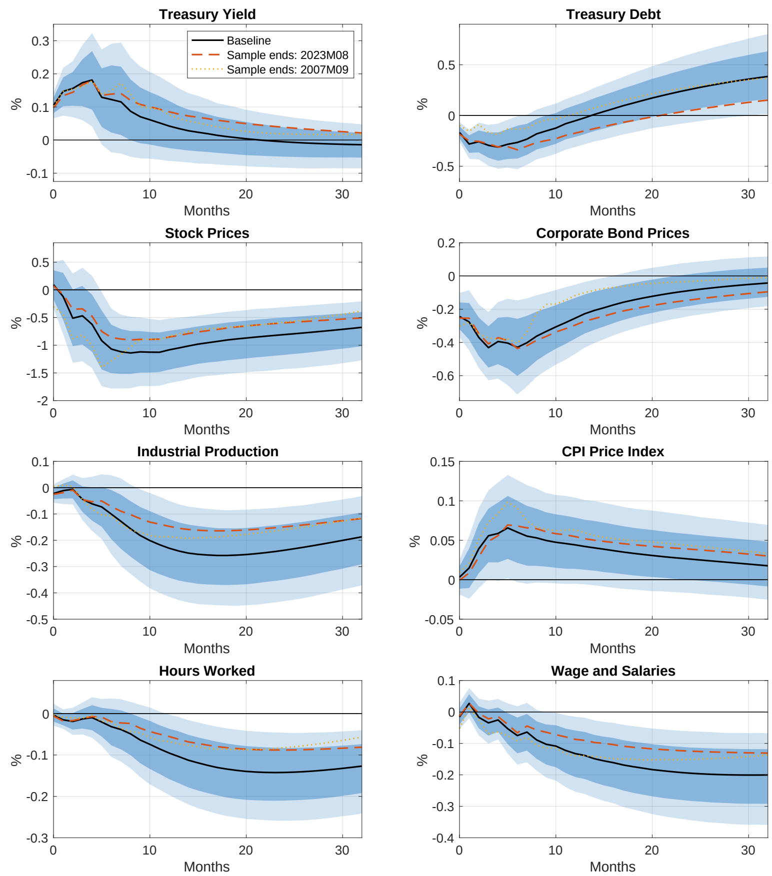


Figure B.5: Sensitivity to Sample Specification

B.6 Controlling for Government Shutdowns and Funding Gaps

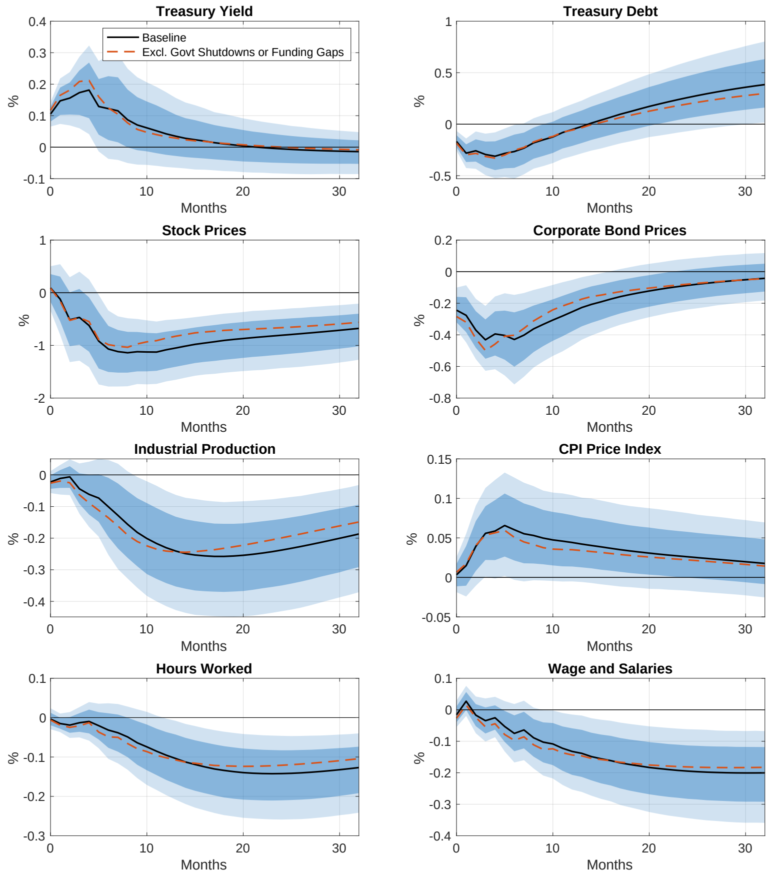
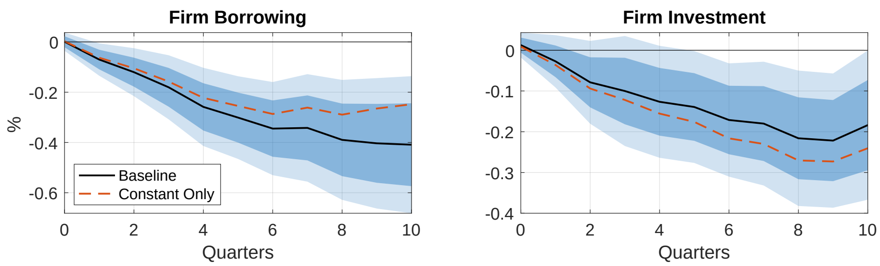
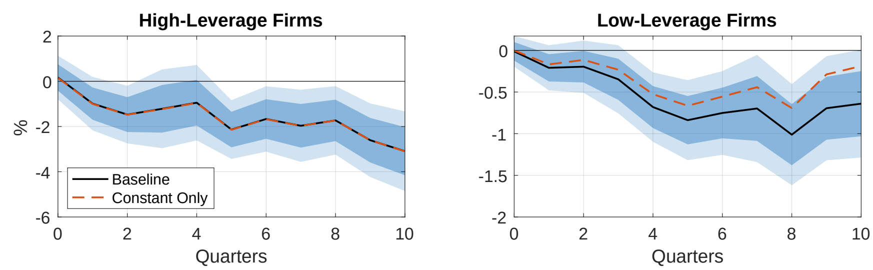


Figure B.6: Sensitivity to Fiscal Disruptions Associated with the Debt Ceiling

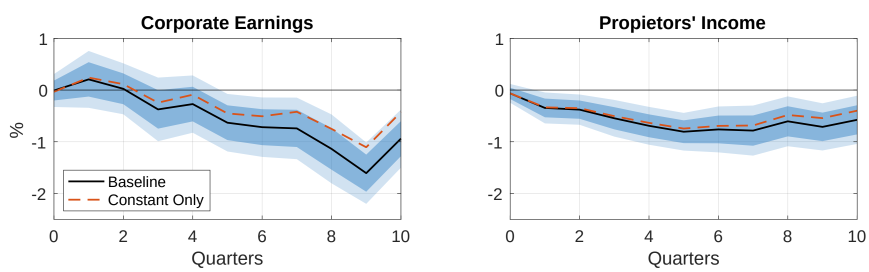
B.7 Sensitivity to Deterministic Variables in Local Projections



(a) Aggregate Borrowing and Investment



(b) Capital Expenditure: High- vs. Low-Leverage Firms



(c) Labor Demand: Capital-Intensive vs. Noncapital-Intensive Jobs

Figure B.7: Sensitivity: Local Projections with(out) Deterministic Trend

C Additional Empirical Results

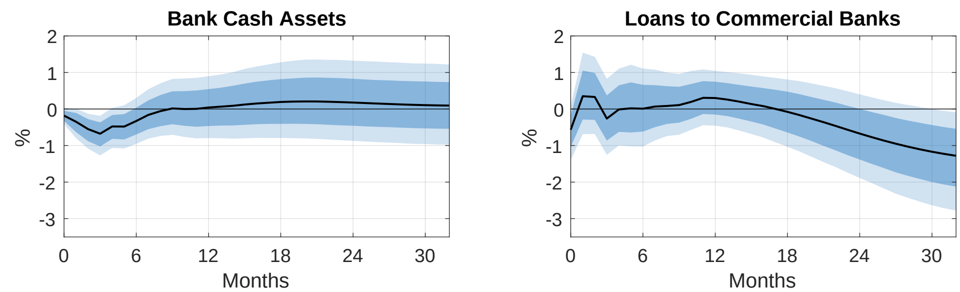
Data Series Supplementary Empirical Analysis.

Variable Name	Description	Source	Sample	Transformation
Monthly variables				
CASACBW027SBOG*	Bank Cash Assets	FRED	1981M11-2019M12	$100 \times log$
LCBACBM027SBOG*	Loans to Commercial Banks	FRED	1981M11-2019M12	$100 \times log$
CPIENGSL	CPI: Energy	FRED	1981M11-2019M12	$100 \times log$
CPILFESL	Core CPI	FRED	1981M11-2019M12	$100 \times log$
CSCICP03USM665S	Consumer Confidence	FRED	1981M11-2019M12	$100 \times log$
PMI	ISM Manufacturing PMI	Bloomberg/Own Calculations	1981M11-2019M12	$100 \times log$
DGS2	2-year U.S. Treasury Yield	FRED	1981M11-2019M12	$100 \times log$
Quarterly variables				
BCNSDODNS*	Corporate Borrowing	FRED	1983Q1-2019Q4	$100 \times log$
TCMILBSNNB*	Noncorporate Borrowing	FRED	1983Q1-2019Q4	$100 \times log$
BOGZ1FL105020005Q + BOGZ1FL105013265Q + NCBNIPPCCB*	Corporate Investment	FRED	1983Q1-2019Q4	$100 \times log$
NNBI + NESABSNNB + NNBNIPPCCB*	Noncorporate Investment	FRED	1983Q1-2019Q4	$100 \times log$
GDPC1	Real Gross Domestic Product	FRED	1983Q1-2019Q4	$100 \times log$
GPDIC1	Real Gross Private Domestic Investment	FRED	1983Q1-2019Q4	$100 \times log$
PCECC96	Real Personal Consumption Expenditures	FRED	1983Q1-2019Q4	$100 \times log$
A955RX1Q020SBEA	Real Government Consumption Expenditures	FRED	1983Q1-2019Q4	$100 \times log$

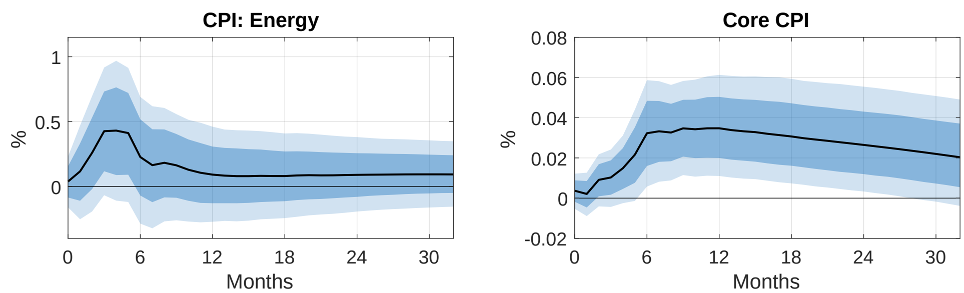
Table C.1: Variables Used in Estimation

Note: Series marked with an asterisk (*) denote deflated values. Monthly variables are deflated using the Consumer Price Index (CPIAUCSL), while quarterly variables are deflated using the GDP Deflator (GDPDEF).

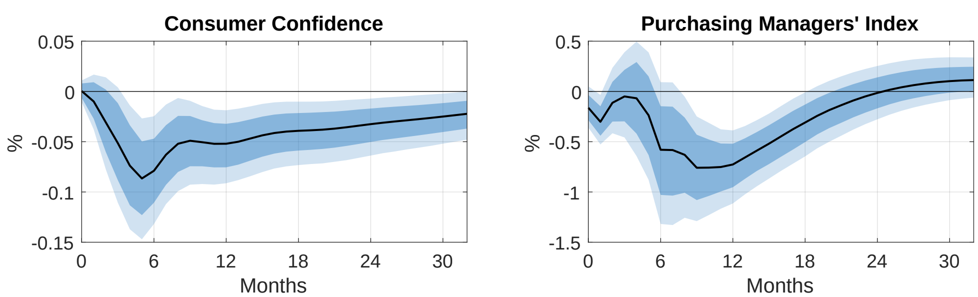
C.1 Monthly Variables



(a) Other bank assets



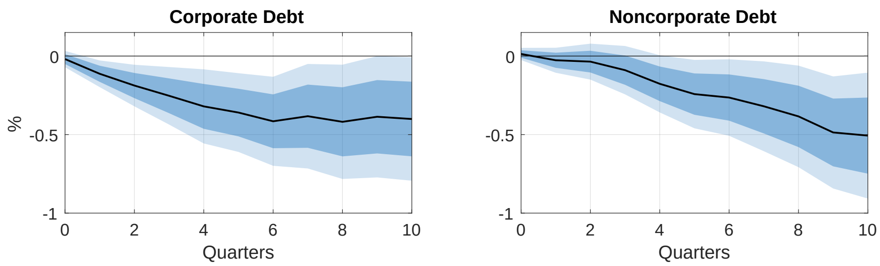
(b) Core and Energy Components



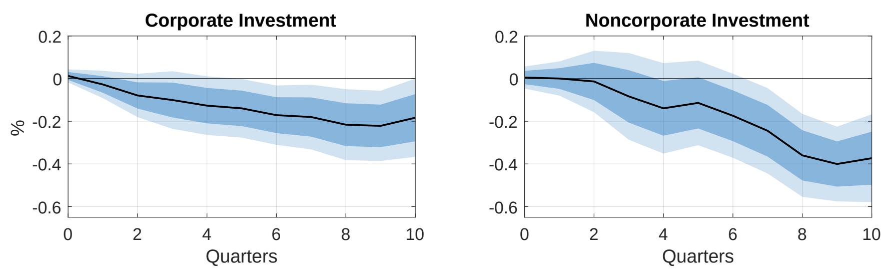
(c) Consumer and Business Expectations

Figure C.1: Additional Aggregate Results

C.2 Quarterly Variables



(a) Firm Borrowing



(b) Firm Investment

Figure C.2: Effects on Production

C.3 Historical Decomposition

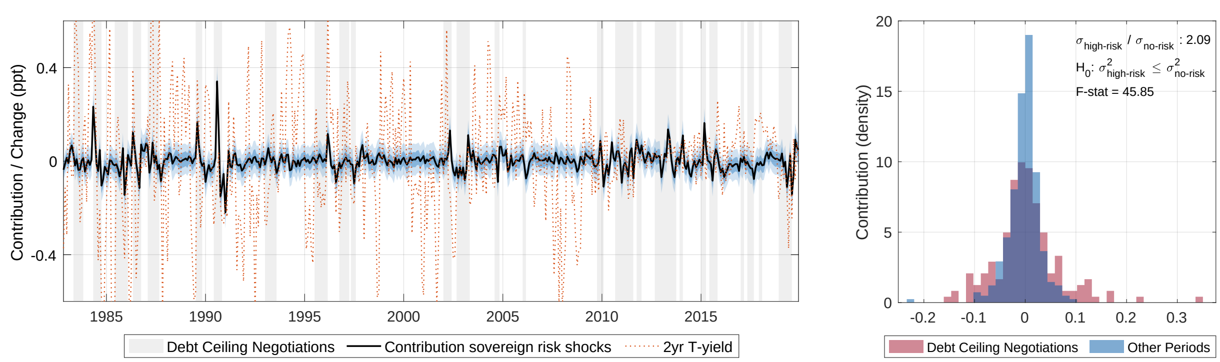


Figure C.3: Historical Contribution of Sovereign Risk Shocks

Note: In the left panel, the shaded areas indicate periods of elevated debt ceiling risk, defined from the beginning of each episode to its resolution. The right panel presents the distribution of historical contributions to the two-year Treasury yield, reported separately across periods with and without elevated debt ceiling risk.

D Full Model and Derivations

D.1 Households

The economy consists of a continuum of identical households with preferences defined over consumption C_t and labor supply L_t. Each household maximizes the expected discounted sum of lifetime utility:

$$U_0 = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \iota_t \left\{ \frac{(C_t - bC_{t-1})^{1-\sigma_H} - 1}{1-\sigma_H} - \chi \frac{L_t^{1+\eta}}{1+\eta} \right\}, \tag{D.1}$$

where $\beta \in (0,1)$ is the subjective discount factor, $\sigma_H > 0$ governs relative risk aversion, and $b \in [0,1)$ captures internal habit formation. The parameter $\eta > 0$ is the inverse of the Frisch elasticity of labor supply, while $\chi > 0$ scales the disutility from working. The term ι_t denotes a preference shock.

Households allocate income between consumption and savings via nominal deposits D_t, which earn a gross return R_t^d. Labor is supplied to unions at a nominal wage equal to the marginal rate of substitution between consumption and leisure, denoted MRS_t. In addition to labor income, households receive dividend payments DIV_t from nonfinancial firms and equity distributions from incumbent financial intermediaries. Each period, they pay two forms of taxes: a fixed real payment X to newly created intermediaries and a lump-sum tax T_t to the government. The nominal flow budget constraint is:

$$P_t C_t + D_t \leq MRS_t L_t + R_{t-1}^d D_{t-1} + DIV_t - P_t X - P_t T_t \tag{D.2}$$

where P_t denotes the price level.

The household's optimality conditions imply the following equilibrium relationships:

- Marginal utility of consumption:

$$\mu_t = \frac{\iota_t}{(C_t - bC_{t-1})^{\sigma_H}} - b\beta \mathbb{E}_t \frac{\iota_{t+1}}{(C_{t+1} - bC_t)^{\sigma_H}}, \tag{D.3}$$

- Stochastic discount factor:

$$\Lambda_{t-1,t} = \beta \frac{\mu_t}{\mu_{t-1}}, \tag{D.4}$$

- Labor supply condition:

$$\iota_t \chi L_t^{\eta} = \mu_t mrs_t, \tag{D.5}$$

  where $mrs_t = MRS_t / P_t$ denotes the real marginal rate of substitution.

- Euler equation for deposits:

$$1 = \mathbb{E}_t \Lambda_{t,t+1} R_t^d \Pi_{t+1}^{-1}, \tag{D.6}$$

with $\Pi_t = P_t / P_{t-1}$ denoting gross inflation.

D.2 Labor Market

The labor market features a two-tier structure. A continuum of labor unions, indexed by $h \in [0,1]$, purchases labor services from households at the marginal rate of substitution MRS_t and resells them to a representative labor packer at wage $W_t(h)$. The labor packer combines the differentiated labor inputs $L_{d,t}(h)$ into a composite aggregate $L_{d,t}$ used in production. Aggregation follows a constant elasticity of substitution (CES) structure:

$$L_{d,t} = \left(\int_0^1 L_{d,t}(h)^{\frac{\epsilon_{w,t}-1}{\epsilon_{w,t}}} \, dh \right)^{\frac{\epsilon_{w,t}}{\epsilon_{w,t}-1}}$$

where $\epsilon_{w,t}$ denotes the time-varying elasticity of substitution across labor types.

Labor Packer. The labor packer operates under perfect competition. It purchases labor at type-specific wages $W_t(h)$, sells the aggregate labor input at wage W_t. Profit maximization yields the labor demand function:

$$L_{d,t}(h) = \left(\frac{W_t(h)}{W_t} \right)^{-\epsilon_{w,t}} L_{d,t},$$

and implies the aggregate nominal wage index:

$$W_t^{1-\epsilon_{w,t}} = \int_0^1 W_t(h)^{1-\epsilon_{w,t}} \, dh.$$

Labor Unions and Wage Setting. Each labor union sets $L_{d,t}(h) = L_t(h)$, repackaging labor acquired from households and selling it to the packer. Unions purchase labor at the marginal rate of substitution MRS_t and sell it at $W_t(h)$, generating nominal profits:

$$DIV_{L,t}(h) = W_t(h) L_{d,t}(h) - MRS_t L_{d,t}(h)$$

Substituting the labor demand curve yields:

$$DIV_{L,t}(h) = W_t(h)\left(\frac{W_t(h)}{W_t}\right)^{-\epsilon_{w,t}} L_{d,t} - MRS_t\left(\frac{W_t(h)}{W_t}\right)^{-\epsilon_{w,t}} L_{d,t}$$

Wage Setting. Nominal wage adjustment is subject to Calvo frictions. In each period, a fraction $1-\phi_w$ of unions can reset their wage, while the remainder index past wages to lagged inflation at rate $\gamma_w \in [0,1]$. A union setting its wage at time t expects to retain it for j periods with probability ϕ_w^j, resulting in an effective wage in period $t+j$ of:

$$W_t(h)\left(\frac{P_{t+j-1}}{P_{t-1}}\right)^{\gamma_w}.$$

The union chooses $W_t(h)$ to maximize the expected discounted stream of real profits:

$$\max_{W_t(h)} \mathbb{E}_t \sum_{j=0}^{\infty} \phi_w^j \Lambda_{t,t+j}\left[\left(\frac{P_{t+j-1}}{P_{t-1}}\right)^{(1-\epsilon_{w,t})\gamma_w} W_t(h)^{1-\epsilon_{w,t}} P_{t+j}^{\epsilon_{w,t}-1} w_{t+j}^{\epsilon_{w,t}} L_{d,t+j} - \right.$$

$$\left. mrs_{t+j}\left(\frac{P_{t+j-1}}{P_{t-1}}\right)^{-\epsilon_{w,t}\gamma_w} W_t(h)^{-\epsilon_{w,t}} P_{t+j}^{\epsilon_{w,t}} w_{t+j}^{\epsilon_{w,t}} L_{d,t+j}\right]$$

where $w_t = W_t/P_t$ is the real wage and $mrs_t = MRS_t/P_t$ is the real marginal rate of substitution.

The resulting first-order condition yields the optimal reset wage:

$$W_t^* = \frac{\epsilon_{w,t}}{\epsilon_{w,t}-1}\frac{F_{1,t}}{F_{2,t}}$$

with recursive components:

$$F_{1,t} = mrs_t P_t^{\epsilon_{w,t}} w_t^{\epsilon_{w,t}} L_{d,t} + \phi_w \mathbb{E}_t \Lambda_{t,t+1}(\Pi_t)^{-\epsilon_{w,t}\gamma_w} F_{1,t+1}$$

$$F_{2,t} = P_t^{\epsilon_{w,t}-1} w_t^{\epsilon_{w,t}} L_{d,t} + \phi_w \mathbb{E}_t \Lambda_{t,t+1}(\Pi_t)^{(1-\epsilon_{w,t})\gamma_w} F_{2,t+1}$$

Expressed in real terms, the optimal wage becomes:

$$w_t^* = \frac{\epsilon_{w,t}}{\epsilon_{w,t}-1}\frac{f_{1,t}}{f_{2,t}} \tag{D.7}$$

where:

$$f_{1,t} = mrs_t w_t^{\epsilon_{w,t}} L_{d,t} + \phi_w \mathbb{E}_t \Lambda_{t,t+1}\left(\frac{\Pi_{t+1}}{\Pi_t^{\gamma_w}}\right)^{\epsilon_{w,t}} f_{1,t+1} \tag{D.8}$$

$$f_{2,t} = w_t^{\epsilon_{w,t}} L_{d,t} + \phi_w \mathbb{E}_t \Lambda_{t,t+1} \left(\frac{\Pi_{t+1}}{\Pi_t^{\gamma_w}} \right)^{(\epsilon_{w,t}-1)} f_{2,t+1} \tag{D.9}$$

Aggregation and Wage Dispersion. Aggregate labor input is derived by integrating over all labor types:

$$L_t = \int_0^1 L_{d,t}(h)\, dh = L_{d,t} v_t^w \tag{D.10}$$

where v_t^w is the wage dispersion index:

$$v_t^w = \int_0^1 \left(\frac{w_t(h)}{w_t} \right)^{-\epsilon_{w,t}} dh.$$

Under Calvo pricing, the wage dispersion index evolves according to:

$$v_t^w = (1-\phi_w) \left(\frac{w_t^*}{w_t} \right)^{-\epsilon_{w,t}} + \phi_w \left(\frac{\Pi_t}{\Pi_{t-1}^{\gamma_w}} \right)^{\epsilon_{w,t}} \left(\frac{w_t}{w_{t-1}} \right)^{\epsilon_{w,t}} v_{t-1}^w \tag{D.11}$$

Finally, the real wage index evolves according to:

$$w_t^{1-\epsilon_{w,t}} = (1-\phi_w)(w_t^*)^{1-\epsilon_{w,t}} + \phi_w \Pi_{t-1}^{\gamma_w(1-\epsilon_{w,t})} (\Pi_t)^{(\epsilon_{w,t}-1)} w_{t-1}^{1-\epsilon_{w,t}} \tag{D.12}$$

D.3 Production

Production in the economy is organized in multiple layers. A representative wholesale firm transforms capital and labor into intermediate output $Y_{m,t}$, while a competitive capital goods producer transforms investment into new capital $\hat{I}_t$. Intermediate goods are sold to a continuum of retail firms indexed by $f \in [0,1]$, which repackage them as $Y_t(f) = Y_{m,t}(f)$ and resell to a final goods producer under monopolistic competition. Final output Y_t is a CES aggregate of differentiated retail goods.

Retail Sector and Price Setting. Retail firms operate under monopolistic competition. Each firm sets a price $P_t(f)$ and faces a downward-sloping demand curve:

$$Y_t(f) = \left(\frac{P_t(f)}{P_t} \right)^{-\epsilon_{p,t}} Y_t$$

where $\epsilon_{p,t}$ denotes the time-varying elasticity of substitution across retail goods, and the aggregate price index satisfies:

$$P_t^{1-\epsilon_{p,t}} = \int_0^1 P_t(f)^{1-\epsilon_{p,t}} \, df.$$

Retailers purchase intermediate goods from the wholesale sector at price $P_{m,t}$ and earn profits:

$$DIV_{R,t}(f) = P_t(f) Y_t(f) - P_{m,t} Y_{m,t}(f)$$

Since retail and intermediate output are one-to-one ($Y_t(f) = Y_{m,t}(f)$), and using the demand function, this simplifies to:

$$DIV_{R,t}(f) = P_t(f)^{1-\epsilon_{p,t}} P_t^{\epsilon_{p,t}} Y_t - P_{m,t} P_t(f)^{-\epsilon_{p,t}} P_t^{\epsilon_{p,t}} Y_t$$

Price Setting. As in the labor market, prices are subject to Calvo rigidity: in each period, a fraction $1 - \phi_p$ of retailers can reoptimize, while others index their previous price to lagged inflation at rate $\gamma_p \in [0, 1]$. A firm unable to reset prices adjusts according to:

$$P_t(f) \left(\frac{P_{t+j-1}}{P_{t-1}} \right)^{\gamma_p}$$

A retailer that can reset its price at time t chooses $P_t(f)$ to maximize the expected discounted stream of real profits:

$$\max_{P_t(f)} \mathbb{E}_t \sum_{j=0}^{\infty} \phi_p^j \Lambda_{t,t+j} \Bigg[P_t(f)^{1-\epsilon_{p,t}} \left(\tfrac{P_{t+j-1}}{P_{t-1}} \right)^{(1-\epsilon_{p,t})\gamma_p} P_{t+j}^{\epsilon_{p,t}-1} Y_{t+j}$$

$$-P_{m,t+j} P_t(f)^{-\epsilon_{p,t}} \left(\tfrac{P_{t+j-1}}{P_{t-1}} \right)^{-\epsilon_{p,t}\gamma_p} P_{t+j}^{\epsilon_{p,t}-1} Y_{t+j} \Bigg]$$

The first-order condition yields the optimal reset price:

$$P_t^* = \frac{\epsilon_{p,t}}{\epsilon_{p,t} - 1} \frac{X_{1,t}}{X_{2,t}}$$

with recursive components:

$$X_{1,t} = p_{m,t} P_t^{\epsilon_{p,t}} Y_t + \phi_p \mathbb{E}_t \Lambda_{t,t+1} (\Pi_t)^{-\epsilon_{p,t}\gamma_p} X_{1,t+1}$$

$$X_{2,t} = P_t^{\epsilon_{p,t}-1} Y_t + \phi_p \mathbb{E}_t \Lambda_{t,t+1} (\Pi_t)^{(1-\epsilon_{p,t})\gamma_p} X_{2,t+1}$$

Alternatively, in real terms:

$$p_t^* = \frac{\epsilon_{p,t}}{\epsilon_{p,t} - 1} \frac{x_{1,t}}{x_{2,t}} \tag{D.13}$$

where:

$$x_{1,t} = p_{m,t} Y_t + \phi_p \mathbb{E}_t \Lambda_{t,t+1} \left(\frac{\Pi_{t+1}}{\Pi_t^{\gamma_p}} \right)^{\epsilon_{p,t}} x_{1,t+1} \tag{D.14}$$

$$x_{2,t} = Y_t + \phi_p \mathbb{E}_t \Lambda_{t,t+1} \left(\frac{\Pi_{t+1}}{\Pi_t^{\gamma_p}} \right)^{(\epsilon_{p,t}-1)} x_{2,t+1} \tag{D.15}$$

Aggregation and Price Dispersion. Aggregate intermediate demand is distorted by price dispersion and satisfies:

$$Y_{m,t} = Y_t v_t^p \tag{D.16}$$

where the dispersion index is:

$$v_t^p = \int_0^1 \left(\frac{P_t(f)}{P_t} \right)^{-\epsilon_{p,t}} df$$

Under Calvo pricing, dispersion evolves according to:

$$v_t^p = (1 - \phi_p) (p_t^*)^{-\epsilon_{p,t}} + \phi_p \left(\frac{\Pi_t}{\Pi_{t-1}^{\gamma_p}} \right)^{\epsilon_{p,t}} v_{t-1}^p \tag{D.17}$$

The aggregate price index satisfies:

$$1 = (1 - \phi_p) (p^*)^{1-\epsilon_{p,t}} + \phi_p (\Pi_{t-1})^{\gamma_p(1-\epsilon_{p,t})} \Pi_t^{\epsilon_{p,t}-1} \tag{D.18}$$

Wholesale Production. The remaining optimality conditions from the wholesale firm's problem in 5.2 relate to the demand for labor and the choice of capital utilization. Profit maximization yields:

$$w_t = (1 - \alpha) p_{m,t} A_t (u_t K_t)^{\alpha} L_{d,t}^{-\alpha} \tag{D.19}$$

$$p_t^k M_{1,t} \delta'(u_t) = \alpha p_{m,t} A_t (u_t K_t)^{\alpha-1} L_{d,t}^{1-\alpha} \tag{D.20}$$

where the utilization cost function $\delta(u_t)$ is assumed to be strictly convex and given by:

$$\delta(u_t) = \delta_0 + \delta_1 (u_t - 1) + \frac{\delta_2}{2} (u_t - 1)^2$$

Capital Goods Production. New capital $\hat{I}_t$ is produced by a competitive capital producer that transforms investment I_t according to:

$$\hat{I}_t = Z_t \left[1 - S\left(\frac{I_t}{I_{t-1}}\right)\right] I_t \tag{D.21}$$

where Z_t is a marginal efficiency of investment (MEI) shock and $S(\cdot)$ is a convex adjustment cost function:

$$S\left(I_t/I_{t-1}\right) = \frac{\kappa_I}{2}\left(I_t/I_{t-1} - 1\right)^2$$

The capital producer chooses investment to maximize the expected present value of profits:

$$\max_{I_t} \mathbb{E}_t \sum_{j=0}^{\infty} \Lambda_{t,t+j} div_{k,t+j}, \qquad \text{with } div_{k,t} = p_t^k Z_t \left[1 - S\left(\frac{I_t}{I_{t-1}}\right)\right] I_t - I_t$$

The resulting first-order condition is:

$$1 = p_t^k Z_t \left[1 - S\left(\frac{I_t}{I_{t-1}}\right) - S'\left(\frac{I_t}{I_{t-1}}\right)\frac{I_t}{I_{t-1}}\right] + \mathbb{E}_t \Lambda_{t,t+1} p_{t+1}^k Z_{t+1} S'\left(\frac{I_{t+1}}{I_t}\right)\left(\frac{I_{t+1}}{I_t^2}\right)^2 \tag{D.22}$$

D.4 Financial Intermediaries

This section derives the full set of optimality and aggregation conditions for the intermediary sector introduced in Section 5.1. The real balance sheet identity of a representative intermediary is:

$$Q_t f_t + Q_{B,t} b_t + re_t = d_t + n_t, \tag{D.23}$$

Intermediaries choose portfolio allocations to maximize the expected discounted value of net worth, subject to an enforcement constraint. The associated Lagrangian is:

$$\mathbb{L} = \left(1 + \lambda_{i,t}\right)\left[\left(1 - \sigma\right)\mathbb{E}_t \Lambda_{t,t+1} n_{i,t+1} + \sigma \mathbb{E}_t \Lambda_{t,t+1} V_{i,t+1}\right] - \lambda_{i,t}\theta_t\left(Q_t f_{i,t} + \Delta Q_{B,t} b_{i,t}\right)$$

Substituting the law of motion for next-period real net worth:

$$\mathbb{L} = \left(1 + \lambda_{i,t}\right)\Big[\left(1 - \sigma\right)\mathbb{E}_t \Lambda_{t,t+1}\Big[\left(R_{t+1}^F - R_t^d\right) Q_t \Pi_{t+1}^{-1} f_{i,t} + \left(R_{t+1}^B - R_t^d\right) Q_{B,t}\Pi_{t+1}^{-1} b_{i,t} +$$

$$+ \left(R_t^{re} - R_t^d\right)\Pi_{t+1}^{-1} re_{i,t} + R_t^d \Pi_{t+1}^{-1} n_{i,t}\Big] + \sigma \mathbb{E}_t \Lambda_{t,t+1} V_{i,t+1}\Big] - \lambda_{i,t}\theta_t\left(Q_t f_{i,t} + \Delta Q_{B,t} b_{i,t}\right)$$

In addition to the no-arbitrage conditions for corporate and government bonds presented in the main text, the first-order condition with respect to reserves implies:

$$\mathbb{E}_t\tilde{\Lambda}_{t,t+1}\left(R_t^{re}-R_t^d\right)\Pi_{t+1}^{-1}=0, \qquad \text{with } \tilde{\Lambda}_{t,t+1}=\Lambda_{t,t+1}\Omega_{t+1} \tag{D.24}$$

where the augmented continuation value term $\Omega_{i,t+1}$ is defined as $\Omega_{i,t+1}\equiv 1-\sigma+\sigma\frac{V_{i,t+1}}{\partial n_{i,t+1}}$.

To derive a closed-form expression for $\frac{V_{i,t+1}}{\partial n_{i,t+1}}$, guess that the value function is linear in net worth, $V_{i,t}=a_t n_{i,t}$. Under this guess, the enforcement constraint becomes:

$$a_t n_{i,t}=\theta_t\left(Q_t f_{i,t}+\Delta Q_{B,t} b_{i,t}\right).$$

Moreover, define the intermediary's leverage ratio as:

$$\phi_{i,t}=\frac{Q_t f_{i,t}+\Delta Q_{B,t} b_{i,t}}{n_{i,t}}$$

Substituting this definition into the constraint gives:

$$a_t=\theta_t\phi_{i,t}$$

Since both a_t and θ_t are common across intermediaries, it follows that $\phi_{i,t}=\phi_t$, and the continuation value term simplifies to:

$$\Omega_t=1-\sigma+\sigma\theta_t\phi_t \tag{D.25}$$

with aggregate leverage given by:

$$\phi_t=\frac{Q_t f_t+\Delta Q_{B,t} b_t}{n_t} \tag{D.26}$$

To verify that the value function is indeed linear, compute the expected discounted value of next-period real net worth:

$$\mathbb{E}_t\Lambda_{t,t+1}\Omega_{t+1}n_{i,t+1}=\mathbb{E}_t\Lambda_{t,t+1}\Omega_{t+1}\Pi_{t+1}^{-1}\left[\left(R_{t+1}^F-R_t^d\right)Q_t f_{i,t}+\right.$$
$$\left.+\left(R_{t+1}^B-R_t^d\right)Q_{B,t}b_{i,t}+\left(R_t^{re}-R_t^d\right)re_{i,t}+R_t^d n_{i,t}\right]$$

which, given that $R_t^{re}=R_t^d$, simplifies to:

$$\mathbb{E}_t\Lambda_{t,t+1}\Omega_{t+1}n_{i,t+1}=\mathbb{E}_t\Lambda_{t,t+1}\Omega_{t+1}\Pi_{t+1}^{-1}\left(R_{t+1}^F-R_t^d\right)n_{i,t}\phi_t+\mathbb{E}_t\Lambda_{t,t+1}\Omega_{t+1}\Pi_{t+1}^{-1}R_t^d n_{i,t}$$

However, by the linearity assumption in 8, we also have:

$$a_t n_{i,t}=\mathbb{E}_t\Lambda_{t,t+1}n_{i,t+1}\Omega_{t+1}$$

Equating the two expressions yields:

$$a_t = \mathbb{E}_t \Lambda_{t,t+1} \Omega_{t+1} \Pi_{t+1}^{-1} \left(R_{t+1}^F - R_t^d \right) \phi_t + \mathbb{E}_t \Lambda_{t,t+1} \Omega_{t+1} \Pi_{t+1}^{-1} R_t^d$$

which confirms that a_t is indeed independent of net worth. Substituting the identity $a_t = \phi_t \theta_t$ into the equation and solving for ϕ_t gives the equilibrium condition for leverage:

$$\phi_t = \frac{\mathbb{E}_t \Lambda_{t,t+1} \Omega_{t+1} \Pi_{t+1}^{-1} R_t^d}{\theta_t - \mathbb{E}_t \Lambda_{t,t+1} \Omega_{t+1} \Pi_{t+1}^{-1} \left(R_{t+1}^F - R_t^d \right)} \tag{D.27}$$

Finally, aggregating across intermediaries yields the law of motion for total real net worth:

$$\begin{aligned} n_t = \sigma \Pi_t^{-1} \Big[& \left(R_t^F - R_{t-1}^d \right) Q_{t-1} f_{t-1} + \left(R_t^B - R_{t-1}^d \right) Q_{B,t-1} b_{t-1} \\ & + \left(R_{t-1}^{re} - R_{t-1}^d \right) re_{t-1} + R_{t-1}^d n_{t-1} \Big] + X \end{aligned} \tag{D.28}$$

D.5 Government

In addition to the equilibrium conditions outlined in Section 5.3, the evolution of real government debt, defined as $b_{G,t} = B_{G,t}/P_t$, follows an exogenous AR(1) process:

$$\ln b_{G,t} = (1 - \rho_B) \ln b_G + \rho_B \ln b_{G,t-1} + s_B \varepsilon_{B,t} \tag{D.29}$$

where b_G denotes the steady-state level of real debt, $\rho_B \in (0, 1)$ governs its persistence, $s_B > 0$ governs shock volatility, and $\varepsilon_{B,t}$ is an i.i.d. innovation.

Government spending G_t evolves analogously according to:

$$\ln G_t = (1 - \rho_G) \ln G + \rho_G \ln G_{t-1} + s_G \varepsilon_{G,t} \tag{D.30}$$

with G denoting steady-state public expenditure, and $\rho_G \in (0, 1)$, $s_G > 0$, and $\varepsilon_{G,t}$ defined as above.

D.6 Central Bank

Beyond its interest rate policy, the central bank manages a discretionary balance sheet comprising long-term government bonds $B_{cb,t}$ and private investment securities $F_{cb,t}$, financed through the issuance of reserves. The real balance sheet identity is:

$$Q_t f_{cb,t} + Q_{B,t} b_{cb,t} = re_t \tag{D.31}$$

where $b_{cb,t} = B_{cb,t}/P_t$ and $f_{cb,t} = F_{cb,t}/P_t$ denote the real holdings of government and private securities, respectively. These holdings follow exogenous autoregressive processes:

$$f_{cb,t} = (1 - \rho_f)\, f_{cb} + \rho_f f_{cb,t-1} + s_f \varepsilon_{f,t} \tag{D.32}$$

$$b_{cb,t} = (1 - \rho_b)\, b_{cb} + \rho_b b_{cb,t-1} + s_b \varepsilon_{b,t} \tag{D.33}$$

while reserves adjust endogenously to ensure that the balance sheet condition holds in the presence of shocks to asset holdings.

The central bank earns income on its asset portfolio and pays interest on reserves. Its nominal net transfer to the government is given by:

$$P_t T_{cb,t} = (1 + \kappa Q_t)\, F_{cb,t-1} + (1 - \kappa Q_{B,t})\, B_{cb,t-1} - R^{re}_{t-1} RE_{t-1}$$

In real terms, and expressed using lagged prices:

$$T_{cb,t} = \left(\frac{1 + \kappa Q_t}{Q_{t-1}}\right) Q_{t-1} f_{cb,t-1} \Pi_t^{-1} + \left(\frac{1 - \kappa Q_{B,t}}{Q_{B,t-1}}\right) Q_{B,t-1} b_{cb,t-1} \Pi_t^{-1} - R^{re}_{t-1} re_{t-1}$$

Using the real balance sheet identity, this simplifies to:

$$T_{cb,t} = \left(R^F_t - R^{re}_{t-1}\right) \Pi_t^{-1} Q_{t-1} f_{cb,t-1} + \left(R^B_t - R^{re}_{t-1}\right) \Pi_t^{-1} Q_{B,t-1} b_{cb,t-1}$$

This transfer reflects the spread between the return on central bank assets and the cost of reserves. The surplus is remitted to the government each period, ensuring that the central bank maintains zero equity in equilibrium.

D.7 Market Clearing

The aggregate quantities of government and private securities are defined as:

$$b_{G,t} = b_t + b_{cb,t} \tag{D.34}$$

$$f_{w,t} = f_t + f_{cb,t} \tag{D.35}$$

Combining the profits remitted from investment firms, labor unions, retail firms, wholesale firms, and financial intermediaries with the household budget constraint, the government budget constraint, and the central bank's balance sheet condition yields the aggregate resource constraint:

$$Y_t = C_t + I_t + G_t \tag{D.36}$$

Finally, the exogenous processes governing the evolution of total factor productivity, financial frictions, markups, investment efficiency, and preferences follow autoregressive dynamics:

$$\ln A_t = \rho_A \ln A_{t-1} + s_A \varepsilon_{A,t} \tag{D.37}$$

$$\ln \theta_t = (1-\rho_\theta) \ln \theta + \rho_\theta \ln \theta_{t-1} + s_\theta \varepsilon_{\theta,t} \tag{D.38}$$

$$\ln \epsilon_{w,t} = (1-\rho_w) \ln \bar{\epsilon}_w + \rho_w \ln \epsilon_{w,t-1} + s_w \varepsilon_{w,t} \tag{D.39}$$

$$\ln \epsilon_{p,t} = (1-\rho_p) \ln \bar{\epsilon}_p + \rho_p \ln \epsilon_{p,t-1} + s_p \varepsilon_{p,t} \tag{D.40}$$

$$\ln Z_t = \rho_Z \ln Z_{t-1} + s_Z \varepsilon_{Z,t} \tag{D.41}$$

$$\ln \iota_t = \rho_\iota \ln \iota_{t-1} + s_\iota \varepsilon_{\iota,t} \tag{D.42}$$

D.8 Equilibrium

The complete set of equilibrium conditions consists of the following blocks:

- Households (4 equations): (D.3)-(D.6);
- Labor market (3 equations): (D.7)-(D.9);
- Production (12 equations):
  - retail firms, (D.13)-(D.15);
  - wholesale firms, (14)-(15), (17)-(19), and (D.19)-(D.20);
  - capital producing firms, (D.21)-(D.22);
- Government (4 equations): (20), (22), and (D.29)-(D.30);
- Central Bank (4 equations): (23) and (D.32)-(D.31);
- Financial Intermediaries (8 equations): (10)-(11) and (D.23)-(D.28);
- Aggregation (17 equations): (D.10)-(D.12), (D.16)-(D.18), (12)-(13), and (D.34)-(D.42);

In total, the model includes 52 equations in 52 unknowns:

$$\Big\{\mu_t, C_t, Y_t, L_t, K_t, Y_{m,t}, mrs_t, \Lambda_{t,t-1}, w_t^*, w_t, v_t^w, v_t^p, f_1, f_2, L_{d,t}, I_t, \hat{I}_t, u_t,$$

$$A_t, p_t^k, M_{1,t}, M_{2,t}, Q_t, x_{1,t}, x_{2,t}, \Pi_t, p_t^*, p_{m,t}, R_t^{re}, re_t, b_{cb,t}, f_{cb,t}, b_t, f_t, f_{w,t},$$

$$b_{G,t}, G_t, \theta_t, R_t^F, R_t^B, Q_t^B, n_t, \Omega_t, \phi_t, \lambda_t, R_t^d, d_t, p_t^D, \epsilon_{w,t}, \epsilon_{p,t}, Z_t, \iota_t\}$$

D.9 Calibration

In addition to the core parameters listed in Table 1 of the main text, the remaining parameters are reported in Table D.1 below.

Parameter	Description	Value	Source
β	Discount factor	$1 - 40^{-1}$	Fernández-Villaverde and Guerrón-Quintana (2020)
b	Habit formation	0.7	Sims and Wu (2021)
σ_H	CRRA coefficient	2	Fernández-Villaverde and Guerrón-Quintana (2020)
η	Inverse Frisch elasticity	4	IRF-targeted
$\bar{\epsilon}_w$	Elasticity of substitution labor	$\frac{\bar{\epsilon}_w}{\bar{\epsilon}_w - 1} - 1 = 20\%$	Galí (2015)
$\bar{\epsilon}_p$	Elasticity of substitution goods	$\frac{\bar{\epsilon}_p}{\bar{\epsilon}_p - 1} - 1 = 20\%$	Galí (2015)
α	Share of capital	0.36	Fernández-Villaverde and Guerrón-Quintana (2020)
ϕ_p	Price rigidity	0.75	Sims and Wu (2021)
ϕ_w	Wage rigidity	0.75	Sims and Wu (2021)
γ_p	Price indexation	0.5	IRF-targeted
γ_w	Wage indexation	0.5	IRF-targeted
κ_I	Investment adjustment cost	2	Sims and Wu (2021)
δ_0	Steady state depreciation	0.016	Fernández-Villaverde and Guerrón-Quintana (2020)
δ_2	Utilization squared term	$0.33 \times \delta_1$	Fernández-Villaverde and Guerrón-Quintana (2020)
X	Transfer to new intermediaries/steady state leverage	Leverage $= 4$	Sims and Wu (2021)
g	Steady state government spending	$\frac{G}{Y} = 0.2$	Sims and Wu (2021)
b_G	Steady state government debt	$\frac{B_G Q_B}{4Y} = 0.41$	Sims and Wu (2021)
f_{cb}	Steady state central private bond holdings	0	Sims and Wu (2021)
b_{cb}	Steady state central bank Treasury holdings	$\frac{b_{cb} Q_B}{4Y} = 0.06$	Sims and Wu (2021)
ρ_f	AR central bank private bonds	0.70	IRF-targeted
ρ_b	AR central bank Treasury	0.60	IRF-targeted

s_r	SD monetary policy	0.0025	Sims and Wu (2021)
s_f	SD central bank private bonds	$0.01 \times 4 \times Y/Q$	Sims and Wu (2021)
s_b	SD central bank Treasury	$0.01 \times 4 \times Y/Q_B$	Sims and Wu (2021)

Table D.1: Calibrated Parameters

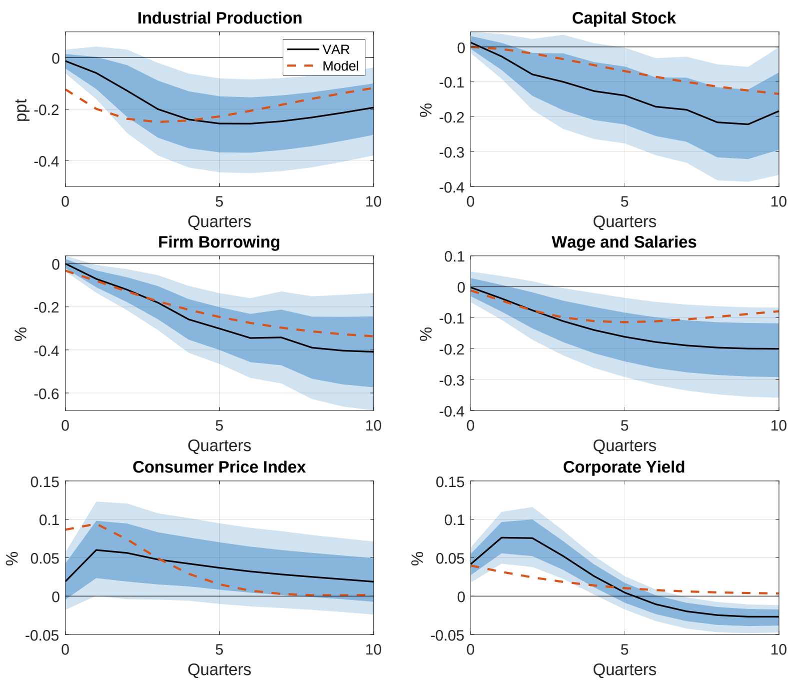


Figure D.1: Selected Impulse Responses Used for Model Calibration

E Additional Model Results

E.1 Broader Effects

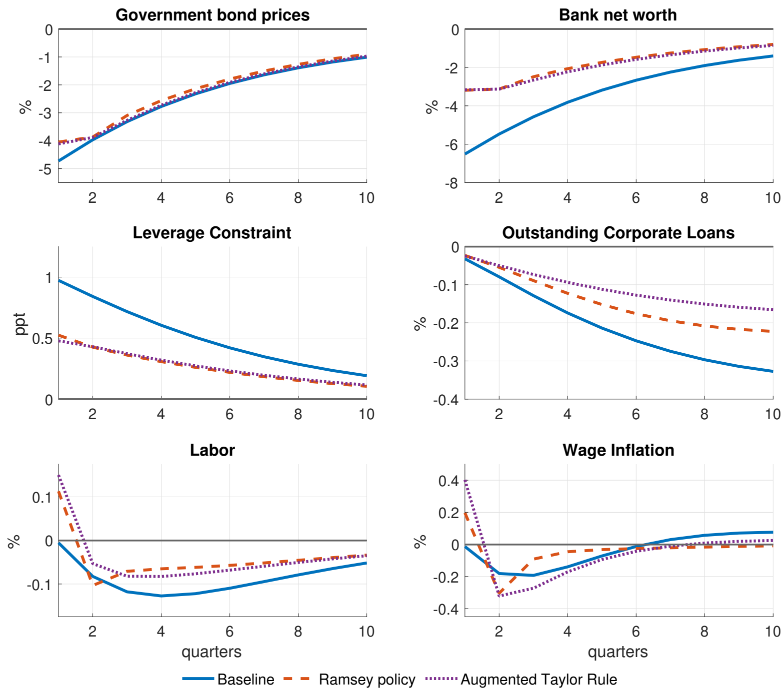


Figure E.1: Impulse Responses to a Sovereign Risk Shock

E.2 Optimal policy

Taylor rule type: (Equation)	**Baseline** (23)	**Augmented** (29)
Response to inflation (ϕ_π)	1.0010 (0.0561)	4.4925 (0.0252)
Response to output (ϕ_y)	0.1726 (0.0044)	0.0002 (0.0017)
Response to bond returns (ϕ_B)	–	0.1164 (0.0002)
Smoothing parameter (ρ_r)	0.0010 (0.0033)	0.0010 (0.0012)

Table E.1: Estimated Taylor rules

Note: Coefficients are estimated from the simulated Ramsey economy (100,000 periods) using the Generalized Method of Moments (GMM) applied to the interest rate rules in Equations (23) and (29). Eicker–White heteroskedasticity-robust standard errors are reported in parentheses.

E.3 Unconventional monetary policy

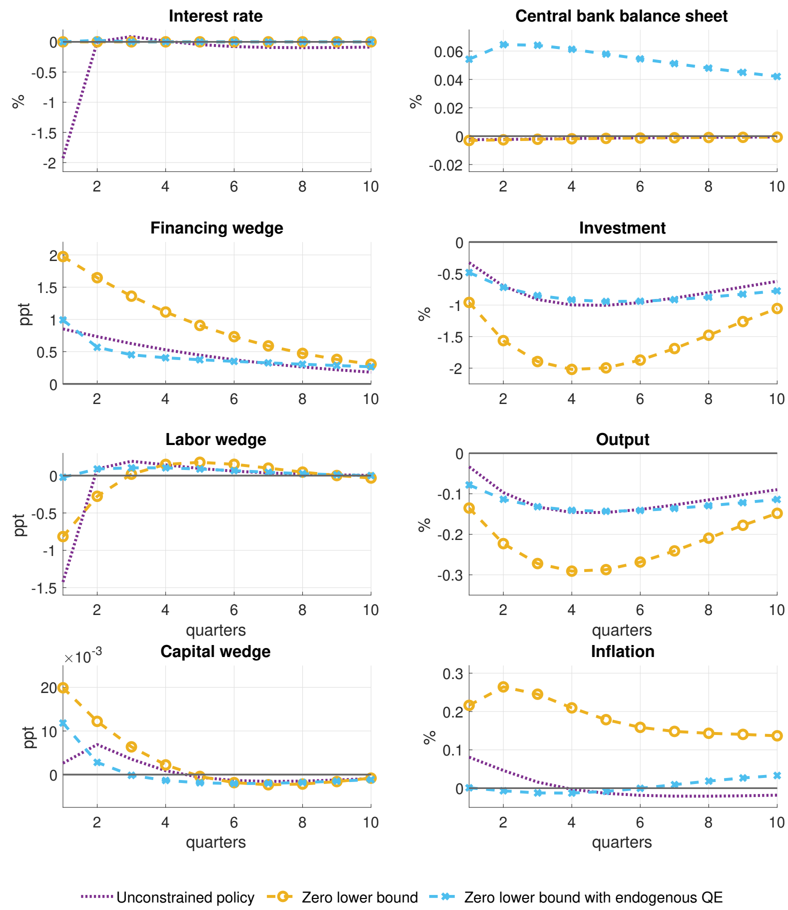


Figure E.2: Optimal Policy at the Zero Lower Bound