The Fragility of Government Funding Advantage*

Jonathan Payne[†] Bálint Szőke[‡]

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Abstract

US federal debt plays a special economic role giving the US government a funding advantage compared to the private sector. Is this an immutable feature of US treasuries arising from a treasury demand function or an equilibrium outcome influenced by government policies? New US historical yield curve estimates are consistent with the later—US financial market interventions coincide with simultaneous increases in US debt issuance and funding advantage when treasury risk remains low. We build a model where US funding advantage emerges from the financial sector's ability to use treasuries to hedge risk. Financial regulation can amplify the hedging properties of US treasuries by creating captive demand in bad times but only if the government runs stable fiscal policy to protect long-run treasury prices. Ultimately, the government cannot simultaneously choose: (i) high funding advantage, (ii) financial sector stability, and (iii) fiscal policy that destabilizes treasury prices. Balancing these tradeoffs has far-reaching welfare implications.

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†Princeton University, Department of Economics. Email: jepayne@princeton.edu

‡Federal Reserve Board, Division of Monetary Affairs. Email: balint.szoke@frb.gov

1 Introduction

US federal debt plays a special role in the economy and so has given the US government a funding advantage, often summarized by the spread between the yield on high-grade US corporate bonds and comparable US treasuries.[1] Macro-finance models have frequently treated US funding advantage as an immutable feature of the economic environment and encoded the "benefits" of holding US debt into agent preferences or the market structure. This means the government can easily "exploit" the funding advantage to increase spending. By contrast, historical studies suggest that the funding advantage emerged as part of a complicated collection of financial-monetary policies that have shaped financial sector demand for US treasuries. As documented in Lehner, Payne, Shurtleff and Szőke (2025), this led to a funding advantage appearing in the late 1860s, well before Bretton-Woods, and falling to zero during the high inflation of the 1970s, despite the emergence of US dollar denominated debt as the international reserve asset. When viewed in this way, generating and exploiting a funding advantage is closely interconnected with government policy, fragile in execution, and imposes far reaching impacts on the macroeconomy. It links the stability of the financial sector to the stability of the government budget constraint. It distorts the portfolio of the financial sector, potentially increasing default and crowding out private liquidity creation and productive investment. In this paper, we study the mechanics, limitations, and trade-offs associated with how government polices influence demand for government debt.

In Section 2, we start by using our new dataset from Lehner et al. (2025) to study the historical statistical properties of the US high-grade corporate to treasury spread over the period from 1860-2024. We draw a collection of stylized lessons. First, the US government has issued large quantities of debt quickly and cheaply when it has combined debt issuance with financial regulation that increases financial sector debt demand. Second, the episodes where the US was able to issue debt without losing its funding advantage are episodes where the government was able to maintain low riskiness on its debt. Third, increasing bond-stock betas (i.e. government debt becoming a worse hedge against aggregate risk) coincide with the erosion of government funding advantage, independently of supply changes. Fourth, across our long sample, financial regime changes and changes to riskiness of government debt returns account for most of the variation in private-public funding spreads. Taken together, our historical evidence suggests that focusing on debt-to-GDP levels and stable treasury demand functions is insufficient for understanding the US macro-fiscal position. We need to consider how strategic regulatory interventions and fiscal policies systematically

[1] This spread is sometimes referred to as the "convenience yield", "convenience spread", or "box spread" in the literature. However, there are also other measures of the convenience yield. So, to avoid confusion we instead use the term high-grade corporate to treasury spread to refer to the measure in our data and government funding advantage or public-private borrowing cost spread to refer to theoretical spread in our model that we are trying to approximate. We choose this terminology to emphasize that we are measuring how much more cheaply the government can raise funds than the private sector.

change debt demand.

In Section 3, we build a structural model that endogenizes the connections between financial sector regulation, fiscal policy, the return process on government debt, and government funding advantage. Our environment is a stochastic neoclassical growth model extended to include a morning sub-period where households need liquidity services provided by a risky banking sector (referred to as the "secondary" asset market) and an afternoon subperiod where there are no frictions (referred to as the "primary" asset market). The economy is populated by households who need bank deposits to be able to consume in the morning sub-period. Banks issue on-demand deposits and equity to households and invest in short assets, capital, and government bonds. In this sense, banks provide both liquidity and intermediation services to households. In the morning sub-period, banks get idiosyncratic deposit withdrawal shocks, which potentially cause them to default because their resource-drawing capacity is constrained and the inter-bank asset markets are characterized by "fire-sale pricing". The combination of households' need for deposits and the possibility of costly default are the "frictions" in the economy that lead to bank demand for "hedging" assets that can help them self insure risks in the secondary asset markets. Absent financial regulation, additional financial frictions, or government debt devaluation, this is an economy where government debt and productive capital are equally useful/useless for hedging risks in the secondary market. That is, government debt does not have an immutable, special role in the economy.

We use our environment to study how government policies can both create and destroy a special role for government debt. We first study financial regulations that require the banks to maintain a particular ratio of weighted average assets to deposits. The functional regulatory form is designed to nest both the banknote backing conditions from the National Banking Era and the Basel III weighted leverage ratio restrictions in the modern period. We show how these government portfolio restrictions in the secondary market determine which asset plays the role of a "hedging" asset for the financial system. If the regulations place more weight on holding government debt, which we refer to as financial repression, then banks end up crowding into the government debt in the bad state of the world when the regulatory constraint binds more. In this sense, the government regulation can create "captive" counter-cyclical demand for it debt. This leads to an appreciation of the price of government debt in the morning market in bad states and so makes government debt a good "hedge" against both aggregate shocks and idiosyncratic withdrawal risk. Consequently, banks voluntarily increase their government debt in the afternoon market to self-insure against morning market shocks, which also leads to banks taking on higher leverage and so, in equilibrium, having more need for government bonds to hedge their risk. The end result is that the price of government debt is inflated in the primary asset market. We interpret the inflated debt price as an embedded "funding advantage", as measured by the difference between the yield on government debt and the yield on an asset issued by the private sector with the same cashflow process.

We then study how the combination of financial repression and government "fiscal instability" erodes the government's funding advantage, where we interpret fiscal instability to mean the (explicit or implicit) government policies that devalue the "long-term" value of government debt in next afternoon market. This is because financial repression ties the solvency of the banking sector to the stability of the government debt prices while at the same time unstable fiscal policy destabilizes government debt prices. This means that the banks are left with a difficult trade-off: if they don't purchase government debt, then they violate the regulatory restrictions on backing deposits but if they purchase government debt, then the government's fiscal policy policy forces them to take losses and pay negative dividends. So the government's fiscal policy makes government debt a worse hedge at the same time that it makes banks less solvent and more concerned about finding a good hedge. Banks respond to this lose-lose situation by defaulting to depositors and effectively "exiting" the deposit market. This erodes the government's captive demand in the banking sector and so the government' funding advantage disappears. It is important to note that this decrease in funding advantage is not coming from a devaluation risk premium emerging on government debt (since that is differenced out in our definition of government funding advantage). Instead, it occurs because government debt no longer plays a special role in interbank market and so no longer provides a non-pecuniary benefit. This is in sharp contrast to models with bond-in-the-utility or bond-in-advance where the role of government debt is exogenous and its marginal usefulness increases as return volatility decreases the market value of government debt. In these models, as the government starts to run irresponsible fiscal policy, the government funding advantage increases. Or put another way, in these models the agents receive welfare from providing resources to the government so, when the government starts to devalue its debt, they feel they are providing the government too few resources and purchase more government debt. This highlights the importance of working with a model where government is endogenously important when we study fiscal policy.

In Section 4, we study the macroeconomic economic tradeoffs for a government choosing restrictions on the financial sector to finance a fiscal rule. Our model leaves the government with complicated trade-offs, which we summarize as a "trilemma" that the government cannot choose all three of: (i) high funding advantage, (ii) a well-functioning financial sector (profitable and stable), and (iii) fiscal policy that leads to systematic real debt devaluation (e.g. "default", "counter-cyclical" issuance, "inflation"). For example, if the US government wants to run policy that leads to a real devaluation of its debt, then according to the trilemma it must choose between maintaining its funding advantage by forcing the financial sector to hold more government debt and maintaining financial stability by allowing the financial sector to substitute away from government debt. Alternatively, if the US government wants to generate a high funding advantage through heavy repression of the financial sector, then it must choose between a maintaining a profitable/stable financial sector and fiscal-monetary policy that would lead to the systematic devaluation of its debt. Ultimately, the trilemma allows the government to use financial regulation to run large long-term deficits but doing so comes with heavy welfare costs, either through distortion of the the financial system or through the use of "austere" fiscal policy to support the long-term value of government debt.

1.1 Related Literature

Our paper is part of a large literature studying financial and fiscal policies in non-Ricardian macroeconomic models. A recent branch of this literature studies the "fiscal-sustainability" of government debt taking fiscal policy and private sector pricing kernels as given (e.g. Jiang, Lustig, Stanford, Van Nieuwerburgh and Xiaolan (2022a); Jiang, Lustig, Van Nieuwerburgh and Xiaolan (2022b); Chen, Jiang, Lustig, Van Nieuwerburgh and Xiaolan (2022)) or deriving private sector pricing kernels from a model with incomplete markets that generate a premium on government debt (e.g. Reis (2021b), Reis (2021a), Brunnermeier, Merkel and Sannikov (2022)). Our paper studies the feasibility and costs of using financial regulation as a means to "choose" private sector pricing kernels that increase government fiscal capacity. Another branch of this literature studies fiscal-monetary connections (e.g. Sargent and Wallace (1981) and the "fiscal theory of the price level" papers such as Leeper (1991), Sims (1994), Woodford (1994), Cochrane (2023), Bianchi, Faccini and Melosi (2023)). Unlike in these papers, government debt in our model is partially backed by financial regulation that creates captive demand within the financial sector and so makes government debt a safe asset. Ultimately, this means that fiscal policy not only backs government debt through the surplus process but also through its effectiveness as a safe asset. In this sense, we bring the fiscal cost of generating a funding cost spread onto the equilibrium path.

Our government design problem is related to the literature studying optimal policy in economies with financial frictions and tax distortions (e.g. Calvo (1978), Bhandari, Evans, Golosov and Sargent (2017a), Bhandari, Evans, Golosov, Sargent et al. (2017b), Chari, Dovis and Kehoe (2020), Bassetto and Cui (2021), Sims (2019), Brunnermeier et al. (2022)). In this paper we take the stand that the government follows a fiscal policy rule governed by unmodeled political constraints but has flexibility in how it wants to restrict the financial sector. We believe this reflects the historical experience of many governments. We use this model to focus on microfounding the "costs" of using financial regulation to increase government fiscal capacity.

We are also part of a long literature attempting to understand how the financial sector and government can create safe assets (e.g. Holmstrom and Tirole (1997), Holmström and Tirole (1998), Gorton and Ordonez (2013), Gorton (2017), He, Krishnamurthy and Milbradt (2016), He, Krishnamurthy and Milbradt (2019), Choi, Kirpalani and Perez (2022)) and the macroeconomic implications of safe asset creation (e.g. Caballero, Farhi and Gourinchas (2008), Caballero, Farhi and Gourinchas (2017), Caballero and Farhi (2018)). Our contribution to this literature is to connect an endogenous safe asset model to a general equilibrium macroeconomy with a government that faces fiscal constraints.

Our historical comparisons extend existing studies on the convenience yield (e.g. Krishnamurthy and Vissing-Jorgensen (2012), Choi et al. (2022)) back to the mid nineteenth century. This makes us part of a literature attempting to connect historical time series for asset prices to government financing costs (e.g. Payne, Szőke, Hall and Sargent (2023b), Payne, Szőke, Hall and Sargent (2023a), Jiang, Lustig, Van Nieuwerburgh and Xiaolan (2021b), Jiang, Krishnamurthy, Lustig and Sun (2021a), Jiang, Lustig, Van Nieuwerburgh and Xiaolan (2020a)). Our Eurozone example adopts the approach in Jiang, Lustig, Van Nieuwerburgh and Xiaolan (2020b). Our focus on modeling the hedging properties of government debt is complementary to the empirical work of Acharya and Laarits (2023).

Section 2 presents historical empirical evidence on the private-public borrowing cost spread. Section 3 describes and characterizes our model. Section **??** discusses how government policies impact the government funding advantage. Section 4 explores implications for macroeconomic policy.

2 Evidence on US Government Funding Advantage

The US Treasury market has long been highly regulated and manipulated by policy makers. Some regulations were introduced with the explicit purpose of creating captive demand for government debt (e.g. the National Banking Acts) or stabilizing debt returns (e.g. treasury market management during the WWII). Other regulations were introduced to increase financial stability but also created incentives to hold government liabilities (e.g. the Dodd-Frank Act and Basel III). These interventions have intersected with government fiscal and monetary policies, particularly when those polices have destabilized government debt prices (e.g. during the 1970s and 1980s). In this section, we study the empirical evidence on how the US Federal government's funding advantage has evolved through major regulatory and fiscal events.

We start in Section 2.1 by outlining a conceptual framework for defining and measuring government funding advantage and convenience revenue. In Section 2.2 we offer a high level description of how government policies impact government funding advantage. In Section 2.3 we use our new yield curve estimates from Lehner et al. (2025) to study government funding advantage, treasury supply, and treasury risk during major episodes in US fiscal history. We show that: (i) the US has been able to significantly increase its debt-to-GDP ratio and its funding advantage when it has combined debt issuance with financial regulation that increase financial sector incentives to hold treasuries, (ii) the clearest examples of (i) are episodes where the government was able to maintain low riskiness on government debt, and (iii) the US has gained (lost) its funding advantage when treasury returns have become less (more) risky—that is, pricing the non-pecuniary return on government debt has many similarities to traditional asset pricing. We use this to motivate our micro-founded macroeconomic model in Section 3.

2.1 Conceptual Framework

We consider a discrete time, infinite horizon economy with time indexed by $t \in \{0, 1, \ldots\}$. The economy contains a representative household, a representative financial intermediary, and a government. The government and the household both issue bonds that pay a fraction ω of the remaining outstanding balance each period, so their average maturity is $1/\omega$. The bonds trade in a competitive market at prices q_t^b and q_t^h respectively. The private sector bonds are in zero net supply whereas the government bonds are in positive net supply b_t.

The representative financial intermediary purchases the assets and receives a non-pecuniary benefit from holding government debt, which means that the government can sell its debt at a higher price than the private sector, $q_t^b > q_t^h$, even though the bonds promise the same cash flow stream. We characterize this *funding advantage* by imposing the following asset pricing structure. The representative financial intermediary has an exogenous stochastic discount factor (SDF) process, $\tilde{\xi}$. Government and private debt satisfy the respective Euler equations:

$$q_t^b = \mathbb{E}\Big[\tilde{\xi}_{t,t+1}\Omega_{t,t+1}\Big(\omega + (1-\omega)q_{t+1}^b\Big)\Big] \qquad \text{and} \qquad q_t^h = \mathbb{E}\Big[\tilde{\xi}_{t,t+1}\Big(\omega + (1-\omega)q_{t+1}^h\Big)\Big],$$

where $\Omega_{t,t+1}$ is a government debt specific wedge capturing the non-pecuniary benefit of government debt. The government's funding advantage compared to the private sector is summarized by the spread:

$$\chi_t := -\omega \log(q_t^h) - \Big(-\omega \log(q_t^b)\Big).$$

which is approximately the difference between the yield on private sector bonds and the yield on government bonds. This spread is sometimes referred to as a "convenience yield" (e.g. Krishnamurthy and Vissing-Jorgensen (2012)) or a treasury "box spread" compared to a synthetic government bond without the non-pecuniary benefits of actual government debt (e.g. van Binsbergen, Diamond and Grotteria (2022)). We do not take a stand on the most appropriate name and instead refer to the yield spread χ_t as the *"private-public borrowing cost spread"* and the price difference $q_t^b - q_t^h$ as the *"treasury premium"*. We consider both to be measures of the government *"funding advantage"* compared to the private sector. but not measures of the special role of debt compared to other assets.

Each period t, the government raises taxes τ_t, spends g_t, and issues long-term debt b_t. The period t government budget constraint is given by:

$$\omega b_{t-1} + g_t = \tau_t + q_t^b \left(b_t - (1-\omega) b_{t-1}\right).$$

Iterating the budget constraint forward gives the lifetime budget constraint:

$$\Big(\omega + (1-\omega) q_t^b\Big) b_{t-1} = \underbrace{\mathbb{E}_t \left[\sum_{s=0}^{\infty} \widetilde{\xi}_{t,t+s} \Big(\tau_{t+s} - g_{t+s}\Big) \right]}_{(i)} +$$
$$+ \underbrace{\Big(q_t^b - q_t^h\Big) b_t + \mathbb{E}_t \left[\sum_{s=1}^{\infty} \widetilde{\xi}_{t,t+s} \Big(q_{t+s}^b - q_{t+s}^h\Big) \Big(b_{t+s} - (1-\omega) b_{t+s-1}\Big) \right]}_{(ii)}.$$

This equation implies that the value of outstanding debt, $(\omega + (1-\omega)q_t^b)b_{t-1}$, is the present discounted value of future surpluses, $\{\tau_{t+s} - g_{t+s}\}_{s\geq 0}$ (term (i)), and the present discounted value of the *"convenience revenue"* the government earns from being able to issue debt more cheaply than the private sector, $\{(q_{t+s}^b - q_{t+s}^h)b_{t+s}\}_{s\geq 0}$ (term (ii)). Following Sargent and Wallace (1981), we can express the convenience revenue as a fraction of output y_t by:

$$(q_t^b - q_t^h)\frac{b_t}{y_t} = \frac{q_t^b b_t}{y_t}(1 - \exp(-\chi_t/\omega)) \tag{2.1}$$

which can be interpreted as the market value of government debt $q_t^b b_t$ multiplied by the implicit "tax" from the government's funding advantage $1 - \exp(-\chi_t/\omega)$.

2.2 Government Policy

This paper studies a question that has long interested regulators and politicians: how do government policies impact borrowing spreads and convenience revenue. Formally, this means studying how government policies change the government debt wedge $\Omega_{t,t+1}$ and so impact the equilibrium spread χ_t in the expression for convenience revenue (2.1). We focus on three main policies: debt supply changes, regulation of financial sector portfolios, and government balance sheet management that creates treasury return risk.

Government debt supply: A large literature has focused on how changing the "quantity" of government debt impacts the borrowing cost spread (e.g. Krishnamurthy and Vissing-Jorgensen (2012), Nagel (2016)). These papers typically impose a reduced form bond-in-the-utility (BIU) model where $\Omega_{t,t+1}$ is a time-invariant, decreasing function of the market value of government debt-to-GDP ratio $q_t^b b_t / y_t$ and independent, exogenous preference shocks ζ_t. This often motivates the approximation that the spread and convenience revenue can be expressed as:

$$\chi_t \approx \omega \log \left(\Omega \left(\frac{q_t^b b_t}{y_t}; \zeta_t \right) \right), \qquad \frac{(q_t^b - q_t^h) b_t}{y_t} \approx \frac{q_t^b b_t}{y_t} \left(1 + \Omega \left(\frac{q_t^b b_t}{y_t}; \zeta_t \right) \right) \tag{2.2}$$

where the formulas are precise for short-term debt in an environment where government debt has no substitutes (see Appendix A.2). This implies that the convenience revenue maximizing debt-to-GDP ratio is independent of other government policies. We illustrate this with the red arrows in the top subplot in Figure 1, which show how an increase in the market value of government debt-to-GDP lowers the spread and moves the economy along the convenience revenue curve. In this sense, in these models the government faces a "Laffer curve" style revenue maximization challenge reminiscent of the monetary literature.

Financial sector portfolio restrictions: Although equation (2.2) has been much studied, we show in subsection 2.3 that there have been very few historical episodes where the US government has embarked on large scale debt increases without also introducing accompanying policies that increase demand for government debt. From a modeling point of view, this means that the functional form of Ω in equation (2.2) has typically depended upon financial sector regulations that incentivize or disincentivize financial intermediaries to hold government debt. This implies that the equilibrium relationships between χ, debt-to-GDP, and convenience revenue become policy variant:

$$\chi_t \approx \omega \log \left(\Omega \left(\frac{q_t^b b_t}{y_t}; \zeta_t, \kappa_t \right) \right), \qquad \frac{(q_t^b - q_t^h) b_t}{y_t} \approx \frac{q_t^b b_t}{y_t} \left(1 + \Omega \left(\frac{q_t^b b_t}{y_t}; \zeta_t, \kappa_t \right) \right) \tag{2.3}$$

where denotes κ_t is a collection of potentially time varying regulation parameters. We illustrate this visually with the blue lines on the middle subplot in Figure 1, which show an example where regulation increases government debt demand and so increases the Ω function, the equilibrium spread curve, and equilibrium convenience revenue curve.

Return risk on government debt: Another branch of the literature (e.g. Acharya and Laarits (2023)) argues that the government's funding advantage arises from the special role that treasuries play in hedging risk. This suggests that $\Omega_{t,t+1}$ should be related to the covariance between returns on treasuries and the overall market. In a reduced form model, this would imply the equilibrium relationships:

$$\chi_t \approx \omega \log \left(f \left(\frac{q_t^b b_t}{y_t}; \zeta_t, \beta_t, \kappa_t \right) \right), \qquad \frac{(q_t^b - q_t^h) b_t}{y_t} \approx \frac{q_t^b b_t}{y_t} \left(1 + f \left(\frac{q_t^b b_t}{y_t}; \zeta_t, \beta_t, \kappa_t \right) \right) \tag{2.4}$$

where f is a functional form and β_t is a measure of the usefulness of treasuries for hedging risk such as the correlation between treasury holding returns and market returns (the so-called bond-stock beta). We interpret the literature as arguing that a more positive bond-stock beta (which corresponds to treasuries being a worse hedge against aggregate risk) should decrease f and so contract the equilibrium spread and convenience revenue curves.

This discussion highlights how the standard BIU model in equation (2.2) can generate misleading policy counterfactuals. Suppose the government introduces a fiscal policy that makes government debt a worse hedge (i.e. increases β) and devalues the total government debt portfolio (a decrease in q_t^b). One such policy would be systematically issuing debt in bad states of the world. Figure 1 shows the impact on the private-public borrowing spread and convenience revenue under the BIU specification (2.2) (the red arrows) and with the more general specification from equation (2.4) (the blue arrows). Evidently, under the BIU model, increasing return risk moves the economy up along the private-public borrowing spread curve and the convenience revenue curve. In this sense, return risk does not change the convenience revenue trade-off but rather provides another way of moving to the convenience revenue maximizing value of $q_t^b b_t / y_t$. By contrast, under the more general specification (1), the return risk shifts the private-public borrowing spread curve down. This contracts the convenience revenue curve and so the government budget constraint. We can interpret these difference in terms of decreases in the quantity (b_t) and quality (β_t) of government debt. In the BIU model, changes to quantity and quality both enter the private-public borrowing spread formula in the same way by decreasing $q_t^b b_t$ and increasing private-public borrowing spread. By contrast, in the data and the more general model, decreases in quality shift the private-public borrowing spread to Debt-to-GDP relationship, which leads to a decrease in the private-public borrowing spread.

2.3 US Government Funding Advantage in the Data

To explore the potential relationships suggested by the literature, we look for patterns in the historical data that are consistent or inconsistent with the different policy relationships discussed in Subsection 2.2. Previous attempts to study historical spreads have used bond indices that mix bonds with different maturities, call or put options, and tax treatments. Instead, we draw on our work in Lehner et al. (2025), which estimates zero-coupon nominal yield curves for high grade corporate bonds and US treasuries incorporating adjustments for differential tax treatments and option values. Using our series, we compute the term structure of private-public borrowing cost spreads as the difference between our tax-adjusted nominal corporate and government yield curves. We also use our yield curves to compute the market value of government debt-to-GDP and the “beta” when excess holding returns

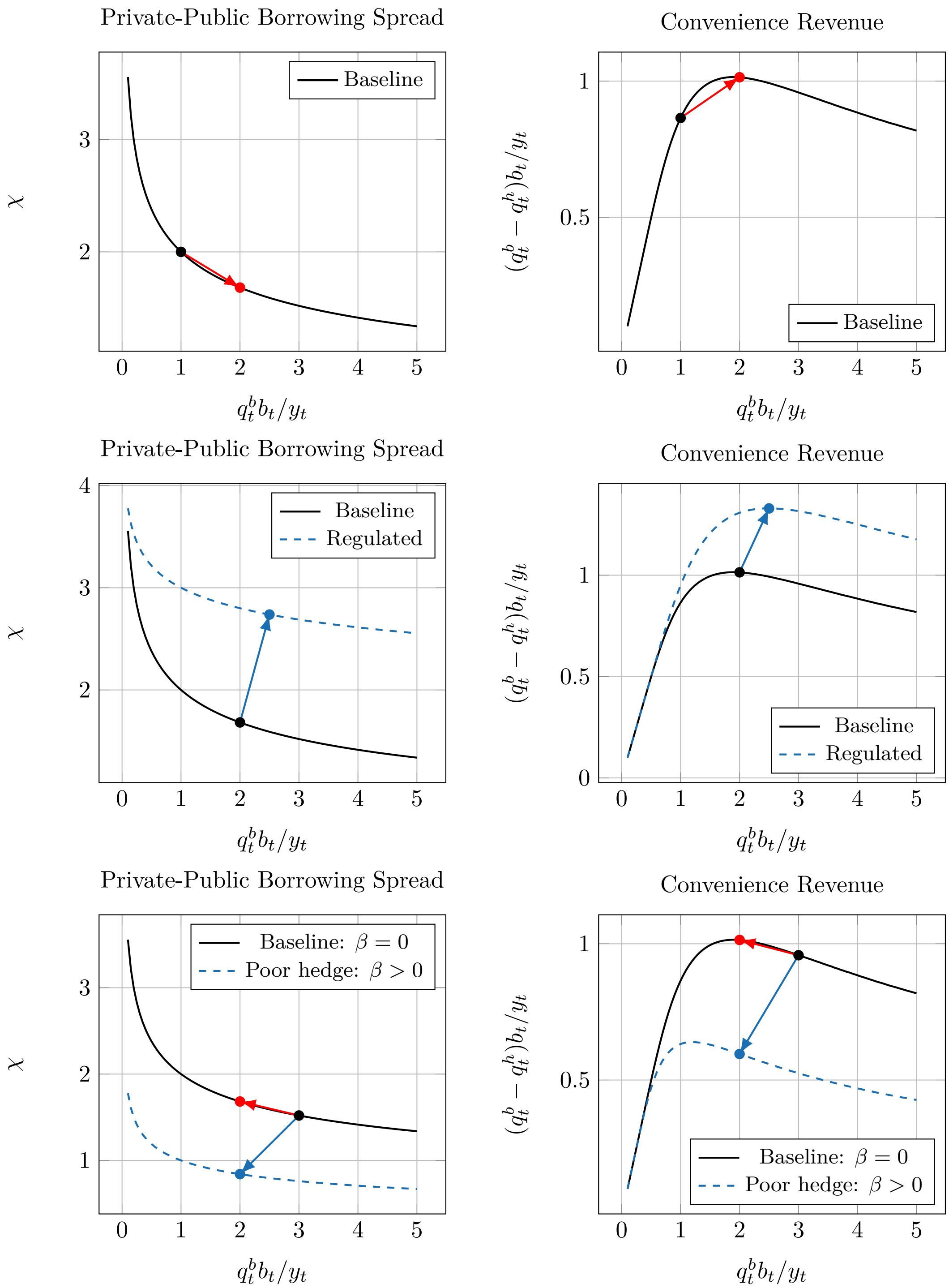

Figure 1: Top plot: shows the impact of a debt-to-GDP increase in a BIU model. Middle plot: show the impact of regulation that increases government debt demand. Bottom plot: shows the impact of an increase in risk on holding government debt.

are regressed against excess stock returns (which we refer to as the bond-stock beta)[2]. We plot our computed series for selected episodes and the full sample in Figures 2-4.

Our data spans more than 150 years, many different financial regulation eras, the end of the gold standard, eight wars, and many other major events. For context, we provide a comprehensive history of key financial policy changes to Appendix B and a detailed timeline of events in Appendix G. The breadth of the time series raises more questions than we can address in this single paper. Here we focus on a collection of stylized lessons about government funding advantage that speak to the policy interactions discussed in the literature and motivate our structural model.

1. The US government has issued large quantities of debt quickly and cheaply when it has combined debt issuance with financial regulation that increases financial sector debt demand.

The top four subplots of Figure 2 show the Debt-to-GDP ratio and the private-public borrowing spread during the Civil War, the Global Financial Crisis, World War I, and World War II, which are the periods in our historical sample with large increases in the market value of government debt-to-GDP (ranging from 25 to 60 percentage points).

Evidently, during both the Civil War and the Global Financial Crisis the US government was able to simultaneously increase debt-to-GDP and its funding advantage. These are both episodes when government debt issuance coincided with large changes to financial sector regulation that increased financial sector incentives to hold treasuries. For the Civil War episode, between 1862-6, Congress passed a collection of National Banking Acts, which established a system of nationally charted banks that were allowed to issue bank notes up to 90% of the minimum of par and market value of qualifying US federal bonds[3] and could only issue a narrow range of loans[4]. For the Global Financial Crisis, Congress enacted the Dodd-Frank Act in July 2010 and the Basel III rules were adopted in 2012. Both of these regulatory changes introduced a large collection of portfolio constraints on the banking sector that penalized bank leverage ratios and encouraged bank government debt holding. Interpreted through the lens of the reduced form model in Section 2.2, neither period is consistent with the commonly used stable equilibrium relationship outlined in equation (2.2). Instead, both periods are consistent with regulation shifting the government debt

[2] Formally, for each maturity j, we regress the monthly excess holding return $rx_{t+1}^{j-1} = \log(q_{t+1}^{(j-1)} - \log(q_t^{(j)}) - r_t$ against the monthly percentage change in the GFD historical total return index on US equities.

[3] Technically, national banks could issue bank notes for circulation according to the following rules. Banks had to deposit certain classes of US Treasury bonds as collateral for note issuance. Permissible bonds were US federal registered bonds bearing coupons of 5% or more. Deposited bonds had to be at least one-third of the bank's capital (not less than $30,000). Banks could issue bank notes up to an amount of 90% of the maximum of the market value of the bonds and the par value of the bonds. The 90% value was changed to 100% in 1900.

[4] National banks could only operate one branch. They were restricted from making mortgages unless they were operating in rural areas, where they could make a limited range of loans collateralized by agricultural land.

demand curve up at the same time as supply increased.

The episode with a clear negative relationship between debt supply and the government funding spread is World War I, although identification is complicated by the gradual retiring of the national banking system after the introduction of the Fed in 1913. The story during World War II is more complicated. On average, the very large debt-to-GDP increase during the war does coincide with lower government funding advantage, although the decrease is small and the relationship is less clear after the war, particularly once the Treasury-Fed Accord is agreed and the Fed becomes independent.

2. The episodes where the US was able to issue debt without losing its funding advantage are episodes where the government was able to maintain low riskiness on government debt.

The bottom four plots in Figure 2 show the rolling bond-stock beta calculated over a 3-year centered window during the four large debt-to-GDP increases in our sample. We can see a striking difference between outcomes during the Global Financial Crisis when government funding advantage went up and World War I when government funding advantage went down. Following the introduction of the Dodd-Frank Act in 2012, the bond-stock beta dropped sharply indicating that holding government debt became a good hedge against aggregate risk. By contrast, during World War I, the bond-stock beta went from zero to weakly positive. For World War II, the bond-stock beta was never significantly different to zero during the period of yield curve control (1942-1951) when the Fed and treasury worked together to stabilize the yield curve. For the Civil War, the short maturity Greenback yield curve estimates are too noisy during the greenback period (1862-1879) to get a clear estimate. However, we can see that the beta for gold-denominated government debt is negative during the war. While it becomes temporarily positive after the war, once convertibility is restored, the bond-stock beta is essentially zero indicating that throughout the 19th century when government funding advantage was high government debt was a “safe-asset” compared to equities.

3. Increasing bond-stock betas (government debt becoming a worse hedge) coincide with the erosion of government funding advantage, independently of supply changes.

Figure 3 depicts our series during the 1970s-80s. This is the period in our sample with the largest increase in the bond-stock beta, which goes from approximately zero to approximately 0.8 during the early 1980s. This indicates holding treasuries provided almost no hedge against aggregate risk during this period. The increase in the bond-stock beta corresponds to a sustained decline in the funding spread even though the Debt-to-GDP ratio moves very little during the period. This means this is another key period that is

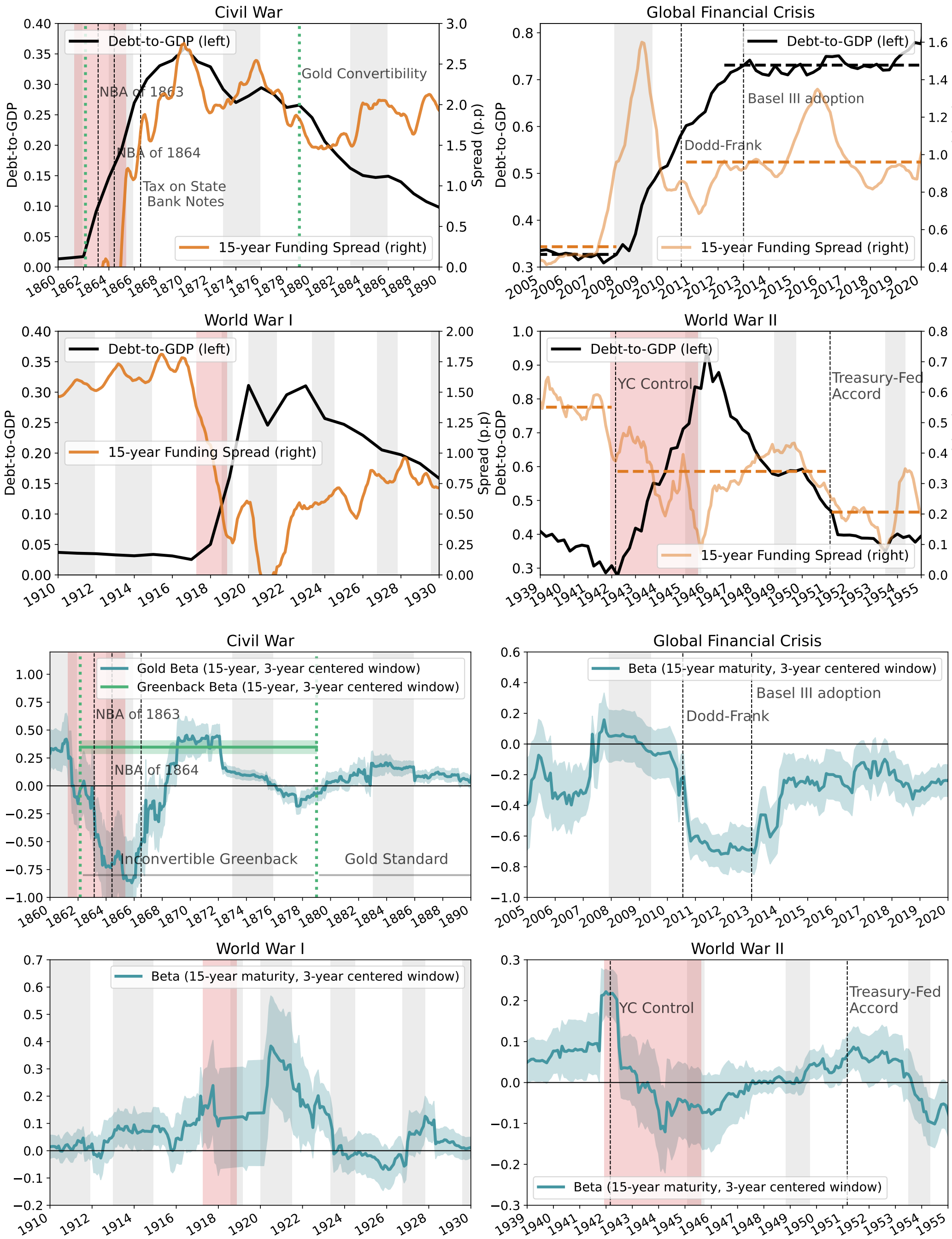

Figure 2: Four Large Debt Expansions: The top four plots show the market value of debt-to-GDP and 15 year private-public borrowing spread during the Civil War, Global Financial Crisis, World War I, and World War II. The bottom four plots show the rolling 36 month bond-stock beta during the same period. The shaded areas show 95% confidence intervals.

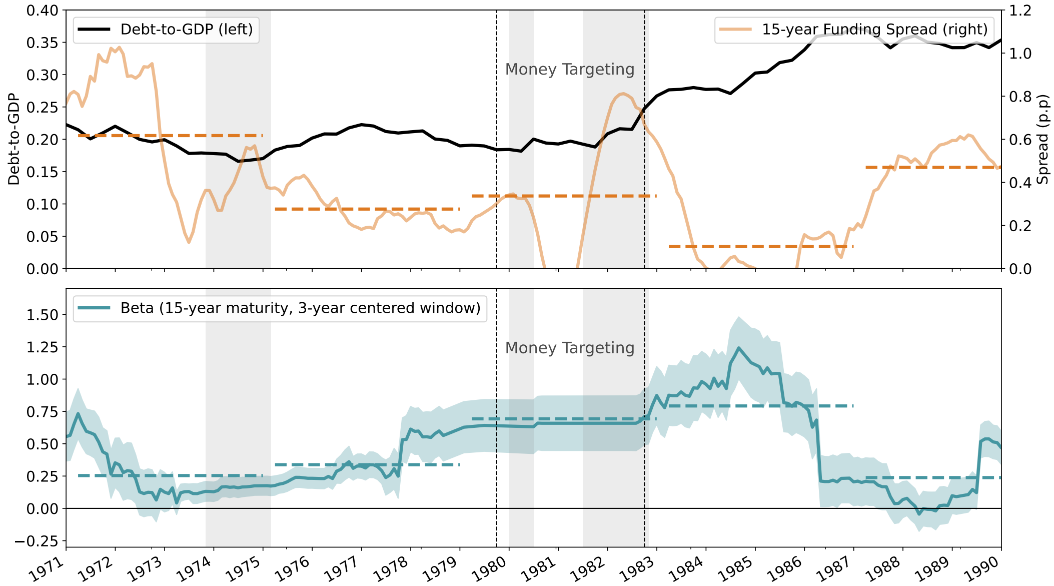

Figure 3: Sub-period From 1971 to 1990

not consistent with the commonly used stable equilibrium relationship outlined in equation (2.2). As illustrated in the bottom panel of Figure 1, in the BIU model, an increase in beta only moves the funding advantage by moving the market value of debt-to-GDP. In order to capture the co-movement between the spread and the bond-stock beta during the 1980s we need a model where changes to the hedging role of government debt directly impacts the private-public borrowing spread.

4. Across the our long sample, financial regime changes and bond-stock beta changes account for most of the variation in private-public funding spreads.

Figure 4 plots our series for our entire sample from 1860-2024. This shows visually that the episodes we discuss are not unrepresentative. The spread is systematically higher during the National Banking Era (approximately 1862-1920), lower during the rest of the twentieth century, and higher again over the last 15 years. The co-movement between debt-to-GDP and the spread varies greatly throughout the sample, while there is a noisy, but consistently negative relationship between the bond-stock beta and the spread.

To make these observations more formal, in Table 2, we regress the spread against Debt-to-GDP, the bond-stock beta, stock market volatility, and controls for regulatory eras. In column (1) we show that, unconditionally, dummies for the National Banking Era, and the Post GFC period explain the majority of the variation in the long sample (an adjusted R^2

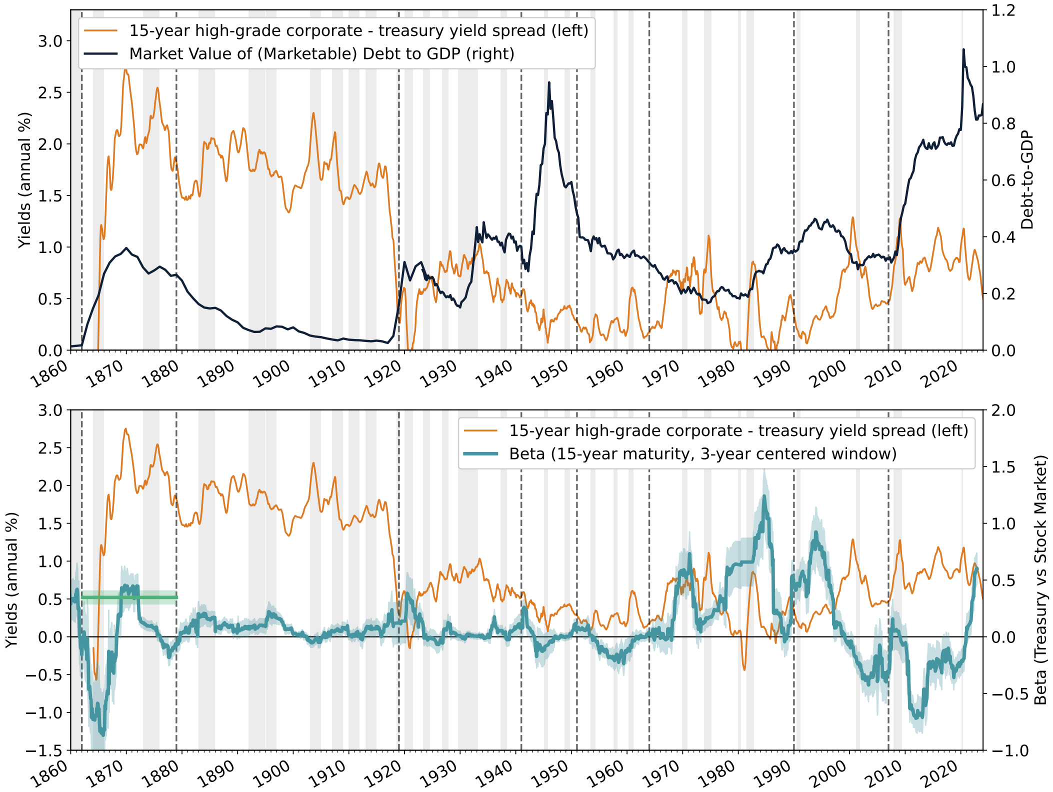

Figure 4: Full Sample: 1860-2024

of 0.70). Introducing the log-debt-to-GDP ratio and stock market volatility in column (2) does help explain additional variation (the adjusted R^2 increases to 0.77) but there is no significantly negative relationship to log-debt-to-GDP. By contrast, introducing the bond-stock beta and stock market volatility in column (3) leads to greater forecastability (the adjusted R^2 increases to 0.86) and the relationship to the bond-stock beta is significant at the 5% threshold. In the final column we include all variables. This does recover a negative relationship between spreads and log-debt-to-GDP during main time period (1917-2010). However, the relationship is actually positive during the National Banking Era and insignficant after the GFC. Furthermore, the introducing log-debt-to-GDP only increases the adjusted R^2 from 0.855 to 0.864, which is a negligible improvement. This reinforces what we saw in the historical episodes—the historical relationship between quantities and spreads is not mechanically negative and quantities changes are not sufficient for explaining the historical movements.

Collectively, we interpret our descriptive statistics and stylized lessons as emphasizing

Table 1: Regression Results: Convenience Yield Analysis

	Dependent variable: Convenience Yield (20-Year)			
	(1)	(2)	(3)	(4)
log(Debt/GDP)[All]		-0.143		-0.211^{***}
		(0.105)		(0.073)
Beta (36M)			-0.178^{**}	-0.238^{***}
			(0.082)	(0.082)
Volatility		1.902^{***}	1.906^{***}	1.725^{***}
		(0.493)	(0.340)	(0.336)
Slope		-0.012	-0.028	-0.003
		(0.037)	(0.024)	(0.025)
Pre-1920 Dummy	1.271^{***}	1.848^{***}	1.127^{***}	1.720^{***}
	(0.065)	(0.254)	(0.131)	(0.398)
Post-2010 Dummy	0.448^{***}	1.138^{***}	0.791^{***}	1.571^{***}
	(0.115)	(0.373)	(0.302)	(0.514)
log(Debt/GDP) × Pre-1920 Dummy		0.225^{*}		0.308^{**}
		(0.120)		(0.122)
log(Debt/GDP) × Post-2010 Dummy		0.350		1.667
		(0.938)		(1.104)
Volatility × Pre-1920 Dummy		-1.722^{***}	-0.473	-0.430
		(0.634)	(0.614)	(0.615)
Volatility × Post-2010 Dummy		-2.587^{***}	-1.914	-3.127^{*}
		(0.920)	(1.421)	(1.737)
Slope × Pre-1920 Dummy		0.109^{**}	0.068	0.012
		(0.043)	(0.047)	(0.056)
Slope × Post-2010 Dummy		0.000	0.003	0.062
		(0.125)	(0.093)	(0.111)
Beta × Pre-1920 Dummy			0.732	0.222
			(0.713)	(0.904)
Beta × Post-2010 Dummy			0.176	0.170
			(0.296)	(0.292)
Constant	0.473^{***}	0.008	0.218^{***}	-0.014
	(0.040)	(0.147)	(0.059)	(0.098)
Significance:	$^{*}p < 0.1$	$^{**}p < 0.05$	$^{***}p < 0.01$	
Period:	1860-2025	1860-2025	1880-2025	1880-2025
Observations	163	163	138	138
Adjusted R^2	0.704	0.767	0.855	0.864

Table 2: Regression Analysis

that the macro-finance literature needs to move beyond studying the debt-to-GDP ratio in models with stable equilibrium relationships. Instead it also needs to focus on how government regulatory policies and government debt return risk impact spreads. Although our reduced equilibrium relationships in Figure 1 and correlations in Section **??** help to illustrate these concerns they none-the-less leaves many important questions unanswered. To what extent can the government control these relationships in a micro-founded general equilibrium model? What are the trade-offs involved with generating funding advantage? Which policy combinations improve household welfare? In order to take up these questions, in Section 3 we construct a general equilibrium model that endogenizes the connections between government polices and funding advantage.

3 A Model of Government Funding Advantage

In this section, we outline a tractable macroeconomic model where financial assets can take on a special role in secondary financial markets to help financial intermediaries manage risk. If government debt takes on this role, then it trades at higher price and lower yield, which gives the government a funding advantage. By contrast, if other assets take on this role, then they would trade at a funding advantage. We use this model to show how financial regulation and fiscal policy interact to influence which asset takes on the special role in the financial markets.

Formally, our model is a stochastic neoclassical growth model extended to include a morning sub-period where households need liquidity services. Financial intermediaries provide these services but this exposes them to frictions in the secondary asset markets (in the morning sub-period) that may force asset sales and/or costly default in bad states of the world. These frictions make our environment a "second-best" world with two interconnected asset pricing distortions: a "liquidity spread" on financial sector liabilities and a "hedging spread" on assets that can help financial intermediaries to self insure risks in the secondary asset markets. Both of these spreads are higher in bad states of the world, reflecting counter-cyclical household demand for liquid assets and counter-cyclical financial sector demand for hedging assets. Absent financial regulation and government default, government debt and productive capital are equally useful for hedging risks in the secondary market. That is, government debt does not have an immutable, special role in the economy.

We study a government facing exogenous surplus shocks that can raise financing by imposing restrictions on financial sector portfolios. This introduces additional asset-specific regulatory pricing distortions, which creates direct regulatory demand for government debt and also changes the equilibrium co-movement between government debt prices and aggregate shocks. In particular, the regulatory restrictions can induce crowding into the secondary government debt market in bad times. This can make government debt a good hedging asset, which in turn generates a government funding advantage. In this sense, the funding advantage emerges endogenously through counter-cyclical captive demand rather than through an immutable, exogenous preference, as in BIU models discussed in Section 2. This means that our endogenous funding advantage becomes policy variant. In particular, systematic devaluation of government debt erodes financial sector profitability, which leads to bank default and exit from the deposit market. This limits the government's ability to create regulatory captive demand and so, in turn, erodes its funding advantage.

3.1 Environment

Setting: The economy is in discrete time with infinite horizon: $t = 0, 1, 2, \ldots$. Each period has morning and afternoon sub-periods. We interpret the afternoon sub-period as a primary asset market and the morning sub-period as a secondary (inter-bank) asset market. We denote variables in the morning market with a breve, $\breve{v}$, and in the afternoon market without a breve, v. There is one consumption good. There is a family of households and a continuum of islands, each with a representative competitive bank. There is a government that issues debt, b_t, in the primary asset market and raises taxes τ_t from the family in the afternoon.

Production technologies: There are two linear production technologies. One is a "morning" short term production technology that transforms m_t goods in the afternoon market at time t into $\breve{y}_{t+1} = \breve{z}_{t+1} m_t$ goods in the morning market at time $t + 1$. Banks can store these goods without cost between morning and afternoon. The other is an "afternoon" production technology that transforms k_t units of capital into $y_{t+1} = z_{t+1} k_t$ units of consumption goods in the afternoon of $t+1$. Capital investment involves an adjustment cost so investment i_t at time t yields $\Phi(\iota_t) k_{t-1}$ additional units of capital at the end of period t, where $\iota_t := i_t / k_{t-1}$ is the investment rate as a proportion of capital available at time t. Capital depreciates at rate $\delta > 0$ so the evolution of physical capital follows:

$$k_t = (1 - \delta) k_{t-1} + \Phi(\iota_t) k_{t-1}.$$

The productivities $(\breve{z}_t, z_t) = (\breve{z}(\varepsilon_t^z), z(\varepsilon_t^z))$ depend upon an exogenous state ε_t^z that is realized at the start of the morning market and follows a Markov Chain with transition matrix Π^z.

Households: We model intra-period heterogeneity in the spirit of Lucas (1990) by using a family of households that separate across islands in the morning sub-periods and pool resources in the afternoon sub-periods. In each afternoon, the family pools after-tax unspent wealth and chooses consumption and a portfolio of bank deposits and equity evenly across the islands. At the start of each morning, the members of the family are separated evenly across the continuum of islands. During separation, households have access to the family's bank deposit on their own island but are excluded from financial markets on other islands. Households on each island are uncertain about their own preferences, in the manner of Diamond and Dybvig (1983) and Allen and Gale (1994). There are two "layers" of uncertainty: household- and island-specific, both of which are resolved immediately after the family is separated in the morning sub-period. First, on each island, in the morning of each time t, a random fraction λ_t of households get utility $u(\breve{c}_t)$ from consuming $\breve{c}_t$, and then die. Second, the fraction λ_t is a random variable following a distribution $\lambda_t \sim \pi(\lambda_t)$ with mean Λ. In the afternoon, surviving members—of fraction $(1 - \Lambda)$—return to the family and a fraction Λ of new members are born keeping the afternoon size of the family unchanged. All family members get utility $u(c_t)$ from consuming c_t in the afternoon. Since λ_t characterizes the heterogeneity across islands we refer to islands by λ_t.

Banks: In the afternoon of each period t, on each island, a one period lived representative bank is set up and issues demand deposits, d_t, and equity, e_t, to the family. The following period $t + 1$, households on island λ_{t+1} can withdraw deposits for resources $\breve{x}^d_{t+1}(\lambda_{t+1}) \leq 1$ either in the morning or in the afternoon of period $t + 1$. Banks face a penalty $\Psi(1 - \breve{x}^d_{t+1})$ for deviating from full repayment of deposits that captures the household need for deposit certainty. In the morning, banks cannot pay or issue dividends. In the afternoon, banks sell their remaining assets to the newly formed banks, pay out dividends $x^e_{t+1}(\lambda_{t+1})$ per share, and then exit.[5]

Markets: We use goods as the numeraire. In the afternoon, government bonds, capital, bank deposits, and bank equity are traded in competitive markets at prices $(q^b_t, q^k_t, q^d_t, q^e_t)$ respectively.[6] In the morning, after the shocks are realized, banks can trade government bonds, at price $\breve{q}^b_t$, and claims on capital, at price $\breve{q}^k_t$, in the secondary asset markets. However, they cannot issue equity or short-sell during the morning market.

Government: In the afternoon of period t, the government purchases consumption goods g_t, raises lump-sum taxes τ_t on the household, and issues long-term bonds in the primary asset market that repay a fraction ω of the outstanding balance in consumption goods at time t. The government's one-period budget constraint in the afternoon is:

$$(\omega + (1 - \omega)q^b_t)B_{t-1} \leq \tau_t - g_t + q^b_t B_t. \tag{3.1}$$

[5]We use bank exit for expositional simplicity. Equivalently, we could model the banks recapitalizing in the afternoon by issuing new equity.

[6]The deposit and equity prices are the same on each island because islands are ex-ante identical.

The government faces an exogenous stochastic fiscal rule. Taxes are an exogenous function of output: $\tau_t = \tau y_t$, where $\tau \in [0,1]$ is a scalar. The government's primary deficit follows an exogenous stochastic process:

$$g_t - \tau y_t = -\eta\omega\Big(B_{t-1} - \bar{b}y_t\Big) + y_t\Big(\sigma^z(\varepsilon_t^z) + \sigma^g\varepsilon_t^g\Big) \tag{3.2}$$

where $\bar{b}$ is a "target level" of debt-to-output ratio and $\eta \geq 0$ measures the sensitivity of primary deficit-to-output to deviations from the target level of outstanding debt-to-output, and ε_t^g is an exogenous state that is realized at the start of the morning market and follows a Markov Chain with transition matrix Π^g. The budget constraint (3.1) and the fiscal rule (3.2) imply an issuance rule for b_t, which is potentially exposed to both TFP shocks through σ^z and government spending shocks through σ^g.

The government can also impose restrictions on banks' portfolios after re-trading in the secondary asset markets, which we model with the constraint:

$$\begin{aligned} \varrho^{\frac{1}{\alpha}}(1-\lambda_t)\breve{x}_t^d(\lambda_t)d_{t-1} &\leq \Upsilon\Big(\breve{q}_t^b\breve{b}_t(\lambda_t),\ \breve{q}_t^k\breve{k}_t(\lambda_t)\Big) \\ &:= \Big(\kappa\big(\breve{q}_t^b\breve{b}_t(\lambda_t)\big)^{\alpha} + (1-\kappa)\big(\breve{q}_t^k\breve{k}_t(\lambda_t)\big)^{\alpha}\Big)^{\frac{1}{\alpha}} \end{aligned} \tag{3.3}$$

where $(1-\lambda_t)d_{t-1}$ is bank λ_t's remaining share of deposits at the end of the morning of period t, and $\big(\breve{b}_t(\lambda_t), \breve{k}_t(\lambda_t)\big)$ denote bank λ's post-trade holdings of government debt and claims on capital, respectively. The pair (ϱ, κ) is a set of regulatory parameters: $\varrho \in [0,1]$ is a leverage constraint that restricts the bank's ability to back its deposit with long term assets, while $\kappa \in [0,1]$ is the relative "weight" on government debt in the calculation of regulatory asset value. We refer to $\kappa = 0.5$ as a "neutral" regulatory regime and $\kappa > 0.5$ as a "repression" regime.[7]

Parametric forms: For numerical exercises, we impose the following parametric forms. We let $u(c) = c^{1-\gamma}/(1-\gamma)$, $\Phi(\iota) =$, and $\Psi(1-\breve{x}^d) = \psi(1-\breve{x}^d)$.

3.1.1 A Broader Interpretation

We have written the model to focus on how portfolio restrictions on the banking sector change the price process for government debt. This because banks have historically been large holders of government debt. However, the forces in the model generalize to other environments.

[7] $\kappa = 0.5$ refers to a regulatory regime that treats government debt and capital symmetrically and just restricts bank risk taking through $\varrho > 0$. Since, absent regulation, government debt and capital have the same return process, we refer to this as a "neutral" regime. $\kappa > 0.5$ is a regime that incentivizes the holding of government debt over capital as regulatory collateral, while $\kappa < 0.5$ corresponds to the opposite case.

Alternative regulations: We have interpreted κ as the weight in explicit macroprudential regulation. One alternative is that it could reflect implicit pressure on the banking sector to purchase government debt (e.g. in the US during WWII). Another alternative is that it could reflect collateral requirements at a government discount window (e.g. in the US after the introduction of the FED). For the latter case, the regulatory requirement is only faced by banks that take significant losses in the morning market rather than by all banks in the economy.

Alternative financial intermediaries: At a more abstract level, the key features of the model that we require are: (i) there is a financial intermediary that provides a service to households that exposes the intermediary to risk, (ii) the financial intermediary faces frictions that generate a wedge in the intermediary Euler equations, (iii) the government restricts the portfolio that the financial intermediary. In this sense, the forces in our model also apply to insurance companies, pension funds, and other financial intermediaries.

3.2 Equilibrium

We set up the equilibrium recursively using the notation that $(\breve{v}, v)$ denotes a variable in the morning and afternoon of the current period respectively and $(\breve{v}', v')$ denotes a variable in the morning and afternoon of the next period respectively. The aggregate state vector each period is $\mathbf{s} := (\boldsymbol{\varepsilon}, k, b, m, d)$, where $\boldsymbol{\varepsilon} := (\varepsilon^z, \varepsilon^g)$ is the vector of exogenous aggregate states, k is aggregate capital stock, b is government debt outstanding. The endogenous state variables k and b evolve according to:

$$k' = (1-\delta)k + \Phi(\iota)k \tag{3.4}$$

$$q^b(\mathbf{s})b' = \big(\eta\omega\bar{b} + \sigma^z(\varepsilon^z) + \sigma^g\varepsilon^g\big)zk + \big(\omega(1-\eta) + (1-\omega)q^b(\mathbf{s})\big)b. \tag{3.5}$$

We guess and verify that afternoon prices are functions $(q^d(\mathbf{s}), q^e(\mathbf{s}), q^k(\mathbf{s}), q^b(\mathbf{s}))$ and the follow period morning prices are functions $\big(\breve{q}^k(\mathbf{s}'), \breve{q}^b(\mathbf{s}')\big)$.

Family problem: At the start of the afternoon sub-period, suppose the family has unspent wealth a. The family's budget constraint in the afternoon sub-period at time t is:

$$c + q^d(\mathbf{s})d' + q^e(\mathbf{s})e' \leq a - \tau(\mathbf{s}) \tag{3.6}$$

where c denotes goods consumed by the family in the afternoon sub-period, (d', e') denote the family portfolio of bank deposits and equity on each island,[8] and $\tau(\mathbf{s})$ denotes the individual lump sum tax in the afternoon sub-period.

[8] The islands are symmetric in the afternoon market so the family allocates resources equally across them.

In the following morning sub-period, the household members of the family separate across islands. The new exogenous aggregate states $(\boldsymbol{\varepsilon}', b')$ are realized and each island receives its idiosyncratic shock draw $\lambda' \sim \pi(\lambda')$ for the fraction of households who have morning consumption needs (we refer to an island with a draw λ' as a "λ'-island"). Households only have access to the deposits held in the bank on their island so, for a given $\mathbf{s}$, a household on an λ'-island consumes $\breve{x}^d(\lambda', \mathbf{s}')d'$, where $\breve{x}^d(\cdot)$ denotes the function for deposit repayment. Household financial wealth not used for consumption in the morning market is returned to the family in the afternoon so, for a given $\mathbf{s}$, the evolution of family wealth between afternoon sub-periods is:

$$a' = \sum_{\lambda'} \Big(x^e(\lambda', \mathbf{s}')e' + (1-\lambda')\breve{x}^d(\lambda', \mathbf{s}')d'\Big)\pi(\lambda') \tag{3.7}$$

where $x^e(\cdot)$ is the dividend per equity share function.

Let $V(a, \mathbf{s})$ denote the value of the household with unspent wealth a at the start of the afternoon. Then, taking as given the law of motion for the aggregate states (3.4) and (3.5), the value function $V(a, \mathbf{s})$ satisfies the Bellman equation (3.8) below:

$$\begin{aligned} V(a, \mathbf{s}) = \max_{\{c,e,d\}} & \left\{ u(c) + \beta \mathbb{E}\left[\sum_{\lambda'} \lambda' u\big(\breve{x}^d(\lambda', \mathbf{s}')d'\big)\pi(\lambda') + (1-\Lambda)V(a', \mathbf{s}') \mid \mathbf{s} \right] \right\} \\ s.t. \qquad & (3.6), (3.7). \end{aligned} \tag{3.8}$$

This leads to the first-order-conditions (FOCs) after imposing the Envelope condition:

$$q^d(\mathbf{s}) = \mathbb{E}\Big[\xi(\mathbf{s}';\mathbf{s})\breve{N}(\mathbf{s}') \mid \mathbf{s}\Big] \tag{3.9}$$

$$q^e(\mathbf{s}) = \mathbb{E}\Big[\xi(\mathbf{s}';\mathbf{s}) \sum_{\lambda'} x^e(\lambda', \mathbf{s}')\pi(\lambda') \mid \mathbf{s}\Big] \tag{3.10}$$

where the stochastic discount factor (SDF) and the "liquidity wedge" for a given $(\lambda', \mathbf{s}')$ are defined by:

$$\begin{aligned} \xi(\mathbf{s}';\mathbf{s}) &:= \beta(1-\Lambda)\frac{\partial_c u(c(\mathbf{s}'))}{\partial_c u(c(\mathbf{s}))}, \\ \breve{N}(\mathbf{s}') &:= \sum_{\lambda'} \left(\left(1 - \lambda' + \lambda' \frac{\partial_c u(\breve{x}^d(\lambda', \mathbf{s}')d')}{(1-\Lambda)\partial_c u(c(\mathbf{s}'))} \right) \breve{x}^d(\lambda', \mathbf{s}') \right) \pi(\lambda'). \end{aligned} \tag{3.11}$$

The liquidity wedge, $\breve{N}(\lambda', \mathbf{s}')$, appears because demand deposits provide liquidity services to the households by allowing them to insure consumption shocks in the morning sub-period. The presence of this asset-specific wedge implies that households are willing to hold demand deposits at a discount.

Bank problem: In the afternoon a new bank is created[9], it chooses a portfolio (m', b', k') of reserve assets, government bonds, and capital. In the following morning, given $\mathbf{s}'$, banks on a λ'-island face the withdrawal constraint $\forall(\lambda', \mathbf{s}')$:

$$\lambda' \breve{x}^d(\lambda', \mathbf{s}')d' \leq \breve{z}'m' + \breve{q}^b(\mathbf{s}')\big(b' - \breve{b}(\lambda', \mathbf{s}')\big) + \breve{q}^k(\mathbf{s}')\big(k' - \breve{k}(\lambda', \mathbf{s}')\big), \tag{3.12}$$

where $\big(\breve{b}(\lambda', \mathbf{s}'), \breve{k}(\lambda', \mathbf{s}')\big)$ denote the bank's portfolios of government bonds and capital chosen in the morning and so $\big(b' - \breve{b}(\lambda', \mathbf{s}'),\ k' - \breve{k}(\lambda', \mathbf{s}')\big)$ denotes the sale of government bonds and capital to finance deposit withdrawals. In the following afternoon, the bank repays equity and deposit holders subject to the budget constraint $\forall(\lambda', \mathbf{s}')$:

$$x^e(\lambda', \mathbf{s}') + (1 - \lambda')\breve{x}^d(\lambda', \mathbf{s}')d' \leq x^k(\lambda', \mathbf{s}')\breve{k}(\lambda', \mathbf{s}') + x^b(\lambda', \mathbf{s}')\breve{b}(\lambda', \mathbf{s}'). \tag{3.13}$$

where $x^k(\lambda', \mathbf{s}')$ and $x^b(\lambda', \mathbf{s}')$ are the afternoon payoffs from capital and government debt:

$$\begin{aligned} x^k(\lambda', \mathbf{s}') &:= z' - \iota(\lambda', \mathbf{s}') + q^k(\mathbf{s}')\big[(1 - \delta) + \Phi(\iota(\lambda', \mathbf{s}')\big] \\ x^b(\lambda', \mathbf{s}') &:= \omega + (1 - \omega)q^b(\mathbf{s}'). \end{aligned}$$

Taking as given the law of motion for the aggregate states, (3.4) and (3.5), the representative bank solves the problem (3.14) below:

$$\begin{aligned} \max_{\substack{m', k', b', d', \breve{x}^d(\cdot), \\ x^e(\cdot), \breve{b}(\cdot), \breve{k}(\cdot), \iota(\cdot)}} \quad & \mathbb{E}_{\mathbf{s}}\Big[\xi(\mathbf{s}'; \mathbf{s}) \sum_{\lambda'} \{x^e(\lambda', \mathbf{s}') - \Psi(\cdot)d'\}\pi(\lambda')\Big] + q^d(\mathbf{s})d' - m' - q^k(\mathbf{s})k' - q^b(\mathbf{s})b' \\ s.t. \quad & (3.12), (3.13), (3.3), \quad \Psi(\lambda', \mathbf{s}') = \psi(1 - \breve{x}^d(\lambda', \mathbf{s}')) \\ & 0 \leq b',\ k',\ m',\ d',\ \breve{b}(\lambda', \mathbf{s}'),\ \breve{k}(\lambda', \mathbf{s}'),\ 1 - \breve{x}^d(\lambda', \mathbf{s}'), \quad \forall(\lambda', \mathbf{s}') \end{aligned} \tag{3.14}$$

where ξ is the household's stochastic discount factor and Ψ is the default penalty. The first order conditions for the portfolio choice in the afternoon market are (dropping the short selling constraints which don't bind):

$$[m']: \qquad 1 = \mathbb{E}_{\mathbf{s}}\Big[\xi(\mathbf{s}'; \mathbf{s})\breve{M}(\mathbf{s}')\breve{z}'\Big] \tag{3.15}$$

$$[k']: \qquad q^k(\mathbf{s}) = \mathbb{E}_{\mathbf{s}}\Big[\xi(\mathbf{s}'; \mathbf{s})\breve{M}(\mathbf{s}')\breve{q}^k(\mathbf{s}')\Big] \tag{3.16}$$

$$[b']: \qquad q^b(\mathbf{s}) = \mathbb{E}_{\mathbf{s}}\Big[\xi(\mathbf{s}'; \mathbf{s})\breve{M}(\mathbf{s}')\breve{q}^b(\mathbf{s}')\Big] \tag{3.17}$$

$$\begin{aligned} [d']: \qquad q^d(\mathbf{s}) = & \ \mathbb{E}_{\mathbf{s}}\Big[\xi(\mathbf{s}'; \mathbf{s}) \sum_{\lambda'} \Big((1 - \lambda')\big[1 + \breve{\mu}^r(\lambda', \mathbf{s}')\big]\Big)\breve{x}^d(\lambda', \mathbf{s}')\pi(\lambda')\Big] \\ & + \mathbb{E}_{\mathbf{s}}\Big[\xi(\mathbf{s}'; \mathbf{s}) \sum_{\lambda'} \Big(\lambda'\breve{\mu}^e(\lambda', \mathbf{s}')\breve{x}^d(\lambda', \mathbf{s}') + \Psi(\lambda', \mathbf{s}')\Big)\pi(\lambda')\Big] \end{aligned} \tag{3.18}$$

[9]Or equivalently, the existing banks raise equity in a frictionless market.

where $\breve{M}(\mathbf{s}')$ is the average marginal value of wealth in the morning conditional on the aggregate state $\mathbf{s}'$:

$$\breve{M}(\mathbf{s}') := \sum_{\lambda'} \breve{\mu}^e(\lambda', \mathbf{s}')\pi(\lambda') \tag{3.19}$$

We can see that equations (3.15), (3.16), and (3.17), are the standard portfolio choice equations augmented with the wedge $\breve{M}(\mathbf{s}')$ reflecting how the interbank market frictions in the morning market distort the bank's portfolio. Equation (3.18) equates the deposit price to the risk-weighted average marginal cost of servicing a unit of deposits in the morning and afternoon.

The first order conditions for the morning market choices and other λ' dependent choices are (dropping the short selling constraints which don't bind):

$$[\breve{x}^d(\cdot)]: \qquad \partial\Psi\Big(1 - \breve{x}^d(\lambda', \mathbf{s}')\Big) = \lambda'\breve{\mu}^e(\lambda', \mathbf{s}') + (1 - \lambda')\Big(1 + \breve{\mu}^r(\lambda', \mathbf{s}')\Big) \tag{3.20}$$

$$[\breve{k}(\cdot)]: \qquad \breve{\mu}^r(\lambda', \mathbf{s}')\partial_{\breve{q}^k\breve{k}}\Upsilon(\lambda', \mathbf{s}') = \breve{\mu}^e(\lambda', \mathbf{s}') - \underline{\breve{\mu}}^k(\lambda', \mathbf{s}') - \breve{R}^k(\mathbf{s}') \tag{3.21}$$

$$[\breve{b}(\cdot)]: \qquad \breve{\mu}^r(\lambda', \mathbf{s}')\partial_{\breve{q}^b\breve{b}}\Upsilon(\lambda', \mathbf{s}') = \breve{\mu}^e(\lambda', \mathbf{s}') - \underline{\breve{\mu}}^b(\lambda', \mathbf{s}') - \breve{R}^b(\mathbf{s}') \tag{3.22}$$

$$[\iota(\cdot)]: \qquad q^k(\mathbf{s}') = \Big(\partial\Phi_\iota(\iota(\lambda', \mathbf{s}'))\Big)^{-1} \tag{3.23}$$

where $\breve{R}^k$ and $\breve{R}^b$ are the morning to afternoon returns:

$$\breve{R}^k(\mathbf{s}') = \frac{z' - \iota(\mathbf{s}') + q^k(\mathbf{s}')\big[(1-\delta) + \Phi(\iota(\mathbf{s}'))\big]}{\breve{q}^k(\mathbf{s}')} \qquad \breve{R}^b(\mathbf{s}') = \frac{\omega + (1-\omega)q^b(\mathbf{s}')}{\breve{q}^b(\mathbf{s}')}$$

Equation (3.20) equates the marginal cost of defaulting on a deposit to the marginal benefit of relaxing the budget and regulatory constraints through deposit default. Equations (3.21) and (3.22) equate the marginal value of relaxing the regulatory constraint with the opportunity cost of foregone investment. Equation (3.23) equates the marginal cost of investment to the price of capital, which implies that ι (and therefore x^k and $\breve{R}^k$) is independent of λ'.

We can now set up a competitive equilibrium. Given a fiscal rule (3.2) and bond price function $q^b(\cdot)$, a budget-feasible government issuance rule $B'(\mathbf{s})$ satisfies (3.1).

Definition 1 (Budget-feasible Competitive Equilibrium)**.** Given regulation parameters (ϱ, κ), and a budget-feasible government policy $\{\tau(\cdot), g(\cdot), B'(\cdot)\}$, a competitive equilibrium is a collection of functions for prices $\{q^d(\cdot), q^e(\cdot), q^k(\cdot), q^b(\cdot), \breve{q}^k(\cdot), \breve{q}^b(\cdot)\}$, payoffs $\{\breve{x}^d(\cdot), x^e(\cdot)\}$, household policies $\{d^h(\cdot), e'(\cdot), c(\cdot)\}$, and bank policies $\{d'(\cdot), m'(\cdot), k'(\cdot), \iota(\cdot), b'(\cdot), \breve{k}(\cdot), \breve{b}(\cdot)\}$, such that

- Taking prices as given, the family solves (3.8),
- Taking prices as given, banks solve (3.14),

- Afternoon and morning goods markets clear:

$$c(\mathbf{s}) + m'(\mathbf{s}) + \iota(\mathbf{s})k + g(\mathbf{s}) = zk, \tag{3.24}$$

$$\sum_{\lambda} \big(\lambda \breve{x}^d(\lambda, \mathbf{s}) d\big)\pi(\lambda) = \breve{z}m, \tag{3.25}$$

morning asset markets clear:

$$\sum_{\lambda} \breve{b}(\lambda, \mathbf{s})\pi(\lambda) = b, \qquad \sum_{\lambda} \breve{k}(\lambda, \mathbf{s})\pi(\lambda) = k, \tag{3.26}$$

and afternoon asset markets clear:

$$d^h(\mathbf{s}) = d'(\mathbf{s}), \qquad e'(\mathbf{s}) = 1, \qquad b'(\mathbf{s}) = B'(\mathbf{s}) \qquad k'(\mathbf{s}) = [1 - \delta + \Phi(\iota(\mathbf{s}))]k.$$

The afternoon market is the standard neoclassical growth model augmented with morning market frictions summarized by the liquidity distortion $\breve{N}(\mathbf{s}) \neq 1$ (equation (3.11) and the interbank market distortion $\breve{M}(\mathbf{s}) \neq 1$ (equation (3.19)). We can see this formally by observing that the afternoon market functions $(c(\mathbf{s}), g(\mathbf{s}), \iota(\mathbf{s}), m'(\mathbf{s}), d'(\mathbf{s}), q^d(\mathbf{s}), q^e(\mathbf{s}), q^k(\mathbf{s}), q^b(\mathbf{s}))$ solve equations (3.9), (3.10), (3.15), (3.16), (3.17), (3.18), (3.23), (3.24), and (3.2).

The novel features of our model appear in the morning market, which generate the liquidity and interbank market distortions. We characterize the equilibrium in the morning market in Proposition (1) below. In the next section, we study how government policies affect the functioning of the morning market.

Proposition 1. *Suppose the short-selling constraints don't bind.*[10] *Then given the state* $\mathbf{s}$*, morning price functions* $\big(\breve{q}^k(\cdot), \breve{q}^b(\cdot)\big)$ *and afternoon payout functions* $\big(x^b(\cdot), x^k(\cdot)\big)$*, the morning choice functions* $\big(\breve{x}^d(\cdot),\ \breve{b}(\cdot),\ \breve{k}(\cdot),\ \breve{\mu}^r(\cdot),\ \breve{\mu}^e(\cdot)\big)$ *satisfy the equations:*

$$\begin{aligned}
\breve{x}^d(\lambda, \mathbf{s}) &= 1 - [\partial_{\breve{x}^d} \Psi]^{-1} \Big(\lambda \breve{\mu}^e(\lambda, \mathbf{s}) + (1 - \lambda)\Big(1 + \breve{\mu}^r(\lambda, \mathbf{s})\Big)\Big) \\
\frac{x^k(\mathbf{s})}{\breve{q}^k(\mathbf{s})} &= \breve{\mu}^e(\lambda, \mathbf{s}) - \breve{\mu}^r(\lambda, \mathbf{s})\partial_{\breve{q}^k \breve{k}} \Upsilon(\lambda, \mathbf{s}) \\
\frac{x^b(\mathbf{s})}{\breve{q}^b(\mathbf{s})} &= \breve{\mu}^e(\lambda, \mathbf{s}) - \breve{\mu}^r(\lambda, \mathbf{s})\partial_{\breve{q}^b \breve{b}} \Upsilon(\lambda, \mathbf{s}) \\
\lambda \breve{x}^d(\lambda, \mathbf{s}) d &= \breve{z}(\mathbf{s}) m + \breve{q}^b(\mathbf{s})\big(b - \breve{b}(\lambda, \mathbf{s})\big) + \breve{q}^k(\mathbf{s})\big(k - \breve{k}(\lambda, \mathbf{s})\big) \\
\breve{\mu}^r(\lambda, \mathbf{s}) &\approx \left(\frac{(1 - \lambda)\breve{x}^d(\lambda, \mathbf{s})\, d}{\Upsilon(\lambda, \mathbf{s})}\right)^{\varpi^r - 1}
\end{aligned}$$

The prices $(\breve{q}^k(\cdot), \breve{q}^b(\cdot))$ *are then pinned down by the asset market clearing conditions in* (3.26).

[10]For example, Ψ is convex and Υ is Cobb-Douglas.

Proof. The first four equations follow directly from rearranging the bank morning FOCs (3.20), (3.21), and (3.22) and the morning goods market clearing condition (3.25). The final equation is an approximation to the Lagrange multiplier that holds exactly in the limit as $\varpi \to \infty$. □

3.3 Morning (Inter-bank) Asset Market and "Captive Demand"

The morning market is governed by the difficulty of managing deposit withdrawals. In our environment, households have a desire for non-state-contingent deposit payouts. Banks offer such deposits but this exposes them to idiosyncratic deposit withdrawal shocks, which they have to try to manage. The economy has low return reserves that payoff in the morning period as well as high return long-term assets (capital and government bonds) that payoff in the afternoon market. In a frictionless world, banks could purchase long-term assets in the afternoon market, then cover deposit withdrawals in the morning market by raising resources from households using the future payout on long-term assets as backing. The difficulty for banks is that frictions in the morning market prevent them from interacting with households and instead force them to sell their long-term assets to other banks in the interbank market. This means that the household stochastic discount factor does not set the inter-temporal rate of substitution between morning and afternoon. Instead, the rate is set by prices in the interbank market. Unfortunately for banks, the interbank market rate is constrained by the aggregate reserves that banks have brought into the market and so morning market asset prices are low. This pushes the market's intertermporal rate of substitution above the household's rate, which potentially leads to banks defaulting on deposits.

Our government "exploits" the frictions in the interbank market rather than attempting to completely "resolve" them. In principle, the government could use tax revenue to directly intermediate the interbank market and overcome the frictions in the banking sector. Instead, our government chooses restrictions on the bank portfolios in order to change the cost of financing a path of government spending and taxes. Formally, these restrictions are given by equation (3.3), which says that government can potentially restrict both bank leverage and asset portfolios. If the government sets $\kappa = 1/2$ and $\alpha = 1$, then the regulatory constraint restricts bank leverage but allows perfect substitution between government bonds and capital to satisfy the regulatory constraint. As the government increases κ above 1/2, it increases pressure on the banking sector to hold government debt, which we refer to as "financial repression".

The banks have two variables they can choose in order to respond to withdraw shocks and the government's regulatory constraints: (i) their asset portfolio between government debt and capital and (ii) the extent to which they default on deposits. How they make this choice will end up determining the extent to which morning market prices or bank default changes in response to the aggregate shocks.

To highlight the different forces at play in the interbank market equations, we characterize equilibrium progressively for increasingly more complicated environments. We start by considering an environment without financial regulation to explain how the interbank market frictions lead to "cash-in-the-market" or "fire-sale" pricing that complicates the banking sector's capacity to handle withdrawal shocks. We then introduce financial repression and show that it generates "captive" bank demand for government debt in bad times and so changes the price process to make government debt a good hedge against the problems arising from withdrawal shocks. Finally, we study fiscal policy that devalues government debt in bad times and show that erodes the "captive" bank demand.

3.3.1 No Financial Regulation

We start without regulatory constraints ($\varrho = 0$, $\mu^r = 0$) to highlight how the interbank market frictions appear in the asset pricing. In this case, because there is no regulation and no shocks between morning and afternoon, capital and government bonds are perfect substitutes with equal returns between morning and afternoon $\breve{R}^k(\mathbf{s}) = \breve{R}^b(\mathbf{s})$.

The banking sector's inability to raise extra resources to supplement their reserves implies that the morning asset markets are characterized by 'fire-sale" pricing: capital and government bonds are traded below their fundamental value. To see this, observe that because there is no regulation and no shocks between morning and afternoon, capital and government bonds are perfect substitutes with equal returns between morning and afternoon $\breve{R}^k(\mathbf{s}) = \breve{R}^b(\mathbf{s})$. In addition, the equity raising constraints mean that the marginal value of resources is greater inside the bank than outside the bank so $\breve{\mu}^e(\lambda, \mathbf{s}) \geq 1$, where the lower bond comes from the storage option. Consequently, the return on assets between morning and afternoon is greater than one:

$$\breve{R}^k(\mathbf{s}) = \breve{R}^b(\mathbf{s}) = \breve{\mu}^e(\lambda, \mathbf{s}) \geq 1,$$

which is the mathematical statement that the market intertemporal rate of substitution, $\breve{R}^i(\mathbf{s})$ for $i \in (k, b)$ between morning and afternoon is greater than the households' intertermporal rate of substitute, 1. This implies that there could be "cash-in-the-market" (Allen and Gale, 1994) or "fire-sale" (Gale and Gottardi, 2020) pricing in the sense that prices in the morning market are less than their afternoon payoffs even though there is no risk or discounting between morning and afternoon:

$$\breve{q}^b(\mathbf{s}) \leq x^b(\mathbf{s}), \qquad \breve{q}^k(\mathbf{s}) \leq x^k(\mathbf{s})$$

These pricing wedges restrict the banking sector's ability to reallocate resources to distressed banks, which, in turn, leads to higher rates of default on deposits.

The interbank market problems are more severe in the low TFP state of the world when the aggregate reserves of the banking sector are low. To see this, from the good market clearing condition, we have:

$$\frac{\breve{z}(\mathbf{s})m}{d} = \sum_{\lambda} \lambda \Big(1 - \big[\partial_{\breve{x}^d} \Psi\big]^{-1} \Big(\lambda \breve{R}^i(\mathbf{s}) + (1-\lambda)\Big)\Big)\pi(\lambda) \qquad i \in \{b, k\}$$

which implies that, in the bad state, as $\breve{z}$ decreases, the return on assets increases so we have fire-sale pricing: $\breve{R}^k(\mathbf{s}') = \breve{R}^b(\mathbf{s}') > 1$, $\breve{q}^b(\mathbf{s}) < x^b(\mathbf{s})$, and $\breve{q}^k(\mathbf{s}) < x^k(\mathbf{s})$. We collect these results in Corollary 1.

Corollary 1. *Without any regulatory constraints ($\varrho = 0$, $\mu^r = 0$), government debt and capital are perfect substitutes in the interbank market. They have the same return, $\breve{R}^k(\mathbf{s}) = \breve{R}^b(\mathbf{s}) \geq 1$, with a strict inequality in the low aggregate state due to "fire-sale" pricing.*

We show these observations for a numerical example in Figure 5, which depicts asset prices as function of productivity $\breve{z}$. The black line shows that, without regulation, both government debt and capital prices decrease when productivity decreases.

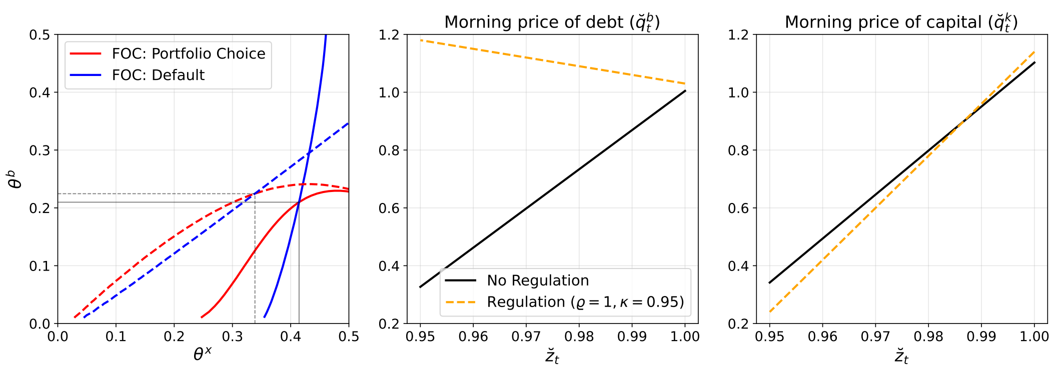

Figure 5: Morning Asset Prices With and Without Financial Repression.

Black line shows the morning market prices in an environment without regulation. The orange line shows the morning market asset prices in an environment with repression.

3.3.2 Financial Regulation and Captive Demand

We now introduce regulatory constraints ($\varrho > 0$, $\kappa \in [0, 1]$) to highlight how the government can influence the morning price process. The regulatory constraint means that banks are no longer indifferent between government debt and capital in the morning market. Instead, they choose both asset holdings and deposit default in order to balance the need to manage withdrawals, the need to satisfy regulatory constraints, and the desire to earn a high return. Formally, let $\breve{a} := \breve{z}(\mathbf{s})m + \breve{q}^k(\mathbf{s})k + \breve{q}^b(\mathbf{s})b$ denote the wealth that a bank brings into the morning sub-period. Let $\breve{\theta}^b := \breve{q}^b(\mathbf{s})b/\breve{a}$ and $\breve{\theta}^x := \breve{x}\breve{q}^b(\mathbf{s})b/\breve{a}$ denote government debt purchases and value of deposits honored as a share of bank wealth. Rearranging the equations in Proposition 1, we can see that the bank's choices are governed by the equations:

$$R^k(\mathbf{s}) - R^b(\mathbf{s}) \approx \frac{\breve{\mu}^r(\lambda,\mathbf{s})}{(\Upsilon(\lambda,\mathbf{s})\breve{a}^{-1})^{\alpha-2}} \left(\frac{\kappa}{\varrho}\left(\breve{\theta}^b\right)^{\alpha-1} - \frac{1-\kappa}{\varrho}\left(1-\breve{\theta}^x-\breve{\theta}^b\right)^{\alpha-1}\right) \quad (3.27)$$

$$\partial\Psi\left(1-\breve{\theta}^x\right) \approx \frac{\breve{\mu}^r(\lambda,\mathbf{s})}{\lambda^{\varpi^r-1}}\left(\lambda\left(\frac{\kappa}{\varrho}\right)\Upsilon(\lambda,\mathbf{s})^{1-\alpha}\left(\breve{\theta}^b\breve{a}\right)^{\alpha-1} + (1-\lambda)\frac{\varrho}{2}\right) + \lambda R^b(\mathbf{s}) + 1 - \lambda \quad (3.28)$$

where the Lagrange multiplier on the regulatory constraint is

$$\breve{\mu}^r(\lambda,\mathbf{s}) \approx \left(\frac{(1-\lambda)\breve{\theta}^x(\lambda,\mathbf{s})\breve{a}}{\Upsilon(\lambda,\mathbf{s})}\right)^{\varpi-1} > 0,$$

which is strictly positive because the regulatory constraint binds. We refer to the first equation as the bank asset portfolio FOC because it says a bank chooses its share of wealth in government bonds to balance the return difference between bonds and capital (the LHS) against the strength of the regulatory constraint (the first term on the RHS) and the relative marginal usefulness of government debt in satisfying the regulatory constraint (the second term on the RHS). We refer to the second equation as the bank deposit default FOC because it says that a bank balances the marginal cost of default (the LHS) against the marginal value of relaxing the budget constraint and regulatory constraints in the interbank market through deposit default (the RHS).

We depict the bank's choice equations (3.27) and (3.28) graphically in the left plot of Figure 5 for the case that $R^k > R^b$. To illustrate how repression distorts the asset market, we consider the comparative static when κ is increased. Evidently, the portfolio FOC contour (the red line) shifts left and up while the default FOC contour (the blue line) rotates clockwise. Together this leads to an increase in fraction of wealth the bank holds in bonds, θ^b, and an increase in deposit default, $1-\theta^x$. This is because financial repression skews the bank's morning portfolio choice to create "captive demand" for government bonds. Because government bonds have the lower return, this tightens the regulatory constraint and so leads to banks defaulting more.

Rearranging the portfolio FOC implies that (after some substitution):

$$\frac{\breve{q}^b(\mathbf{s})}{\breve{q}^k(\mathbf{s})} = \frac{x^b(\lambda,\mathbf{s})}{x^k(\lambda,\mathbf{s})}\left(\frac{1-\frac{\breve{\mu}^r(\lambda,\mathbf{s})}{\breve{\mu}^e(\lambda,\mathbf{s})}\left(\frac{1-\kappa}{\varrho}\right)(1-\breve{\theta}^x-\breve{\theta}^b)^{\alpha-1}}{1-\frac{\breve{\mu}^r(\lambda,\mathbf{s})}{\breve{\mu}^e(\lambda,\mathbf{s})}\frac{\kappa}{\varrho}(\breve{\theta}^b)^{\alpha-1}}\right)$$

If government debt is sufficiently privileged in the regulatory constraint ($\kappa > 1/2$) and so $\frac{\kappa}{\varrho}(\breve{\theta}^b)^{\alpha-1} > \frac{1-\kappa}{\varrho}(1-\breve{\theta}^x-\breve{\theta}^b)^{\alpha-1}$, then the regulatory constraint inflates the price of government debt in the interbank market and so the return on government debt is lower than the return on capital: $\breve{R}^k(\mathbf{s}) > \breve{R}^b(\mathbf{s})$. In this case, we can also see that $\breve{\mu}^r(\lambda, \mathbf{s})$ is higher for low $\breve{z}$ states and so the distortion from the regulatory constraint is higher following negative TFP shocks. This ultimately means that the price ratio $\frac{\breve{q}^b(\mathbf{s})}{\breve{q}^k(\mathbf{s})}$ is higher in bad states of the world and government debt becomes a good hedge against aggregate shocks. Conceptually, the government can exploit the fire-sale pricing in the morning market to skew the price of government debt high in bad states of the world.

The orange lines in the center and right plots in Figure 5 depict the equilibrium price outcomes for a particular numerical experiment. Evidently, with regulation, the price of government debt increases in bad times whereas the price of capital decrease further. In this sense, the government can use regulation to choose which asset appreciates in bad times. We summarize these results in Corollary 2 below.

Corollary 2. *With regulatory constraints that favor government debt ($\varrho > 0$, $\kappa > 1/2$), government debt and capital are imperfect substitutes in the interbank market. In the bad state of the world, the return on capital is higher $\breve{R}^k(\mathbf{s}_B) > \breve{R}^b(\mathbf{s}_B)$ and the relative morning price of government debt appreciates: $\breve{q}^b(\mathbf{s}_B)/\breve{q}^b(\mathbf{s}_B) > \breve{q}^b(\mathbf{s}_G)/\breve{q}^b(\mathbf{s}_G)$.*

3.3.3 Debt Devaluation and Financial Repression

Finally, we consider the impact of a government policy that devalues government debt in the bad aggregate state $x^b(\mathbf{s}_B) < x^b(\mathbf{s}_G)$ (e.g. setting $\sigma_z > 0$ so the government issues debt in bad states) in an environment with financial repression. The impact of such a policy on bank decisions is shown in the left plot of Figure 6 below. A decrease in $x^b(\mathbf{s}_B)$ shifts the portfolio choice curve down and to the right because it lowers the return on government debt. The default choice curve rotates slightly clockwise because default has become more valuable. The result is that demand for government debt falls (θ^b decreases) and the banks default more (θ^x decreases). The relative size of the adjustment through demand versus the relative size of the adjustment through bankruptcy is governed by the relative slope of the two FOCs. A higher default cost means that the default FOC is steeper and so more adjustment comes through θ^b. By contrast, a lower α makes debt and capital less substitutable so more adjustment comes through θ^x.

Conceptually, the combination financial repression and government devaluation in bad states of the world lead to these outcomes because they put the banking sector in a difficult position. If they don't purchase government debt, then they violate the regulatory penalty. If they purchase government debt, then the government's fiscal policy devalues their debt in the afternoon and forces losses onto the equity holders. The banks respond to this lose-lose situation by defaulting on depositors and effectively "exiting" the deposit market.

The center and right plots show how the bank behavior translates to the equilibrium prices in the morning market. The combination of repression and debt devaluation in bad states means that price of government debt once again becomes pro-cyclical. That is, so many banks default that the government loses their captive demand.

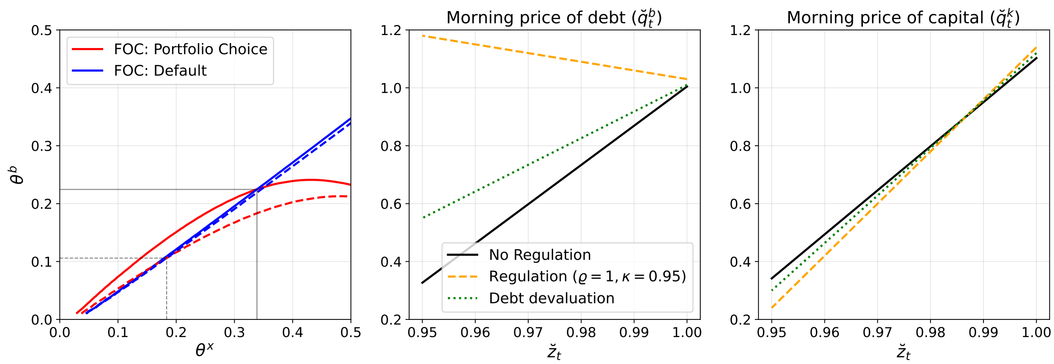

Figure 6: Morning Asset Prices With and Without Debt Devaluation.

Black line shows the morning market prices in an environment without regulation. The orange line shows the morning market asset prices in an environment with repression.

3.4 Afternoon Markets and Policy Variant Government Funding Advantage

We now return to the afternoon market to study how the frictions and regulation in the morning market can generate or erode a funding advantage for the government. To calculate the funding advantage of the government, we need to define a "synthetic" reference bond: a bond issued by the private sector and held by the banking sector that has the same payout as government debt (i.e. the same ω) but has no regulatory benefit in the morning market and is in zero-net supply. We index the bond by h and let $(\breve{q}_t^h, q_t^h)$ denote its price in the morning and afternoon markets. We define the treasury premium as $q^b(\mathbf{s}) - q^h(\mathbf{s})$ and private-public borrowing spread as:

$$\chi(\mathbf{s}) := -\omega \log(q^h(\mathbf{s})) - (-\omega \log(q^b(\mathbf{s})))$$
$$= \omega \log\left(\mathbb{E}\left[\xi(\mathbf{s}')\breve{M}(\lambda', \mathbf{s}')\frac{\breve{q}^b(\mathbf{s}')}{\breve{q}^h(\mathbf{s}')}\breve{q}^h(\mathbf{s}') \mid \mathbf{s}\right]\right) - \omega \log\left(\mathbb{E}\left[\xi(\mathbf{s}')\breve{M}(\lambda', \mathbf{s}')\breve{q}^h(\mathbf{s}') \mid \mathbf{s}\right]\right) \quad (3.29)$$

where we have expanded the terms using the bank first order conditions. We interpret $\chi(\mathbf{s})$ as the model counterpart to our empirical measure of government funding advantage in Section 2.3.

In our model, government funding advantage arises from the special role that government debt plays in the financial sector in the morning market. We can see this by expanding (3.29) to get the approximate expression:

$$\chi(\mathbf{s}) \approx \omega \log\left(\mathbb{E}\left[\frac{\breve{q}^b(\mathbf{s}')}{\breve{q}^h(\mathbf{s}')}\right]|\mathbf{s}\right) + \omega \mathrm{Cov}\left(\frac{\xi(\mathbf{s})\breve{M}(\mathbf{s})\breve{q}^h(\mathbf{s}')}{\mathbb{E}[\xi(\mathbf{s}')\breve{M}(\mathbf{s}')\breve{q}^h(\mathbf{s}')]}, \frac{\breve{q}^b(\mathbf{s})/\breve{q}^h(\mathbf{s}')}{\mathbb{E}\left[\breve{q}^b(\mathbf{s}')/\breve{q}^h(\mathbf{s}')\right]}\right)$$

So, the government's funding advantage arises from the average appreciation of government debt in the next period's morning markets and the covariance between government debt appreciation and the bank's marginal valuation of additional resources. By introducing regulation that ensures that re-trading government debt is valuable in bad times, the government introduces a positive covariance and so introduces a government borrowing cost advantage. That is, regulation makes government debt a particularly "good-hedge" for mitigating the banking sector's frictions in the morning market and so earns a premium.

3.5 Impact of Government Policy Changes

In this section, we use our model to return to the question of how government policy interacts with government funding advantage. This allows us to make precise the reduced form analysis of policy changes in Section 2.2. Figure 7 reconstructs the analogous plots to Figure 1 using an uncalibrated version of our model. The left plots show the equilibrium relationship between spreads and debt-to-GDP while the right plots show the equilibrium relationship between debt-to-GDP and convenience revenue. The black line show a baseline case with $\kappa = 0.8$ (a moderate incentive to hold government debt) and $\sigma^z = 0$ (no covariance between debt issuance and the business cycle).

The top panel shows the impact of an increase in regulatory incentives to hold treasuries (an increase in κ from 0.8 to 0.95). As discussed in the previous sections, this induces a positive feedback loop in our model: introducing financial repression that makes government debt a good hedge leads to banks issuing more deposits and taking more leverage, which in turn means that the banks are dependent on having a good hedge. In this sense, the government can use the frictions in the interbank market to create additional demand for government debt. Ultimately, this increases government fiscal capacity by shifting up the equilibrium relationships between χ and debt-to-GDP and convenience revenue and debt-to-GDP.

The bottom panel shows the impact of an increase in σ^z, which means that the government issues additional debt during bad states of the world and so devalues afternoon prices in bad states of the world. This induces the negative feedback loop in our model: introducing financial repression and while running fiscal policy that devalues government debt in bad states of the world forces banks to take losses. Instead of crowding into the government debt market, the banks default on deposits and essentially exit the market. In this sense, the additional demand for government debt collapses under fiscal policies that do not protect the long-run value of debt. Ultimately, this decreases government fiscal capacity

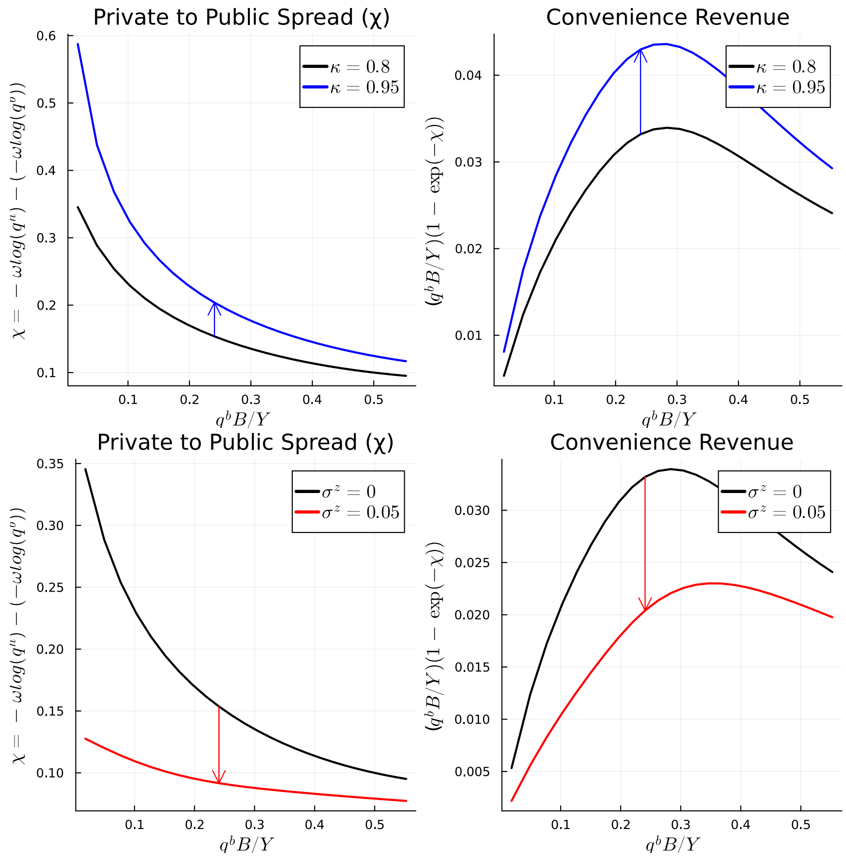

Figure 7: Policy Experiments in Our Model

by shifting down the equilibrium relationships between χ and debt-to-GDP and convenience revenue and debt-to-GDP.

Taken together, we can see that our model gives the government both the strength to create a funding advantage but also makes the funding advantage fragile—the government must run fiscal policy that supports the longer term value of government debt.

3.6 Comparison to Other Models and Spreads

To compare to other papers it is helpful to define a second synthetic reference asset. Let f index an additional zero-net supply bonds issued by the private sector with the same payouts as government debt (same ω) but that is only held by the family and does not trade in the morning market. Let q^f denote the price of the bond and let $x^f := \omega + (1-\omega)q^f$ denote the afternoon payoff on the bonds. Then, we can decompose the difference between the household required rate of return and the treasury yield (sometimes referred to as the "convenience yield" in the literature) as:

$$
\begin{aligned}
&-\omega \log(\mathbb{E}[\xi(\mathbf{s}') \mid \mathbf{s}]) - (-\omega \log(q^b(\mathbf{s}))) \qquad (3.30)\\
&= \underbrace{\omega \log \left(\mathbb{E}\left[\xi(\mathbf{s}') \breve{M}(\lambda', \mathbf{s}') \frac{\breve{q}^b(\mathbf{s}')}{\breve{q}^h(\mathbf{s}')} \breve{q}^h(\mathbf{s}') \mid \mathbf{s} \right] \right) - \omega \log \left(\mathbb{E}\left[\xi(\mathbf{s}') \breve{M}(\lambda', \mathbf{s}') \breve{q}^h(\mathbf{s}') \mid \mathbf{s} \right] \right)}_{\text{Private-public borrowing cost spread} =: \chi} \\
&+ \underbrace{\omega \log \left(\mathbb{E}\left[\xi(\mathbf{s}') \breve{M}(\lambda', \mathbf{s}') \breve{q}^h(\mathbf{s}') \mid \mathbf{s} \right] \right) - \omega \log \left(\mathbb{E}\left[\xi(\mathbf{s}') x^f(\mathbf{s}') \mid \mathbf{s} \right] \right)}_{\text{Market segmentation/liquidity spread} =: \chi^b} \\
&+ \underbrace{\omega \log \left(\mathbb{E}\left[\xi(\mathbf{s}') x^f(\mathbf{s}') \mid \mathbf{s} \right] \right) - \omega \log(\mathbb{E}[\xi(\mathbf{s}') \mid \mathbf{s}])}_{\text{Risk premium}}
\end{aligned}
$$

The first component is the government funding advantage we discussed above. The second component is the difference between the banking sector's valuation of a hypothetical bond with the same cash-flows as government debt and the household's valuation of the same bond. We interpret this wedge as the spread coming from the market segmentation that prevents households from directly holding assets and/or the additional liquidity of the bond for the financial sector. Expanding the second term gives the analogous expression:

$$
\chi^b(\mathbf{s}) \approx \omega \log \left(\mathbb{E}\left[\breve{M}(\mathbf{s}') \right] \right) + \omega \mathrm{Cov} \left(\frac{\xi(\mathbf{s}) \breve{q}^h(\mathbf{s})}{\mathbb{E}[\xi(\mathbf{s}') \breve{q}^h(\mathbf{s}')]}, \frac{\breve{M}(\mathbf{s})}{\mathbb{E}\left[\breve{M}(\mathbf{s}') \right]} \right),
$$

which shows that the frictions in the banking sector, as captured by $\breve{M}$, distort the return required by the banking sector to hold government debt. That is, χ^b is the risk-premium arising from market segmentation and bank frictions. The final component is the risk premium on government debt, as valued by the family of households in the economy.

The decomposition in equation (3.30) highlights how our model nests or relates to alternative models of government funding advantage used in the literature:

1. *Bond-in-the-utility (BIU):* Suppose we remove the morning market, regulatory constraints, and banking sector and instead introduce a utility benefit of holding government debt and capital in the afternoon market. Then the household Bellman equation becomes:

$$
\begin{aligned}
V(a, \mathbf{s}) = \max_{c, b', k'} &\left\{ u(c) + \nu(q^b(\mathbf{s}) b, q^k(\mathbf{s}) k) + \beta \mathbb{E}[V(a', \mathbf{s})] \right\} \quad s.t. \\
c + q^b(\mathbf{s}) b' + q^k(\mathbf{s}) k' &\leq a - \tau(\mathbf{s}) \\
a' &= x^b(\mathbf{s}) b' + x^k(\mathbf{s}) k',
\end{aligned}
$$

which leads to the FOC for government debt:

$$q^b(\mathbf{s}) = \left(\frac{1}{1 - \partial_{q^b b}\nu(q^b b, q^k k)/u'(c)}\right)\mathbb{E}_{\mathbf{s}}[\xi(\mathbf{s}';\mathbf{s})q^b(\mathbf{s}')].$$

For one-period bonds, this implies that the private-public borrowing cost spread becomes:

$$\chi(\mathbf{s}) = \log\left(\frac{1}{1 - \partial_{q^b b}\nu(q^b b, q^k k)/u'(c)}\right). \tag{3.31}$$

and for longer duration bonds the spread becomes (to first order):

$$\begin{aligned}\chi(\mathbf{s}) \approx \omega \log&\left(\frac{1}{1 - \partial_{q^b b}\nu(q^b b, q^k k)/u'(c)}\right)\\ &+ \omega\left(\log\left(\mathbb{E}_t\left[q^b(\mathbf{s}')|\mathbf{s}\right]\right) - \log\left(\mathbb{E}_t\left[q^f(\mathbf{s}')|\mathbf{s}\right]\right)\right)\\ &+ \omega\left(\frac{Cov\left[\xi(\mathbf{s}';\mathbf{s}), q^b(\mathbf{s}')|\mathbf{s}\right]}{\mathbb{E}_t\left[\xi(\mathbf{s}';\mathbf{s})\right]\mathbb{E}_t\left[q^b(\mathbf{s}')|\mathbf{s}\right]} - \frac{Cov\left[\xi(\mathbf{s}';\mathbf{s}), q^f(\mathbf{s}')|\mathbf{s}\right]}{\mathbb{E}_t\left[\xi(\mathbf{s}';\mathbf{s})\right]\mathbb{E}_t\left[q^f(\mathbf{s}')|\mathbf{s}\right]}\right)\end{aligned}$$

Relative to the BIU formulation, our model endogenizes how the scale and elasticity parameters in the functional form BIU $\nu(q^b(\mathbf{s})b, q^k(\mathbf{s})k)$ relate to the government repression parameters and fiscal rule. This means that government policies no longer impact the spread primarily by changing $q^b b$ in the term $\partial_{q^b b}\nu(q^b b, q^k k)$. Instead they change the shape of $\partial_{q^b b}\nu(q^b b, q^k k)$.

2. *Segmentation with Bond-in-Utility:* Suppose we take the BIU formulation from the previous bullet (i.e. no morning market) but now introduce a banking sector that receives utility from holding government debt. In this case, the private-public borrowing cost spread is still given by equation (3.31) so we still have all the problems/features discussed in Section (2.2). However, the model does opens up a market segmentation spread $\chi^b > 0$ that can be used to match additional spreads in the data.

3. *Bond collateral/bond-in-advance:* A number of papers model a binding bond collateral constraint (motivated by moral hazard problems or other information frictions). We can nest this in our environment by removing the interbank market frictions, removing idiosyncratic deposit withdrawal shocks, removing the possibility of bank deposit default, and replacing our regulatory constraint by a linear collateral ratio in the morning market:

$$(1-\lambda)d \leq \kappa\breve{q}^b(\mathbf{s})\breve{b}$$

Deposits, d, are chosen in the previous afternoon and, in equilibrium banks hold all the government debt so $\breve{b} = B$. Assuming the collateral constraint binds, this implies that the bond price in the morning market is given by:

$$\breve{q}^b(\mathbf{s}) = \frac{(1-\lambda)d}{\kappa B}$$

So, the morning price is inversely related to κ and is not influenced by future government debt prices or other government policies. In this sense, the bond collateral model creates very captive demand that is very hard for the government to erode.

4 Macroeconomic Policy Implications (Preliminary)

We conclude by examining the macroeconomic implications of a government that seeks to fund a surplus process by imposing restrictions on financial sector portfolios. Our model with an endogenous, policy-variant government funding advantage leaves the government with complicated trade-offs. We start by illustrating a numerical "trilemma" style result that highlights restrictions on the government's ability to jointly choose afternoon government debt payoffs, private-public borrowing cost spreads, and bank profitability. We then consider the dynamic, general equilibrium trade-offs associated with a particular government fiscal policy variable: the cyclicality of debt issuance.

4.1 Policy Trade-offs: A Financing Trilemma

We start by considering the relationship between financial repression (which the government directly controls through regulation), the afternoon payoff on government debt (which the government indirectly controls in equilibrium through fiscal policy), and two variables: the average rate of default and the private-public borrowing cost spread. Figure 8 shows the equilibrium relationship visually, where the government polices are on the x and y-axes and the equilibrium default and borrowing cost spread (at the ergodic mean) given by the heat map. Evidently, increasing financial repression can increase the private-public borrowing cost spread. However, when accompanied by a devaluation of US debt, increasing financial repression also leads to higher default rates in the financial sector. As discussed in Section 3.3.3, this is because banks are being forced to hold debt with a negative return and so they start to default and exit the deposit market.

We summarize this observation as a stylized "trilemma" for the government. In our model, by varying κ and x^b, the government cannot choose all three of:

1. High funding advantage,

2. A well-functioning financial sector (profitable and stable), and

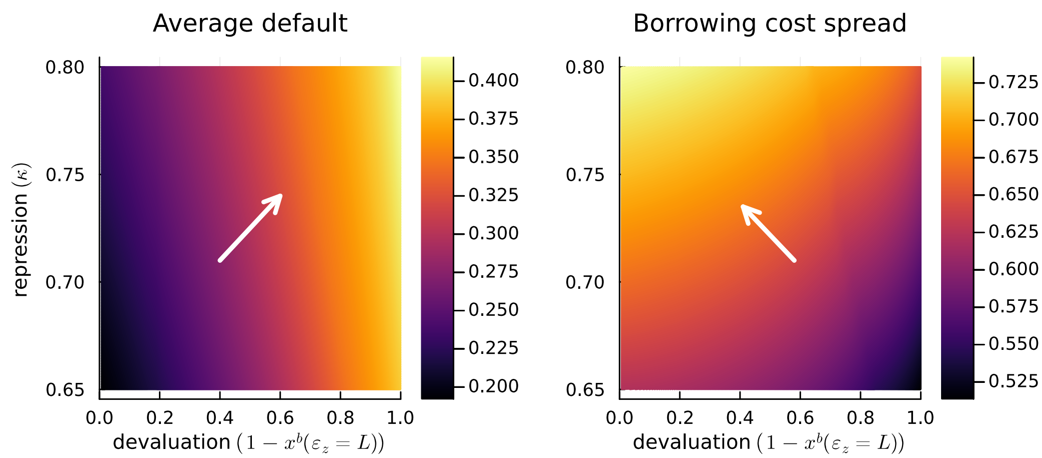

Figure 8: Government Financing Trade-offs

The left subplot shows a heat map with level of government repression on the y-axis, the devaluation of government debt on x-axis, and average default rate in the financial sector as the color. The right subplot shows a heat map with the same x and y-axes but with the private-public borrowing cost spread as the color.

3. Fiscal policy that leads to systematic debt devaluation in bad times (e.g. "default", "counter-cyclical" issuance, "inflation").

At a very stylized level, we can interpret some historical periods from Section 2.3 through the lens of our trilemma. During the 1970s, the US government ran systematically high (and volatile) inflation leading to the real devaluation of US debt. According to the trilemma, this meant it had to choose between maintaining its funding advantage by forcing the financial sector to hold more government debt and maintaining financial stability by allowing the financial sector to substitute away from government debt at the expense of the government's funding advantage. So our model interprets Figure 3 as the government choosing to lose its funding advantage from 1975 to 1985 rather than forcing a financial crisis.

Another period of interest is the National Banking Era (1865-1913). During this time, the government placed heavy financial repression on the banking sector to generate a high government funding advantage. According to the trilemma, this meant it had to choose between a profitable financial sector and fiscal-monetary policy that would lead to the systematic devaluation of its debt. So, again, our model interprets Figure 2 as the government choosing to maintain relatively stable bond returns (through the return to the gold standard after the Civil War) and ensure banking sector profitability.

4.2 Stock-Bond Beta and Funding Costs

The previous subsection shows results when an equilibrium government debt payoff, x^b, is taken as given. To make these arguments more concrete, we now focus on a particular government fiscal policy that could lead to systematic debt devaluation (and so activate the third branch of the trilemma): a fiscal rule that runs deficits in bad times and so forces debt issuance and low government bond prices in bad times (positive stock-bond beta, or $\sigma^z > 0$). In Section 3, we discussed how such a policy would impact the interbank asset markets. We now study the impact on the macroeconomy.

Studying the bottom panel of Figure 4, we can identify three sub-periods with very different stock-bond correlations. Evidently, the "beta" was close to zero through World War I, approximately 0.5 for the period from 1965 to 1990, and then approximately -0.5 for the period from 2010 to 2024. Loosely speaking, we can summarize the riskiness of government debt in the three eras by using different degrees of bond return cyclicality (σ^z) in the fiscal rule (3.2): the period 1870-1910 can be described by $\sigma^z \approx 0$, the 1970s-1980s can be described by $\sigma^z > 0$ and the post-2010 period can be described by $\sigma^z < 0$.

To understand the role of these government policies in our environment, we solve the model for a range of σ_z and κ values. Where possible, we take parameters from the literature. The details of the parameter choices are discussed in Appendix E. Figure 9 shows a collection of variables at their ergodic means for economies with different economic parameters: the private-public borrowing cost spread, investment, welfare, convenience revenue, deficit-to-GDP and debt-to-GDP.

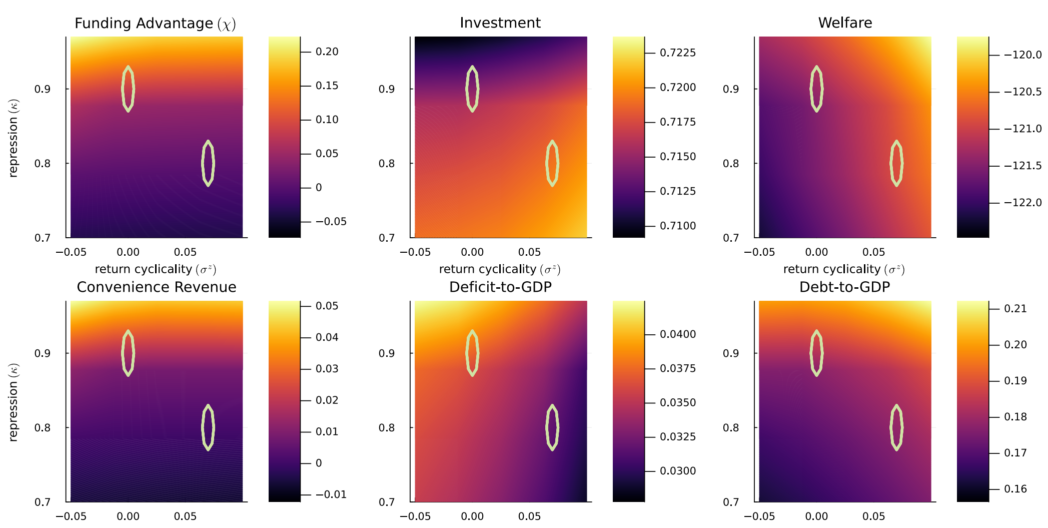

Figure 9: Government Financing Trade-offs. The white circles correspond to the two different regulatory eras in Table 3.

	1870-1910	1970s-1980s
σ^z	0.0	0.08
κ	0.9	0.8
χ	1.3	0.15

Table 3: Ergodic variables for the different policy eras.

To provide some illustrative numerical results, in Table 3, we approximately match the within-subperiod stock-bond correlations by setting the value of $\sigma^z(\varepsilon^z = L)$ (deficit shock in "recessions") accordingly. We then calibrate the value of κ for each subperiod by matching the subperiod-specific average private-public borrowing cost spread. We show these calibrated policy combinations visually with circles on Figure 9.

Figure 9 and Table 3 illustrate a number of points about the connections between financial-fiscal policies and macroeconomic outcomes. First, we can see that the government is able to create a borrowing cost spread, which generates "convenience" revenue and so allows the government to run a long term deficits. In this sense, the government can generate a funding advantage that allows it to issue debt "unbacked" by future tax revenue. Both more repression (an increase in κ) and more counter-cylical bond returns (a decrease in σ^z) lead to higher seigniorage revenue and larger long run deficits because they both make government debt a more useful hedge for the financial sector and so lead to higher borrowing cost spreads.

However, we can also see that the government policies required to generate convenience revenue have large macroeconomic consequences. The investment rate, bank profitability, and liquidity creation all fall because the government is generating the borrowing cost spread by either manipulating the financial sector or running austerity policies that squeeze household consumption in bad times. In this sense, there is no free lunch! The government can engineer a special role for its assets but it cannot do so without distorting the rest of the economy.

4.3 Connection to Different Macro-Fiscal Literatures:

Our paper is connected to a number of very large literatures studying fiscal and financial policies in general equilibrium macro models. We close this section by providing some thoughts on how our analysis is distinct but complementary to these literatures:

(i) *Ramsey and constrained planner models*[11]: Our environment has an incomplete secondary interbank market that restricts the movement of resources to distressed banks. Consequently, the constrained planner would respond by reallocating resources across

[11] E.g. Chari et al. (2020), Bassetto and Cui (2021)

islands to liquidity constrained banks in the morning market and across states by restricting the leverage of the banking sector in the afternoon market. In principle, a Ramsey planner could implement this without any "financial regulation" if it had a sufficiently large set of tax and transfer tools. By contrast, our paper considers a government facing political restrictions that limit its policy choice set to financial regulation. This allows us to focus on the "costs" of using financial regulation to increase government fiscal capacity. We show that these costs involve subtle covariances between the different wedges on the private sector Euler equations and so the government faces a trade-off between expanding fiscal capacity and the stability of the financial sector. We view our work as microfounding the (implicit) cost of "taxing" the financial sector. Future work could consider how a Ramsey planner might balance this cost against the distortionary costs of other taxes.

(ii) *Macroeconomic safe asset models*[12]: In our model, the household need for deposits and the frictions on the banking sector create bank demand for a safe-asset that allows them to hedge default risk and the associated costs. In this sense, we have a similar argument to the "safe-asset" literature, which suggests government debt can earn a "convenience yield" by playing the role of the "liquid" or "safe" asset in the economy. However, this literature typically models the special role of government debt using an exogenous bond-in-utility or bond-in-advance formulation, which allows the government to easily increase fiscal capacity by exploiting the funding cost spread. This is helpful for studying asset pricing but we believe this makes these models less suitable for studying fiscal policy. By contrast, we generate a private-public funding cost spread through government financial regulations that create a captive market for government debt in bad times, which endogenously makes government debt a good hedge against both aggregate and idiosyncratic risk. One benefit of endogenizing the government's funding advantage in this way is that we can show how fiscal policy can potentially erode the safe-asset role of government debt. Another benefit is that we can see that the full cost of making government debt a safe asset involves financial instability and the crowding out of real investment and private liquidity creation.

(iii) *Non-Ricardian macro-fiscal models*[13]: Similar to this literature, we are very interested in the trade-offs about how the government backs its liabilities. In our model, government debt is partially backed by an exogenous surplus process but also by restrictions that create captive demand within the financial sector in bad times and so change the price process of government debt. We believe this makes the following important contributions to this literature: (i) we provide a model of an endogenous private-public

[12] Caballero et al. (2008), Caballero et al. (2017), Choi et al. (2022), Kekre and Lenel (2024).

[13] This includes (but is not limited to) Sargent and Wallace (1981) and the "fiscal theory of the price level" literature, e.g., Leeper (1991), Sims (1994), Woodford (1994), Cochrane (2023), Bianchi et al. (2023), and the recent literature on fiscal backing, e.g., Jiang et al. (2022a,b); Chen et al. (2022).

borrowing cost spread that, unlike other papers in the literature, is intimately related to government fiscal policy, and (ii) we relate the government private-public borrowing cost spread to frictions within the financial sector that reflect some overlooked features of financial history. Ultimately, this means that, in our model, exploiting the government's funding cost spread is hard work that depends very tightly on the fiscal rule, and doesn't invalidate the key trade-offs in models where government debt is backed by future taxation. In this sense, we show that non-pecuniary benefits of government debt are not an alternative backing. There is no free lunch. Overall, we believe we show how to introduce a government private-public funding cost spread while maintaining the importance of fiscal policy for determining the role of government debt.

5 Conclusion

In this paper, we show how the government can generate a funding advantage through restrictions on the financial sector that make government debt a "safe-asset" for the economy. Endogenizing government funding advantage in this way allows us to characterize how it is related to financial and fiscal policy. We show that government default erodes its funding advantage because it changes the role that government debt plays in the financial sector and so changes the debt demand function. This is very different to bond-in-utility and bond-in-advance models where bond demand is exogenous and the fundinga advantage increases when the government starts to default (because the real value of government debt becomes scarce). Our results suggest that macroeconomists should be very cautious about modeling government funding advantage using exogenous, immutable demand functions that fit empirical "safe-asset" curves. Like for the Phillips Curve, these relationships break down once the government attempts to exploit them.

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A Budget Constraint Arithmetic

Let $b_t^{(n)}$ denote the amount of n-period zero-coupon bonds issued at time t. Let the total (face value of) outstanding debt in period t be $b_t := \sum_{n=1}^{\infty} b_t^{(n)}$ and the "portfolio shares" are $b_t^{(n)}/b_t$. In any period t, the government enters with a stock of promised payments $\{b_{t-1}^{(n)}\}_{n\geq 1}$ and issues new (zero-coupon) bonds $\{b_t^{(n)}\}_{n\geq 1}$, where $b_t^{(n)}$ is the amount of bond of maturity n issued in period t.[14] The government budget constraint can be written as

$$\begin{aligned}\sum_{n=1}^{\infty} q_t^{(n)} b_t^{(n)} &= \sum_{n=1}^{\infty} q_t^{(n-1)} b_{t-1}^{(n)} + g_t - \tau_t \\ &= b_{t-1}^{(1)} + \sum_{n=1}^{\infty} q_t^{(n)} b_{t-1}^{(n+1)} + g_t - \tau_t\end{aligned}$$

where g_t is government spending and τ_t is tax revenues. Let Δ_t be the net amount of dollars that the government raises in period t from "refinancing" its debt:

$$\Delta_t := \sum_{n=1}^{\infty} q_t^{(n)} \left[b_t^{(n)} - b_{t-1}^{(n+1)}\right]$$

so that the budget constraint becomes

$$g_t + b_{t-1}^{(1)} = \tau_t + \Delta_t.$$

The role of the yield curve for government financing can be summarized by the Δ_t term. The government's total deficit (including interest payments) is $g_t + b_{t-1}^{(1)} - \tau_t$, while its primary deficit is $def_t := g_t - \tau_t$. As a result, the difference between Δ_t and $\widetilde{\Delta}_t$ can be viewed as the contribution of the borrowing cost spread to period t surplus.

Iterating the budget constraint forward gives the lifetime budget constraint:

$$\begin{aligned}\sum_{j=1}^{\infty} q_t^{(j-1)} b_{t-1}^{(j)} = &\underbrace{\mathbb{E}_t\left[\sum_{s=0}^{\infty} \xi_{t,t+s}\left(\tau_{t+s} - g_{t+s}\right)\right]}_{(i)} + \underbrace{\sum_{j=1}^{\infty}\left(q_t^{(j)} - \widetilde{q}_t^{(j)}\right) b_{t-1}^{(j+1)}}_{(ii)} \\ &+ \underbrace{\mathbb{E}_t\left[\sum_{s=0}^{\infty} \xi_{t,t+s}\left\{\sum_{j=1}^{\infty}\left(q_{t+s}^{(j)} - \widetilde{q}_{t+s}^{(j)}\right)\left(b_{t+s}^{(j)} - b_{t-1+s}^{(j+1)}\right)\right\}\right]}_{(iii)}.\end{aligned}$$

where $q_t^{(j)}$ and $\widetilde{q}_t^{(j)}$ denote the zero-coupon prices of the government and public sector's j-period zero-coupon bonds, respectively.

[14] For instance, one period bond issued in period t and maturing in $t+1$ is $b_t^{(1)}$. Similarly, $b_{t-1}^{(n)}$ is the amount of n-period bond issued in period $t-1$ coming due in period $t-1+n$.

A.1 Models with representative long-term debt

The *admissible set of portfolios* is restricted to follow an exponential rule, i.e.

$$b_t^{(n)} = b_t \omega (1-\omega)^{n-1}$$

In other words, the assumption is that we can summarize/proxy the portfolio $\{b_t^{(n)}\}_{n=1}^{\infty}$ with a pair of scalars (b_t, ω). The variable Δ_t can be written as:

$$\Delta(b_t, \omega_t; b_{t-1}, \omega_{t-1}) := \sum_{n=1}^{\infty} q_t^{(n)} \Big[\underbrace{(1-\omega_t)^{n-1} \omega_t b_t}_{=b_t^{(n)}} - \underbrace{(1-\omega_{t-1})^{n} \omega_{t-1} b_{t-1}}_{=b_{t-1}^{(n+1)}} \Big]$$

In the above expression, if the government enters the period with a portfolio (b_{t-1}, ω_{t-1}) and wants to exit it with a portfolio (b_t, ω_t), then for each maturity $n \geq 1$ it must issue/buy back $b_t^{(n)} - b_{t-1}^{(n+1)}$ many bonds at price $q_t^{(n)}$.

Suppose for now that ω_t is fixed over time, i.e. $\omega_t = \omega$. We can then write

$$\Delta_t := \underbrace{\left(\sum_{n=1}^{\infty} q_t^{(n)} (1-\omega)^{n-1} \omega \right)}_{=:q_t^b(\omega)} \Big(b_t - (1-\omega) b_{t-1} \Big) = q_t^b \Big(b_t - (1-\omega) b_{t-1} \Big)$$

where q_t^b denotes the market price of a "unit" of government debt portfolio (at face value) with average maturity $1/\omega$. From the definition of Δ_t we can write the law of motion of (the face value of) debt as

$$b_t = (1-\omega) b_{t-1} + \frac{\Delta_t}{q_t^b}$$

so if $\omega < 1$ and q_t^b depends on (b_t, b_{t-1}), q_t^b will behave as an (endogenous) debt adjustment cost. In this case, the government budget constraint is

$$g_t + \omega b_{t-1} = \tau_t + q_t^b \Big(b_t - (1-\omega) b_{t-1} \Big).$$

The intertemporal budget constraint can be written as

$$b_{t-1}^{(1)} + \underbrace{\left\{ \sum_{j=1}^{\infty} q_t^{(j)} (1-\omega)^{j-1} \omega \right\}}_{=:q_t^b(\omega)} (1-\omega) b_{t-1} = \underbrace{\mathbb{E}_t \left[\sum_{s=0}^{\infty} \xi_{t,t+s} \Big(\tau_{t+s} - g_{t+s} \Big) \right]}_{(i)} +$$

$$+ \underbrace{\Big(q_t^b - \widetilde{q}_t^b \Big) (1-\omega) b_{t-1}}_{(ii)} + \underbrace{\mathbb{E}_t \left[\sum_{s=0}^{\infty} \xi_{t,t+s} \Big(b_{t+s} - (1-\omega) b_{t+s-1} \Big) \Big(q_{t+s}^b - \widetilde{q}_{t+s}^b \Big) \right]}_{(iii)}.$$

or using the definition of the "weighted price" q_t^b:

$$\Big(\omega + q_t^b (1-\omega) \Big) b_{t-1} = \underbrace{\mathbb{E}_t \left[\sum_{s=0}^{\infty} \xi_{t,t+s} \Big(\tau_{t+s} - g_{t+s} \Big) \right]}_{(i)} + \underbrace{\Big(q_t^b - \widetilde{q}_t^b \Big) (1-\omega) b_{t-1}}_{(ii)}$$

$$+ \underbrace{\mathbb{E}_t \left[\sum_{s=0}^{\infty} \xi_{t,t+s} \Big(q_{t+s}^b - \widetilde{q}_{t+s}^b \Big) \Big(b_{t+s} - (1-\omega) b_{t+s-1} \Big) \right]}_{(iii)}.$$

The "yield" embedded in the representative price of the government debt portfolio is

$$q_t^b = \sum_{j=1}^{\infty} \left(\frac{1}{1+y_t} \right)^j (1-\omega)^{j-1} \omega = \frac{\omega}{1+y_t} \left(\frac{1}{1 - \frac{1-\omega}{1+y_t}} \right) = \frac{1}{1+y_t/\omega} \approx \exp(-y_t/\omega)$$

which makes sense given that the government portfolio's average maturity is $1/\omega$.

A.2 Bond-in-Utility

For example, Krishnamurthy and Vissing-Jorgensen (2012) and many subsequent papers use the parametric specification:

$$\Omega_{t,t+1} = \Omega(\theta_t/y_t) = \exp\left(\beta_0 + \beta_1 \log\left(\theta_t/y_t\right) + \log(\zeta_t)\right)$$

where θ_t is the market value of all "convenience assets" that earn a non-pecuniary benefit, y_t is GDP, and $\log(\zeta_t)$ is a time-t adapted i.i.d. mean zero random variable often interpreted as a demand shock. For 1-period government and corporate bonds without default risk, this implies that the funding advantage is given by:

$$\chi_t^{(1)} = \log(\Omega(\theta_t/y_t)) = \beta_0 + \beta_1 \log(\theta_t/y_t) + \log(\zeta_t)$$

For $j-$maturity government and corporate bonds with default risk, the funding advantage also includes additional covariance terms. To a first order approximation, this becomes:

$$\chi_t^{(j)} \approx \frac{1}{j}\left(\beta_0 + \beta_1 \log\left(\theta_t / y_t\right) + \log(\zeta_t)\right) + \frac{1}{j}\left(\log\left(\mathbb{E}_t\left[q_{t+1}^{(j-1)}\right]\right) - \log\left(\mathbb{E}_t\left[\tilde{q}_{t+1}^{(j-1)}\right]\right)\right)$$
$$+ \frac{1}{j}\left(\frac{Cov\left[\xi_{t,t+1}, q_{t+1}^{(j-1)}\right]}{\mathbb{E}_t\left[\xi_{t,t+1}\right]\mathbb{E}_t\left[q_{t+1}^{(j-1)}\right]} - \frac{Cov\left[\xi_{t,t+1}, \tilde{q}_{t+1}^{(j-1)}\right]}{\mathbb{E}_t\left[\xi_{t,t+1}\right]\mathbb{E}_t\left[\tilde{q}_{t+1}^{(j-1)}\right]}\right)$$

So, for short term debt in an world where government debt is the only convenience asset ($\theta_t = q_t^b b_t$) we get equation (2.2).

B Context on Historical Financial Sector Regulation

To help interpret the historical data, we outline some key historical changes in monetary, financial, and fiscal policy. We provide a summary in Table 4 and a more comprehensive time-line in Appendix G.

	Regulation Parameters	Discussion
1791-1862	$\varrho \approx 0$, $\kappa = 0.5$	*Pre-Civil War:* bank regulation was typically at the state level, and regulation was not tightly enforced.
1862-1913	$\varrho = 0.9$, $\kappa = 1$ for $q^b \leq 1$	*National Banking Era:* has tight repression on the banking sector, which could only use government debt to back money creation.
1913-2007	$\varrho > 0$, κ varying and more implicit	*FED and New Deal Regulation:* has implicit advantages for government debt through the acceptance of US debt at the FED discount window and the Bretton Woods reserve requirements (from 1944-1971).
2008-2024	ϱ = leverage ratio, κ = risk weight on US debt	*Basel III and Dodd-Frank Act:* led to increased regulation of the financial sector, with asset requirements based on their risk weights.

Table 4: Summary of Financial Eras

1791-1862: Banks of The US and State Banks. Between April 1792 and February 1862, the federal government minted gold and silver coins but not paper notes. Instead, state legislatures charted state banks, which could issue their own bank notes. Initially, the First (1791-1811) and Second (1816-1836) Banks of the United States operated at the national level and indirectly regulated state bank bank note creation but Andrew Jackson (1829-1837) allowed the Bank's charter to expire (1836). In the subsequent decades (1837-1862), states expanded their banking sectors by allowing the automatic chartering of banks without requiring explicit approval from the state legislature. This period is often referred to as the "free banking era" and was perceived to be characterized by weak enforcement of bank portfolio restrictions, high bank risk taking, and discounted state bank notes. From the point of view of our model, we interpret this as a period with a low effective leverage requirement (low ϱ) and no particular weight on US federal debt ($\kappa = 0.5$).

1862-1913: National Banking System. The outbreak of the Civil War in 1861 put significant strain on the monetary and financial systems, leading to major policy changes. On February 25, 1862, Congress passed a Legal Tender Act that authorized the Treasury to issue 150 million dollars of a paper currency known as greenbacks that the government did not promise immediately to exchange for gold dollars. In addition, between 1863-6, Congress passed a collection of National Banking Acts, which established a system of nationally charted banks and the Office of the Comptroller of the Currency. National banks faced restrictions on what loans they could make[15] and were allowed to issue bank notes up to 90% of the minimum of par and market value of qualifying US federal bonds.[16] These national bank notes were intended to replace the state bank notes as a standardised currency that could be used across the country. In order to achieve this, Congress imposed a 10% annual tax on state bank notes, which was significantly greater than the 1% annual tax on national bank notes.[17] From the point of view of our model, the National Banking Era is a period of explicit financial repression with $\varrho = 0.9$ and $\kappa = 1$ when bonds trade below par (and $\kappa = q_t^b$ when bonds traded above par).

1915-1971: Establishment of the Federal Reserve Bank, Deposit Insurance, and Bretton Woods. Bank runs and stock market crashes were a common feature of all different monetary and banking policy arrangements during the 19th century. There were country wide bank panics in 1819, 1827, 1857, 1873, 1893, and 1907 as well as many other local bank panics in New York and other financial hubs. In response, The Federal Reserve System Act was passed in 1913 to create a Federal Reserve Bank (FRB) to act as a reserve money

[15]National banks could only operate one branch. They were restricted from making mortgages unless they were operating in rural areas, where they could make a limited range of loans collateralized by agricultural land.

[16]Technically, national banks could issue bank notes for circulation according to the following rules. Banks had to deposit certain classes of US Treasury bonds as collateral for note issuance. Permissible bonds were US federal registered bonds bearing coupons of 5% or more. Deposited bonds had to be at least one-third of the bank's capital (not less than $30,000). Banks could issue bank notes up to an amount of 90% of the maximum of the market value of the bonds and the par value of the bonds. The 90% value was changed to 100% in 1900.

[17]Before 1900, the banks had to pay 1.0% tax on the notes they had issued. After 1900, they had to pay a 0.5% tax.

creator of last resort to prevent bank runs. The Bank started operations in late 1914. The inability to prevent bank failures during the depression prompted Franklin D. Roosevelt to introduce a further reorganization of the financial sector. The 1933 Banking act introduced deposit insurance for retail banks, established the Federal Deposit Insurance Corporation (FDIC), and separated commercial and investment banking. The 1934 and 1938 household acts established the Federal National Mortgage Association (commonly known as Fannie Mae) to insure long term mortgages. These reforms ultimately relaxed the explicit financial repression from the National Banking Era. However, the FRB started to privilege government debt as collateral for discount window lending, which acted as an implicit advantage to government debt.

The difficulties of financing World War II led to the government "fixing" the yield curve from 1942-1951, with yields on long term bonds set at 2.5% (see Garbade (2020)). The policy was implemented through coordination between the Treasury and the Federal Reserve, with the Fed agreeing to absorb excess bond supply at the fixed price, and implicit coordination with the banking system, which ended up predominately holding government debt. This coordination ended in 1951 with the Treasury-Fed Accord that establishes official Fed independence from fiscal policy. At the international level, the 1944 Bretton Woods Agreement set up an international system of fixed exchange rate with US doller convertable to gold.

1972-2007: Financial Deregulation. Internationally, the US effectively terminated the Bretton Woods systems in 1971 by ending convertibility to gold. Domestically, the government embarked on a program of financial deregulation. In 1994, the Riegle-Neal Interstate Banking and Branching Efficiency Act allowed banks to operate across states. In 1999, the Gramm-Leach-Bliley Act repealed the provisions of the Glass-Steagall Act that prohibited banks from holding other financial companies. In our model, we would interpret this as a decrease in the effective ϱ.

2008-2024: Financial Crisis, Basel-III, and Dodd-Frank Act. The 2007-9 financial crisis led to extensive new regulation on the banking sector and the Dodd-Frank Wall Street Reform and Consumer Protection Act. In addition, the Basel-III regulation introduces restrictions so that ϱ reflects the bank leverage requirement and κ is the "risk" weight on government debt for calculating risk weighted asset ratios.

C Additional Empirical Results

In this section of the appendix, we include additional empirical results. Table 5 shows the regression for the full sample with different controls. Table 6 shows moments for different subperiods.

	Dependent variable: 10y AAA Corporate Bond Yield - 10y Treasury Yield		
	(1)	(2)	(3)
const	1.064***	1.957***	1.946***
	(0.200)	(0.318)	(0.315)
debt-to-GDP	-0.331***	0.052	0.046
	(0.037)	(0.061)	(0.061)
sigma(R)	-0.379***	-0.012	-0.022
	(0.085)	(0.136)	(0.135)
slope	0.011	-0.034	-0.024
	(0.030)	(0.027)	(0.028)
volatility	1.451***	-0.237	-0.221
	(0.334)	(0.438)	(0.435)
1920-2024		-1.047***	
		(0.379)	
1920-2024*debt-to-GDP		-0.261***	
		(0.090)	
1920-2024*sigma(R)		-0.290*	
		(0.169)	
1920-2024*vol		2.101***	
		(0.639)	
1920-2007			-1.006***
			(0.381)
1920-2007*debt-to-GDP			-0.335***
			(0.108)
1920-2007*sigma(R)			-0.344**
			(0.173)
1920-2007*vol			2.172***
			(0.663)
2009-2024			-0.488
			(1.647)
2009-2024*debt-to-GDP			0.516
			(1.144)
2009-2024*sigma(R)			-0.264
			(0.789)
2009-2024*vol			-0.884
			(1.755)
Observations	154	154	154
R^2	0.598	0.725	0.736
Adjusted R^2	0.587	0.709	0.714
Residual Std. Error	0.398 (df=149)	0.334 (df=145)	0.332 (df=141)
F Statistic	55.402*** (df=4; 149)	47.668*** (df=8; 145)	32.758*** (df=12; 141)
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 5: Regressions for the sample 1870-2024. The first column regresses the spread on debt-to-GDP, government debt return volatility, slope, volatility. The second column introduces a dummy for the National Banking Era (1870-1919). The third column introduces dummies for the National Banking Era (1870-1919), Post WWI (1920-2007), and Post-GFC (2009-2024) periods. We drop the year 2008.

	1870-1919	1920-1951	1952-1993	1994-2007	2008-2025
Private-public borrowing cost spread: (χ_t)					
mean	1.734	1.066	0.431	0.663	0.717
vol	0.277	0.302	0.269	0.228	0.247
corr($\cdot$, Δy)	-0.142	-0.121	-0.128	-0.557	-0.529
Debt-to-GDP: $(q_t^b b_t / y_t)$					
mean	0.126	0.512	0.477	0.655	1.07
vol	0.065	0.174	0.137	0.047	0.084
corr($\cdot$, Δy)	0.044	-0.24	-0.049	-0.374	-0.079
Real return: $((\omega + (1-\omega) q_{t+1}^b)/q_t^b - 1)$					
mean	2.338	2.262	1.818	3.004	1.057
vol	4.71	7.68	8.61	9.57	10.09
corr($\cdot$, Δy)	-0.206	-0.295	-0.14	-0.414	0.131
Surplus-to-GDP: $(g_t - \tau_t)/y_t$					
mean	0.071	-3.794	-1.956	-1.168	-6.153
vol	2.611	7.298	1.067	1.763	3.554
corr($\cdot$, Δy)	-0.083	-0.221	-0.261	0.137	0.356

Table 6: Summary statistics for different policy eras.

D Equilibrium Characterization

We set up the equilibrium recursively using the notation that $(\breve{v}, v)$ denotes a variable in the morning and afternoon of the current period respectively and $(\breve{v}', v')$ denotes a variable in the morning and afternoon of the next period respectively. The aggregate state vector each afternoon sub-period is $\mathbf{s} := (\mathbf{z}, b, k, d, m)$, where $\mathbf{z} = (\breve{z}, z)$ is the realization of the exogenous aggregate TFP values, k is aggregate capital stock, and b is government debt outstanding (both determined in the previous afternoon sub-period). We guess and verify that afternoon prices are functions $(q^d(\mathbf{s}), q^e(\mathbf{s}), q^k(\mathbf{s}), q^b(\mathbf{s}))$ and the follow period morning prices are functions $\breve{q}^k(\mathbf{s}'), \breve{q}^b(\mathbf{s}')$.

D.1 Household Problem

Family problem: The family solves the problem:

$$V(a,\mathbf{s}) = \max_{\{c,e',d'\}} \left\{ u(c) + \beta\mathbb{E}\left[\sum_{\lambda} \lambda' u\big(\breve{x}^d(\lambda',\mathbf{s}')d'\big)\pi(\lambda') + (1-\Lambda)V(a',\mathbf{s}') \mid \mathbf{s}\right]\right\}$$

$$s.t. \qquad c + q^d(\mathbf{s})d' + q^e(\mathbf{s})e' \leq a - \tau(\mathbf{s})$$

$$a' = \sum_{\lambda'} \Big(x^e(\lambda',\mathbf{s}')e' + (1-\lambda')\breve{x}^d(\lambda',\mathbf{s}')d'\Big)\pi(\lambda').$$

After substituting in the law of motion wealth, the Lagrangian is:

$$\begin{aligned}\mathcal{L} = u(c) &+ \beta\mathbb{E}\Big[\sum_{\lambda} \lambda' u\big(\breve{x}^d(\lambda',\mathbf{s}')d'\big)\pi(\lambda') \\ &+ (1-\Lambda)V\Big(\sum_{\lambda'}\Big(x^e(\lambda',\mathbf{s}')e' + (1-\lambda')\breve{x}^d(\lambda',\mathbf{s}')d'\Big)\pi(\lambda'),\mathbf{s}'\Big) \mid \mathbf{s}\Big] \\ &+ \mu^c(\mathbf{s})\big(a - \tau(\mathbf{s}) - c - q^d(\mathbf{s})d' - q^e(\mathbf{s})e'\big)\end{aligned}$$

where $\mu^c(\mathbf{s})$ is the Lagrange multipliers on the afternoon budget constraint. The FOCs are:

$$[c]: \qquad 0 = \partial_c u(c) - \mu^c(\mathbf{s})$$

$$[e']: \qquad 0 = \mathbb{E}\left[\beta(1-\Lambda)\partial_{a'}V(a',\mathbf{s}')\sum_{\lambda'} x^e(\lambda',\mathbf{s}')\pi(\lambda') \;\Big|\; \mathbf{s}\right] - \mu^c(\mathbf{s})q^e(\mathbf{s})$$

$$\begin{aligned}[d']: \qquad 0 = &\ \mathbb{E}\left[\beta(1-\Lambda)\partial_{a'}V(a',\mathbf{s}')\sum_{\lambda'}(1-\lambda')\breve{x}^d(\lambda',\mathbf{s}')\pi(\lambda') \;\Big|\; \mathbf{s}\right] - \mu^c(\mathbf{s})q^d(\mathbf{s}) \\ &+ \mathbb{E}\left[\beta\sum_{\lambda}\lambda'\breve{x}^d(\lambda',\mathbf{s}')\partial_c u\big(\breve{x}^d(\lambda',\mathbf{s}')d'\big)\pi(\lambda') \;\Big|\; \mathbf{s}\right]\end{aligned}$$

Using the envelope condition, we have:

$$\partial_a V(a,\mathbf{s}) = \mu^c(\mathbf{s}) = \partial_c u(c)$$

and so we get the asset pricing conditions:

$$
\begin{aligned}
q^e(\mathbf{s}) &= \mathbb{E}\left[\beta(1-\Lambda)\frac{\partial_c u(c(\mathbf{s}'))}{\partial_c u(c(\mathbf{s}))}\sum_{\lambda'} x^e(\lambda',\mathbf{s}')\pi(\lambda') \mid \mathbf{s}\right] \\
q^d(\mathbf{s}) &= \mathbb{E}\left[\beta(1-\Lambda)\frac{\partial_c u(c(\mathbf{s}'))}{\partial_c u(c(\mathbf{s}))}\sum_{\lambda'}(1-\lambda')\breve{x}^d(\lambda',\mathbf{s}')\pi(\lambda') \mid \mathbf{s}\right] \\
&\quad + \mathbb{E}\left[\beta\sum_{\lambda}\lambda'\frac{\partial_c u(\breve{x}^d(\lambda',\mathbf{s}')d')}{\partial_c u(c(\mathbf{s}))}\breve{x}^d(\lambda',\mathbf{s}')\pi(\lambda') \mid \mathbf{s}\right] \\
&= \mathbb{E}\left[\beta(1-\Lambda)\frac{\partial_c u(c(\mathbf{s}'))}{\partial_c u(c(\mathbf{s}))}\sum_{\lambda'}\left(1-\lambda'+\lambda'\frac{\partial_c u(\breve{x}^d(\lambda',\mathbf{s}')d')}{(1-\Lambda)\partial_c u(c(\mathbf{s}'))}\right)\breve{x}^d(\lambda',\mathbf{s}')\pi(\lambda') \mid \mathbf{s}\right]
\end{aligned}
$$

We define:

$$
\begin{aligned}
\xi(\mathbf{s}';\mathbf{s}) &:= \beta(1-\Lambda)\frac{\partial_c u(c(\mathbf{s}'))}{\partial_c u(c(\mathbf{s}))}, \\
\breve{N}(\mathbf{s}') &:= \sum_{\lambda'}\left(\left(1-\lambda'+\lambda'\frac{\partial_c u(\breve{x}^d(\lambda',\mathbf{s}')d')}{(1-\Lambda)\partial_c u(c(\mathbf{s}'))}\right)\breve{x}^d(\lambda',\mathbf{s}')\right)\pi(\lambda')
\end{aligned}
$$

to get the expressions:

$$
\begin{aligned}
q^d(\mathbf{s}) &= \mathbb{E}\Big[\xi(\mathbf{s}';\mathbf{s})\breve{N}(\mathbf{s}') \mid \mathbf{s}\Big] \\
q^e(\mathbf{s}) &= \mathbb{E}\Big[\xi(\mathbf{s}';\mathbf{s})\sum_{\lambda'} x^e(\lambda',\mathbf{s}')\pi(\lambda') \mid \mathbf{s}\Big]
\end{aligned}
$$

D.2 Bank Problem

The bank solves:

$$
\begin{aligned}
\max_{\substack{m',k',b',d',\breve{x}^d(\cdot),\\ \breve{b}(\cdot),\breve{k}(\cdot),x^e(\cdot),\iota(\cdot)}} \quad & \Bigg\{\mathbb{E}\left[\xi(\mathbf{s}';\mathbf{s})\sum_{\lambda'}\Big(x^e(\lambda',\mathbf{s}')-\Psi(1-\breve{x}^d(\lambda',\mathbf{s}'))d'\Big)\pi(\lambda') \mid \mathbf{s}\right] + q^d(\mathbf{s})d' \\
& \qquad - m' - q^k(\mathbf{s})k' - q^b(\mathbf{s})b'\Bigg\} \\
s.t. \quad & \lambda'\breve{x}^d(\lambda',\mathbf{s}')d' \le \breve{z}'m' + \breve{q}^b(\mathbf{s}')\big(b'-\breve{b}(\lambda',\mathbf{s}')\big) + \breve{q}^k(\mathbf{s}')\big(k'-\breve{k}(\lambda',\mathbf{s}')\big) \\
& x^e(\lambda',\mathbf{s}') + (1-\lambda')\breve{x}^d(\lambda',\mathbf{s}')d' \\
& \qquad \le \big(z' + (1-\delta)q^k(\mathbf{s}') + q^k(\mathbf{s}')\Phi(\iota(\lambda',\mathbf{s}')) - \iota(\lambda',\mathbf{s}')\big)\breve{k}(\lambda',\mathbf{s}') \\
& \qquad\quad + \big(\omega + (1-\omega)q^b(\mathbf{s}')\big)\breve{b}(\lambda',\mathbf{s}'), \\
& \frac{\varrho}{2}(1-\lambda')\breve{x}^d(\lambda',\mathbf{s}')d' \le \kappa\ \breve{q}^b(\mathbf{s}')\breve{b}(\lambda',\mathbf{s}') + (1-\kappa)\ \breve{q}^k(\mathbf{s}')\breve{k}(\lambda',\mathbf{s}'), \\
& 0 \le b',\ k',\ m',\ d',\ \breve{b}(\lambda',\mathbf{s}'),\ \breve{k}(\lambda',\mathbf{s}'),\ 1-\breve{x}^d(\lambda',\mathbf{s}') \qquad \forall(\lambda',\mathbf{s}')
\end{aligned}
$$

where $\iota(\lambda', \mathbf{s}')$ is the investment rate per unit of available capital $\breve{k}(\lambda', \mathbf{s}')$. In our model, the bank must have zero dividends in the morning, $\breve{x}^e = 0$. This means that all the adjustment when the bank takes losses must go through wither the deposit payout or afternoon dividends.

The Lagrangian is:

$$
\begin{aligned}
\mathcal{L} = \mathbb{E}_{\mathbf{s}} & \left[\xi(\mathbf{s}';\mathbf{s}) \sum_{\lambda'} \Big(x^e(\lambda', \mathbf{s}') - \Psi(1 - \breve{x}^d(\lambda', \mathbf{s}'))d' \Big) \pi(\lambda') \right] + q^d(\mathbf{s})d' - m' - q^k(\mathbf{s})k' \\
& - q^b(\mathbf{s})b' + \mathbb{E}_{\mathbf{s}} \Big[\xi(\mathbf{s}';\mathbf{s}) \sum_{\lambda'} \breve{\mu}^e(\lambda', \mathbf{s}') \Big(\breve{z}'m' + \breve{q}^b(\mathbf{s}')\big(b' - \breve{b}(\lambda', \mathbf{s}')\big) \\
& \qquad + \breve{q}^k(\mathbf{s}')\big(k' - \breve{k}(\lambda', \mathbf{s}')\big) - \lambda' \breve{x}^d(\lambda', \mathbf{s}')d' \Big) \pi(\lambda') \Big] \\
& + \mathbb{E}_{\mathbf{s}} \Big[\xi(\mathbf{s}';\mathbf{s}) \sum_{\lambda'} \mu^e(\lambda', \mathbf{s}') \Big(\big(z' - \iota(\lambda', \mathbf{s}') + q^k(\mathbf{s}')(1 - \delta + \Phi(\iota(\lambda', \mathbf{s}')))\big) \breve{k}(\lambda', \mathbf{s}') + \\
& \qquad + \big(\omega + (1-\omega)q^b(\mathbf{s}')\big)\breve{b}(\lambda', \mathbf{s}') - x^e(\lambda', \mathbf{s}') - (1 - \lambda')\breve{x}^d(\lambda', \mathbf{s}')d' \Big) \pi(\lambda') \Big] \\
& + \mathbb{E}_{\mathbf{s}} \Big[\xi(\mathbf{s}';\mathbf{s}) \sum_{\lambda'} \breve{\mu}^r(\lambda', \mathbf{s}') \Big(\kappa \; \breve{q}^b(\mathbf{s}')\breve{b}(\lambda', \mathbf{s}') + (1-\kappa) \; \breve{q}^k(\mathbf{s}')\breve{k}(\lambda', \mathbf{s}') \\
& \qquad - \frac{\varrho}{2}(1 - \lambda')\breve{x}^d(\lambda', \mathbf{s}')d' \Big) \pi(\lambda') \Big] + \underline{\mu}^b(\mathbf{s})b' + \underline{\mu}^k(\mathbf{s})k' + \underline{\mu}^m(\mathbf{s})m' + \underline{\mu}^d(\mathbf{s})d' \\
& + \mathbb{E}_{\mathbf{s}} \Big[\xi(\mathbf{s}';\mathbf{s}) \sum_{\lambda'} \Big(\underline{\breve{\mu}}^b(\lambda', \mathbf{s}')\breve{q}^b(\mathbf{s}')\breve{b}(\lambda', \mathbf{s}') + \underline{\breve{\mu}}^k(\lambda', \mathbf{s}')\breve{q}^k(\mathbf{s}')\breve{k}(\lambda', \mathbf{s}') \Big) \pi(\lambda') \Big]
\end{aligned}
$$

where $\mathbb{E}_{\mathbf{s}} = \mathbb{E}[\cdot|\mathbf{s}]$. The first order conditions for the portfolio choice at formation are:

$$
\begin{aligned}
[m']: \qquad & 0 = -1 + \mathbb{E}_{\mathbf{s}} \Big[\xi(\mathbf{s}';\mathbf{s}) \sum_{\lambda'} \breve{\mu}^e(\lambda', \mathbf{s}')\breve{z}'\pi(\lambda') \Big] + \underline{\mu}^m \\
[k']: \qquad & 0 = -q^k(\mathbf{s}) + \mathbb{E}_{\mathbf{s}} \Big[\xi(\mathbf{s}';\mathbf{s}) \sum_{\lambda'} \breve{\mu}^e(\lambda', \mathbf{s}')\breve{q}^k(\mathbf{s}')\pi(\lambda') \Big] + \underline{\mu}^k \\
[b']: \qquad & 0 = -q^b(\mathbf{s}) + \mathbb{E}_{\mathbf{s}} \Big[\xi(\mathbf{s}';\mathbf{s}) \sum_{\lambda'} \breve{\mu}^e(\lambda', \mathbf{s}')\breve{q}^b(\mathbf{s}')\pi(\lambda') \Big] + \underline{\mu}^b \\
[d']: \qquad & 0 = q^d(\mathbf{s}) - \mathbb{E}_{\mathbf{s}} \Big[\xi(\mathbf{s}';\mathbf{s}) \sum_{\lambda'} \Big(\Psi(1 - \breve{x}^d(\lambda', \mathbf{s}')) + \lambda'\breve{\mu}^e(\lambda', \mathbf{s}')\breve{x}^d(\lambda', \mathbf{s}') \\
& \qquad + (1 - \lambda')\Big\{1 + \breve{\mu}^r(\lambda', \mathbf{s}')\Big\}\breve{x}^d(\lambda', \mathbf{s}') \Big) \pi(\lambda') \Big] + \underline{\mu}^d
\end{aligned}
$$

These equations can be rearranged as:

$$\begin{aligned}
[m']: &\quad 1 = \mathbb{E}_{\mathbf{s}}\Big[\xi(\mathbf{s}';\mathbf{s})\breve{M}(\mathbf{s}')\breve{z}'\Big] + \underline{\mu}^m \\
[k']: &\quad q^k(\mathbf{s}) = \mathbb{E}_{\mathbf{s}}\Big[\xi(\mathbf{s}';\mathbf{s})\breve{M}(\mathbf{s}')\breve{q}^k(\mathbf{s}')\Big] + \underline{\mu}^k \\
[b']: &\quad q^b(\mathbf{s}) = \mathbb{E}_{\mathbf{s}}\Big[\xi(\mathbf{s}';\mathbf{s})\breve{M}(\mathbf{s}')\breve{q}^b(\mathbf{s}')\Big] + \underline{\mu}^b \\
[d']: &\quad q^d(\mathbf{s}) = \mathbb{E}_{\mathbf{s}}\Big[\xi(\mathbf{s}';\mathbf{s})\Big(\sum_{\lambda'}\Big\{\Big(\lambda'\breve{\mu}^e(\lambda',\mathbf{s}') + (1-\lambda') + \\
&\qquad + (1-\lambda')\breve{\mu}^r(\lambda',\mathbf{s}')\Big)\breve{x}^d(\lambda',\mathbf{s}') + \Psi(1-\breve{x}^d(\lambda',\mathbf{s}'))\Big]\pi(\lambda')\Big\} - \underline{\mu}^d
\end{aligned}$$

where:

$$\breve{M}(\mathbf{s}') := \sum_{\lambda'}\breve{\mu}^e(\lambda',\mathbf{s}')\pi(\lambda')$$

The first order conditions for the portfolio choice in the morning market are:

$$\begin{aligned}
[\breve{x}^d(\lambda',\mathbf{s}')]: &\quad 0 = \Psi'(1-\breve{x}^d(\lambda',\mathbf{s}')) - \lambda'\breve{\mu}^e(\lambda',\mathbf{s}') - (1-\lambda')\Big(1 + \frac{\varrho}{2}\breve{\mu}^r(\lambda',\mathbf{s}')\Big) \\
[\breve{b}(\lambda',\mathbf{s}')]: &\quad 0 = -\breve{\mu}^e(\lambda',\mathbf{s}')\breve{q}^b(\mathbf{s}') + \Big(\omega + (1-\omega)q^b(\mathbf{s}')\Big) \\
&\qquad + \breve{\mu}^r(\lambda',\mathbf{s}')(\kappa/\varrho)\breve{q}^b(\mathbf{s}') + \underline{\breve{\mu}}^b(\lambda',\mathbf{s}')\breve{q}^b(\mathbf{s}') \\
[\breve{k}(\lambda',\mathbf{s}')]: &\quad 0 = \breve{\mu}^e(\lambda',\mathbf{s}')\breve{q}^k(\mathbf{s}') - \Big(z' - \iota(\lambda',\mathbf{s}') + q^k(\mathbf{s}')(1-\delta+\Phi(\iota(\lambda',\mathbf{s}')))\Big) \\
&\qquad - \breve{\mu}^r(\lambda',\mathbf{s}')((1-\kappa)/\varrho)\breve{q}^k(\mathbf{s}') - \underline{\breve{\mu}}^k(\lambda',\mathbf{s}')\breve{q}^k(\mathbf{s}') \\
[\iota(\lambda',\mathbf{s}')]: &\quad 0 = -1 + q^k(\mathbf{s}')\partial\Phi_\iota(\iota(\lambda',\mathbf{s}'))
\end{aligned}$$

D.3 Government

The government budget constraint

$$\Big(\omega + (1-\omega)q^b(\mathbf{s})\Big)b = \tau zk - g(\mathbf{s}) + q^b(\mathbf{s})b'.$$

The government faces an exogenous stochastic fiscal rule. Taxes are an exogenous function of output: $\tau(\mathbf{s}) = \tau zk$. Spending follows an exogenous stochastic process:

$$g(\mathbf{s}) = \Big(\tau + \eta\omega\bar{b} + \sigma^z\varepsilon_z + \sigma^g\varepsilon_g\Big)zk - \eta\omega b$$

D.4 Equilibrium Conditions

The functions:

$$\Big(c(\mathbf{s}),\ g(\mathbf{s}),\ \iota(\mathbf{s}),\ m'(\mathbf{s}),\ d'(\mathbf{s}),\ q^d(\mathbf{s}),\ q^e(\mathbf{s}),\ q^k(\mathbf{s}),\ q^b(\mathbf{s})\Big)$$

solve the equations: (assuming underlined Lagrange multipliers are soft functions, otherwise they should have complementarity conditions)

$$\begin{aligned}
zk &= c(\mathbf{s}) + m'(\mathbf{s}) + \iota(\mathbf{s})k + g(\mathbf{s}) \\
1 &= \mathbb{E}_{\mathbf{s}}\Big[\xi(\mathbf{s}';\mathbf{s})\breve{M}(\mathbf{s}')\breve{z}'\Big] + \underline{\mu}^m(\mathbf{s}) \\
q^k(\mathbf{s}) &= \mathbb{E}_{\mathbf{s}}\Big[\xi(\mathbf{s}';\mathbf{s})\breve{M}(\mathbf{s}')\breve{q}^k(\mathbf{s}')\Big] + \underline{\mu}^k(\mathbf{s}) \\
q^b(\mathbf{s}) &= \mathbb{E}_{\mathbf{s}}\Big[\xi(\mathbf{s}';\mathbf{s})\breve{M}(\mathbf{s}')\breve{q}^b(\mathbf{s}')\Big] + \underline{\mu}^b(\mathbf{s}) \\
q^d(\mathbf{s}) &= \mathbb{E}_{\mathbf{s}}\Big[\xi(\mathbf{s}';\mathbf{s})\Big(\sum_{\lambda'}\Big[\Big(\lambda'\breve{\mu}^e(\lambda',\mathbf{s}') + (1-\lambda')\Big\{1+\breve{\mu}^r(\lambda',\mathbf{s}')\Big\}\Big)\breve{x}^d(\lambda',\mathbf{s}') \\
&\qquad + \Psi(1-\breve{x}^d(\lambda',\mathbf{s}'))\Big]\pi(\lambda')\Big)\Big] - \underline{\mu}^d(\mathbf{s}) \\
q^d(\mathbf{s}) &= \mathbb{E}_{\mathbf{s}}\Big[\xi(\mathbf{s}';\mathbf{s})\breve{N}(\mathbf{s}')\Big] \\
q^e(\mathbf{s}) &= \mathbb{E}_{\mathbf{s}}\Big[\xi(\mathbf{s}';\mathbf{s})\sum_{\lambda'} x^e(\lambda',\mathbf{s}')\pi(\lambda')\Big] \\
q^k(\mathbf{s}) &= \Big[\partial_\iota\Phi(\iota(\mathbf{s}))\Big]^{-1} \\
g(\mathbf{s}) &= \Big(\tau + \eta\omega\bar{b} + \sigma^z\varepsilon_z + \sigma^g\varepsilon_g\Big)zk - \eta\omega b
\end{aligned}$$

and functions

$$\Big(\breve{x}^d(\lambda,\mathbf{s}),\ \breve{b}(\lambda,\mathbf{s}),\ \breve{k}(\lambda,\mathbf{s}),\ \breve{\mu}^e(\lambda,\mathbf{s}),\ \breve{\mu}^r(\lambda,\mathbf{s}),\ x^e(\lambda,\mathbf{s}),\ \mu^e(\lambda,\mathbf{s}),\ \breve{q}^k(\mathbf{s}),\ \breve{q}^b(\mathbf{s})\Big)$$

solve the equations (assuming underlined Lagrange multipliers are soft functions, otherwise they should have complementarity conditions)

$$
\begin{aligned}
\Psi'(\lambda,\mathbf{s}) &= \lambda\breve{\mu}^e(\lambda,\mathbf{s}) + (1-\lambda)\Big(1+\breve{\mu}^r(\lambda,\mathbf{s})\Big) \\
\breve{q}^b(\mathbf{s}) &= \Big[\breve{\mu}^e(\lambda,\mathbf{s}) - (\kappa/\varrho)\breve{\mu}^r(\lambda,\mathbf{s}) - \underline{\breve{\mu}}^b(\lambda,\mathbf{s})\Big]^{-1}\Big(\omega + (1-\omega)q^b(\mathbf{s})\Big) \\
\breve{q}^k(\mathbf{s}) &= \Big[\breve{\mu}^e(\lambda,\mathbf{s}) - ((1-\kappa)/\varrho)\breve{\mu}^r(\lambda,\mathbf{s}) - \underline{\breve{\mu}}^k(\lambda,\mathbf{s})\Big]^{-1}\Big(z - \iota(\mathbf{s}) + q^k(\mathbf{s})k'/k\Big) \\
\lambda\breve{x}^d(\lambda,\mathbf{s})d &= \breve{z}m + \breve{q}^b(\mathbf{s})\big(b - \breve{b}(\lambda,\mathbf{s})\big) + \breve{q}^k(\mathbf{s})\big(k - \breve{k}(\lambda,\mathbf{s})\big) \\
x^e(\lambda,\mathbf{s}) &= \Big(z - \iota(\mathbf{s}) + q^k(\mathbf{s})\frac{k'}{k}\Big)\breve{k}(\lambda,\mathbf{s}) + \big(\omega + (1-\omega)q^b(\mathbf{s})\big)\breve{b}(\lambda,\mathbf{s}) - (1-\lambda)\breve{x}^d(\lambda,\mathbf{s})d \\
0 &= \Big(\kappa\ \breve{q}^b(\mathbf{s})\breve{b}(\lambda,\mathbf{s}) + (1-\kappa)\ \breve{q}^k(\mathbf{s})\breve{k}(\lambda,\mathbf{s}) - \frac{\varrho}{2}(1-\lambda)\breve{x}^d(\lambda,\mathbf{s})d\Big)\breve{\mu}^r(\lambda,\mathbf{s}) \\
b &= \sum_{\lambda}\breve{b}(\lambda,\mathbf{s})\pi(\lambda) \\
\breve{z}m &= \sum_{\lambda}\big(\lambda\breve{x}^d(\lambda,\mathbf{s})d\big)\pi(\lambda)
\end{aligned}
$$

with the state vector $\mathbf{s} = (\mathbf{z}, k, b, d, m)$ evolving according to:

$$
\begin{aligned}
\breve{z}' &= \varepsilon_z' \\
z' &= z(\varepsilon_z') \\
k' &= (1-\delta)k + \Phi(\iota(\mathbf{s}))k \\
q^b(\mathbf{s})b' &= g(\mathbf{s}) - \tau z k + \Big(\omega + (1-\omega)q^b(\mathbf{s})\Big)b \\
d' &= d'(\mathbf{s}) \\
m' &= m'(\mathbf{s})
\end{aligned}
$$

and where

$$
\begin{aligned}
\xi(\mathbf{s}';\mathbf{s}) &:= \beta(1-\Lambda)\frac{\partial_c u(c(\mathbf{s}'))}{\partial_c u(c(\mathbf{s}))} \\
\breve{N}(\mathbf{s}') &:= \sum_{\lambda'}\left(1 - \lambda' + \lambda'\frac{\partial_c u(\breve{x}^d(\lambda',\mathbf{s}')d')}{(1-\Lambda)\partial_c u(c(\mathbf{s}'))}\right)\breve{x}^d(\lambda',\mathbf{s}')\pi(\lambda') \\
\breve{M}(\mathbf{s}') &:= \sum_{\lambda'}\breve{\mu}^e(\lambda',\mathbf{s}')\pi(\lambda')
\end{aligned}
$$

E Numerical Illustration

	Value
β	0.99
γ	1.0
δ	1.0
λ	[0.9, 0.15]
π_λ	[0.35, 0.65]
ψ	3
$\breve{z}$	[1.0, 0.95]
z	[1.05, 1.0]
P	[0.95 0.05; 0.95 0.05]
$\bar{b}$	0.1
τ_y	0.1
η	1.9
ω	0.2

Table 7: Parameters.

F Funding Advantage Across the Eurozone

The historical US data provides a comparison across very different regulatory eras. However, it is difficult to isolate changes in the role of government debt from changes in the risk on government debt. For the modern period, we can use data from credit default swaps (CDS) to approximate risk-adjusted borrowing cost spreads, which we consider an alternative empirical proxy to our notion of funding advantage. In this subsection, we follow Jiang et al. (2020b) and do this for European countries during the Eurozone crisis (2009-15). To help illustrate the connection to their paper and acknowledge that this is different object to a high grade corporate-treasury spread, we use their terminology and refer to the spread as the risk-adjusted convenience yield rather than risk adjusted borrowing cost. Doing this analysis allows us to study an important prediction of our model: increases in the likelihood of government debt devaluation (implicit or explicit) erode the risk-adjusted convenience yield.

F.1 Regulatory Context

In the Eurozone context, there are a number of components of regulation that are particularly important to our analysis and are well captured by our model. The first is the treatment of government debt from European countries as collateral by the European Central Bank (ECB). Before 2005, the ECB decided collateral terms using a private discretionary rating system that could deviate from those of private credit agencies. In 2005, the ECB moved to a market based criteria that linked the collateral value to a combination of the credit ratings from different agencies. In principle, this meant that the government debt of a number of European countries (particularly Greece and Cyprus) should have become ineligible as collateral during the Eurozone crisis (2009-2015). However, the ECB repeatedly relaxed the criteria. In 2008, they lowered the minimum market credit rating requirement and then announced wavers for Greek debt (April 2010), Irish debt (March 2011), and Portugese debt (July 2011). From May 2010, the ECB started to purchase Greek, Portugese, and Irish bonds as part of its "Security Markets Programme" (SMP), which was extended to Spanish and Italian bonds in 2011. We interpret the April 2010 announcement as resolving uncertainty that European government debt could lose its collateral status. Ultimately, the ECB treatment of Greek, Irish, Portugese, Spanish, and Italian debt as collateral allowed the European banks to take low interest loans from the ECB and purchase high yielding government assets without increasing their risk-weighted assets or their TIER 1 capital ratio.

In addition, the deposit insurance system in Europe does not have the same backing as in the US. All European Union member states are required to maintain a minimum government deposit guarantee. However, this guarantee is not backed by the ECB or the European Union but instead by the independent member state. So, for countries in the Eurozone, they cannot easily create money to recapitalize their banking sectors. In this sense, as in our model, the Eurozone deposits are not necessarily risk free, particularly when the government is unable to access debt markets. We saw this risk materialize in Iceland, Cyprus, and Greece during the Eurozone crisis.

F.2 Borrowing Cost Spreads (Risk Adjusted Convenience Yields)

We can express the yield on a government bond from Eurozone country i with maturity h and price $q_t^{i,h}$ as:

$$y_t^{i,h} = r_t^h - \chi_t^{i,h}$$

where $y_t^{i,h} = -\frac{1}{h}\log(q_t^{i,h})$ is the yield on the bond, $r_t^h = -\frac{1}{h}\log \mathbb{E}[\Xi_{t,t+h}]$ is the expectation of the h period (nominal) SDF pricing government debt, and $\chi_t^{i,h}$ is the convenience yield on the bond. We breakup the convenience yield into:

$$\chi_t^{i,h} = \widetilde{\chi}_t^{i,h} - s_t^{i,h}$$

where $s_t^{i,h} = -\frac{1}{h}\log \mathbb{E}_t\left[\Xi_{t,t+h}\prod_{j=1}^{h}(1-\mathfrak{d}_{t+j}^i)\right] + \frac{1}{h}\log\mathbb{E}[\Xi_{t,t+h}]$ is market rate for default risk insurance, $\mathfrak{d}_{t+j}^i$ is the probability of government default, and $\widetilde{\chi}_t^{i,h}$ is the risk-adjusted convenience yield on the bond. Following the approach in Jiang et al. (2020b), we proxy $s_t^{i,h}$ by the credit default spread and, instead of estimating r_t, we focus on the difference between the convenience yield in country i and Germany. Assuming that there is a common SDF across the Eurozone, we have that:

$$\widetilde{\chi}_t^{i,h} - \widetilde{\chi}_t^{DE} = s_t^{i,h} - s_t^{DE,h} - (y_t^{i,h} - y_t^{DE,h})$$

We plot the risk-adjusted convenience yield differentials in Figure 10 for key Eurozone countries over the period from 2004 to 2024 which includes the European Sovereign Debt Crisis. The top row are countries that maintained relatively strong fiscal positions during the Eurozone crisis while the bottom row are countries that faced ratings downgrades and speculation about their fiscal sustainability. For calculations, we use Euro denominated 5 year CDS spreads from Markit and 5 year sovereign yields from Global Financial Data. Evidently, risk-adjusted convenience yields decreased significantly more in the countries on the bottom row. In Figure 11 we plot the risk-adjusted convenience yield against the CDS spread and show that the negative relationship we saw in the cross-section is also true in the time series. These plots suggest that, even after controlling for the different risk characteristics of the sovereign bonds, there was a higher erosion of sovereign debt premia in the countries facing fiscal challenges during the crisis. As we saw in Subsection **??**, this is a puzzle for workhorse macroeconomic models that use BIU or BIA formulations to generate convenience yields because those models predict the risk-adjusted convenience yield increases when the market value of government debt falls. By contrast, our model suggests a potential resolution: that an increase in the probability of government default lead to a decrease in the risk adjusted convenience yield because the hedging role of Irish, Italian, Portuguese, and Spanish debt diminished ($\widetilde{\chi}_h$ decreased) even though their collateral role at the ECB stayed the same ($\widetilde{\chi}_r$ stayed the same). A complementary explanation is proposed by Jiang et al. (2020b), which suggests that the heterogeneous decreases in the risk-adjusted convenience yields reflect how different fiscal policies during the crisis lead to different expectations about post-crisis debt issuance. We nest both explanations in our macroeconomic model.

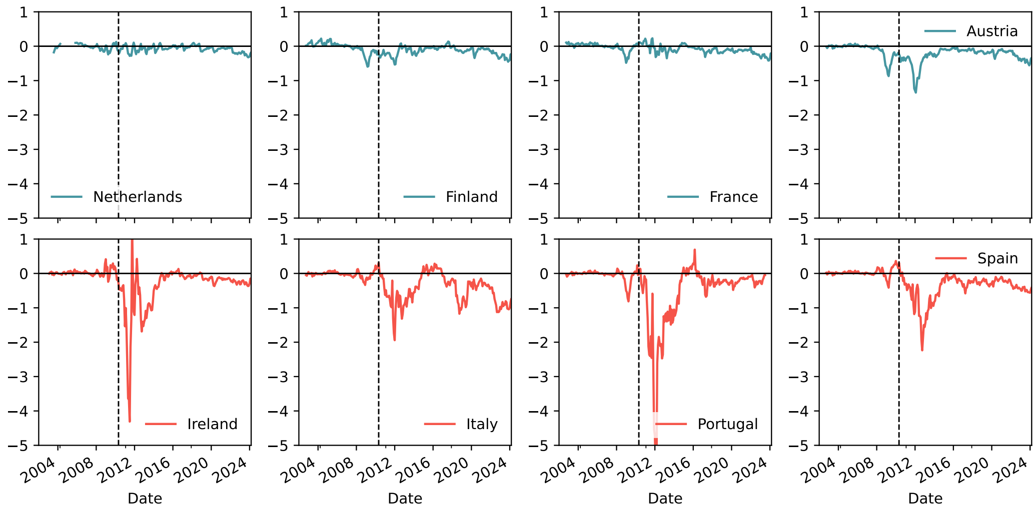

Figure 10: Difference in Risk Adjusted Convenience Yields to Germany.

The dashed line is at April 2010, the date at which the ECB announced the waver for Greek debt.

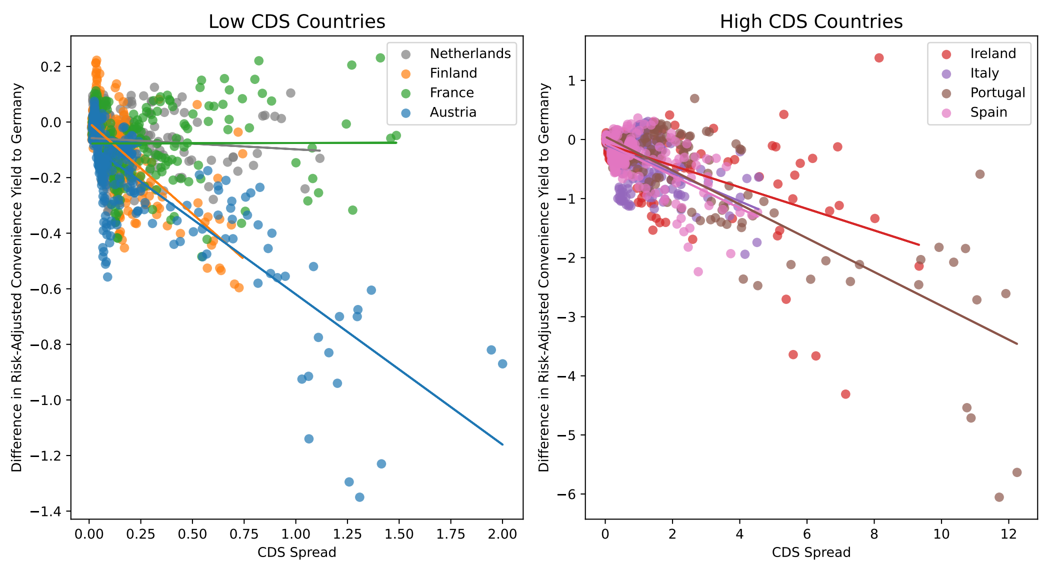

Figure 11: Difference in Risk Adjusted Convenience Yields to Germany vs CDS Spreads.

The left plot show countries that maintained low CDS spreads during the Eurozone crisis while the right plots shows countries that had high CDS spreads. The dots represent monthly observations and the lines represent linear regressions for each country.

G US Historical Time Line

The text references many changes to monetary and financial regulation. In this section, we collect those events into a historical timeline, which is shown in table 8. The time line is broken up into a collection a collection of banking “eras”. The first era is from 1791-1836, during which the First and Second Banks of the US operated alongside state banks. The second era is from 1837-1962, during which state banks could automatically gain bank charters without a congressional review process, often referred to as the “free banking” era. The third era is from 1863-1913, during which the federal government charted national banks that issued bank notes backed by US federal government debt. The fourth era is from 1913-1933, during which the Federal Reserve Bank was introduced to act as lender-of-last resort to the banking sector. The fifth era is from 1934-1980, during which the New Deal financial regulations were in place. The sixth era is from 1980s-2009, during which the New Deal financial regulations were gradually unwound. Finally, there is the era from 2010 to the present day, during which the Dodd-Frank Act another financial crisis legislation are in place.

Table 8 Time Line of Monetary and Financial Events

1791	Congress charters the First Bank of the US. The bank is privately owned. It operates as a commercial bank but also has the special privileges of acting as banker for the federal government (storing tax revenue and making loans) and being able to operate across states. It shares responsibility with state banks for bank note issuance. It influences state bank money and credit issuance by setting the rate at which it redeems state notes collected as tax revenue into gold.
1792	Coinage Act of 1792. Authorizes the US to issue a new currency, the US gold dollar.
1811	Charter of the First Bank of the US expires and is not renewed.
1812-5	War of 1812. Convertibility to bank notes to gold is suspended. Government issues Treasury Notes to finance the war.
1816	Congress charters the Second Bank of the U.S.
1819	Panic of 1819. Cotton prices fall, farms go bankrupt, and banks fail.
1832	Jackson vetoes bill to recharter Second Bank.
1833	Jackson removes federal deposits from Second Bank of the US
1834	Coinage Act of 1834. Changes the ratio of silver to gold from 15:1 to 16:1.

1836	Charter of the Sector Bank of the US expires and is not renewed. The Second Bank becomes a private corporation.
1837	"Free Banking" Era begins. Michigan Act allows the automatic chartering of banks (without requiring explicit approval from state legislature) that issue bank notes backed by specie (gold and silver coins). Over the next few years, other states pass similar laws.
1837	Panic of 1837. Sharp decrease in real estate prices leads to large bank losses. In New York, every bank suspends payment in gold and silver coinage. Many banks fail.
1857	Coinage Act of 1857. Foreign coins can longer be legal tender.
1857	Panic of 1857. Railroad company stocks drop sharply. Ohio Life Insurance and Trust company fails, which prompts a collapse in stock prices and widespread failures across mercantile firms.
1861-5	Civil War.
1862	Legal Tender Act. Authorizes the federal government to use nonconvertible greenback paper dollars to pay its bills.
1863-4	The National Bank Acts. The National Currency Act (1863) and The National Bank Act (1864) establish a system of nationally charted banks and the Office of the Comptroller of the Currency. National banks can issue national bank notes up to 90% of the minimum of par and market value of qualifying US federal bonds. Limit on aggregate national bank note issuance is $300 million. Banks must pay a 1% annual tax per on outstanding national bank notes backed by US federal bonds. State banks must start paying a 2% annual tax on state bank notes.
1865-6	Additional National Bank Acts. State banks must start paying a 10% annual tax on state bank notes.
1870	Limit on aggregate national bank note issuance increases to $354 million.
1873	Bank panic of 1873. Widespread failure of railroad firms leads to stock market crash and bank failures. Jay Cooke and Company goes bankrupt.
1875	Congress repeals limit on aggregate national bank note issuance.
1879	US Treasury starts to promise to convert greenbacks to dollars one-for-one.

1893	Bank panic. A combination of falling commodity prices, oversupply of silver, and a fall in US Treasury gold reserves prompted a run on bank deposits.
1896	Cross of Gold Speech. Democratic presidential candidate William Jennings Bryan gives a speech in favor of allowing unlimited coinage of silver into money demand ("free silver").
1900	Tax on national bank notes backed by US federal bonds paying coupons less than or equal to 2% is reduced to 0.5% per annum.
1900	Gold Standard Act. The gold dollar becomes the standard unit of account (further restricting the possibility of "free silver").
1907	Panic of 1907. The Knickerbocker Trust Company collapses prompting a bank run. J.P. Morgan organizes New York bankers to provide liquidity to shore up the banking system.
1913	Federal Reserve Act. Establishment of the Federal Reserve Bank to act as a reserve money creator of last resort during financial panics.
1914-8	World War I.
1917	2nd Liberty Loan Act establishes a $15 billion aggregate limit on the amount of government bonds issued.
1929	Stock market crash and start of the Great Depression.
1929	US issues first Treasury Bill.
1933	Banking Act ("Glass-Steagall Act"). Establishes the Federal Deposit Insurance Corporation (FDIC). Separates commercial and investment banking. Introduces cap on deposit interest rate ("Regulation Q").
1933	President Roosevelt issues an Executive Order requiring people and businesses to sell their gold to the government at $20.67 per ounce.
1934	Gold Reserve Act.
1934	National Housing Act. Establishes the Federal Savings and Loan Insurance Corporation (FSLIC).
1935	The last national bank notes are replaced by Federal Reserve notes.
1938	Amendment to the National Housing Act established the Federal National Mortgage Association (FNMA), commonly known as Fannie Mae.
1939-45	World War II.

1942	The Treasury and Federal Reserve agree to fix the yield curve on Treasury securities.
1944	Bretton Woods Agreement.
1951	Treasury-Fed Accord ends the fixed yield curve on Treasury securities and establishes the Fed's policy independence from fiscal concerns.
1968	Housing and Urban Development Act of 1968. Creates the Government National Mortgage Association (GNMA), commonly known as Ginnie Mae.
1966	Fed applies Regulation Q to impose deposit rate ceiling for the first time.
1971	US effectively terminates the Bretton Woods system by ending the convertibility of the US dollar to gold.
1977	Congress issues the Fed with the dual mandate to "promote effectively the goals of maximum employment, stable prices, and moderate long term interest rates".
1980	Depository Institutions Deregulation and Monetary Control Act of 1980 starts to phase out Regulation Q.
1986-1989	Savings and loan crisis.
1994	Riegle-Neal Interstate Banking and Branching Efficiency Act. Allows banks to operate across states.
1999	Gramm–Leach–Bliley Act. Repeals provisions of the Glass-Steagall Act that prohibited a bank holding company from owning other financial companies.
2007-9	Great Financial Crisis.
2010	Dodd-Frank Wall Street Reform and Consumer Protection Act.