Historical US Funding Cost Advantage: 1860-2024*

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Abstract

We estimate a historical funding cost advantage of the US government, as measured by the spread between yields on high-grade corporate bonds and treasuries. We construct a new dataset with monthly price, cash-flow, and rating information for US high-grade corporate bonds over the period 1860-2024. We deploy a Dynamic Nelson-Siegel model to estimate US high-grade corporate and treasury yield curves making adjustments for tax treatment and other features. A high-grade corporate to treasury spread emerged well before Bretton Woods with the introduction of the 1862-65 National Banking Acts. In the 20th century, there are low frequency movements in average spreads that coincide with large changes to financial sector regulation. Once we control for such regulatory changes, we find that little of the movement in the high-grade corporate to treasury spread can be accounted for by changes in the debt-to-GDP ratio. Inflation risk eroded the funding cost advantage on nominal government debt in the 1970s.

JEL classification: E31, E43, G12, N21, N41

Key words: Corporate Yields, Convenience Yields, Government Debt Capacity, Hamiltonian Monte Carlo.

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1 Introduction

Many researchers have argued that the US government enjoys a funding advantage because it can issue bonds at lower interest rates than the private sector, even when the private sector bonds have the same risk profile, maturity, and tax treatment. In macroeconomic modeling this allows the government to issue debt that is not necessarily backed by future fiscal surpluses (a "seigniorage" of "convenience" benefit source of financing). The magnitude of the government's funding cost advantage is often measured by the spread between yields on high-grade US corporate bonds and the yields on US treasuries (e.g. Krishnamurthy and Vissing-Jorgensen (2012)). In this paper, we revisit and expand the historical evidence on US high-grade corporate to treasury spreads. This involves the compilation of new bond datasets, the estimation of corporate and government yield curves for the period 1860-2024, and corrections to make corporate and government debt comparable (e.g. adjustments for taxes and callability). In doing so, we uncover the statistical properties of US funding advantage and show how it has evolved with major changes in monetary, financial, and fiscal policies.

We construct zero-coupon yield curves for high-grade corporate and government bonds that promise consistent pecuniary payouts. This involves constructing a new micro-level dataset with historical bond price, coupon, and maturity information from 1860-2024 to match existing datasets for Treasuries. To ensure we can compare across maturities, we estimate zero coupon yield curves by deploying the techniques from Payne et al. (2025), which fits a dynamic Nelson and Siegel (1987) parametric interpolation model of the yield curve with stochastic volatility and bond specific measurement errors. To ensure we can compare bonds with similar default risk, we limit our corporate bond estimate to Aaa-rated bonds. For the nineteenth century, we construct a synthetic Aaa classification using Macaulay (1938) and error clustering. For the twentieth century, we construct a new ratings database by transcribing Moody's manuals. To ensure our yield curve reflect claims to payouts with the same tax treatment, we exclude tax-advantaged bonds or, where possible, make corrections for tax concessions. In particular, we exclude the so called government "flower-bonds" that traded between 1921-1985 and offered tax concessions that effectively offset inflation risk. After making these adjustments, we compute the spread between Aaa-rated corporate and treasury yield curves. This offers a "like-for-like" comparison between

government and corporate yields at all maturities that captures the funding advantage of the US government.

We infer a collection of stylized facts about relative government debt prices and funding cost advantage. First, we identify low frequency movements in average funding cost spreads that coincide with large changes to financial sector regulation and the Federal Reserve's large scale bond purchase programs. Contrary to existing narratives, once we control for such regulatory, monetary, and fiscal policy changes, we find that little of the movement in the funding cost spread can be accounted for by changes in the debt-to-GDP ratio. The funding cost spread on US Treasuries emerged well before Bretton Woods and global dollar dominance with the introduction of the 1862-65 National Banking Acts. It generally stayed high during the gold standard but then dropped sharply after World War I and followed a trend decline after the Great Depression. Quantitative easing during World War II led to an increase in the funding cost spread at the short maturities while quantitative easing after the 2007-09 financial crisis led to an increase at long maturities.

Second, we find that heightened inflation risk during the Great Inflation in the 1970s coincided with an erosion of the funding cost spread on nominal government debt. This is in contrast to conclusions drawn from the series commonly used in the literature (e.g. the spread between the long-term treasury yield and Aaa corporate yield indices used by Krishnamurthy and Vissing-Jorgensen (2012), Cieslak et al. (2024) and other papers), which document the Aaa Corporate-Treasury spread reaching its highest level during the Great Inflation. The reason for the discrepancy is that the commonly used indices do not take into account the differential tax treatments of a certain subclass of government bonds, the so called "flower bonds". Holders of flower bonds could use the par value of their debt to off-set estate taxes, which meant that the bonds acted as a good inflation hedge. As a result, flower bonds traded like "real-bonds" and saw low yields during the Great Inflation in the 1970-80s. Ultimately, this (and other issues in the series) mean that the commonly used index-based spread in the literature is for many periods effectively a comparison between a nominal, callable corporate bond and a "real" treasury with a put option against inflation risk. We conclude that a large portion of the 1970's variation in existing AAA Corporate-Treasury series is attributable to the (negative) inflation risk premia on flower bonds instead of a heightened funding advantage on regular US Treasuries.

Related literature: The empirical section extends existing studies on the convenience yield (e.g. Krishnamurthy and Vissing-Jorgensen (2012), Choi et al. (2022), Cieslak et al. (2024)) 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 et al. (2025), Jiang et al. (2022a), Chen et al. (2022), Jiang et al. (2022b), Jiang et al. (2021b), Jiang et al. (2021a), Jiang et al. (2020)).

Technically, our work is related to Svensson (1995), Dahlquist and Svensson (1996), Cecchetti (1988), Annaert et al. (2013), Andreasen et al. (2019), Diebold and Li (2006), Diebold et al. (2006) and Diebold et al. (2008) who, like Gürkaynak et al. (2007) and ourselves, implement versions of the parametric yield curve model of Nelson and Siegel (1987). A "Dynamic Nelson-Siegel Approach", studied in detail in Diebold and Rudebusch (2013), makes assumptions on the yield curve parameters' time-variation in order to improve the model's forecasting ability. We make assumptions about yield curve parameters' time-variations in order to pool information across time periods.

The paper is structured as follows. Section 2 explains our conceptual framework. Section 3 examines our dataset, traces the evolution of US bond markets, and outlines the institutional details regarding the distinctions between corporate and government bonds. Section 4 briefly summarizes our statistical methodology. Section 5 presents our estimate of the high-grade corporate yield curve and the term structure of AAA Corporate-Treasury spreads. Section 6 revisits key relationships studied in the macro finance literature using our new measure of the funding cost spread. Section 7 concludes.

2 Conceptual Framework

In this section, we introduce the notion of a government funding cost advantage using a stylized model. Consider a discrete time, infinite horizon economy with time indexed by $t \in \{0, 1, \ldots\}$. The economy contains a representative private sector investor and a government. The government issues bonds with different cash-flow profiles neither of them is subject to default risk. Let $\mathcal{N}_t$ denote the set of government bonds outstanding at time t. Each bond $i \in \mathcal{N}_t$ promises a sequence of coupon and principal payments $\mathsf{c}_{t,i} := \{c_{t,i}^{(j)}\}_{j=1}^{\infty}$ with $c_{t,i}^{(j)}$ denoting period-t promises of j-period-

ahead dollars. These coupon-bearing bonds trade in a competitive market at prices $p_{t,i}$ and are in positive net supply $B_{t.i}$, where $B_{t.i}$ is the total amount (face value) of newly issued and outstanding bond i in period t. In equilibrium, the law of one price holds implying that

$$p_{t,i} = \sum_{j=1}^{\infty} q_t^{(j)} c_{t,i}^{(j)}, \qquad \forall i \in \mathcal{N}_t, \forall t \geq 0, \tag{2.1}$$

where $q_t^{(j)}$ denotes the price of a government promise to one dollar at time $t+j$ with $q_t^{(0)} = 1$. We call the sequence $\mathsf{q}_t := \{q_t^{(j)}\}_{j=0}^{\infty}$ the government's *discount function*. Using condition (2.1), we can express the period-t market value of the government debt portfolio in the following (equivalent) forms:

$$\sum_{i \in \mathcal{N}_t} p_{t,i} B_{t,i} = \sum_{i \in \mathcal{N}_t} \sum_{j=1}^{\infty} q_t^{(j)} c_{t,i}^{(j)} B_{t,i} = \sum_{j=1}^{\infty} q_t^{(j)} \sum_{i \in \mathcal{N}_t} c_{t,i}^{(j)} B_{t,i} =: \sum_{j=1}^{\infty} q_t^{(j)} b_t^{(j)},$$

where the last expression defines $b_t^{(j)} := \sum_{i \in \mathcal{N}_t} c_{t,i}^{(j)} B_{t,i}$ as the number of $t+j$ dollars that the government has at time t promised to deliver. We call the sequence $\mathsf{b}_t := \{b_t^{(j)}\}_{j \geq 1}$ the *zero-coupon equivalent* government debt portfolio and construct the panel $\{\mathsf{b}_t\}_{t \geq 0}$ from historical data by adding up all of the dollar principal-plus-coupon payments promised by the government at time t.

Each period t, the government enters with a stock of promised payments b_{t-1}, spends g_t, raises taxes τ_t and finances the resulting deficit/surplus by "restructuring" its debt portfolio in the form of new issues of zero-coupon bonds b_t. The period t government budget constraint can be written as

$$b_{t-1}^{(1)} + g_t - \tau_t = \sum_{j=1}^{\infty} q_t^{(j)} \left(b_t^{(j)} - b_{t-1}^{(j+1)} \right)$$

that is, period-t interest payments, $b_{t-1}^{(1)}$, and primary deficit, $(g_t - \tau_t)$, must be financed by refinancing the government debt portfolio at market prices $\{q_t^{(j)}\}_{j \geq 1}$. In other words, the government's borrowing costs can be fully characterized by the discount function q_t.

The basic premise of this paper is that when high-grade private corporations consider issuing debt that matches the cash-flow profile of government bonds, they face a different discount function $\widetilde{\mathsf{q}}_t$ with $\widetilde{\mathsf{q}}_t \leq \mathsf{q}_t$. This is because the representative

investor 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, $q_t^{(j)} \geq \widetilde{q}_t^{(j)}$, even though the bonds promise the same cash flow stream and the same (zero) default risk. Following the literature, we characterize this non-pecuniary benefit by imposing that the elements of q_t and $\widetilde{\mathsf{q}}_t$ solve the investor Euler equations $\forall j \geq 1$:

$$q_t^{(j)} = \mathbb{E}\Big[\xi_{t,t+1}\Omega_{t,t+1}q_{t+1}^{(j-1)}\Big], \qquad \widetilde{q}_t^{(j)} = \mathbb{E}\Big[\xi_{t,t+1}\widetilde{q}_{t+1}^{(j-1)}\Big] \qquad \text{with} \;\; q_t^{(0)} = \widetilde{q}_t^{(0)} = 1,$$

where $\xi_{t,t+1}$ is the investor's stochastic discount factor and $\Omega_{t,t+1}$ is a government debt specific wedge capturing the non-pecuniary benefit of government debt.

Iterating the government budget constraint forward gives the lifetime budget constraint under the private sector's stochastic discount factor (see Appendix A):

$$\begin{aligned}\sum_{j=1}^{\infty} q_t^{(j-1)} b_{t-1}^{(j)} = \mathbb{E}_t\left[\sum_{s=0}^{\infty}\xi_{t,t+s}\Big(\tau_{t+s} - g_{t+s}\Big)\right] + \sum_{j=1}^{\infty}\Big(q_t^{(j)} - \widetilde{q}_t^{(j)}\Big)b_{t-1}^{(j+1)} \\ + \mathbb{E}_t\left[\sum_{s=0}^{\infty}\xi_{t,t+s}\left\{\sum_{j=1}^{\infty}\Big(q_{t+s}^{(j)} - \widetilde{q}_{t+s}^{(j)}\Big)\Big(b_{t+s}^{(j)} - b_{t-1+s}^{(j+1)}\Big)\right\}\right].\end{aligned} \tag{2.2}$$

This equation implies that the market value of outstanding debt (including interest payments) can be written as a sum of three components: the present discounted value of future primary surpluses, a term associated with the revaluation of the *stock* of existing government debt, and the present discounted value of the "seigniorage revenue" the government earns from being able to issue *new* debt more cheaply than the private sector.

We characterize the government's funding advantage through the term structure of the high-grade corporate to treasury yield spreads:

$$\chi_t^{(j)} := \frac{1}{j}\log\left(q_t^{(j)}\right) - \frac{1}{j}\log\left(\widetilde{q}_t^{(j)}\right), \qquad \forall j \geq 1, \;\; \text{with} \;\; \chi_t^{(0)} = 0.$$

Evidently, the portion of the market value of government debt which is unbacked by future surpluses, i.e., the last two terms on the right-hand-side of (2.2), is an increasing function of $\{\chi_t^{(j)}\}_{j\geq 1}$. In the special case of $\mathsf{q}_t = \widetilde{\mathsf{q}}_t$, we obtain the standard result that current debt must be fully backed by future primary surpluses.

This paper provides an empirical counterpart for the term structure of the high-grade corporate to treasury yield spread, $\{\chi_t^{(j)}\}_{j\geq 1}$, that can be used to inform macroe-

conomic modeling. This means that we need to measure the spread between high-grade corporate and treasury bonds that have the same payout risk, maturity, and tax-treatment. As discussed in the subsequent sections, this is a non-trivial task that requires both original data collection and statistical work.

3 Measuring Government Funding Advantage

We define the government's funding advantage as the premium that private investors are willing to pay for the government's promise of "paying \$1 j-periods ahead", relative to the same commitment made by high-grade private corporations.

Ideally, such premiums would be measured by directly comparing the prices of commensurate private and public sector zero-coupon bonds. The fact that such assets do not exist in large numbers poses a significant challenge to accurately measure the government's funding advantage. There are two distinct levels of difficulty: (i) we need to infer discount functions q_t and $\widetilde{\mathsf{q}}_t$ from the prices of *coupon-bearing bonds* and (ii) the available private and public sector coupon-bearing bonds differ in certain "technical factors" (Cook and Hendershott, 1978) which contribute to observed price differentials but do not reflect the government's funding advantage. To overcome these difficulties, we must estimate zero-coupon yield curves while utilizing pricing formulas that explicitly control for these technical factors.

The source of these technical factors stems from the US government's longstanding practice of designing debt instruments with appealing contractual features (e.g., extended call deferment periods, exchange options) and providing preferential treatment to its own IOUs (e.g., tax exemptions, large regulatory weights). While these provisions have been effective in reducing federal borrowing costs, most were not 'budget neutral', as they resulted in government losses primarily through reduced tax revenues. This distinction is important because the defining feature of funding advantage is that the government does not need to back it with current or future revenues. Therefore, measuring the government's funding cost advantage requires removing the influence of these factors from observed high-grade corporate to treasury yield spreads.

Index-based yield spreads: The most widely used measure of government funding advantage (or "convenience yield") in the macro-finance literature—likely favored for its relatively long time series—is derived from comparing two yield indexes:

- Moody's Seasoned Aaa-rated long-maturity corporate bond index—constructed from a sample of industrial and utility bonds (industrial only after 2002) with more than 20 years to maturity

- The Federal Reserve Board's long-term US government bond yield index—constructed as the average yield on all outstanding government bonds neither due nor callable in less than 10 years.[1]

For brevity, we will call this the *index-based* AAA Corporate-Treasury spread. This measure was used by Krishnamurthy and Vissing-Jorgensen (2012), Choi et al. (2022), Cieslak et al. (2024) among many others.

The index-based AAA Corporate-Treasury spread is derived from *before-tax yields-to-maturity*, calculated under the assumption that the future cash flows are default-free and repayment dates (or call dates) are known with certainty. Within this framework, the bond's "yield" is defined as the discount rate, $\overline{y}_t$, which equates the observed bond price to the present value of future cash flows. This calculation employs formula (2.1), assuming $q_t^{(j)} = (1 + \overline{y}_t)^{-j}$ and that $\mathsf{c}_{t,i}$ represents before-tax promised cash flows. This approach is understood as an approximation made for simplicity, as observed prices arguably reflect the present value of *after-tax* cash flows, which should ideally factor into "market yield" calculations. This approximation is likely to be relatively innocuous if the bonds included in the indexes share similar tax treatments and are traded close to par.[2] Unfortunately, as we describe in subsection 3.1.1, there were at least two periods in the 20th century during which US government debt enjoyed substantial (federal) tax advantages compared to corporate bonds. As a result, at least part of the index-based AAA Corporate-Treasury spread can be attributed to tax effects that do not reflect the government's funding advantage. Correcting for these tax effects is an important objective of this paper.

[1] More precisely, the Treasury bonds included are due or callable after 12 years for 1926–41, 15 years for 1941–51, 12 years for 1952, and 10 years for 1953–99. The FRED code of this series is LTGOVTBD. The series was discontinued in 2000, after which point the "market yield on US Treasury Securities at 20-year constant maturity" is used (FRED code: GS20).

[2] Robichek and Niebuhr (1970) and McCulloch (1975) demonstrate that tax-induced biases can distort the shape of the yield curve when it is derived from below-par price quotations. We will come back to this point in section 3.1.1.

3.1 Data and Institutional Details

Before presenting our estimation strategy, this subsection describes our datasets and outlines the historical context and institutional details underlying the key technical factors that hinder the use of "raw" yields on high-grade corporate and Treasury bonds in constructing a measure of the US government funding advantage.

Brief History of the US Bond Market: The U.S. corporate bond market traces its origins to the early 19th century, driven by the need to finance large infrastructure projects. The first corporate bonds were issued by banks and canal companies, but the market truly expanded with the rise of the railroad industry. By the 1850s, railroad companies were expanding into the "wild west" at a scale and level of uncertainty that they could no longer raise sufficient capital from the local and fragmented banks of the time. The solution was to issue bonded debt to a broader pool of investors, which created what is considered the world's first corporate bond market (Sylla et al., 2006). Essentially a railroad bond market in its early decades, by the early 1900s, the corporate bond market was several times larger than that of the UK or US sovereign debt markets.[3] By the late 19th and early 20th centuries, the market matured, with securities becoming more standardized, and industrial corporations and utilities also began issuing bonds.

Concurrently, the federal government initially issued bonds infrequently, as Congress was responsible for debt management, leading to long-maturity issuances with significant variations in maturities, coupon rates, denominations, and units of account (Payne et al., 2025). The expansion and standardization of federal debt issuance occurred gradually over time, with Congress delegating more autonomy in designing and issuing securities to the Treasury Department between 1917 and 1939. Both markets continued to expand throughout the 20th century and by the mid-20th century, US Treasury securities had become the world's largest and most liquid debt market, with a standardized set of securities at various maturities.

Treasuries dominated in scale but both corporate and Treasury bonds traded actively on major exchanges like the New York Stock Exchange (NYSE) and were held by similar investors, including banks, insurers, and wealthy individuals. Both corporate and government bonds shared similar features, such as fixed coupon pay-

[3]The US actually paid off its entire national debt in 1836.

ments and typically long maturities and exhibited relatively high liquidity compared to other asset classes. On the corporate side, railroad bonds declined in importance as industrials and utilities became the dominant issuers in the 20th century, increasingly offering high-grade bonds.

Data: To estimate historical yield curves for Treasury bonds, we use the standard CRSP Treasury Securities database (containing monthly bond prices) in conjunction with the comprehensive bond panel assembled by Hall et al. (2018) and utilized in Payne et al. (2025).

For high-grade US corporate bonds, we construct a new historical dataset, providing monthly data on trading prices and cash-flows as well as bond characteristics and credit ratings from 1860-2024. Monthly prices and cash-flows date back to 1860, along with detailed bond characteristics such as maturity, denomination and callability. Annual Moody's credit ratings date back to their earliest availability: 1909 for railroads and 1914 for public utilities and industrials. Our dataset integrates existing databases with hand-collected prices and bond characteristics from historical newspapers, business magazines, and financial releases by companies. Appendix C provides further details on our high-grade corporate bond data set.

3.1.1 Differential Tax Treatments

Income taxes: Before the introduction of US income taxation in 1913, neither corporate nor government bonds faced federal income taxes. Since then, income earned by both corporations and individuals from long-term securities holdings has been subject to two types of taxes. Interest payments are taxed at the relevant (holder-specific) marginal income tax rate τ^{inc}, while the difference between the purchase price and the redemption value is taxed at the long-term capital gains tax rate τ^{cg}. From 1913 to 1941, an unusual situation existed where proceeds from corporate bonds were taxed while US federal government bonds were (either partially or wholly) tax exempt, creating an obvious tax advantage for US treasuries.

Another notable aspect of the US tax code, occasionally of significant importance, is that long-term capital gains tax rates were consistently lower than marginal income tax rates throughout the 20th century.[4] As a result, bonds with income predominantly

[4] A useful rule of thumb is that τ^{cg} is one half τ^{inc}.

derived from long-term capital gains——such as low-coupon bonds traded well below par (the so called seasoned discount bonds)——tended to benefit from a relative tax advantage compared to bonds whose income primarily came from interest payments, such as newly issued bonds.[5] When interpreting the high-grade corporate-to-treasury yield spread, it is essential to consider the compositional differences between corporate and government bonds, especially regarding the relative prevalence of seasoned discount bonds versus newly issued bonds within the bond samples.[6]

In this context, a key legislation that unexpectedly gained prominence in the late 1960s and early 1970s was the Congressional mandate, established in 1917, which imposed a 4-1/4 percent interest rate ceiling on new long-term Treasury bonds.[7] Consequently, when interest rates surpassed the 4-1/4 percent ceiling in the 1960s, the US Treasury was unable to issue new bonds with maturities exceeding 5 years (extended to 7 years in 1967) and so the average maturity of outstanding US debt declined significantly, and the government bond portfolio became heavily concentrated in seasoned discount bonds—benefiting from substantial "capital gains tax advantage". The ceiling on long-term U.S. Treasury bonds was effectively lifted in 1971 when $10 billion worth of bonds were authorized without regard to the ceiling. Since then, the bond authorization limit has been raised multiple times, and the issuance of long-term bonds has become a regular component of the Treasury's refunding operations.

Estate tax provisions: A notable tax policy between 1921 and 1971 was the issuance of a subclass of government bonds, known as "flower bonds", which could be used to pay the bondholder's federal estate taxes upon their death *at par value* (instead of market value) plus accrued interest. Moreover, prior to the Tax Reform Act of 1976, flower bonds were valued as inherited property *at their par value* on the date of

[5]This is in addition to the advantage that a larger part of the tax is collected at a later date.

[6]In practice, for newly issued securities, the coupon rate typically adjusts to ensure that bonds are sold at par, making newly issued bonds largely unaffected by the capital gains tax. Conversely, for seasoned securities with fixed coupon rates, it is the price that adjusts to ensure that, in equilibrium, comparable securities offer similar yields-to-maturity. During periods when market yields rise above the bond's coupon rate, this adjustment can lead to a pronounced "capital gains tax advantage".

[7]As explained in Department of the Treasury (1976), the primary rationale for setting a ceiling rate of 4-1/4 percent on long-term government bonds was to minimize borrowing costs tied to the United States' involvement in WWI. This ceiling was intentionally set 25 basis points below prevailing market yields, reflecting the belief that the American public would buy Liberty Bonds for reasons beyond comparative yield considerations.

the decedent's death, effectively exempting them from long-term capital gains taxes. This meant that flower bonds effectively acted as an inflation hedge: rising inflation expectations drove up interest rates, which reduced the bond's market price relative to its par value. This decline, in turn, enhanced the bond's capital gains tax advantage, helping to maintain its *after-tax* return and offering protection against inflation risk. In this way, flower bonds functioned in a manner akin to inflation-protected bonds.

Flower bonds constituted an important subset of Treasury securities during the early decades of the post-WWII period.[8] The first recorded flower bond in CRSP was issued in 1922 and the last flower bond matured (or was redeemed) in 1985. Importantly, from 1955-1971, (almost) all outstanding treasuries with maturity greater that 10 years were flower bonds. Effective March 1971, Congress eliminated flower bond privileges on new US bond issues, ensuring a gradual reduction in their overall supply as outstanding issues used for estate tax purposes were progressively retired over time. The passage of the Tax Reform Act of 1976 in October brought two key provisions that reduced the appeal of flower bonds. First, the Act effectively terminated the flower bonds' exemption from capital gains taxes. Second, the Act extended the holding period required to qualify for the long-term capital gains tax rate from six months to one year, aiming to discourage "deathbed" purchases of flower bonds.

3.1.2 Differences in Cash-flow Risk

Callability: Call provisions, which grant the issuer the right to repay the bond's principal ("call" the security) before its maturity, introduce uncertainty to the underlying cash flows from the bondholder's perspective. Because issuers are likely to call bonds when their market price sufficiently exceeds the call price to offset the costs of refinancing and administering the call, such bonds are typically expected to trade at a discount compared to otherwise identical non-callable bonds. Call provisions are accompanied by a *call-deferment period*—a predetermined timeframe after issuance (but before maturity) during which the issuer cannot call the bond. Non-callable bonds, by comparison, can be regarded as having a call-deferment period that extends to their maturity. Intuitively, the size of the discount investors demand for holding callable bonds is inversely related to the length of the call-deferment period.

Prior to the late 1980's, virtually all corporate bonds had some kind of call pro-

[8] McCulloch (1975), Cook (1977), Cook and Hendershott (1978), and Mayers and Clifford (1987).

vision with very brief call-deferment periods. In particular, these bonds were usually callable on any interest payment dates, with notice periods typically ranging from 30 to 60 days. The call price usually started at a premium (reflecting a refinancing penalty) and gradually declined to par over time, often following a structured schedule. Some bonds allowed partial redemptions, while others required full redemption, and only a small number included a non-zero (typically 5 year) call-deferment period.

In contrast, most US government bonds are non-callable. Those with call provisions typically feature long call-deferment periods, often only a few years shorter than the bonds' maturity. This pronounced difference in typical call-deferment periods between corporate and government bonds likely contributes to the observed corporate–treasury yield spreads. However, this does not reflect the government's funding advantage. This is because the losses resulting from the government's need to refinance its debt always at prevailing market rates, rather than a lower preset call price (often set at par), ultimately be offset by future revenues.

Default Risk: In the early 1900s, Moody's Investors Service began assigning credit ratings to bonds and other financial assets, with "Aaa" denoting the highest level of creditworthiness. This rating was based on factors such as physical capital, debt levels relative to assets and revenue, profitability, and liquidity. To qualify for an "Aaa" rating, bonds needed a long-term track record of exceptionally strong interest coverage and substantial physical assets backing the issue, ensuring minimal investment risk. Most bonds were either first mortgages or well protected underlying mortgages. Moody's argued that even in changing economic conditions, the fundamental strength of these securities would remain intact. As Hickman (1958) found, credit ratings offered investors valuable insights into bond quality and default probabilities. However, their performance was not significantly better than the bond market's own assessment, as reflected in interest rate spreads.

3.1.3 Differential Treatments during Policy Interventions

Corporate and government bond markets have historically been subject to different regulatory frameworks, evolving in response to financial and economic pressures. In the decades before the Civil War, only state-chartered banks existed, which were not

incentivized to hold Treasuries.[9] This changed with the National Banking Acts of 1863–1866, which established a system of nationally chartered single-branch banks. These banks were permitted to issue banknotes up to 90% of the lower of the par or market value of qualifying US federal bonds, effectively tying their balance sheets to government debt. However, national banks were prohibited from using railroad bonds as backing for their notes and faced strict limitations on the types of loans they could issue.

World War II brought further regulatory intervention, as concerns over war financing led to the government "fixing" the yield curve from 1942 to 1951, with the T-bill rate set to 3/8% and the long-term bond yield capped at 2.5% (see Garbade (2020) and Rose (2021)). This 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 predominantly holding government debt. The arrangement ended with the 1951 Treasury-Fed Accord, establishing official Fed independence from the Treasury.

The 2007–2009 financial crisis triggered extensive regulatory reforms, including the Dodd-Frank Wall Street Reform and Consumer Protection Act, which introduced new oversight for financial institutions. Additionally, the Basel III regulations imposed stricter capital requirements and portfolio constraints on banks, penalizing excessive leverage and encouraging the holding of government debt over assets like corporate bonds. In response to the crisis, the Federal Reserve also launched a quantitative easing (QE) program, purchasing long-term government bonds to lower interest rates and stabilize financial markets.

4 Constructing Yield Curves and Spreads

Our goal is to compute the spread between yields on bonds issued by the corporate and government sectors that offer the same cash flows. This means we need to calculate zero coupon yield curves for corporate and US federal bonds (to match maturity), restrict the corporate sample to bonds with comparable default probability (to match payout risk), restrict to the sample to nominal bonds with similar tax treatment (to

[9] These banks, chartered by state legislatures, could issue their own banknotes and were subject to diverse balance sheet regulations, often requiring them to hold gold and state bonds. However, no state banks could operate nationally.

match after tax real pecuniary benefits), and adjust for the callability of corporate debt (to match effective duration).

4.1 Zero-Coupon Yield Curves

To infer term structures of zero-coupon yields on high-grade corporate bonds, we adopt the estimation approach from Payne et al. (2025). This entails using the popular Dynamic Nelson-Siegel (DNS) model of Diebold and Li (2006) extended with stochastic volatility. This model allows for a dynamic relationship between three factors (that can be thought of as levels, slopes, and curvatures of yield curves), which enables us to learn about yields at all dates simultaneously by pooling information across time periods. We briefly summarize the approach here, for further details see our companion papers Payne et al. (2023) and Payne et al. (2025).

We parameterize the discount function q_t by parameterizing the corresponding j-period zero-coupon yields defined as $y_t^{(j)} := -\log q_t^{(j)}/j$.

Assumption 1. The j-period zero-coupon yield takes the form

$$y_t^{(j)} = L_t + S_t\left(\frac{1-\exp(-j\tau)}{j\tau}\right) + C_t\left(\frac{1-\exp(-j\tau)}{j\tau} - \exp(-j\tau)\right)$$

where L_t, S_t, and C_t are hidden factors that characterize the level, slope, and curvature of the yield curve at time t. The vector $\lambda_t := [L_t, S_t, C_t]'$ follows a drift-less random walk:

$$\lambda_{t+1} = \lambda_t + \Sigma_t^{\frac{1}{2}}\varepsilon_{\lambda,t+1} \tag{4.1}$$

where Σ_t is a covariance matrix with $\Sigma_t = \Xi_t\Omega\Xi_t$. Here, Ω is the time-invariant correlation matrix and Ξ_t is a diagonal matrix with marginal standard deviations σ_t that follow:

$$\log\sigma_{t+1} = \log\sigma_t + \Xi_\sigma\varepsilon_{\sigma,t+1} \tag{4.2}$$

where Ξ_σ is a positive definite diagonal matrix. Shocks $\{\varepsilon_{\lambda,t}, \varepsilon_{\sigma,t}\}_{t\geq 1}$ are Standard Normal.

This is the yield curve model of Diebold and Li (2006) and Diebold et al. (2006)

except for the law of motion of the yield curve factors (4.1). Different from these papers, we assume that the yield curve factors are random walks and the corresponding shock volatilities are time-varying to help the model accommodate consequences of wars and important institutional changes for high-grade corporate zero-coupon yield curves.

We assume that the discount function q_t can price high-grade coupon-bearing corporate bonds well.

Assumption 2. The law of one price holds for high-grade corporate bonds and for each $t \geq 0$. That is, the price of bond i with promised payments $\mathsf{c}_{t,i}$ is given by:

$$p_{t,i} = \sum_{j=1}^{\infty} q_t^{(j)} c_{t,i}^{(j)}.$$

Assumption 2 expresses our key identifying restriction: within each time period, a common discount function prices all high-grade corporate bonds that we include in our sample, i.e., there is no cross-sectional variation in how corporate promises of bond repayment are priced. In principle, q_t implicitly includes compensations for default risks, convenience benefits, and inflation risk, so it should be thought of as the price of a *risky* promise. Our specification allows these components to vary with maturity j and time t, but not by individual bond. Effectively, we assume that the cross-sectional heterogeneity in the class of high-grade corporate bonds (Aaa rated bonds from 1900 onward) is relatively small. To be robust to this assumption and limit the extent to which heterogeneous bond characteristics distort our estimates we introduce *bond specific* pricing errors.

Assumption 3. The observed price of bond i with promised payments $\mathsf{c}_{t,i}$ differs from the price in Assumption 2 by an independent pricing error that has a time-invariant Gaussian distribution with mean 0 and standard deviation σ_i^m. That is, we have:

$$\tilde{p}_{t,i} = \sum_{j=1}^{\infty} q_t^{(j)} c_{t,i}^{(j)} + d_{t,i} \sigma_i^m \varepsilon_{t,i} \tag{4.3}$$

where $\tilde{p}_{t,i}$ denotes the *observed* period-t dollar price of bond i and $d_{t,i}$ is the Macaulay duration of bond i in period t.[10]

[10]We adjust the price error by the inverse duration to ensure that the error in yield terms does

Assumptions 1-3 give rise to a non-linear state space model with state equations (4.1)-(4.2) and observation equation (4.3). We estimate this model with Bayesian Markov Chain Monte Carlo (MCMC) methods assuming the weakly informative priors detailed in Appendix D.

4.2 Sample Restrictions

We apply several sample restrictions to ensure that we are comparing bonds with the same pecuniary payouts.

Restriction to Aaa corporate bonds. We limit our sample to high-grade corporate bonds to minimize default risk. To classify bonds, we primarily rely on Moody's credit ratings, which became available in 1909, and restrict our sample to Aaa-rated bonds. For bonds maturing before 1909, we follow Macaulay (1938) in identifying high-quality issuers, relying on the selection of railroad companies included in his high-grade railroad bond yield index. Specifically, we include companies from which Macaulay selected at least one bond for his index. Macaulay carefully selected companies based on their financial strength and excluded them before they encountered financial trouble, to ensure that his index reflected only the most creditworthy issuers. However, as pointed out in Homer and Sylla (2004), constructing an index equivalent to a modern Aaa bond index prior to 1900 presents challenges due to the limited number of true high-grade issuers and even Macaulay's "high-grade" sample exhibits some variation in credit quality.

Restriction to nominal treasuries with analogous tax treatments. We exclude the flower bond treasuries and TIPS from our sample. Since all corporate bonds in our sample are nominal, we restrict to nominal Treasury bonds to ensure that we are comparing yield curves on bonds with similar exposure to inflation risk.

Adjustment of maturity for callable corporate debt. For callable corporate bonds, we assume perfect foresight of the call date. Specifically, we treat these bonds as priced with a maturity corresponding to the date the bonds were called. Our bond-specific measurement errors help to mitigate potential issues with this assumption.

not become unbounded as the bond nears maturity.

5 Corporate Bond Yields and Convenience Spreads

In this section, we describe the key outputs from our estimation: the high-grade corporate bond yield curve, the treasury yield curve, and the AAA Corporate-Treasury spread curve for the period 1860-2024. We show that our spread estimate differs significantly from existing series during the Great Inflation period (1965-1980) due to the implicit inflation protection embedded in "flower-bonds".

5.1 High-Grade Corporate Bond Yield Curves

The top panel of Figure 1 depicts selected long term nominal yields on high-grade US corporate bonds. The solid black line represents the median of our 20-year zero coupon yield estimates. Bands around the posterior median depict the 90% interquantile range. Between 1860-1900, long term high-grade corporate yields trended downward from around 8% to around 4% (the "great bond bull market"), then climbed slowly back to 5% by World War I. During the war and the subsequent 1920 recession long term corporate yields reached more than 7% before they began their renewed downward decline (interrupted briefly by the Great Depression). During World War II and the 1950s, the 20-year high-grade corporate yield exhibited surprising stability up until the late 1960s when, in tandem with increasing inflation, it reached its peak of 18% during the 1981-1982 recession.

The blue dashed line in the top panel of Figure 1 depicts the high-grade railroad bond index from Macaulay (1938) computed as the average yield-to-maturity on selected long term bonds issued by reputable railroad companies between 1857-1937. The red solid line is Moody's Seasoned Aaa Corporate Bond Yield index computed as the average yield-to-maturity on bonds with maturity 20 years and above. This index is available from 1919 onward. While yields-to-maturity are different from the notion of a zero-coupon yield, we find it reassuring that our estimates broadly align with Macaulay's high-grade railroad and Moody's Aaa indexes.[11]

One of the main advantages of estimating the whole yield curve is to observe shorter maturity private borrowing costs. The middle panel of Figure 1 depicts our posterior median estimates of the 10-year and 2-year zero-coupon yields on high-grade

[11] Yield-to-maturity is computed under the assumption of a flat yield curve. In this sense, yield-to-maturity of a particular bond can be considered as the weighted average of zero-coupon yields with the bond's cash-flows acting as weights.

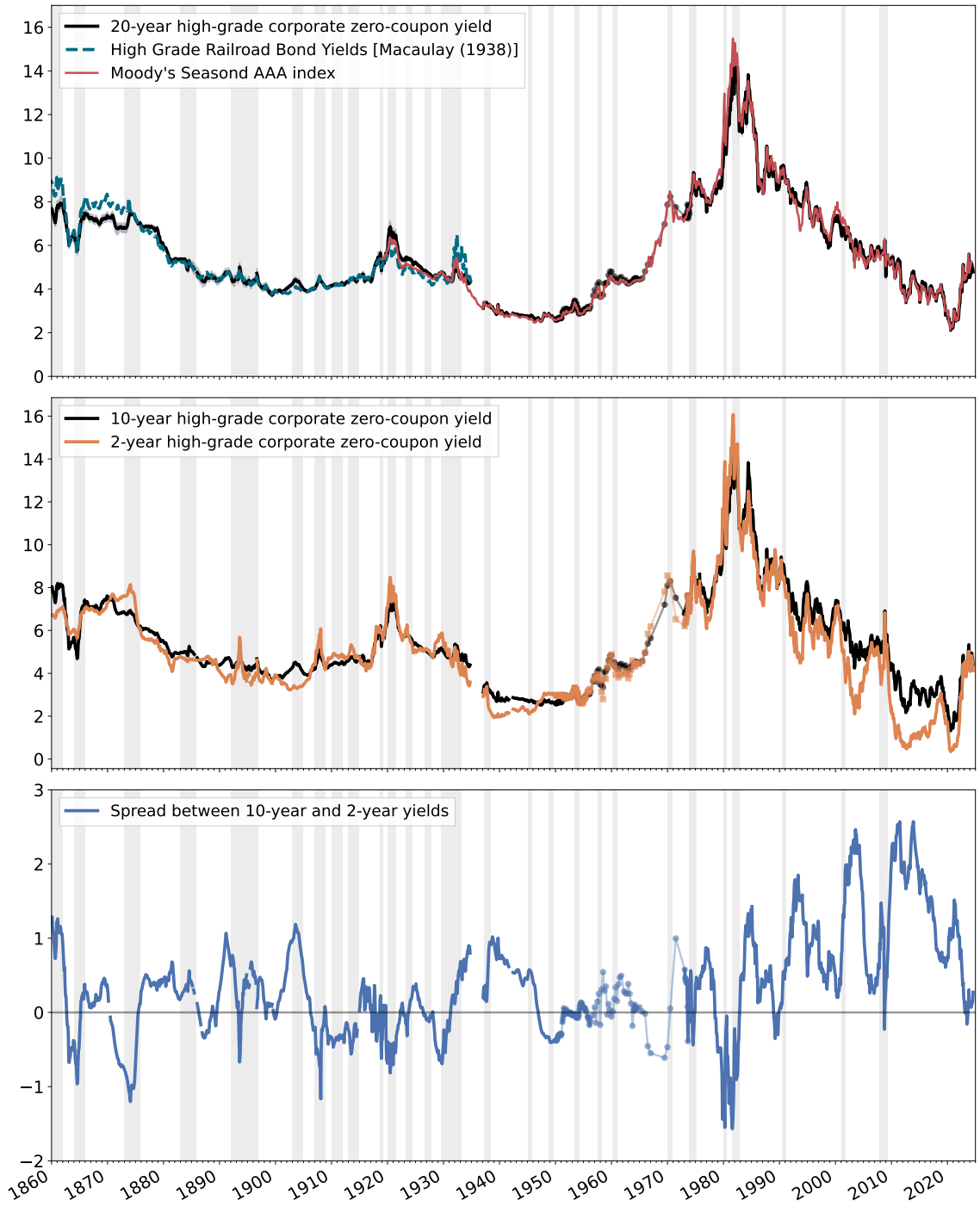


Figure 1: High-grade Nominal Corporate Zero-Coupon Yields 1860-2024

Top panel depicts our posterior median estimate of the 20-year high-grade corporate zero-coupon yield (black). The blue dashed line depicts the High Grade Railroad Bond Index from Macaulay (1938). The red solid line is Moody's Seasoned Aaa bond index. Middle panel depicts posterior median estimates of the 10- (black) and 2-year (orange) high-grade corporate yields. Bottom panel depicts the spread between the 10-year and 2-year yields. The light gray intervals depict NBER recessions.

corporate bonds. The bottom panel shows the corresponding spread. Evidently, short- and medium-term yields follow the same trend as the 20-year yield, but they are more volatile, especially in the post WWII period. Before the 1980s, the spread between the 10-year and 2-year zero-coupon yields is close to zero, suggesting that for about 100 years, the average yield curve on high-grade corporate bonds was flat on average.

5.2 Treasury Yield Curves

In previous work, we estimated historical zero-coupon yield curves on US Treasuries from 1790-1933 (see Payne et al. (2025)). For this paper, we extend our estimation to 1934-2024 to provide a consistent comparison to the corporate yield curve. An important deviation from the literature is that we restrict attention to nominal bonds by excluding flower bonds and other bonds that effectively traded as real debt. In the first subsection, we highlight why eliminating flower bonds has a large impact on the Treasury yield curve. We then discuss the overall time series for the Treasury yield curve.

5.2.1 Treasury Yields in the 1960-80 Inflation Episode

As discussed, before 1971, the US Federal government issued "flower bonds" which bondholders could use to pay federal estate taxes upon their death *at par value* plus accrued interest (see Cook (1977), Mayers and Clifford (1987)). In addition, before 1976, flower bonds were *valued as inherited property at their par value* on the date of the decedent's death, effectively exempting them from capital gains tax and acting as an effective inflation hedge. This meant that flower bonds effectively acted as an inflation hedge.

Importantly, from 1955-1971, (almost) all outstanding treasuries with maturity greater that 10 years were flower bonds. This uneven distribution across the maturity spectrum is reflected on the yield-to-maturity plots in Figure 2. Each subplot depicts yields-to-maturity against corresponding maturities (in years) for all bonds outstanding in a given month. Black dots and squares represent non-callable and callable non-flower bonds, respectively. Red dots and squares represent non-callable and callable flower bonds, respectively. Evidently, prior to 1971 all bonds beyond 10 years to maturity are flower bonds, implying that the commonly used average

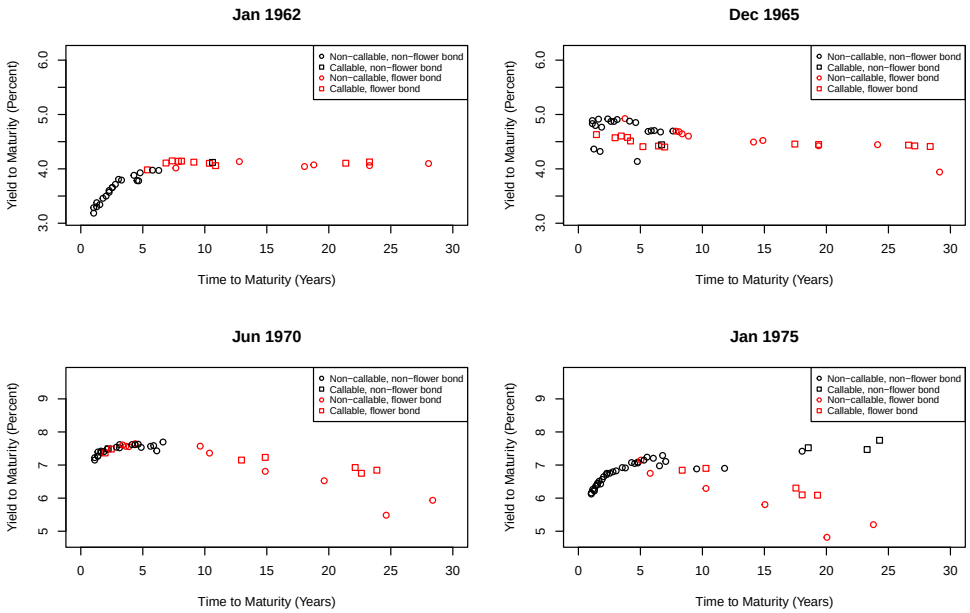


Figure 2: US Treasuries Yields Before and During the Great Inflation

Panels depict yields-to-maturity (y-axes) against years-to-maturity (x-axes) for different dates (panel title). Each circle/square corresponds to a separate bond outstanding in the given month. Red color represents "flower bonds", black color is for regular bonds. Circles show non-callable bonds, squares represent callable bonds. If a callable bond is traded at a premium in the given month Yield-to-Call and Years-to-Call is shown on the vertical and horizonatal axes, respectively.

long-term government debt series (e.g. LTGOVTBD in FRED) is completely made up of flower bonds over this period. We can also see that the red flower bond dots and regular bond black dots move differently once inflation takes off. Prior to 1965, the red and black dots form a consistent shape. However, by 1975, the red and black dots have dramatically departed.

To get a sense of the magnitude of the "flower bond effect", we estimate our yield curve model from Section 4 using a sample that includes only flower bonds and a sample that excludes all flower bonds. The results are depicted in Figure 3. The black line shows the posterior median estimate of the 20-year zero-coupon yield without flower bonds. The green line shows the posterior median estimate of the 20-year zero-coupon yield using only flower bonds. Evidently, before the end of 1965, the two yields are indistinguishable. This implies that the average long-term government yield index, represented by the red line in Figure 3, is a good approximation of long-term treasury yields.

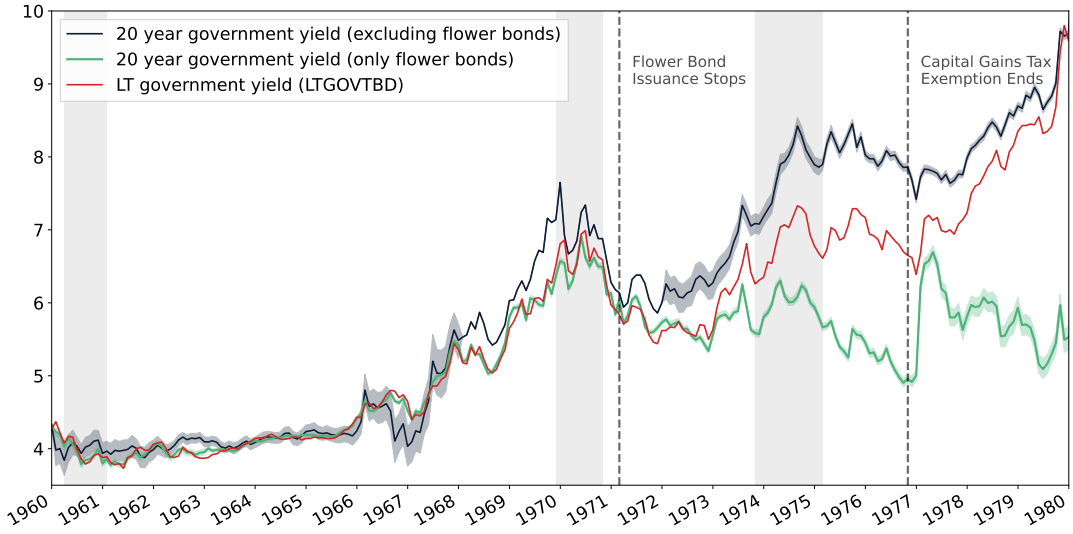


Figure 3: Long Term Government Yields With and Without Flower Bonds

Black solid line is the posterior median estimate of the 20-year zero-coupon yield on US Treasuries excluding all flower bonds from the sample. Green solid line is the posterior median estimate of the 20-year zero-coupon yield on flower bonds only. Bands denote 90% posterior interquantile ranges. Red solid line is the average long-term government yield index (LTGOVBD).

From 1966 onward, however, a gap opens up between the black and green lines due to the slow increase in the flower bond premium which affected mainly the lowest-coupon issues.[12] 1971 brought two important changes in the US treasury market. First, the 4-1/4% ceiling on new US bond issues was lifted and so long-term bonds without flower bond provisions started to reappear (with higher coupons). Second, effective March 1971, Congress eliminated flower bond privileges on new US bond issues, thereby ensuring a steadily declining stock as outstanding issues purchased for estate tax purposes were retired over time. The flower bond premium started to increase sharply on all flower bonds, which can be attributed to the combination of (1) the steady decline in the supply of flower bonds and (2) increased demand for flower bonds as rapid inflation drove up the value of estates, but tax laws were not adjusted in a timely manner to correct for the impact on the level of estate taxes. We

[12] Among the outstanding flower bonds, the ones actually purchased because of the estate-tax feature tended to be the lowest coupon bonds, such as the 3's of 1995 and the 3-1/2 of 1998, which were selling at the largest discounts. Evidence of this can be seen in the amount outstanding, with the net decline from year to year measuring the amount redeemed for estate tax purposes. See Cook (1977).

can see these effects reflected in the decrease in the green line between 1973-1976 in Figure 3. The next big regulatory change was the Tax Reform Act of 1976, passed in October, which effectively terminated the flower bonds' exemption from capital gains taxes. Figure 3 demonstrates that the Tax Reform Act of 1976 had a major impact on the pricing of flower bonds. The 20-year zero-coupon yield on flower bonds jumped from around 5% to almost 7% in the two months following the passage of the Act.

Ultimately, because the value of flower bond provisions was inversely related to market prices of bonds, flower bonds implicitly hedged inflation and/or interest rate risk. As a result, these bonds were not priced as regular nominal bonds but instead like real bonds. In fact, to a first approximation, the spread between the black and green lines in Figure 3 can be interpreted as a compensation for inflation risk, which is highest between 1971-1976. In this sense, the yield on flower bonds is not comparable to the yield on corporate bonds: one uses tax revenue to provide an inflation protected return while the other does not. This reinforces why we take the flower bonds out of our baseline estimate for the Treasury yield curve.

5.2.2 Treasury Yields

Before we turn to the construction of high-grade corporate-Treasury yield spreads, it is instructive to see the extent to which the Treasury and Corporate yield curves co-move with each other. The top panel of Figure 4 depicts the 10-year high-grade corporate yield against the 10-year zero-coupon Treasury yields from Payne et al. (2025) combined with our estimates for the modern period. Evidently, the two yields follow similar trend dynamics, but long term treasury yields are persistently lower than high-grade corporate yields throughout our sample. In addition, despite the similar trend, short- and medium-term fluctuations of the two yield curves around their respective trends are very different in the early part of the sample. We can see this reflected in the middle and bottom panels of Figure 4. The middle panel depicts yield curve slopes defined as the spreads between the 10 year and 2 year zero-coupon yields on high-grade corporate bonds (blue) and on US treasuries (orange). The bottom panel shows the 10 year centered rolling correlation between the long end of the yield curves (blue) and the 2-year yields (orange). The corporate and treasury yield curves are only weakly correlated between 1860-1950 and then became highly synchronized after the late 1950s. Despite this convergence, the two yield

curves seemed to decouple during the yield curve control period (1942-1951), the Great Inflation, and the post 2008 period.

5.3 Properties of the AAA Corporate-Treasury Spread

Figure 5 shows our estimates of the 10-year (top) and 20-year (bottom) AAA Corporate-Treasury spread, as measured by our estimate for the high-grade corporate zero-coupon yield minus our estimate for the treasury zero-coupon yield. Evidently, both measures of the spread exhibit large low frequency variations with their long-run mean value ranging between 0-2 % over the last 160 years. On average, the spread peaked during the National Banking Era (1862-1913) and generally stayed high during the gold standard. Its long-run mean dropped sharply after World War I and reached its lowest levels during the high inflation of the 1970's and 1980's.

The red line in Figure 5 depicts the index-based high-grade corporate-treasury spread introduced by Krishnamurthy and Vissing-Jorgensen (2012). Our 20-year spread estimate follows this measure fairly closely except during the high inflation of the 1970's and 1980's. While the index-based measure (the red line) reaches its highest values during this period, our estimate shows the opposite: the high-grade corporate to treasury spread is close to zero. The difference occurs because we exclude the flower bonds from our sample, suggesting that a large portion of the variation in the index-based measure is attributable to an "inflation risk premium" instead of a "specialness premium" on US treasuries.[13]

We find more discrepancies relative to index-based measure (the red line) at shorter maturities, which are arguably more relevant for US government borrowing costs. In particular, at the 10-year horizon, which approximates the average debt maturity of US federal debt between 1860-2024 well, our estimates indicate relatively high spreads during the yield curve control period, and relatively low spreads during the decade after the Global Financial Crisis (GFC). Details of the Fed's Treasury buying programs during these two episodes provide a potential explanation for these patters in the term structure of funding cost spreads. While during the 1940s and 1950s the Fed purchased predominantly short-term government debt, the post-2008 quantitative easings (QE) focused on the purchase of long-term Treasuries.

[13]This is consistent with Figure 1 in Cook and Hendershott (1978), which suggests that after adjusting for "tax effects" yield spreads between high grade corporate and government bonds stayed below 1% before 1975.

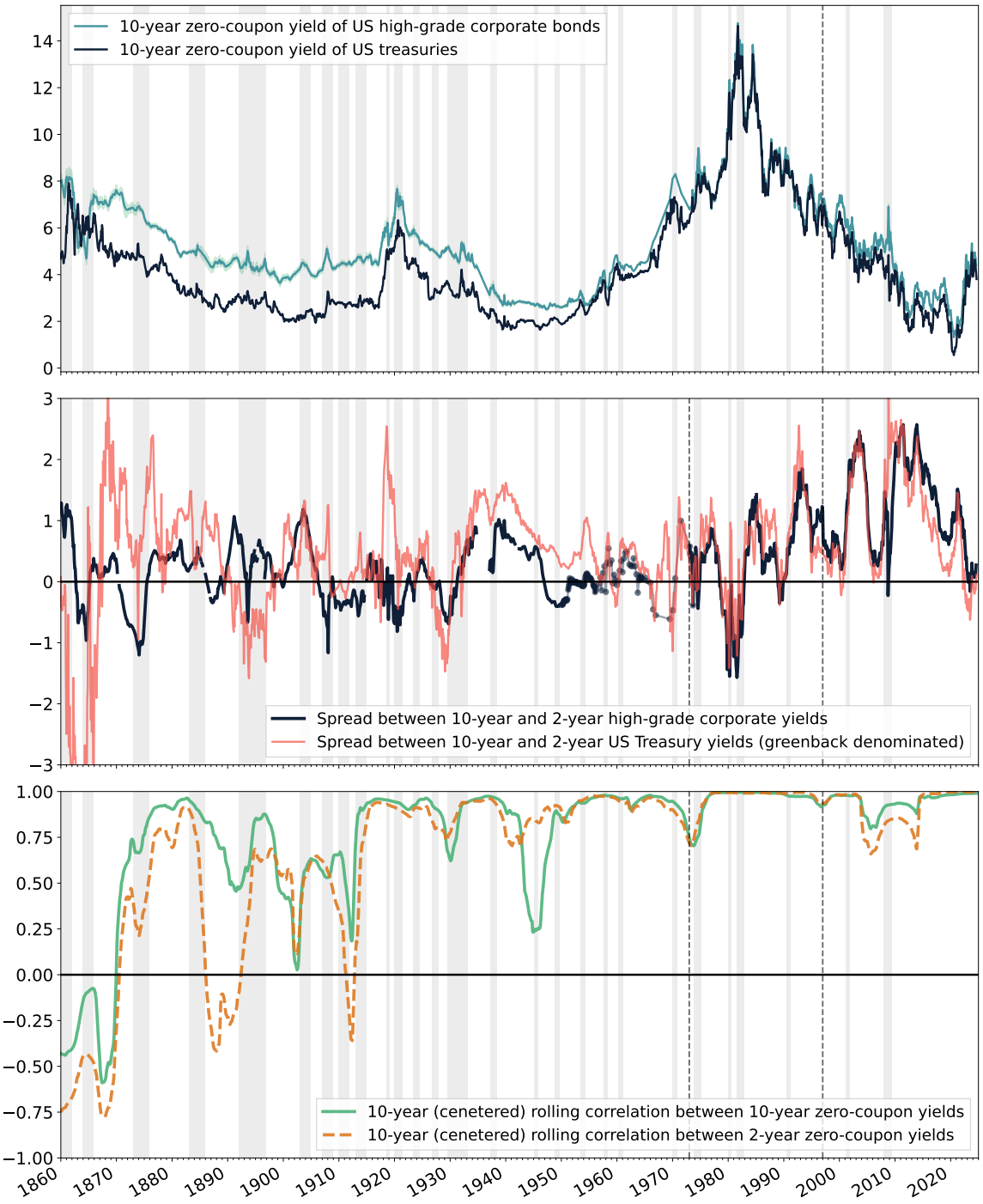


Figure 4: Difference Between Private and Public Borrowing Costs

Top panel depicts posterior median estimates of the 10-year zero-coupon yields on high-grade corporate debt (blue) and US Treasuries (black). Middle panel depicts spreads between 10-year and 2-year yields for high-grade corporate debt (black) and US Treasuries (red). Bottom panel depicts 10-year (centered) rolling correlations computed from the monthly series of posterior median estimates of 10-year (green solid) and 2-year (orange dashed) zero-coupon yields.

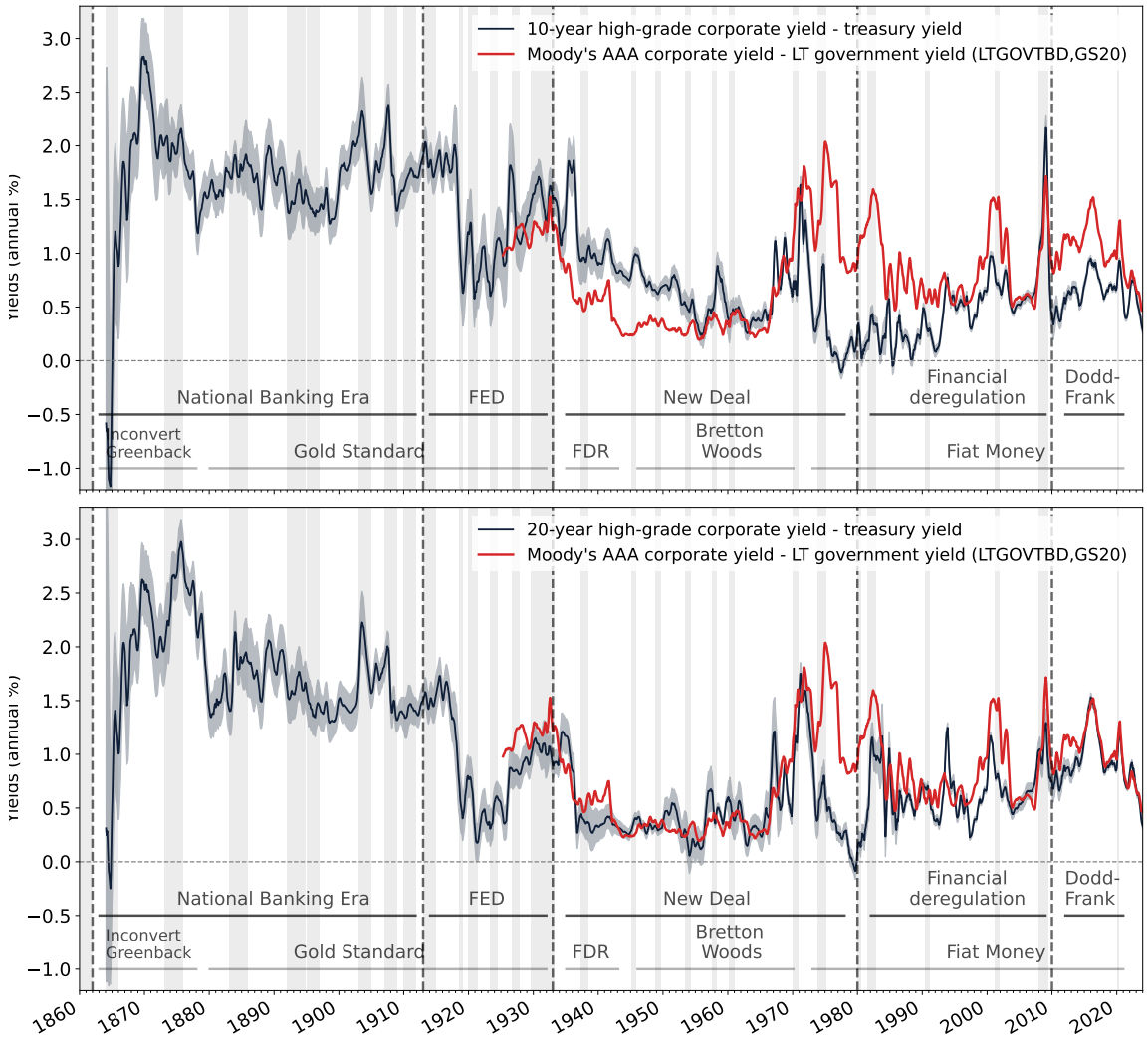


Figure 5: High-Grade Corporate to Treasury Spread Estimates: 1860-2024

Top panel depicts the 12-month centered moving average of the posterior median estimate of the 10-year convenience spread (black solid line) defined as the difference between 10-year zero-coupon yields on high-grade corporate debt and US Treasuries. The gray bands depict 90% posterior interquantile ranges. The red solid line shows the 12-month centered moving average of the index-based AAA Corporate-Treasury spread proposed by Krishnamurthy and Vissing-Jorgensen (2012). Bottom panel depicts the 20-year convenience spread against the index-based measure. Dashed vertical lines denote financial regulatory eras. Bottom labeling shows monetary standards. The light gray intervals depict NBER recessions.

6 Implications for the Macro-Finance Literature

We conclude this section by discussing how our estimate of the high-grade corporate to treasury spread relates to some recent narratives in the literature. In particular, we argue that many of the relationships identified in the current research rely on the behavior of the index-based measure during the high-inflation period of 1965–1985 and lose identification using our series.

6.1 Comovement With Inflation

Our estimate of the AAA Corporate-Treasury spread helps to resolve a "puzzle" with the existing index-based estimate: the correlation between inflation and the AAA Corporate-Treasury spread appears to become positive during the Great Inflation.

To study how the use of our high-grade corporate to treasury spread measure affects the relationship between inflation and the Aaa Corporate-Treasury spread on US treasuries, Figure 6 depicts (annual) CPI inflation from Officer and Williamson (2021) along with our 10-year spread estimate[14] between 1870-2024. The dashed vertical lines divide the sample into 5 sub-periods. These sub-periods are the: (i) National Banking Era (1868-1919), (ii) Interwar years (1920-1941), (iii) Yield Curve Control (1942-1951), (iv) Post Treasury-Fed Accord (1952-1999), (v) Post 2000 (2000-2024). The numbers at the bottom of Figure 6 show the correlations between the two time series over the respective sub-periods. Evidently, the co-movement between inflation and the convenience spread was remarkably stable over the period of 1870-2024. Except for the yield curve control years, when the correlation is close to zero, the relationship is negative with a correlation coefficient ranging from -0.4 to -0.15. In particular, unlike for the existing index-based measure, we do not find that the correlation became positive during the Post Treasury-Fed Accord (1952-1999) period.

Our results are in contrast to a recent paper Cieslak et al. (2024), which documents and attempts to rationalize a change in the correlation between inflation and the AAA Corporate-Treasury spread during the high inflation period. The difference between our findings and those of Cieslak et al. (2024) stems from our reassessment of how the Treasury yields behaved during the high inflation period. The positive correlation observed in the existing index-based series from 1952-1999 appears to be driven by the

[14] We annualize our monthly estimate by taking the mean convenience spread each year.

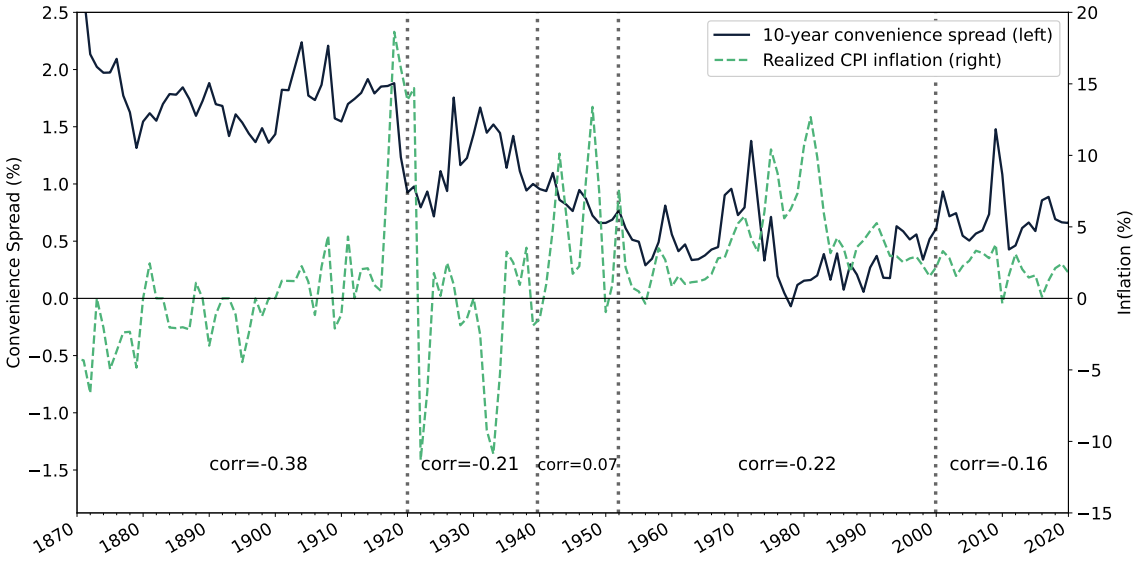


Figure 6: Convenience Spread vs Realized CPI Inflation: 1870-2024, Annual

Black line depicts our annualized 10-year convenience spread (left axis) defined as the yearly average of the monthly series. Green dashed line shows the realized annual CPI inflation between period $t-1$ and period t (right axis). Vertical dashed line divide the sample into five sub-periods. Numbers at the bottom show correlations between the two time series within the respective sub-samples.

inclusion of "real" flower bonds in the index that appreciated during the high-inflation period. This suggests that the pattern is not due to an increase in the non-pecuniary or "convenience" benefits of US Treasuries, as proposed by Cieslak et al. (2024). Instead, it appears because the government effectively used tax incentives to ensure that the real return on flower bonds remained high and this distorted the index-based measure of the high-grade corporate to treasury spread.

6.2 Treasury Demand and US Government Market Power

There has been recent interest in finding instruments for US Treasury demand and estimating the US government's market power. In this section, we investigate one such instrument that has been used in the literature: foreign volatility shocks as rotators for US debt demand.

Figure 7 depicts the relationship between the AAA Corporate-Treasury spread and debt issuance for maturities less than one year (the left panel) and for maturities greater than one year (the right panel). The red dots depict periods with high foreign volatility while the blue dots depict periods with low volatility in returns on UK equities. Changes to the shape of the equilibrium relationship in periods of high volatility have been interpreted as evidence of rotation in US debt demand (e.g. by Choi et al. (2022)). Contrary to the literature, we find little evidence that the foreign volatility acts as a rotator, except for very short term maturities.

Our findings have implications for estimation of US treasury market power. Following Choi et al. (2022), we impose a log linearized government issuance policy rule:

$$\lambda \log(q_t^b B_t / Y_t) = \log(\chi_t) + \log(1 - \xi \epsilon_t^{-1}(\sigma_t)) - \omega_t$$

where $q_t^b B_t / Y_t$ is the market value of debt-to-GDP ratio, χ_t is the AAA Corporate-Treasury spread, ξ is an indicator function whether debt issuance reacts systematically to elasticity, $\epsilon_t^{-1}(\sigma_t)$ is the inverse elasticity, $\sigma_t \in \{\sigma_L, \sigma_H\}$ is foreign volatility, and ω_t is an iid policy shock. We then estimate the price elasticity ϵ_t in high and low foreign volatility periods $\sigma \in \{\sigma_L, \sigma_H\}$. Finally, we test if $\xi = 1$ (debt issuance reacts systematically to elasticity) or $\xi = 0$ (debt issuance does not react systematically to elasticity) is a better fit. The results are shown in Table 1. Contrary to Choi et al. (2022), we find little evidence that US government issuance reacts systematically to elasticity shocks at maturities greater than 1 year. In other words, using the

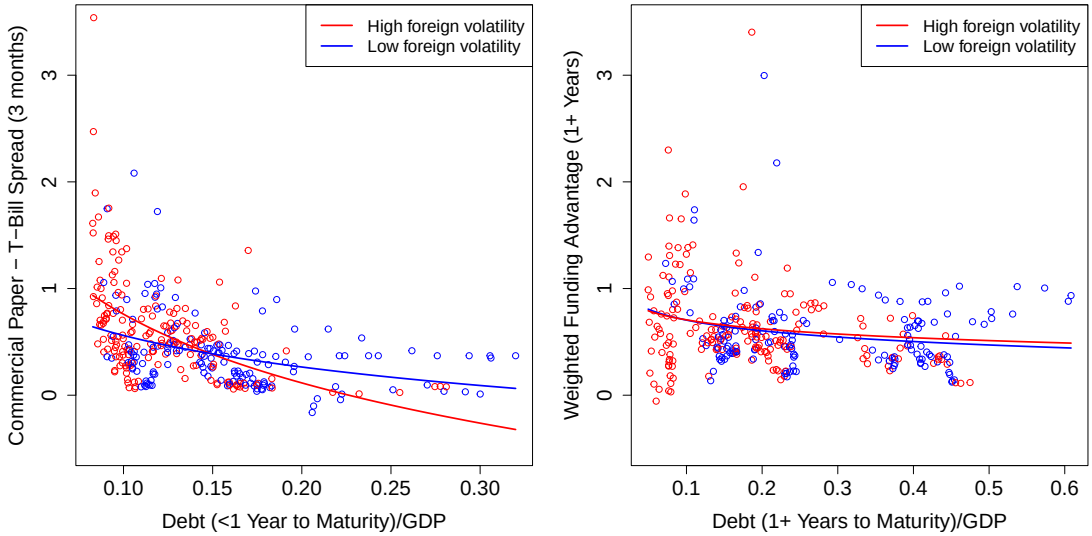


Figure 7: Convenience Spread vs Debt/GDP: 1919-2008, Annual, High and Low Foreign Volatility

framework of Choi et al. (2022), our results suggest that the US hasn't been exploiting its market power in the bond market for maturities above 1 year. However, we do find evidence for systematic reaction at maturities < 1 year. Since inflation and volatility are correlated, this may reflect monetary policy adjustments rather than exploitation of safe-asset monopoly power.

Cost elasticity	$\lambda = 0$	$\lambda = 1$	$\lambda = 2$
< 1 Year to Maturity	-2.630^{***}	-2.712^{***}	-2.281^{**}
1+ Year to Maturity	0.575	-1.439	-1.585

Table 1: Null hypothesis: US debt issuance does not react to elasticity ($\xi = 0$)

6.3 Convenience Spread and Debt Supply

A much studied historical relationship in the literature is the negative correlation between the convenience spread and the supply of US government debt. Figure 8 revisits this relationship by depicting our estimate of the 10-year convenience spread along with the market value of debt-to-GDP ratio since 1865. The top panel represents

the co-movement between these variables as time series, the bottom panel reports the same information as a scatter plot replicating Figure 1 in Krishnamurthy and Vissing-Jorgensen (2012) (we include the maturity specific scatter plots in Figure 12 Appendix E, which show the downward sloping relationship is primarily at the short end of the yield curve.). Evidently, there seems to be a negative co-movement between the stochastic trend components of these series. The long-run mean of the high-grade corporate-treasury spread is highest during the National Banking Era when the mean debt-to-GDP ratio is at its lowest level in our sample. Moreover, as the long run mean of the debt-to-GDP ratio started to shift upward after WWI and WWII, the spread started to trend down. The shape of the scatter plot in Figure 8 is a reflection of this negative correlation between the low-frequency components of the convenience spread and the debt-to-GDP ratio. Notice, however, that the "slope" of this equilibrium relationship is flatter than what Krishnamurthy and Vissing-Jorgensen (2012) found, suggesting that the co-variation attributable to the year-to-year fluctuations in the government debt supply is more muted.

To show that the equilibrium relationship between government debt supply and the convenience spread has different properties under different monetary, fiscal, and financial regulation regimes, we divide our 160-year sample into the following sub-periods (represented by different colors in the bottom panel of Figure 8): (a) National Banking Era (1865-1919); (b) Interwar period (1920-1940); (c) Yield Curve Control (1941-1951); (d) Post WWII low inflation (1952-1964, 1990-2007); (e) Post WWII high inflation (1965-1989); (f) Post Global Financial Crisis and Quantitative Easing (2010-2024). To study the relationship between government debt supply and the convenience spread more systematically, in Table 2 we rerun the regression from Krishnamurthy and Vissing-Jorgensen (2012) using our sub-samples from our extended dataset.

The regressions confirm what can be seen visually in Figure 8:

1. For 1868-1919 (National Banking Era) the debt/GDP ratio is insignificant and has a small positive coefficient. We run the regression with and without the average corporate default rate during the period but find it makes little difference, which suggests it is not changes in the likelihood of corporate default that is driving the result.

2. Similarly, for 1942-1951 (Yield Curve Control) and for 2010-2024 (QE period)

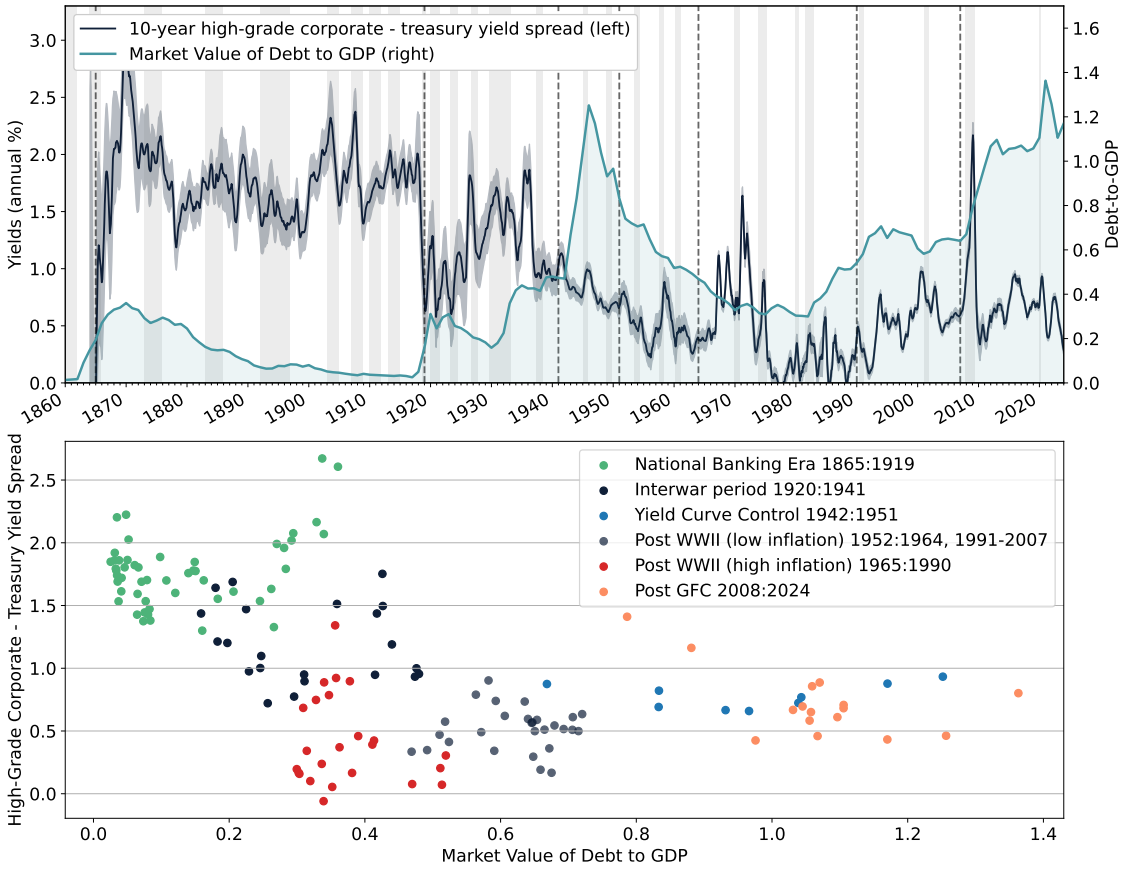


Figure 8: High-grade corporate-Treasury spread vs Debt/GDP: 1860-2024

Top panel depicts the 12-month centered moving average of our 10-year high-grade corporate-treasury spread estimate (left axis) along with the market value of government debt to GDP ratio (right axis). Bottom panel is the scatter plot of the annualized spread and debt-to-GDP from the top panel. The vertical dashed lines in the top panel and the color coding in the bottom panel divide the sample into six sub-periods specified in the text (and in the bottom panel's legend).

	1868-1919 (NBE)		1920-2007 (FED, Macroprudential Regulation)						Dodd-Frank
	no EDF	with EDF	1920-41	1942-1951	1952-1964 1991-2007	1965-1990	1952-2007	All 1920-2007	2010-2024
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$ln(debt/GDP)$	0.071 (0.065)	0.061 (0.073)	-0.774^{***} (0.206)	0.1148 (0.172)	-0.255^{***} (0.091)	-0.366^{**} (0.168)	-0.0461 (0.070)	-0.184^{*} (0.099)	0.064 (0.306)
$Volatility$	-0.237 (0.434)	-0.327 (0.497)	0.1835 (0.559)	0.1871 (1.685)	2.064^{***} (1.784)	-1.335 (1.358)	-0.008 (0.781)	1.765^{***} (0.547)	2.213^{***} (0.611)
$Slope$	-0.039 (0.041)	-0.035 (0.043)	0.176^{**} (0.066)	0.1403 (0.085)	-0.0277^{*} (0.050)	-0.0124 (0.037)	-0.032 (0.020)	-0.031 (0.040)	-0.015 (0.029)
EDF		0.007 (0.019)							
$constant$	1.99^{***} (0.235)	1.970^{***} (0.247)	-0.0917 (0.341)	0.5092 (0.279)	0.1865^{**} (0.090)	-0.0187 (0.280)	0.448^{***} (0.098)	0.302^{***} (0.113)	0.536^{***} (0.130)
Adj R^2	-0.03	-0.05	0.35	0.082	0.19	0.052	0.05	2.1e-4	0.193
F-test	0.666	0.425	0.013	0.367	8.39e-06	0.0428	0.262	5.91e-13	0.003
AIC	36.60	38.44	3.038	-14.89	-78.06	99.88	109.1	74.75	-33.43
N	51 (A)	51 (A)	22 (A)	10 (A)	114 (Q)	97 (Q)	221 (Q)	88 (A)	56 (Q)

Nota: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 2: Relationship Between Treasury Supply and the 10-year High-grade Corporate-Treasury Spread

the debt/GDP ratio is insignificant and has a small positive coefficient.

3. For the Interwar period (1920-1941) we find a significant downward sloping relationship between the high-grade corporate-treasury spread and government debt supply, with a value similar to Krishnamurthy and Vissing-Jorgensen (2012).[15]

4. For 1952-2007 (post Fed-Treasury Accord), we find a broadly negative relationship, but the coefficients are about half as large as the coefficient in the interwar period. In addition, while we find significantly negative coefficients within the low inflation (column 5) and high inflation (column 6) sub-periods, overall the coefficient on $\log(Debt/GDP)$ is close to zero and insignificant.

The scatter plot in Figure 8 and the whole sample regression in Table 2 have been interpreted as reflecting an exploitable stable demand function. However, our analysis suggests that the equilibrium relationship between the high-grade corporate-to-Treasury spread and the debt-to-GDP ratio is best represented as an outcome of large low frequency shifts in the demand for and supply of government debt. Financial regulation and government monetary-fiscal policies change the bond demand and supply functions, which ends up being reflected in the relationship between government debt supply and the corporate-treasury spread. This suggests attempts to exploit the relationship in Figure 8 are vulnerable to the Lucas critique.

6.4 High Inflation Period and the Lucas Critique

The 1970's High Inflation period provides a good laboratory to test whether the scatter plot in Figure 8 can be viewed as a stable exploitable relationship. From the perspective of the 1940's and 1950's the persistently high inflation rates of the 1970's can reasonably be considered as unexpected and as such, they devalued the outstanding stock of long-term nominal debt. Under the assumption of a stable exploitable relationship between government debt supply and the convenience spread, this reduction in the value of debt would have led to an increase in the convenience spread. As the "special asset" becomes scarcer in the economy, the private sector is willing to pay a higher premium for holding the remaining stock of it. Indeed, as we

[15] Krishnamurthy and Vissing-Jorgensen (2012) uses a different range and finds the coefficient to be in the range of -0.55 to -1.66 depending upon the exact time period and bond yield chosen.

saw in section 5.3, this is exactly what happened according to the index-based AAA corporate-Treasury spread.

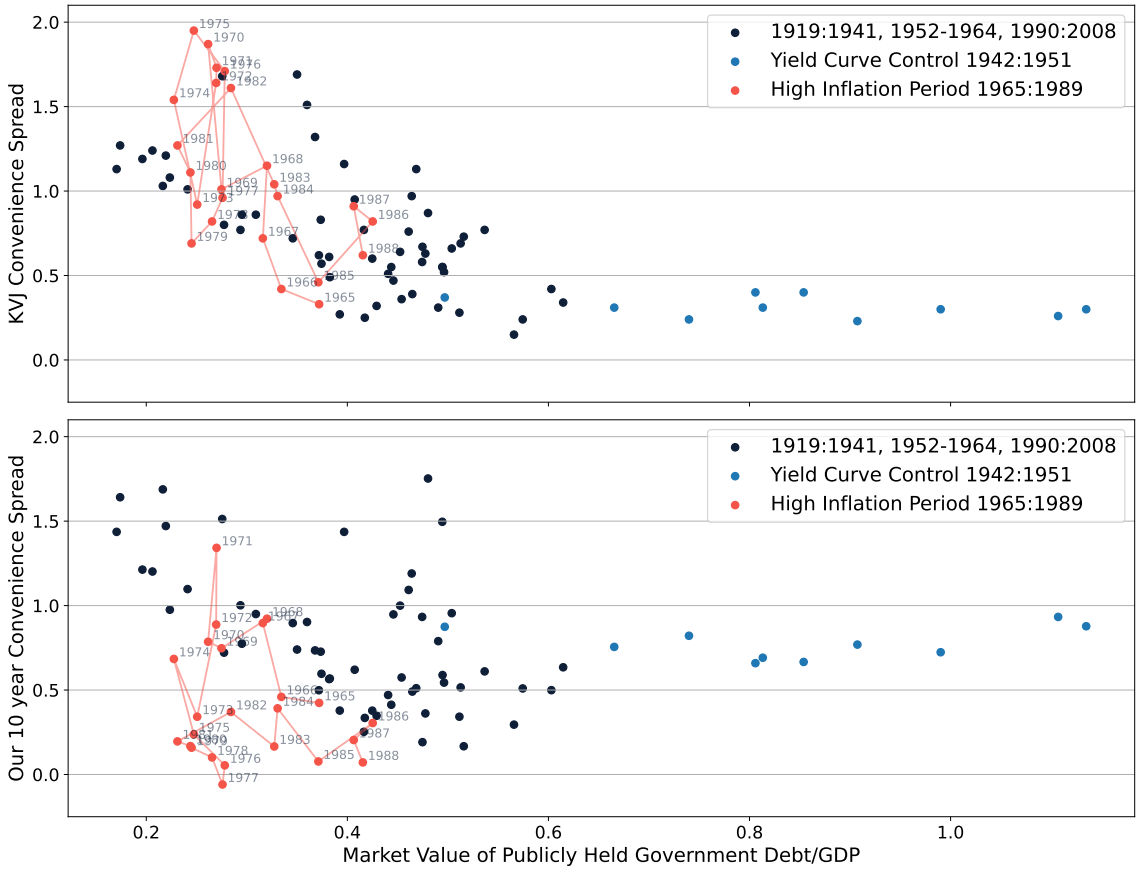


Figure 9: High-grade Corporate-Treasury Spread vs Debt/GDP: 1919-2008, Annual

Top panel depicts a scatter plot of the KVJ convenience spread proxy against the market value of publicly held government debt to GDP ratio. The bottom panel depicts a scatter plot of our 10-year convenience spread estimate against the time series of debt-to-GDP ratio used in the top panel. Red dots highlight the High Inflation period.

As an illustration, the top panel of Figure 9 replicates the scatter plot between the index-based AAA corporate-Treasury spread and the market value of debt-to-GDP ratio over the period 1919-2008 which was the original sample studied by Krishnamurthy and Vissing-Jorgensen (2012). As before, the red dots denote the High Inflation period of 1965-1990 with the lines linking consecutive years to show the direction of time. Looking at this figure, one can easily get the impression that as the series of unexpected inflation shocks started to devalue long-term government debt after

1965, the high-grade corporate-treasury spread started to increase (i.e. the economy was moving along a stable demand function for US treasuries). The bottom panel of Figure 9—showing the same scatter plot except for the index-based spread measure being replaced by our 10-year high-grade corporate-to-Treasury spread estimate—tells a drastically different story.[16] While for the first few years, between 1965-1971, the high-grade corporate-to-Treasury spread went up, the relationship eventually broke down and for most of the 1970's and early 1980's the spread remained close to zero. In other words, taking into account the special tax treatment of flower bonds leads to a complete revision of our understanding of what happened to the high-grade corporate-to-Treasury spread during the Great Inflation period. Instead of reaching its highest levels since WWI, losing the nominal anchor during the 1970's coincided with an almost complete erosion of the premium on US treasuries.

7 Conclusion

In this paper, we construct new estimates for historical high-grade corporate and nominal treasury yield curves and use them to compute a term structure of Aaa-rated corporate to US Treasury spreads. We use our estimates to document how the long-run mean of the US funding cost advantage, as measured by the AAA Corporate-Treasury spread, has fluctuated in response to financial sector regulation and monetary-fiscal policies, thereby challenging prevailing narratives about the existence of an exploitable demand function for US treasuries.

[16]The light blue dots represent the yield curve control period. As we saw before, Fed QE pushed the medium term convenience yield up (relative to the 20-year).

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A Government Budget Constraint Arithmetic

The market value of the portfolio of coupon-bearing government bonds in period t is:

$$\mathcal{B}_t := \sum_{i \in \mathcal{N}_t} q_{t,i} B_{t,i}$$

where $B_{t,i}$ is the face value of bond i at date t, $q_{t,i}$ is the market price of bond i at date t and $\mathcal{N}_t$ is the set of bonds outstanding at date t. Each bond i is characterized by a triple (c_i, p_i, T_i), where c_i is the coupon rate, p_i is the principal, and T_i is the maturity date. We can turn the maturity date into a time-to-maturity variable, $J_{t,i} = T_i - t$.

Suppose that the usual asset pricing equation holds for all bonds:

$$q_{t,i} = \sum_{n=1}^{\infty} q_t^{(n)} \mathsf{c}_{t,i}^{(n)} \qquad \forall i \in \mathcal{M}_t$$

where $q_t^{(n)}$ is a discount function which is independent of i and only depends on (t, n). By definition, $q_t^{(0)} = 1$.

That said, we can re-express the market value of the government debt portfolio (of coupon-bearing bonds) in terms of a portfolio of zero-coupon bonds:

$$\begin{aligned} \mathcal{B}_t := \sum_{i \in \mathcal{M}_t} q_{t,i} B_{t,i} &= \sum_{i \in \mathcal{M}_t} \sum_{n=1}^{\infty} q_t^{(n)} \mathsf{c}_{t,i}^{(n)} B_{t,i} \\ &= \sum_{n=1}^{\infty} q_t^{(n)} \sum_{i \in \mathcal{M}_t} \mathsf{c}_{t,i}^{(n)} B_{t,i} = \sum_{n=1}^{\infty} q_t^{(n)} b_t^{(n)} \end{aligned}$$

where $b_t^{(n)}$ denotes the number of $t + n$ dollars that the government has at time t promised to deliver. To construct the panel $\{\{b_t^{(n)}\}_{n=1}^{\infty}\}_{t \geq 1}$ from historical data, we add up all of the dollar principal-plus-coupon payments, $\mathsf{c}_{t,i}^{(n)}$, that the government has at time t promised to deliver at date $t + n$. 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 $b_t^{(n)}/b_t$.

A.1 Government Budget Constraint and Bond Returns

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.[17] 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. Alternatively, we can also write the budget constraint in terms of holding period returns:

$$\begin{aligned}\mathcal{B}_t = \sum_{n=1}^{\infty} q_t^{(n)} b_t^{(n)} &= \sum_{n=1}^{\infty} q_t^{(n-1)} b_{t-1}^{(n)} + def_t \\ &= \sum_{n=1}^{\infty} \left(\frac{q_t^{(n-1)}}{q_{t-1}^{(n)}} \right) q_{t-1}^{(n)} b_{t-1}^{(n)} + def_t \\ &= \sum_{n=1}^{\infty} R_t^{(n)} q_{t-1}^{(n)} b_{t-1}^{(n)} + def_t = \underbrace{\frac{\sum_{n=1}^{\infty} R_t^{(n)} q_{t-1}^{(n)} b_{t-1}^{(n)}}{\sum_{n=1}^{\infty} q_{t-1}^{(n)} b_{t-1}^{(n)}}}_{=\mathcal{R}_t} \sum_{n=1}^{\infty} q_{t-1}^{(n)} b_{t-1}^{(n)} + def_t \\ &= \mathcal{R}_t \mathcal{B}_{t-1} + def_t\end{aligned}$$

where $\mathcal{R}_t$ denotes the holding period return on the government debt portfolio which defined by the weighted average of the one-period holding period returns (of n-period

[17] 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 $t-1+n$.

zero coupon bonds): $r_{t+1}^{(n)} := \log R_{t+1}^{(n)} = \log q_{t+1}^{(n-1)} - \log q_t^{(n)}$. The log holding period returns $\{r_{t+1}^{(n)}\}_{n\geq 1}$ can be easily computed as

$$r_{t+1}^{(n)} = -(n-1)y_{t+1}^{(n-1)} + ny_t^{(n)}$$

from the time-series of zero-coupon yield curves $\{y_t^{(n)}\}_{n\geq 1}$. Yet another way to write the budget constraint is

$$\sum_{n=1}^{\infty}(q_t^{(n)} - \tilde{q}_t^{(n)})b_t^{(n)} + \sum_{n=1}^{\infty}\tilde{q}_t^{(n)}b_t^{(n)} = \sum_{n=1}^{\infty}(q_t^{(n-1)} - \tilde{q}_t^{(n-1)})b_{t-1}^{(n)} + \sum_{n=1}^{\infty}\tilde{q}_t^{(n-1)}b_{t-1}^{(n)} + def_t$$
$$\widetilde{\mathcal{B}}_t = \widetilde{\Delta}_t - \Delta_t + \widetilde{R}_t\widetilde{\mathcal{B}}_{t-1} + def_t$$

where $\widetilde{R}_t$ denotes the holding period return on the government debt portfolio under the high-grade corporate yield curve.

With these notations, the two versions of the budget constraint can be expressed as

$$\begin{aligned}\mathcal{B}_{t-1} &= \mathcal{R}_t^{-1}\Big(- def_t + \mathcal{B}_t\Big)\\ &= \sum_{s=0}\left(\prod_{h=0}^{s}\mathcal{R}_{t+h}^{-1}\right)(-def_{t+s})\end{aligned}$$

and

$$\begin{aligned}\widetilde{\mathcal{B}}_{t-1} &= \widetilde{\mathcal{R}}_t^{-1}\Big(- def_t + \Delta_t - \widetilde{\Delta}_t + \widetilde{\mathcal{B}}_t\Big)\\ &= \sum_{s=0}\left(\prod_{h=0}^{s}\widetilde{\mathcal{R}}_{t+h}^{-1}\right)\Big(- def_{t+s} + \widetilde{\Delta}_{t+s} - \Delta_{t+s}\Big)\\ \Leftrightarrow \quad \widetilde{\mathcal{R}}_t\widetilde{\mathcal{B}}_{t-1} &= -def_t + \Delta_t - \widetilde{\Delta}_t + \sum_{s=1}\left(\prod_{h=1}^{s}\widetilde{\mathcal{R}}_{t+h}^{-1}\right)\Big(- def_{t+s} + \Delta_{t+s} - \widetilde{\Delta}_{t+s}\Big)\end{aligned}$$

A.2 Models with representative long-term debt

The *admissible set of portfolios* is restricted to follow an exponential rule, i.e. $\forall t,\ \exists\,(b_t, \omega_t)$ s.t.

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

In other words, the assumption is that we can summarize/proxy the $\{b_t^{(n)}\}_{n=1}^{\infty}$ with a pair of scalars (b_t, ω_t). 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 not a choice variable and it's 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

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

B Additional Details on Historical Context

To help interpret the historical data, this Appendix provides further details on some key institutional details impacting the corporate and government bond markets that present challenges for measuring the funding advantage of the US government.

Denomination

The denomination of both Treasury and corporate bonds has evolved similarly through-

out American financial history. From 1800 to 1933, the US adhered to a gold standard except from 1861 to 1878 when it temporarily suspended gold convertibility and issued a paper currency known as "greenbacks". During this period, both federal and corporate bonds were typically denominated in gold (or greenbacks during the suspension). Following the Gold Reserve Act of 1933, which prohibited private US citizens from holding gold coins, both markets transitioned to nominal dollar denomination. The Bretton Woods Agreement (1944-1971) reintroduced a type of gold standard by establishing an international system of fixed exchange rates with the US dollar convertible to gold until its collapse in 1971 when the dollar was floated. Since then, both Treasury and corporate bonds have been issued exclusively in nominal terms until the introduction of Treasury Inflation-Protected Securities (TIPS) in 1997, which provide explicit inflation protection.

Credit ratings

The rise of corporate bonds was accompanied by the development of credit ratings. Beginning in 1832, the "American Railroad Journal" published detailed assessments of railroad companies, covering physical descriptions of the railroads, their assets, liabilities, and earnings. In 1868, its former editor Henry V. Poor published the first volume of "Poor's Manual of the Railroads of the United States", a comprehensive resource detailing financial statements, operational statistics, and the capital structure of their securities. In 1909, John Moody in his "Moody's Manual of Railroads and Corporation Securities" first introduced a structured rating system for these securities that established the foundation for modern credit ratings.

C The High-Grade Corporate Bond Dataset

We construct a new historical dataset of high-grade US corporate bonds, providing monthly data on trading prices and cash-flows as well as bond characteristics and credit ratings from 1860-2024. Monthly prices and cash-flows date back to 1860, along with detailed bond characteristics such as maturity, denomination and callability. Annual Moody's credit ratings date back to their earliest availability: 1909 for railroads and 1914 for public utilities and industrials. Our dataset integrates existing databases with hand-collected prices and bond characteristics from historical newspapers, business magazines, and financial releases by companies.

C.1 Bond Prices

To compile end-of-month trading prices from 1860-2024 we rely on five main data sources: *Global Financial Data (GFD)*, the *Commercial & Financial Chronicle (CFC)*, *Barron's Magazine*, the *Lehman Brothers Fixed Income Database*, and the *Merrill Lynch Bond Index Database*. From 1860-1884 we take bond price data from *Global Financial Data (GFD)*. The GFD dataset covers nearly 800 corporate bonds from 1791 to 1884, almost all of which are railroad bonds, reflecting their dominance in the bond market during that period. The price data is particularly rich between 1870-1884, featuring both daily time series of trading prices and bond characteristics such as the bonds name, coupon, and company information. The data does not include further bond characteristics such as maturity date or denomination. From 1884 to 1963, we collect end-of-month trading prices from the *Commercial & Financial Chronicle*. The *Commercial & Financial Chronicle* was a weekly business newspaper published from 1865 to 1987.[18] We use bond quotations from the New York Stock Exchange, focusing on actual sale prices, as reported in the "Stock Exchange Quotation / Bond Record" section. From 1884 to 1918, we collect only railroad bond prices. Beginning in January 1918, we expand the collection to include all corporate bonds, reflecting the growing importance of utility and industrial securities in the corporate bond market during the early 20th century. From 1964 to 1972, we collect bond closing prices from *Barron's Magazine*. *Barron's* is a weekly financial newspaper founded in 1921, providing coverage of closing prices for actively traded corporate bonds in their "Listed Bond Quotations" section. From 1973 to 1997 we rely on the *Lehman Brothers Fixed Income Database* distributed by Hong and Warga (2000) which provides comprehensive monthly bond-specific information from January 1973 to December 1997, including bond price, ratings and coupons. After 1997 we use the *Merill Lynch Bond Index Database* which provides a similar level of detail. We use daily closing prices from the New York Stock Exchange as reported in *The New York Times (NYT)* to fill in any gaps in our sample between 1884 and 1972.

[18] Scanned digital copies of the Chronicle are available from the Federal Reserve Archival System for Economic Research (FRASER) from July 1865 to December 1963.

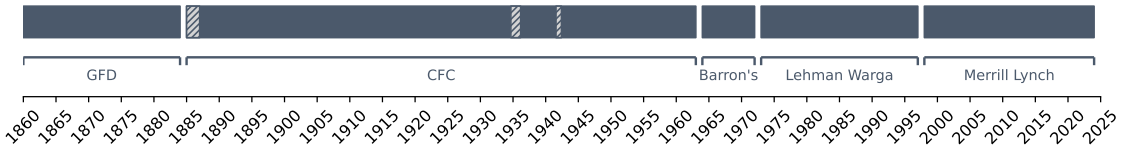


Figure 10: Corporate Bond Price Data Sources

Data sources for bond prices from 1860-2024. GFD, Lehman Warga, and Merrill Lynch are existing datasets, while bond price data from the CFC and Barron's was manually collected using scans from digital archives. Light gray areas indicate gaps in the current sample.

C.2 Bond Characteristics

A major challenge with computing yield curves is that we need accurate information about bond maturity and coupon payments. For the period after 1972, we are able to rely on detailed bond information from the *Lehman Brothers Fixed Income Database* and the *Merrill Lynch Bond Index Database*. For bonds maturing between 1900 to 1972, we extract the maturity, coupon and coupon schedule from various *Moody's Manuals* which were first published in 1900. Initially titled *Moody's Manual of Industrial and Miscellaneous Securities*, it was later replaced by *Moody's Manual of Railroads and Corporation Securities*, and subsequently by *Moody's Analyses of Investments*. These manuals provide comprehensive information on outstanding bonds, including the issue and maturity dates, coupon rates and schedules. For the pre-1900 period, we draw maturity and coupon information from a variety of sources. These include the *Investors' Supplement of the Commercial and Financial Chronicle*, the *American Railroad Journal*, *Poor's Manual of Railroads*, the *Catalogue of Railroad Mortgages*, various publications by Joseph G. Martins on the Boston stock market, and annual reports to stockholders of various railroad companies.

C.3 Credit Ratings

To classify high-grade bonds, we mainly rely on Moody's credit ratings which are readily available from the *Lehman Brothers Fixed Income Database* and the *Merrill Lynch Bond Index Database*. Prior to the availability of these datasets, we collect annual bond ratings from the *Moody's Manuals*. Moody's first issued credit ratings

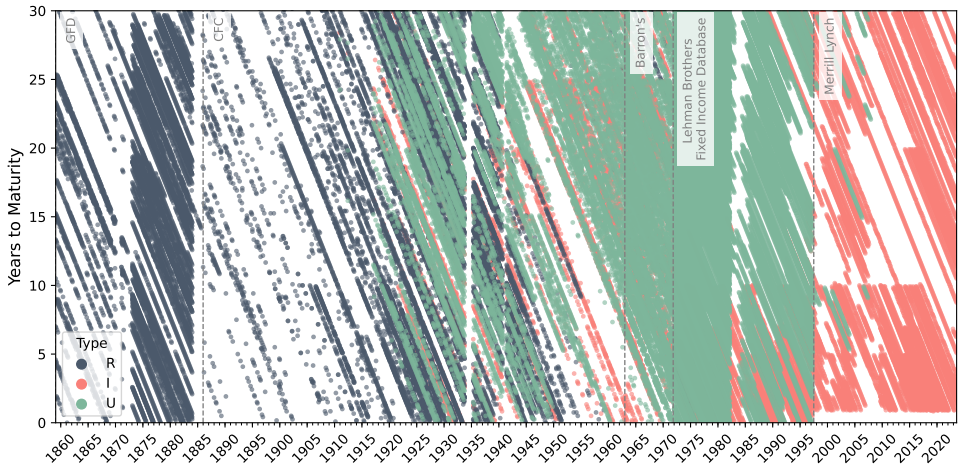


Figure 11: Maturities of observed high-grade corporate bonds

Years-to-maturity of high-grade corporate bonds, defined as those rated at least A by Moody's. R (gray) stands for "railroad companies", I (red) stands for "industrials", U (green) stands for "utilities".

in 1909 for railroads, expanding to public utilities and industrial companies in 1914.[19] Further details on how we identify high-grade bonds prior to 1909 are provided in Section 4.2.

[19]We focus on Moody's ratings since they are the earliest available, whereas Poor's ratings began in 1922 and Fitch's in 1924.

D Additional Details on the Estimation

Table 3: Prior Distributions of the Dynamic Nelson-Siegel Model

Parameter	Description	Priors	Hyper parameters
L_0	initial level factor	$\mathcal{N}(\mu, \sigma^2)$	$(\mu, \sigma) = (10, 5)$
S_0	initial slope factor	$\mathcal{N}(\mu, \sigma^2)$	$(\mu, \sigma) = (0, 10)$
C_0	initial curvature factor	$\mathcal{N}(\mu, \sigma^2)$	$(\mu, \sigma) = (0, 10)$
τ	location parameter	$\log\mathcal{N}(\mu, \sigma^2)$	$(\mu, \sigma) = (5, 5)$
σ_0	initial shock volatilities	$\log\mathcal{N}(\mu, \sigma^2)$	$(\mu, \sigma) = (0.05, 0.1)$
Ω	correlation of shocks	LKJ(η)	$\eta = 5$
Ξ_σ	volatilities of σ_t shocks	Exp(λ)	$\lambda = 20$
$\sigma_m^{(i)}$	volatilities of pricing error	Exp(λ)	$\lambda = 0.1$

[1] The LKJ distribution is defined by $p(\Omega|\eta) \propto \det(\Omega)^{\eta-1}$. See Lewandowski et al. (2009)

E Other Empirical Results

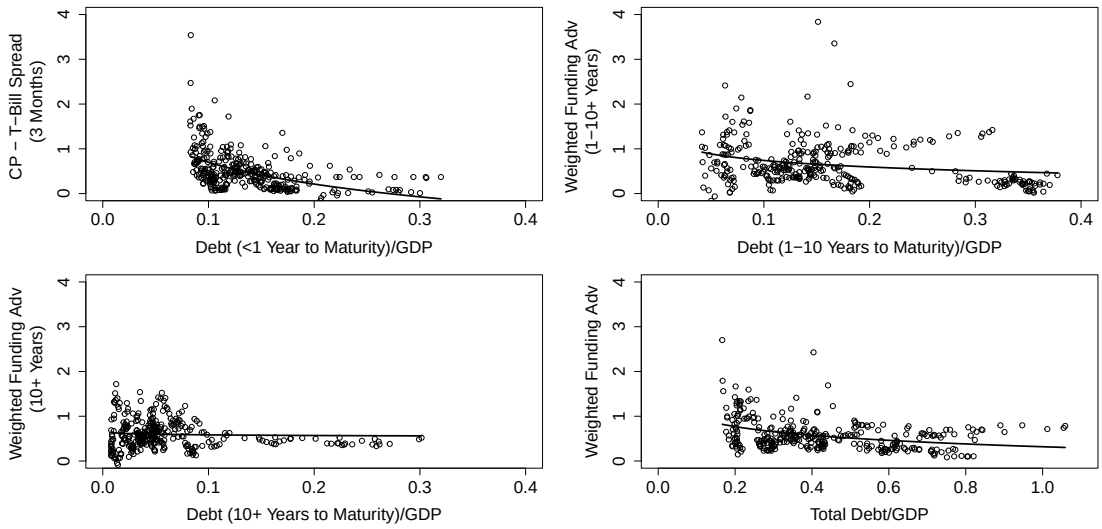


Figure 12: Post WWII: Downward sloping relationship between funding cost spread and debt-to-GDP ratio holds at short maturities