Reconstructing a Century of U.S. Corporate Bonds: Credit Risk in Historical Perspective*

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Abstract

Do corporate bond investors earn compensation for bearing credit risk? We construct a new historical corporate bond database spanning 128 years, from 1895 to 2022, which allows us to estimate a corporate bond counterpart to the equity risk premium. Combining hand-collected monthly corporate bond quotes from three archival print sources with modern datasets, we assemble a panel comprising over 100,000 unique bonds and more than 7 million observations. While evidence from recent samples suggests that corporate bond excess returns are driven largely by the term premium similar to that earned by U.S. Treasuries, our longer historical sample reveals a sizable and statistically significant credit risk premium. Aggregate credit spreads predict future corporate bond returns and macroeconomic aggregates, although their predictive power for business cycle fluctuations weakens when prewar data, including the Great Depression, are added.

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1 Introduction

Do investors earn a risk premium on corporate debt, above and beyond the term premium offered by government bonds of comparable maturity (Fisher, 1959)? A long history of yield spreads between U.S. corporate and government bonds shows that they are large relative to observed default frequencies and losses and vary substantially over the business cycle, implying a sizable and time-varying *ex ante* premium for bearing credit risk.[1] Yet recent empirical evidence indicates that corporate bond returns are roughly in line with those earned on U.S. Treasury securities of comparable maturity, suggesting a negligible *ex post* observed credit risk premium (van Binsbergen, Nozawa, and Schwert, 2025). In this paper, we employ newly constructed historical data to reconcile these seemingly conflicting facts.

When investors hold corporate bonds, they expect to be compensated for two types of risk that are absent from short-term risk-free assets. This idea can be formalized through the following excess return decomposition:

$$\mathbb{E}\left[r_{t+1} - r_{f,t}\right] \;=\; \mathbb{E}\left[r_{t+1} - r^{\text{Trsy}}_{t+1}\right] \;+\; \mathbb{E}\left[r^{\text{Trsy}}_{t+1} - r_{f,t}\right].$$

The first part of the payoff comes from the risk that U.S. government bonds are typically presumed not to carry: the possibility that the issuer may default on its obligations. This component is commonly referred to as the *credit risk premium*, measured as the average excess return on a defaultable bond over a Treasury security with comparable maturity/duration.[2] At the same time, corporate bonds with fixed coupons and long maturities expose investors to interest rate risk. The compensation for this second type of risk is the *term premium* – the same reward Treasury investors receive for holding long-maturity bonds compared to rolling over short-term Treasury bills.

Estimating the credit risk premium separately from the term premium requires reliable

[1] Related studies include, but are not limited to, Amato and Remolona (2003); Philippon (2009); Giesecke, Longstaff, Schaefer, and Strebulaev (2011); Gilchrist and Zakrajšek (2012); Culp, Nozawa, and Veronesi (2018).

[2] Following the literature, we define this term more broadly to cover all excess compensation investors demand from corporate bonds beyond comparable Treasuries. Under this definition, the credit risk premium includes not only the default risk premium but also a potential liquidity premium.

long-run bond return data. The classic benchmark in the field is Ibbotson's *Stocks, Bonds, Bills, and Inflation* (SBBI) series, which report aggregate returns on long-term corporate and government bonds beginning in 1926. Consistent with evidence from more recent samples, the difference between the two series implies only a small credit risk premium (e.g., Ibbotson and Sinquefield, 1976). Subsequent studies, however, highlight several biases in the SBBI data, including an overrepresentation of high-grade bonds and maturity mismatches between corporate and government bonds. Moreover, returns are approximated from yield indices, rather than constructed from bond-level prices, using ad hoc assumptions about coupons and maturities. Attempts to mitigate these issues have produced mixed empirical results. While some studies find that corrections increase the estimated premium, others do not.[3] Thus, the seemingly simple question – whether the credit risk premium is positive and economically significant – remains unresolved, underscoring the need for more granular and comprehensive long-run data on corporate bonds.

We address this challenge by constructing a new historical corporate bond database spanning 128 years, from 1895 to 2022. The database integrates hand-collected monthly bond quotes from three key archival print sources – *Commercial and Financial Chronicle*, *Standard & Poor's Bond Guide*, and *Mergent/Moody's Bond Record* – with existing datasets from Lehman Brothers and Wharton Research Data Services (WRDS). By combining these sources, we create monthly cross-sections of corporate bond records, offering unparalleled coverage and granularity unattainable from any single source.

The database construction process involves meticulous data collection and validation, including digitizing over 80,000 pages of archival material and implementing rigorous double-blind data entry protocols to ensure accuracy. Since standard identifiers such as CUSIPs were absent in the early period and not reported in archival records until much later, we construct price and return time series across sources by manually tracking bonds by their names and cross-checking their characteristics. Many of these bond characteristics are collected from

[3]For discussions on the issues of Ibbotson's SBBI data and how they affect the size of the credit risk premium estimate, see Hallerbach and Houweling (2011), Asvanunt and Richardson (2017), Kizer, Grover, and Hendershot (2019), and McQuarrie (2020). A comprehensive review of this literature is provided by Marsh, Dimson, and Staunton (2024).

Moody's Manual, a comprehensive reference series first published in 1900, providing detailed information on companies and their securities. Drawing from over half a million manually scanned pages, Moody's Manual fills a critical gap in bond characteristics left by standard datasets such as Mergent FISD, which focus on more recent periods. The resulting database, encompassing over 100,000 unique bonds and more than 7 million observations, provides a robust foundation for corporate bond research.

With this database in hand, we first document a set of historical facts about the U.S. corporate bond market. In the late 19th century, the market was dominated by transportation bonds, reflecting the central role of railroad financing in early American capital markets. Public utilities and industrial firms rose in prominence through the mid-20th century, while financial issuers became dominant only in the post-1980 period. Beyond sectoral composition, bond characteristics also evolved substantially: bonds shifted from being predominantly secured and extremely long-dated (with an average maturity of around 30 years) to largely unsecured debentures with much shorter maturities (averaging about 10 years), and the distribution of credit ratings changed markedly over time in response to major market events and structural shifts in the economy. These patterns highlight that the modern corporate bond market represents only a small and relatively recent part of a much longer historical experience. Against this structural backdrop, our constructed yield and credit spread series capture major episodes of economic distress – including the post-World War I recessions, the Great Depression, the 1970s stagflation, and the 2008 global financial crisis – revealing substantial time variation in credit conditions over the past century.

We also construct the time series of the value-weighted return on the aggregate corporate bond market, which to our knowledge is the first built from the ground up using actual bond-level prices over such a long horizon. By doing so, we avoid the ad hoc assumptions about coupons and maturities that plague existing historical indices and obtain return patterns that differ strikingly from the widely used SBBI data. While our series exhibits severe drawdowns and extreme volatility during the Great Depression, Ibbotson's series shows little movement because it relies on synthetic returns derived only from the yields of AAA-rated bonds. Con-

versely, in the postwar period, the SBBI data artificially inflate return volatility by imposing a counterfactually long maturity. By aggregating bond-level data, our return series provides a much more accurate representation of how corporate bond market dynamics evolve over time.

Armed with this richer return history, we revisit the central question motivating our paper: how large is the credit risk premium? Examining rating-sorted portfolios over the recent sample beginning in 1986 – the period studied by van Binsbergen, Nozawa, and Schwert (2025) – we find results broadly consistent with theirs. The credit risk premium is small and statistically insignificant for investment-grade bonds, with the term premium accounting for the vast majority of excess corporate bond returns. Extending the sample back to 1947 (postwar sample) or even further back to 1926, however, paints a completely different picture. Over the long run, the estimated credit risk premium is substantially larger and highly significant across all rating categories, demonstrating a clear, monotonic relationship between credit risk and its compensation. We further show that corporate bonds that are more exposed to aggregate risk proxies, such as stock and corporate bond market returns as well as shocks to industrial production growth and inflation, earn substantially higher expected returns. Crucially, this cross-sectional variation is driven almost entirely by the credit risk premium.

Then, why do we obtain such a small estimate of the credit risk premium in the recent sample? This finding is particularly puzzling and difficult to reconcile with the persistently high credit spreads over the same period, a phenomenon often described as the "credit spread puzzle." Although the credit spread and the credit risk premium are conceptually distinct – the former being a promised-yield differential and the latter an expected-return differential that accounts for default losses – the two should track each other closely for investment-grade bonds, where expected default losses are very small. Yet a striking divergence emerges when the postwar period is split into two halves: while the average credit spread is remarkably stable across the two subperiods, the estimated credit risk premium exceeds the average credit spread in the first half (1947-1985) but falls well below it in the second half (1986-2022).

To reconcile this wedge, we derive a general relation decomposing the estimated credit risk premium into the average credit spread, the spread duration effect, and the net convexity

adjustment. This decomposition reveals that the recent period is highly unrepresentative: spread increases and their impact through the spread duration effect dominate in the second half of the postwar sample, pushing our estimate of the credit risk premium far below the average credit spread. Over the full historical sample, which encompasses multiple cycles of spread widening and tightening, this wedge narrows considerably, and the estimated credit risk premium aligns closely with the average credit spread.

Furthermore, we identify an important measurement bias in the literature stemming from the neglect of embedded call provisions when matching corporate bonds to Treasury benchmarks. A large fraction of corporate bonds include callability features that allow issuers to refinance their debt when interest rates decline. During the long secular decline in interest rates following the 1980s, these embedded calls frequently moved into the money, causing effective durations to fall substantially below standard Macaulay durations. When these bonds are incorrectly matched to long-duration Treasuries based on their Macaulay durations, the benchmark implicitly assumes excessive interest rate exposure, mechanically inflating the estimated term premium and in turn systematically understating the credit risk premium. This bias is important in the post-1986 subsample due to the persistent decline in interest rates and compounds the small-sample problem discussed above.

Taken together, the evidence indicates that the corporate bond market has historically offered a sizable reward for bearing credit risk. The apparent absence of such a premium in some modern samples largely reflects data limitations and measurement challenges rather than a fundamental feature of the corporate bond market. By extending the data back more than a century, our analysis provides a clearer perspective on the long-run performance of corporate credit.

Finally, we explore the time-series properties of our data by examining the relationship between credit risk and business cycle fluctuations. To do so, we extend the aggregate credit spread measure of Gilchrist and Zakrajšek (2012), the so-called GZ spread, back to 1926, substantially lengthening the original series. Our extended GZ spread robustly predicts future corporate bond market returns across multiple horizons, indicating substantial time variation

in expected returns in the corporate bond market. In addition, the GZ spread significantly predicts the probability of an NBER recession over the subsequent year, even after controlling for standard predictors such as the term spread and the real short rate. Beyond recessions, the GZ spread also forecasts declines in real activity measures such as industrial production growth and nonfarm payroll employment growth in the postwar sample, although this predictive power weakens when the sample is extended back to the prewar period. This attenuation largely reflects the statistical challenge of pooling distinct historical regimes – the prolonged episode of elevated credit spreads during the Great Depression and in the prewar era, followed by a sharp and persistent compression in the postwar period. Nonetheless, our extended series provides a valuable out-of-sample validation for the economic content of the GZ spread over a substantially longer time span, while revealing that its predictive power varies across regimes.

Overall, our database addresses a critical shortcoming in the literature by providing a much-needed long-term perspective on corporate bond prices and returns. The unprecedented richness of the data supports more rigorous empirical analysis of market dynamics, overcoming the limitations of existing short-sample datasets. More broadly, our work demonstrates that it is possible to construct a "CRSP" for corporate bonds by exploiting archival print sources, thereby establishing a new benchmark for future empirical research.

Related literature

Our paper contributes to the extensive body of historical studies on asset markets, with a particular focus on corporate bonds. Early contributions include Macaulay (1938), which reports yield data for high-quality railroad bonds from 1856 to 1937, and the NBER-sponsored studies of Hickman (1953, 1958, 1960), which provide extensive historical evidence on the size, quality, and default experience of the U.S. corporate bond market over 1900-1944.[4] While these early studies provide important historical perspectives on the corporate bond market, they focus primarily on yields, defaults, and other bond characteristics, providing little evidence on returns. The first widely used long-run return series for the U.S. corporate bond market, which

[4]In addition, Friedman and Schwartz (1963) study U.S. monetary history from 1867 to 1960, and Homer and Sylla (1991) trace the history of interest rates from ancient times to the late 20th century.

begins in 1926, is provided by Ibbotson and Sinquefield (1976).[5] This series, later incorporated into Ibbotson's SBBI data, serves as an important benchmark for corporate bond performance in empirical research (Goyal and Welch, 2008). More recently, Dimson, Marsh, and Staunton (2009) conduct a broad analysis of long-run investment returns on various assets, but the limitations of existing corporate bond datasets remain clear: Chambers, Dimson, Ilmanen, and Rintamäki (2024) emphasize the substantial challenges associated with the sparse availability of data on quotes, credit ratings, defaults, and recovery rates, and argue that these limitations make it difficult to measure the performance of the U.S. corporate bond market reliably, at least prior to 1973. Accordingly, existing return series for the corporate bond market are typically constructed from yield indices under ad hoc assumptions about coupons and maturities. Our corporate bond database addresses these limitations and provides a stronger foundation for analyzing the long-run performance of U.S. corporate bonds.[6]

Within this broader historical literature, three papers are particularly relevant to our work and warrant direct comparison. First, Giesecke, Longstaff, Schaefer, and Strebulaev (2011) construct a novel dataset on U.S. nonfinancial corporate bonds over 1866-2008 using archival sources including the *Commercial and Financial Chronicle*, among others, as we do.[7] Their focus, however, is on measuring long-run default rates rather than assembling bond-level information on prices and characteristics. Second, Jordà, Knoll, Kuvshinov, Schularick, and Taylor (2019) provide a comprehensive examination of asset returns over nearly 150 years for stocks, housing, and government bonds. Yet, their analysis does not include corporate bonds. Third, Lehner, Payne, and Szoke (2025) compile long-run micro-level corporate bond data to study the Treasury funding advantage, but their analysis focuses on the AAA segment rather than the entire market. Our paper complements these important contributions by constructing a new historical database that allows us to study long-run trends and pricing patterns in the corporate bond market over more than a century.

[5]Influential work by Siegel (1992, 1994) presents long-run evidence on stock market performance.

[6]For a recent study of historical corporate bond returns on the Brussels Stock Exchange in Belgium, see Van Mencxel, Annaert, and Deloof (2024).

[7]In a related study using the same dataset, Giesecke, Longstaff, Schaefer, and Strebulaev (2014) show that over their 150-year sample period, corporate default crises had substantially smaller macroeconomic effects compared to banking crises.

Equipped with our corporate bond database, we shed new light on the long-running debate over the size of the corporate credit risk premium. A classic benchmark is the result of Ibbotson and Sinquefield (1976), which has often been interpreted as implying only a modest credit risk premium. Subsequent work, however, has questioned whether this conclusion reflects the underlying return dynamics or limitations of the data. Hallerbach and Houweling (2011) emphasize quality and maturity biases in Ibbotson's series, while Asvanunt and Richardson (2017) show that correcting the maturity mismatch raises the estimated premium materially. By contrast, Kizer, Grover, and Hendershot (2019) and McQuarrie (2020) argue that, once additional adjustments are made, the premium remains small in the available historical series. Using a recent sample, van Binsbergen, Nozawa, and Schwert (2025) likewise find that corporate bond excess returns are driven largely by the term premium, leaving only a limited role for the credit risk premium, especially for investment-grade bonds. Using the comprehensive bond-level database we construct, we revisit this debate and provide new evidence on the true size of the credit risk premium.

Lastly, our paper contributes to the literature on credit cycles, which examines how changes in credit market conditions influence real economic activity. Gilchrist and Zakrajšek (2012) investigate the role of the GZ spread in predicting future macroeconomic outcomes. They also calculate the excess bond premium, a measure that isolates credit market sentiment from expected default risk, using firm-level data on corporate bond prices. Similarly, Greenwood and Hanson (2013) show that during credit booms, the credit quality of corporate debt issuers deteriorates, signaling an overheating of credit markets that, in turn, predicts lower excess returns for corporate bondholders. Building on this work, López-Salido, Stein, and Zakrajšek (2017) demonstrate that elevated credit-market sentiment, measured through the spread between Baa-rated industrial bond yields and Treasury yields, predicts a decline in future economic activity. Related, Atkeson, Eisfeldt, and Weill (2017) construct a long historical measure of firms' financial soundness via distance to insolvency derived from structural credit risk models and show that its cross-sectional distribution serves as an aggregate state variable capturing business cycle fluctuations. Our paper adds to this literature by extending

the GZ spread to a much longer historical sample.

The rest of the paper proceeds as follows. Section 2 describes the construction of our corporate bond database. Section 3 presents new historical facts about the U.S. corporate bond market and traces the behavior of corporate bond yields, credit spreads, and returns. Section 4 studies the size of the credit risk premium. Section 5 extends the GZ spread and explores the relationship between credit markets and business cycles. Section 6 concludes.

2 A new historical corporate bond database

To construct a historical corporate bond database that spans over a century, we complement existing datasets by hand-collecting monthly corporate bond quotes from three separate sources: (i) the Commercial and Financial Chronicle, (ii) the Standard & Poor's Bond Guide, and (iii) Mergent/Moody's Bond Record. Figure 1 illustrates the data coverage periods for these three new sources as well as for two existing datasets from Lehman Brothers and Wharton Research Data Services (WRDS). By combining all five sources, we create monthly cross-sections of corporate bond records spanning 128 calendar years, from 1895 to 2022.

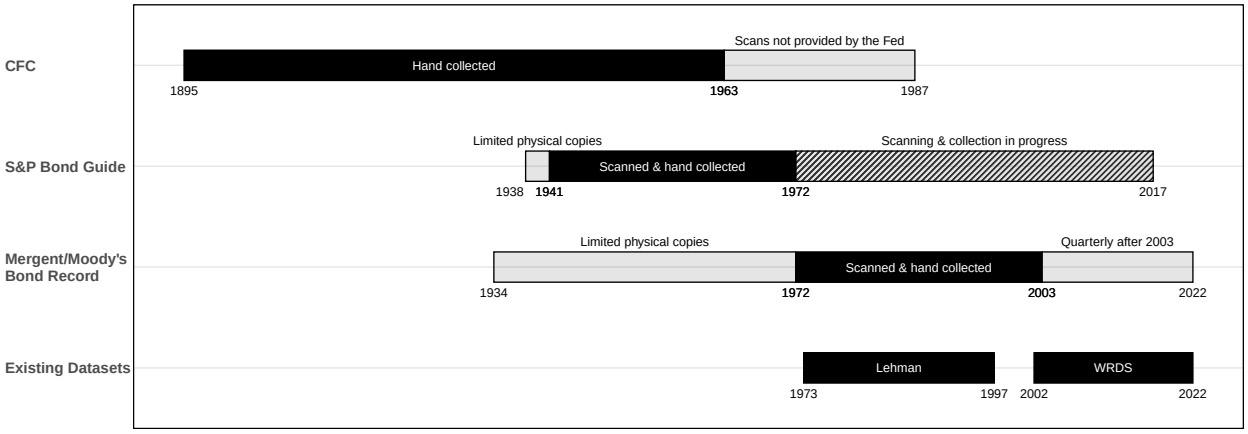


Figure 1: Coverage of the new corporate bond database. This figure illustrates the construction of our historical corporate bond database, showing data coverage periods for five sources: (i) Commercial and Financial Chronicle (CFC), (ii) Standard & Poor's (S&P) Bond Guide, and (iii) Mergent/Moody's Bond Record, (iv) Lehman Brothers, and (v) Wharton Research Data Services (WRDS). The first three sources are hand-collected and represent novel additions, while the latter two come from existing datasets. The bars represent the availability of each data source, with darker shading indicating periods for which we collect data. Annotations provide explanations for uncollected data periods. The resulting database comprises monthly cross-sections of corporate bond records spanning 128 calendar years, from April 1895 to June 2022.

In this section, we detail the construction of our database. We begin by describing the process of hand-collecting monthly corporate bond records from the three archival sources, highlighting their historical context, coverage, and content (Section 2.1). We then explain how we enhance the data by adding comprehensive bond characteristics, manually collected from Moody's Manual (Section 2.2). Lastly, we outline how we clean the raw data and aggregate information across sources to construct price time series (Section 2.3).

2.1 Print sources for historical corporate bond prices

The first print source, the Commercial and Financial Chronicle (in short, CFC), was a weekly business newspaper published from 1865 to 1987. Although published weekly, the CFC offers monthly bond records from May 1865 through supplementary publications.[8] Scanned copies of the CFC are available from the Federal Reserve Archival System for Economic Research (FRASER), covering the period from May 1895 to December 1963, for which we collect data.[9] Within these publications, bond quotes are provided under "General Quotations." Initially, bond records were categorized into "Railroad" and "Miscellaneous Securities," reflecting that railroad bonds were a dominant part of the early stage U.S. corporate bond market. As the market evolved and expanded toward other industries, this categorization scheme was updated in August 1916 to include "Railroad," "Public Utilities," and "Industrial and Miscellaneous Securities." As an example, Panel A of Figure 2 presents a partial segment from the March 1928 issue. The excerpt displays bid and ask prices, along with detailed information for each bond, including the company/bond name and coupon dates. Sale prices, when available, are marked with the prefix "*s*."

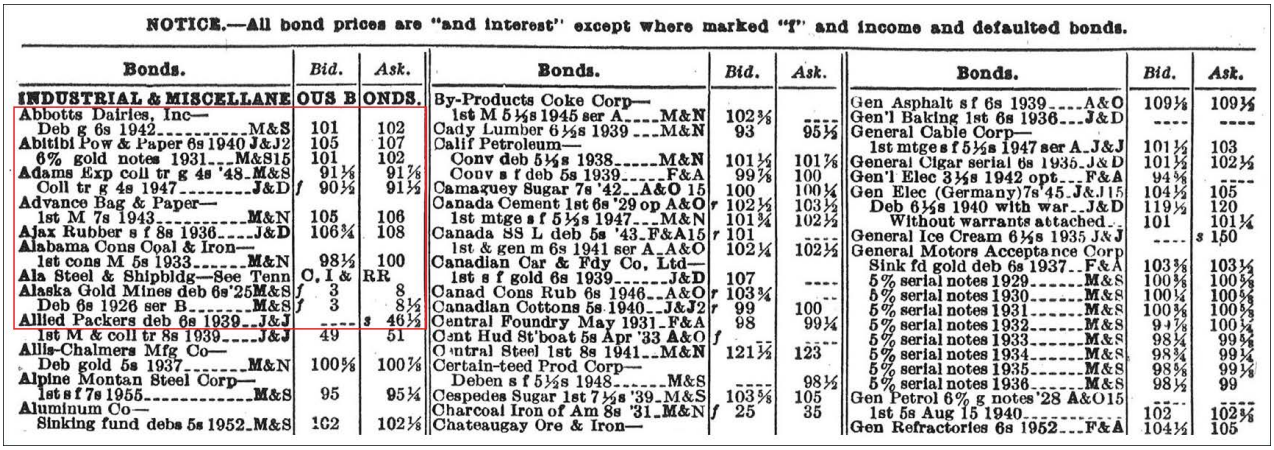
The Standard & Poor's Bond Guide (hereafter, S&P Bond Guide) is another print source, published from 1938 to 2017.[10] We first collect the physical copies and manually scan them

[8]These records appear in the "Quotation Supplement" from May 1895 to February 1902, the "Bank and Quotation Supplement/Section" from March 1902 to February 1928, and the "Bank and Quotation Record" from March 1928 to March 1987.

[9]Even within this period, some records are missing in FRASER, such as the January and February 1928 issues. In these cases, we obtain physical copies and manually scan them. Physical copies are also available for the post-1963 period, but we assign a relatively lower priority to collecting data from them as bond coverage in the CFC begins to decline in the 1950s and becomes limited by the time FRASER stops providing scans.

[10]Prior to May 1941, when Standard Statistics merged with Poor's Publishing Company, this publication

Panel A: Commercial and Financial Chronicle (March 1928)



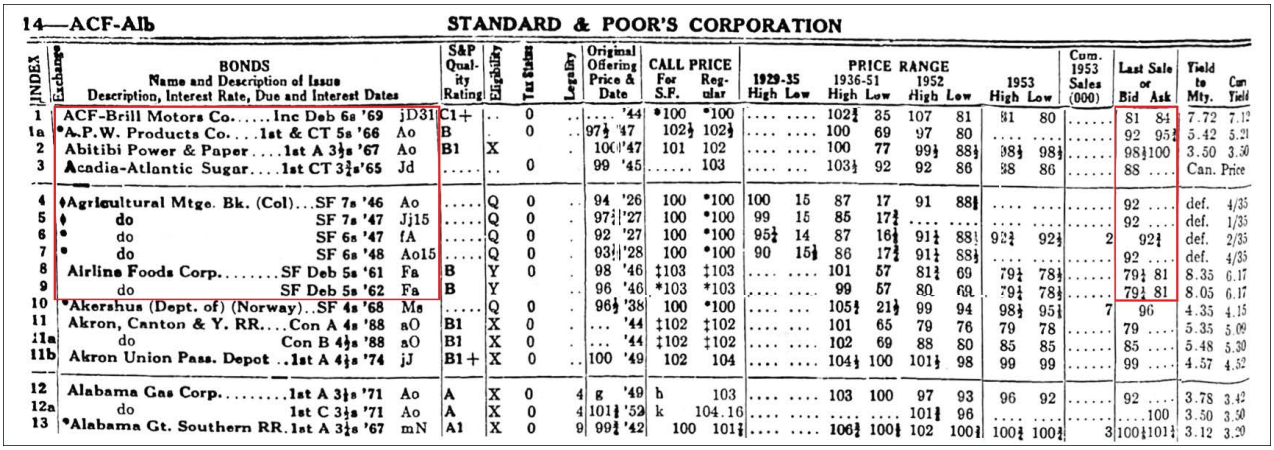
NOTICE.—All bond prices are "and interest" except where marked "f" and income and defaulted bonds.

Bonds.	Bid.	Ask.
INDUSTRIAL & MISCELLANEOUS BONDS.		
Abbotts Dairies, Inc—		
Deb g 6s 1942 M&S	101	102
Abitibi Pow & Paper 6s 1940 J&J	105	107
6% gold notes 1931 M&S	101	102
Adams Exp coll tr g 4s '48 M&S	91⅛	91⅞
Coll tr g 4s 1947 J&D f	90½	91½
Advance Bag & Paper—		
1st M 7s 1943 M&N	105	106
Ajax Rubber s f 8s 1936 J&D	106¾	108
Alabama Cons Coal & Iron—		
1st cons M 5s 1933 M&N	98½	100
Ala Steel & Shipbldg—See Tenn C, I &	RR	
Alaska Gold Mines deb 6s '25 M&S f	3	8
Deb 6s 1926 ser B M&S f	3	8½
Allied Packers deb 6s 1939 J&J	---- s	46½
1st M & coll tr 8s 1939 J&J	49	51
Allis-Chalmers Mfg Co—		
Deb gold 5s 1937 M&N	100⅝	100⅞
Alpine Montan Steel Corp—		
1st s f 7s 1955 M&S	95	95¼
Aluminum Co—		
Sinking fund debs 5s 1952 M&S	102	102⅛

Bonds.	Bid.	Ask.
By-Products Coke Corp—		
1st M 5½s 1945 ser A M&N	102⅜	----
Cady Lumber 6½s 1939 M&N	93	95½
Calif Petroleum—		
Conv deb 5½s 1938 M&N	101½	101⅞
Conv s f deb 5s 1939 F&A	99⅞	100
Camaguey Sugar 7s '42 A&O	100	100¼
Canada Cement 1st 6s '29 op A&O r	102½	103½
1st mtge s f 5½s 1947 M&N	101¾	102½
Canada SS L deb 5s '43 F&A r	101	----
1st & gen m 6s 1941 ser A A&O	102¼	102½
Canadian Car & Fdy Co, Ltd—		
1st s f gold 6s 1939 J&D	107	----
Canad Cons Rub 6s 1946 A&O r	103¾	----
Canadian Cottons 5s 1940 J&J r	99	100
Central Foundry May 1931 F&A	98	99¼
Cent Hud St'boat 5s Apr '33 A&O f	----	----
Central Steel 1st 8s 1941 M&N	121½	123
Certain-teed Prod Corp—		
Deben s f 5½s 1948 M&S	----	98½
Cespedes Sugar 1st 7½s '39 M&S	103⅜	105
Charcoal Iron of Am 8s '31 M&N f	25	35
Chateaugay Ore & Iron—		

Bonds.	Bid.	Ask.
Gen Asphalt s f 6s 1939 A&O	109⅛	109½
Gen'l Baking 1st 6s 1936 J&D	----	----
General Cable Corp—		
1st mtge s f 5½s 1947 ser A J&J	101½	103
General Cigar serial 6s 1935 J&D	101½	102½
Gen'l Elec 3½s 1942 opt F&A	94⅝	----
Gen Elec (Germany) 7s '45 J&J	104½	105
Deb 6½s 1940 with war J&D	119½	120
Without warrants attached	101	101¼
General Ice Cream 6½s 1935 J&J	---- s	150
General Motors Acceptance Corp		
Sink fd gold deb 6s 1937 F&A	103⅜	103½
5% serial notes 1929 M&S	100⅜	100⅝
5% serial notes 1930 M&S	100½	100⅝
5% serial notes 1931 M&S	100⅜	100⅝
5% serial notes 1932 M&S	99⅞	100¼
5% serial notes 1933 M&S	98¼	99⅝
5% serial notes 1934 M&S	98¾	99¼
5% serial notes 1935 M&S	98⅝	99⅛
5% serial notes 1936 M&S	98½	99
Gen Petrol 6% g notes '28 A&O	----	----
1st 5s Aug 15 1940	102	102¾
Gen Refractories 6s 1952 F&A	104½	105

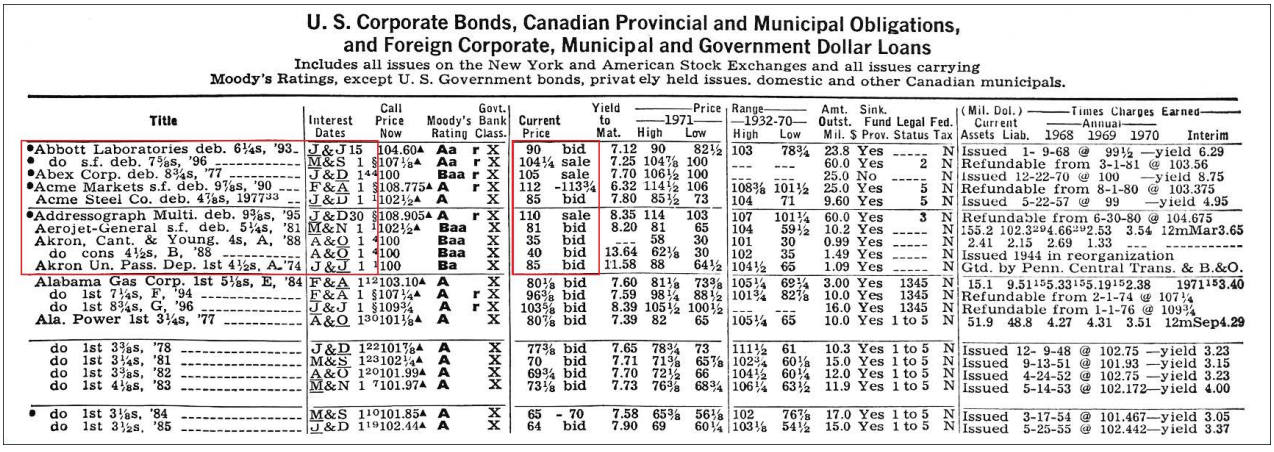
Panel B: Standard & Poor's Bond Guide (March 1953)



14—ACF-Alb — STANDARD & POOR'S CORPORATION

INDEX	Exchange	BONDS Name and Description of Issue Description, Interest Rate, Due and Interest Dates	S&P Quality Rating	Eligibility	Tax Status	Legality	Original Offering Price & Date	CALL PRICE For S.F.	CALL PRICE Regular	PRICE RANGE 1929-35 High	1929-35 Low	PRICE RANGE 1936-51 High	1936-51 Low	PRICE RANGE 1952 High	1952 Low	1953 High	1953 Low	Cum. 1953 Sales (000)	Last Sale or Bid	Last Sale or Ask	Yield to Mty.	Yield to Call
1		ACF-Brill Motors Co. Inc Deb 6s '69	jD31	C1+		..	0	..	.... '44	*100	*100	....		102¾	35	107	81	81	80	.....	81	84	7.72	7.12
1a		*A.P.W. Products Co. 1st & CT 5s '66	Ao	B		..	0	..	97½ '47	102½	102½	....		100	69	97	80	....	.....	92	95½	5.42	5.21
2		Abitibi Power & Paper 1st A 3½s '67	Ao	B1	X		0	.	100 '47	101	102	....		100	77	99½	88½	98½	98½	.....	98¼	100	3.50	3.50
3		Acadia-Atlantic Sugar. 1st CT 3¾s '65	Jd	.....		..	0		99 '45	.....	103	....		103½	92	92	86	88	86	.....	88	....	Can. Price	
4		♦Agricultural Mtge. Bk. (Col) SF 7s '46	Ao	.....	Q	0	.	..	94 '26	100	*100	100	15	87	17	91	88¼	....	.....	92	....	def.	4/35
5		♦ do SF 7s '47	Jj15	.....	Q	0	.		97½ '27	100	*100	99	15	85	17¼	....	.....	....	.....	92	....	def.	1/35
6		• do SF 6s '47	fA	.....	Q	0	.		92 '27	100	*100	95½	14	87	16½	91½	88½	92½	92½	2	92½	def.	2/35
7		• do SF 6s '48	Ao15	.....	Q	0	.		93½ '28	100	*100	90	15½	86	17¼	91½	88½	....	.....	92	....	def.	4/35
8		Airline Foods Corp. SF Deb 5s '61	Fa	B	Y	0	.		98 '46	‡103	‡103	....		101	57	81¼	69	79½	78½	.....	79½	81	8.35	6.17
9		do SF Deb 5s '62	Fa	B	Y		..		96 '46	*103	*103	....		99	57	80	69	79½	78½	.....	79½	81	8.05	6.17
10		*Akershus (Dept. of) (Norway) SF 4s '68	Ms	.....	Q	0	.		96½ '38	100	*100	....		105¼	21½	99	94	98½	95¼	7	96		4.35	4.15
11		Akron, Canton & Y. RR. Con A 4s '88	aO	B1	X	0	.		... '44	‡102	‡102	....		101	65	79	76	79	78	.....	79	....	5.35	5.09
11a		do Con B 4½s '88	aO	B1	X	0	.		... '44	‡102	‡102	....		102	69	88	80	85	85	.....	85	....	5.48	5.30
11b		Akron Union Pass. Depot 1st A 4½s '74	jJ	B1+	X	0	..		100 '49	102	104	....		104½	100	101½	98	99	99	.....	99	....	4.57	4.52
12		Alabama Gas Corp. 1st A 3½s '71	Ao	A	X	0	4		g '49	h	103	....		103	100	97	93	96	92	.....	92	....	3.78	3.42
12a		do 1st C 3½s '71	Ao	A	X	0	4		101½ '52	k	104.16	....		....		101½	96	....	.....	....	100		3.50	3.50
13		*Alabama Gt. Southern RR. 1st A 3½s '67	mN	A1	X	0	9		99½ '42	100	101½	....		106½	100½	102	100½	100½	100½	3	100½	101½	3.12	3.20

Panel C: Mergent/Moody's Bond Record (January 1972)



U. S. Corporate Bonds, Canadian Provincial and Municipal Obligations, and Foreign Corporate, Municipal and Government Dollar Loans

Includes all issues on the New York and American Stock Exchanges and all issues carrying Moody's Ratings, except U. S. Government bonds, privately held issues, domestic and other Canadian municipals.

Title	Interest Dates	Call Price Now	Moody's Rating	Govt. Bank Class.	Current Price	Yield to Mat.	Price 1971 High	Price 1971 Low	Range 1932-70 High	Range 1932-70 Low	Amt. Outst. Mil. $	Sink. Fund Prov.	Legal Fed. Status	Tax	(Mil. Dol.) Current Assets	(Mil. Dol.) Current Liab.	Times Charges Earned Annual 1968	1969	1970	Interim
•Abbott Laboratories deb. 6¼s, '93	J&J 15	104.60▲	Aa	r X	90 bid	7.12	90	82½	103	78¾	23.8	Yes	-----	N	Issued 1- 9-68 @ 99½ —yield 6.29					
• do s.f. deb. 7⅝s, '96	M&S 1	§107⅛▲	Aa	r X	104¼ sale	7.25	104⅞	100	---	---	60.0	Yes	2	N	Refundable from 3-1-81 @ 103.56					
•Abex Corp. deb. 8¾s, '77	J&D 14	100	Baa	r X	105 sale	7.70	106½	100	---	---	25.0	No	-----	N	Issued 12-22-70 @ 100 —yield 8.75					
•Acme Markets s.f. deb. 9⅞s, '90	F&A 1	§108.775▲	A	r X	112 -113¾	6.32	114½	106	108⅜	101½	25.0	Yes	5	N	Refundable from 8-1-80 @ 103.375					
Acme Steel Co. deb. 4⅞s, 1977[33]	J&D 1	102½▲	A	X	85 bid	7.80	85½	73	104	71	9.60	Yes	5	N	Issued 5-22-57 @ 99 —yield 4.95					
•Addressograph Multi. deb. 9¾s, '95	J&D30	§108.905▲	A	r X	110 sale	8.35	114	103	107	101¼	60.0	Yes	3	N	Refundable from 6-30-80 @ 104.675					
Aerojet-General s.f. deb. 5¼s, '81	M&N 1	§102½▲	Baa	X	81 bid	8.20	81	65	104	59½	10.2	Yes	-----	N	155.2	102.3	2.94	4.66	2.53	3.54 12mMar3.65
Akron, Cant. & Young. 4s, A, '88	A&O 1	§100	Baa	X	35 bid	---	58	30	101	30	0.99	Yes	-----	N	2.41	2.15	2.69	1.33	---	-----
do cons 4½s, B, '88	A&O 1	§100	Baa	X	40 bid	13.64	62⅛	30	102	35	1.49	Yes	-----	N	Issued 1944 in reorganization					
Akron Un. Pass. Dep. 1st 4½s, A. '74	J&J 1	§100	Ba	X	85 bid	11.58	88	64½	104½	65	1.09	Yes	-----	N	Gtd. by Penn. Central Trans. & B.&O.					
Alabama Gas Corp. 1st 5⅛s, E, '84	F&A 1	§12 103.10▲	A	X	80⅛ bid	7.60	81⅛	73⅜	105¼	69¼	3.00	Yes	1345	N	15.1	9.5	1.15	5.33	1.15	1.19 2.38 1971 1.53 3.40
do 1st 7¼s, F, '94	F&A 1	§107¼▲	A	r X	96⅜ bid	7.59	98¼	88½	101¾	82⅞	10.0	Yes	1345	N	Refundable from 2-1-74 @ 107¼					
do 1st 8¾s, G, '96	J&J 1	§109¾	A	r X	103⅝ bid	8.39	105½	100½	---	---	16.0	Yes	1345	N	Refundable from 1-1-76 @ 109¾					
Ala. Power 1st 3¼s, '77	A&O 1	30 101⅛▲	A	X	80⅞ bid	7.39	82	65	105¼	65	10.0	Yes	1 to 5	N	51.9	48.8	4.27	4.31	3.51	12mSep4.29
do 1st 3⅜s, '78	J&D 1	22 101⅞▲	A	X	77⅜ bid	7.65	78¾	73	111½	61	10.3	Yes	1 to 5	N	Issued 12- 9-48 @ 102.75 —yield 3.23					
do 1st 3¼s, '81	M&S 1	23 102⅛▲	A	X	70 bid	7.71	71⅜	65⅞	102¾	60⅛	15.0	Yes	1 to 5	N	Issued 9-13-51 @ 101.93 —yield 3.15					
do 1st 3⅜s, '82	A&O 1	20 101.99▲	A	X	69¾ bid	7.70	72½	66	104½	60¼	12.0	Yes	1 to 5	N	Issued 4-24-52 @ 102.75 —yield 3.23					
do 1st 4⅛s, '83	M&N 1	7 101.97▲	A	X	73⅛ bid	7.73	76⅜	68¾	106¼	63½	11.9	Yes	1 to 5	N	Issued 5-14-53 @ 102.172—yield 4.00					
• do 1st 3⅛s, '84	M&S 1	10 101.85▲	A	X	65 - 70	7.58	65⅜	56⅛	102	76⅞	17.0	Yes	1 to 5	N	Issued 3-17-54 @ 101.467—yield 3.05					
do 1st 3½s, '85	J&D 1	19 102.44▲	A	X	64 bid	7.90	69	60¼	103⅛	54½	15.0	Yes	1 to 5	N	Issued 5-25-55 @ 102.442—yield 3.37					

Figure 2: Archival print sources for monthly corporate bond prices. This figure displays excerpts from scanned original copies of three print sources: the Commercial and Financial Chronicle (Panel A), the Standard & Poor's Bond Guide (Panel B), and Mergent/Moody's Bond Record (Panel C).

to produce high-resolution images. Our data coverage is only partial, from January 1941 to December 1972, for two reasons. First, earlier issues are difficult to locate.[11] Second, although most post-1972 issues have been scanned, data entry is still ongoing.[12] Panel B of Figure 2 shows an excerpt from the March 1953 issue. Similar to the CFC, it provides the company/bond name, coupon dates, and monthly bond quotes. In the "Last Sale or Bid Ask" column, bid and ask prices are represented by two numbers, while a single number centered in the column indicates a sale price. In addition to pricing data, the S&P Bond Guide includes other bond characteristics, such as the S&P rating and yield to maturity. It also reports the amount outstanding on a separate page, but the scan is omitted here due to space constraints.

Our third source was a print publication first released in 1934 under the title of Moody's Bond Record. In 1998, however, Moody's Investors Service sold its publishing division to Financial Communications, which later became Mergent, leading to the rebranding of the publication as Mergent's Bond Record in July 1999. We collect and manually scan physical copies for the period between January 1972 and December 2003. We begin our data collection from 1972, although the publication dates back to 1934, due to difficulties in finding earlier physical records. We stop our data collection at 2003, despite its continued availability beyond 2003, because its publication frequency changed to quarterly thereafter. Panel C of Figure 2 features a portion of the January 1972 issue. Like the CFC and the S&P Bond Guide, it includes information such as the company/bond name, coupon dates, and monthly bond quotes. The "Current Price" column typically contains bids or sales; if a single price is listed, an accompanying note describes the type (bid/sale), but if there are two numbers, they represent bid and ask prices. While more condensed than the S&P Bond Guide, it contains comparable details, including Moody's rating, yield to maturity, and the amount outstanding.

We convert these scanned records – totaling over 80,000 pages across the three sources – into a machine-readable format. Each price is entered manually because the documents are old and lack a consistent layout, making standard OCR highly unreliable. To ensure

was known as Poor's Bond Guide.

[11] Related, we are unable to obtain the October 1945 and March 1948 issues.

[12] While this period is well covered by other data sources, we plan to continue our data collection for robustness checks.

accuracy, we implement a rigorous double-blind data entry process involving three independent freelancers. Freelancers A and B separately enter all values, and Freelancer C compares their entries, resolving any discrepancies by consulting the original scan. The accuracy rate of each freelancer typically exceeds 99%. Combined with the double-blind procedure, this should result in data that closely reflect the original documents. The Internet Appendix describes how the excerpts in Figure 2 are transformed into Excel-format data, along with further explanation of the symbols, abbreviations, and prefixes used in the original print sources.

Two clarifications are in order regarding how bond prices are reported in the archival sources. First, by default, all three sources report clean prices per \$100 of face value.[13] Accordingly, to compute the actual amount paid by the buyer (i.e., the dirty price), accrued interest must be added to the reported price, unless the bond is quoted "flat" or marked with "f." A bond trades flat when no accrued interest is due, typically because the issuer is in default and no longer makes interest payments, or because it is structured as an income bond (more prevalent in the past and notably issued by railroad companies under financial hardship), for which interest is payable only if the issuer has sufficient earnings.[14]

Second, bonds have quoted prices even after default, as they continue to trade based on the residual value of the claim. The CFC reports prices for many defaulted bonds, which tend to trade at very low values. In the S&P Bond Guide, default status is explicitly flagged: as shown in Panel B of Figure 2, the label "def" in the yield column indicates the bond has been in default since the date listed next to it. Similarly, in Mergent/Moody's Bond Record, default information appears in the "Interest Dates" column, where interest and principal defaults are denoted with symbols † and ‡, respectively, along with the associated default date. This feature helps mitigate concerns about survivorship bias, because unlike stocks, returns around default events for bonds remain observable and are not lost from the data.

[13]The CFC adopted this convention beginning with the February 1909 issue, following the New York Stock Exchange's transition to quoting all bonds in terms of clean prices starting January 2, 1909. Before this change, the CFC primarily reported dirty prices and used a specific mark to indicate when clean prices were reported.

[14]The CFC often puts "f" for non-defaulted, non-income bonds. This implies that the reported price is a dirty price, inclusive of accrued interest.

2.2 Bond characteristics from Moody's Manual

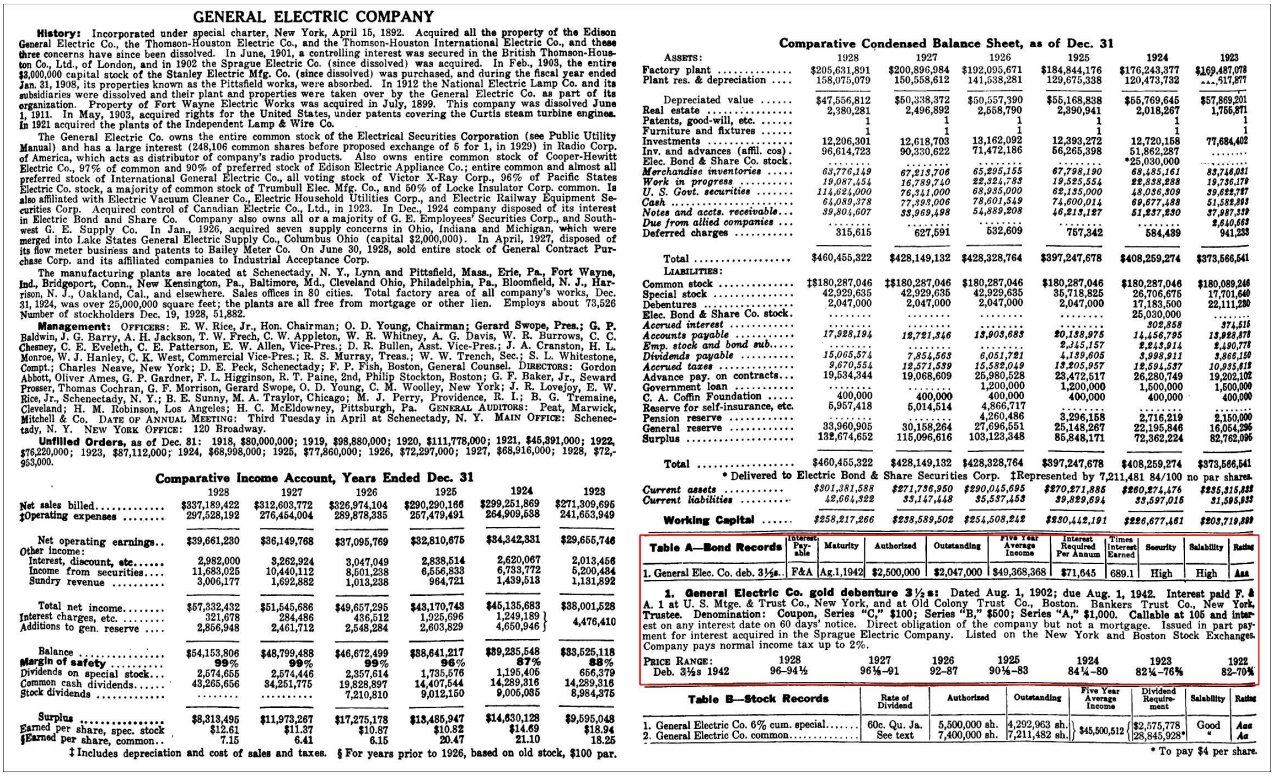
In the process of compiling monthly corporate bond quotes, we also collect information about the bonds themselves. While some attributes are explicitly given as separate fields (e.g., interest payment dates), most are parsed from the bond name (e.g., coupon rate, maturity date). Relying solely on bond names is, however, risky and often unreliable; the print publications can easily have typos and occasionally omit elements due to space constraints. Moreover, some bond attributes are simply absent depending on the source. For instance, the CFC does not report amounts outstanding or credit ratings. It is therefore important to verify the information collected from monthly records and to supplement it with additional characteristics when necessary.

To this end, we exploit Moody's Manual, an annual reference series that contains detailed information on companies and their securities. First published in 1900, the manual includes not only company history and business description but also financial statements and details of the securities issued.[15] This allows us to verify bond attributes and supplement missing details. Note that for similar purposes, Mergent FISD (Fixed Income Securities Database) is widely used in the literature. While it provides good coverage for bonds that were actively traded in the mid-1990s onward, its coverage of older bonds is virtually nonexistent. Since our goal is to extend the data over a much longer horizon, Mergent FISD alone is insufficient.[16] We bridge this gap by referencing Moody's Manual.

We collect physical copies of Moody's Manual and scan them to create digital copies. Each annual volume covers a large number of firms, totaling several thousand pages. To illustrate our mapping process, consider the bond record "Gen'l Elec 3 1/2s 1942 opt" observed in Panel A of Figure 2. The process begins by identifying the bond issuer from the bond name –

[15] Only a few prior studies have utilized firm-level accounting and financial statement data from Moody's Manual. Wahal (2019) hand-collects data on revenues, cost of goods sold, SG&A expenses, depreciation, interest expense, and total assets for 1940-1963 to examine profitability and investment premiums. Kuehn, Schreindorfer, and Schulz (2023) extract firm-level leverage ratios from Moody's Manual for 1927-1935 and calibrate their structural credit risk model to the Great Depression episode.

[16] Mergent FISD has virtually no overlap with our corporate bond records from the CFC (1895-1963) and limited overlap with our collected portion of the S&P Bond Guide (1941-1972). Many bonds from Mergent/Moody's Bond Record (1972-2003) also remain unmatched.



GENERAL ELECTRIC COMPANY

History: Incorporated under special charter, New York, April 15, 1892. Acquired all the property of the Edison General Electric Co., the Thomson-Houston Electric Co., and the Thomson-Houston International Electric Co., and these three concerns have since been dissolved. In June, 1901, a controlling interest was secured in the British Thomson-Houston Co., Ltd., of London, and in 1902 the Sprague Electric Co. (since dissolved) was acquired. In Feb., 1903, the entire $3,000,000 capital stock of the Stanley Electric Mfg. Co. (since dissolved) was purchased, and during the fiscal year ended Jan. 31, 1908, its properties known as the Pittsfield works, were absorbed. In 1912 the National Electric Lamp Co. and its subsidiaries were dissolved and their plant and properties were taken over by the General Electric Co. as part of its organization. Property of Fort Wayne Electric Works was acquired in July, 1899. This company was dissolved June 1, 1911. In May, 1903, acquired rights for the United States, under patents covering the Curtis steam turbine engines. In 1921 acquired the plants of the Independent Lamp & Wire Co.

The General Electric Co. owns the entire common stock of the Electrical Securities Corporation (see Public Utility Manual) and has a large interest (248,106 common shares before proposed exchange of 5 for 1, in 1929) in Radio Corp. of America, which acts as distributor of company's radio products. Also owns entire common stock of Cooper-Hewitt Electric Co., 97% of common and 90% of preferred stock of Edison Electric Appliance Co.; entire common and almost all preferred stock of International General Electric Co., all voting stock of Victor X-Ray Corp., 96% of Pacific States Electric Co. stock, a majority of common stock of Trumbull Elec. Mfg. Co., and 50% of Locke Insulator Corp. common. Is also affiliated with Electric Vacuum Cleaner Co., Electric Household Utilities Corp., and Electric Railway Equipment Securities Corp. Acquired control of Canadian Electric Co., Ltd., in 1923. In Dec., 1924 company disposed of its interest in Electric Bond and Share Co. Company also owns all or a majority of G. E. Employees' Securities Corp., and Southwest G. E. Supply Co. In Jan., 1926, acquired seven supply concerns in Ohio, Indiana and Michigan, which were merged into Lake States General Electric Supply Co., Columbus Ohio (capital $2,000,000). In April, 1927, disposed of its flow meter business and patents to Bailey Meter Co. On June 30, 1928, sold entire stock of General Contract Purchase Corp. and its affiliated companies to Industrial Acceptance Corp.

The manufacturing plants are located at Schenectady, N. Y., Lynn and Pittsfield, Mass., Erie, Pa., Fort Wayne, Ind., Bridgeport, Conn., New Kensington, Pa., Baltimore, Md., Cleveland Ohio, Philadelphia, Pa., Bloomfield, N. J., Harrison, N. J., Oakland, Cal., and elsewhere. Sales offices in 80 cities. Total factory area of all company's works, Dec. 31, 1924, was over 25,000,000 square feet; the plants are all free from mortgage or other lien. Employs about 73,526 Number of stockholders Dec. 19, 1928, 51,882.

Management: OFFICERS: E. W. Rice, Jr., Hon. Chairman; O. D. Young, Chairman; Gerard Swope, Pres.; G. P. Baldwin, J. G. Barry, A. H. Jackson, T. W. Frech, C. W. Appleton, W. R. Whitney, A. G. Davis, W. R. Burrows, C. C. Chesney, C. E. Eveleth, C. E. Patterson, E. W. Allen, Vice-Pres.; D. R. Bullen, Asst. Vice-Pres.; J. A. Cranston, H. L. Monroe, W. J. Hanley, C. K. West, Commercial Vice-Pres.; R. S. Murray, Treas.; W. W. Trench, Sec.; S. L. Whitestone, Compt.; Charles Neave, New York; D. E. Peck, Schenectady; F. P. Fish, Boston, General Counsel. DIRECTORS: Gordon Abbott, Oliver Ames, G. P. Gardner, F. L. Higginson, R. T. Paine, 2nd, Philip Stockton, Boston; G. F. Baker, Jr., Seward Prosser, Thomas Cochran, G. F. Morrison, Gerard Swope, O. D. Young, C. M. Woolley, New York; J. R. Lovejoy, E. W. Rice, Jr., Schenectady, N. Y.; B. E. Sunny, M. A. Traylor, Chicago; M. J. Perry, Providence, R. I.; B. G. Tremaine, Cleveland; H. M. Robinson, Los Angeles; H. C. McEldowney, Pittsburgh, Pa. GENERAL AUDITORS: Peat, Marwick, Mitchell & Co. DATE OF ANNUAL MEETING: Third Tuesday in April at Schenectady, N. Y. MAIN OFFICE: Schenectady, N. Y. NEW YORK OFFICE: 120 Broadway.

Unfilled Orders, as of Dec. 31: 1918, $80,000,000; 1919, $98,880,000; 1920, $111,778,000; 1921, $45,391,000; 1922, $76,220,000; 1923, $87,112,000; 1924, $68,998,000; 1925, $77,860,000; 1926, $72,297,000; 1927, $68,916,000; 1928, $72,-953,000.

Comparative Income Account, Years Ended Dec. 31

	1928	1927	1926	1925	1924	1923
Net sales billed	$337,189,422	$312,603,772	$326,974,104	$290,290,166	$299,251,869	$271,309,695
‡Operating expenses	297,528,192	276,454,004	289,878,335	257,479,491	264,909,538	241,653,949
Net operating earnings	$39,661,230	$36,149,768	$37,095,769	$32,810,675	$34,342,331	$29,655,746
Other income:						
Interest, discount, etc.	2,982,000	3,262,924	3,047,049	2,838,514	2,620,067	2,013,456
Income from securities	11,683,025	10,440,112	8,501,238	6,556,833	6,733,772	5,200,484
Sundry revenue	3,006,177	1,692,882	1,013,238	964,721	1,439,513	1,131,892
Total net income	$57,332,432	$51,545,686	$49,657,295	$43,170,743	$45,135,683	$38,001,528
Interest charges, etc.	321,678	294,486	436,512	1,925,696	1,249,189	4,476,410
Additions to gen. reserve	2,856,948	2,461,712	2,548,284	2,603,829	4,650,946	
Balance	$54,153,806	$48,799,488	$46,672,499	$38,641,217	$39,235,548	$33,525,118
Margin of safety	99%	99%	99%	96%	87%	88%
Dividends on special stock	2,574,556	2,574,446	2,357,614	1,735,576	1,196,406	656,379
Common cash dividends	43,265,656	34,251,775	19,828,897	14,407,544	14,289,316	14,289,316
Stock dividends			7,210,810	9,012,150	9,006,085	8,984,375
Surplus	$8,313,495	$11,973,267	$17,275,178	$13,485,947	$14,630,128	$9,595,048
Earned per share, spec. stock	$12.61	$11.37	$10.87	$10.32	$14.69	$18.94
‡Earned per share, common	7.15	5.41	6.15	20.47	21.10	18.25

‡ Includes depreciation and cost of sales and taxes. § For years prior to 1926, based on old stock, $100 par.

Comparative Condensed Balance Sheet, as of Dec. 31

ASSETS:	1928	1927	1926	1925	1924	1923
Factory plant	$205,631,891	$200,896,984	$192,095,671	$184,844,176	$176,243,377	$169,487,073
Plant res. & depreciation	158,075,079	150,558,612	141,538,281	129,675,338	120,473,732	517,877
Depreciated value	$47,556,812	$50,338,372	$50,557,390	$55,168,838	$55,769,645	$57,869,201
Real estate	2,380,281	2,496,892	2,558,790	2,390,941	2,018,267	1,755,871
Patents, good-will, etc.	1	1	1	1	1	1
Furniture and fixtures	1	1	1	1	1	1
Investments	12,206,301	12,618,703	13,162,092	12,393,272	12,720,158	77,684,402
Inv. and advances (affil. cos)	96,614,723	90,330,622	71,472,186	56,265,398	51,862,287	
Elec. Bond & Share Co. stock					*25,030,000	
Merchandise inventories	*63,776,149*	*67,213,706*	*65,295,155*	*67,798,190*	*68,185,161*	*83,746,031*
Work in progress	*19,087,454*	*16,799,740*	*22,324,783*	*19,585,534*	*22,856,898*	*19,736,179*
U. S. Govt. securities	*114,624,000*	*76,311,000*	*68,935,000*	*62,135,000*	*48,056,309*	*39,622,787*
Cash	*64,089,378*	*77,393,006*	*78,601,549*	*74,600,014*	*69,677,488*	*51,528,993*
Notes and accts. receivable	*39,801,607*	*33,969,498*	*54,889,208*	*46,213,187*	*51,857,830*	*37,987,339*
Due from allied companies						*2,540,663*
Deferred charges	315,615	627,591	532,609	757,342	584,489	941,233
Total	$460,455,322	$428,149,132	$428,328,764	$397,247,678	$408,259,274	$373,566,541
LIABILITIES:						
Common stock	‡$180,287,046	‡$180,287,046	$180,287,046	$180,287,046	$180,287,046	$180,089,246
Special stock	42,929,635	42,929,635	42,929,635	35,718,825	26,706,675	17,701,540
Debentures	2,047,000	2,047,000	2,047,000	2,047,000	17,183,500	22,111,280
Elec. Bond & Share Co. stock					25,030,000	
Accrued interest					*302,858*	*374,515*
Accounts payable	*17,928,194*	*12,781,346*	*13,903,683*	*$0,139,975*	*14,456,795*	*13,928,878*
Emp. stock and bond sub.				*2,345,157*	*2,213,914*	*2,490,778*
Dividends payable	*15,065,574*	*7,854,563*	*6,051,721*	*4,139,605*	*3,998,911*	*3,866,150*
Accrued taxes	*9,670,554*	*12,571,539*	*15,538,049*	*13,205,857*	*12,591,587*	*10,935,618*
Advance pay. on contracts	19,534,344	19,068,509	25,980,528	23,472,517	26,280,749	19,202,102
Government loan			1,200,000	1,200,000	1,500,000	1,500,000
C. A. Coffin Foundation	400,000	400,000	400,000	400,000	400,000	400,000
Reserve for self-insurance, etc.	5,367,418	5,014,514	4,866,717			
Pension reserve			4,260,486	3,296,158	2,716,219	2,150,000
General reserve	33,960,905	30,158,264	27,696,551	25,148,267	22,195,846	16,054,296
Surplus	132,674,652	115,096,616	103,123,348	85,848,171	72,362,224	82,762,096
Total	$460,455,322	$428,149,132	$428,328,764	$397,247,678	$408,259,274	$373,566,541

* Delivered to Electric Bond & Share Securities Corp. ‡Represented by 7,211,481 84/100 no par shares.

Current assets	*$301,381,588*	*$271,736,950*	*$290,045,695*	*$270,271,885*	*$260,271,476*	*$225,515,888*
Current liabilities	*42,664,322*	*35,147,448*	*35,537,453*	*39,829,694*	*33,597,015*	*31,595,933*
Working Capital	*$258,217,266*	*$236,589,502*	*$254,508,242*	*$230,442,191*	*$226,677,461*	*$203,719,899*

Table A—Bond Records

	Interest Payable	Maturity	Authorized	Outstanding	Five Year Average Income	Interest Required Per Annum	Times Interest Earned	Security	Salability	Rating
1. General Elec. Co. deb. 3½s	F&A	Ag.1,1942	$2,500,000	$2,047,000	$49,368,368	$71,645	689.1	High	High	Aaa

1. General Electric Co. gold debenture 3½ s: Dated Aug. 1, 1902; due Aug. 1, 1942. Interest paid F. & A. 1 at U. S. Mtge. & Trust Co., New York, and at Old Colony Trust Co., Boston. Bankers Trust Co., New York, Trustee. Denomination: Coupon, Series "C," $100; Series "B," $500; Series "A," $1,000. Callable at 105 and interest on any interest date on 60 days' notice. Direct obligation of the company but not a mortgage. Issued in part payment for interest acquired in the Sprague Electric Company. Listed on the New York and Boston Stock Exchanges. Company pays normal income tax up to 2%.

PRICE RANGE:	1928	1927	1926	1925	1924	1923	1922
Deb. 3½s 1942	96–94½	96⅛–91	92–87	90½–83	84¼–80	82¼–76⅝	82–70⅝

Table B—Stock Records

	Rate of Dividend	Authorized	Outstanding	Five Year Average Income	Dividend Requirement	Salability	Rating
1. General Electric Co. 6% cum. special	60c. Qu. Ja.	5,500,000 sh.	4,292,963 sh.	$45,500,512	$2,575,778	Good	Aaa
2. General Electric Co. common	See text	7,400,000 sh.	7,211,482 sh.		28,845,928*	"	Aa

* To pay $4 per share.

Figure 3: Moody's Manual – General Electric. This figure displays a section of the 1929 Moody's Manual containing information about General Electric. The excerpt provides details on the company's history, business description, condensed financial statements, and issued securities. Specifically, bond details are listed in the "Bond Records" table and its caption. From this, we collect and verify key bond attributes, including the issue date, dated date, maturity date, coupon details (rate, type, payment dates), denomination currency, issuer domicile, collateral status, embedded options, amount outstanding, and Moody's credit rating.

in this case, General Electric (GE). For each year we observe this bond, we search for GE in that year's manual. Figure 3 shows the relevant section from the 1929 volume. Along with the company's income statement and balance sheet, the "Bond Records" table provides detailed information on its outstanding bonds. We identify the bond in question and validate the attributes already in our data. Additionally, we collect any missing information, such as issue date, dated date, maturity date, coupon details (rate, type, and payment dates), denomination currency, issuer domicile, collateral status, embedded options, amount outstanding, and Moody's credit rating. The last two items can vary over time, so we update them annually. Our data collection currently traces back to 1917. Moody's first published bond ratings in 1909, with coverage in earlier issues less comprehensive and primarily focusing on railroad bonds.

2.3 Data cleaning and time series aggregation

Our historical corporate bond database is constructed by consolidating monthly bond records from five different sources. As an initial step, we perform basic data integrity checks to identify potential publication errors. Specifically, we flag observations in which the bid price exceeds the ask price, monthly price changes are unusually large, prices differ substantially across sources, or bond characteristics are inconsistent with the Mergent FISD. Most of these issues stem from typographical errors (such as switched values, misplaced entries, or missing digits), which we either correct or remove. Our detailed procedure for error detection and data cleaning, along with concrete examples, is provided in the Internet Appendix. We also provide a detailed description of the issues in the Lehman data and explain how we identify, clean, and correct them.

Next, we generate and assign a unique ID to each bond because consistent bond identifiers are lacking within and across sources. Neither the CFC nor the S&P Bond Guide provides bond identifiers; although CUSIPs (Committee on Uniform Security Identification Procedures) were introduced in 1964, they were not reported in Mergent/Moody's Bond Record until 1991. Despite this, we manually track bonds over time and construct their time series based on their names.[17] It is important to note that for the three print sources, the publication month does not correspond to the data month: the published bond records reflect values at the end of the preceding month. For example, the March 1928 issue of the CFC contains bond quotes observed at the end of February 1928. Therefore, we shift the publication month backward by one month to align with the actual data month.

With the bonds linked into consistent time series, we then apply standard filters following Dickerson, Mueller, and Robotti (2023), retaining only corporate bonds issued by U.S.-domiciled entities and denominated in U.S. dollars. We also exclude exotic instruments such as structured notes, equity-linked notes, mortgage-backed securities, and asset-backed securi-

[17]This process is not always straightforward. For instance, bond names can change due to issuer name changes or M&As. Inconsistent formatting, such as variations in abbreviations, acronyms, or omitted terms, can further complicate tracking. To maintain accuracy, we review these cases individually. When a bond name disappears in one month, we examine bonds that newly appear in the same period to check if one of them is actually the same bond, just under a different name. This verification is based on comparing the characteristics of the original and candidate bonds, with the help of Moody's Manual.

ties.[18] Unlike Dickerson, Mueller, and Robotti (2023), we keep bonds with variable coupons, nonstandard coupon frequencies, or convertible features at this stage, as they are legitimate corporate bonds and should remain in the database.[19]

Table 1 provides descriptive statistics for the aggregate corporate bond database, which spans more than a century, from April 1895 to June 2022. The three new hand-collected sources significantly improve the breadth and depth of the database, bringing the total to over 100,000 unique bonds and more than 7 million observations. The CFC and S&P Bond Guide extend the historical coverage into the early 1900s and even the late 1800s. Although Mergent/Moody's Bond Record largely overlaps with the Lehman Brothers dataset in terms of sample period, it is especially valuable for filling the data gap between Lehman Brothers and WRDS from 1998 to 2002.

Source	Sample period	# Unique bonds	# Observations	# Bonds per month
CFC	04/1895 – 11/1963	16,653	1,935,252	2,349
S&P Bond Guide	12/1940 – 11/1972	10,799	971,289	2,529
Mergent/Moody's Bond Record	12/1971 – 11/2003	25,579	2,402,367	6,256
Lehman Brothers	01/1973 – 03/1998	18,603	1,659,923	5,478
WRDS	07/2002 – 06/2022	63,097	2,436,008	10,150
Aggregate database	04/1895 – 06/2022	101,395	7,335,499	4,804

Table 1: Descriptive characteristics by source. The table presents descriptive characteristics of our corporate bond database, which spans from April 1895 to June 2022 and combines data from five major sources: CFC, S&P Bond Guide, Mergent/Moody's Bond Record, Lehman Brothers, and WRDS. For each source, it shows the sample period, total number of unique bonds, total number of observations, and the average number of bonds per month. The final row represents the aggregated corporate bond database.

3 Long-run perspectives on the corporate bond market

Leveraging our newly constructed database, this section presents historical patterns in the U.S. corporate bond market and provides long-run perspectives. We document trends in bond characteristics (Section 3.1), yields (Section 3.2), credit spreads (Section 3.3), and returns (Section 3.4).

[18] Dickerson, Mueller, and Robotti (2023) additionally discard bonds that are privately placed or traded under Rule 144A, using the relevant field provided by Mergent FISD. We apply this filter where possible: all bonds in WRDS and some in Mergent/Moody's Bond Record and the Lehman Brothers dataset are matched with Mergent FISD. For other bonds, such classification is not available.

[19] We later drop them from our empirical analysis of yields and returns, consistent with standard practice.

3.1 Trends in bond characteristics

Figure 4 illustrates how key characteristics of the U.S. corporate bond market have changed over time, with bars corresponding to December observations shown at five-year intervals. Panel A shows the sectoral composition of outstanding corporate bonds starting in December 1895. In the early part of the sample, the market is overwhelmingly dominated by transportation firms, reflecting the central role of railroad bonds in 19th- and early 20th-century capital markets. Railroad projects required massive, long-term investments that were largely financed through bond issuance, making transportation bonds the backbone of the early corporate bond market. Beginning in the early 20th century, public utilities emerge as an increasingly important sector, consistent with the expansion of electricity, water, and telecommunications infrastructure. Industrial firms gradually gain prominence over the mid-20th century as manufacturing and diversified conglomerates expand their use of public debt markets. By contrast, the dominance of financial issuers is a relatively recent phenomenon, concentrated in the post-1980 period and driven by the growth of large, bond-issuing financial intermediaries and holding companies. These patterns imply that the industry composition of the corporate bond market has shifted substantially over time and that modern samples capture a very different issuer mix than earlier periods.

While the industry information in Panel A is inferred directly from issuer names in monthly bond records, the bond characteristics shown in the remaining panels rely on data from Moody's Manual, which we collect beginning in 1917. Consequently, Panels B, C, and D start in December 1920. Panel B presents changes in the number of non-financial corporate bonds by credit rating. In 1920, the majority of outstanding bonds carry high ratings, particularly AAA and AA. Low-rated bonds observed prior to World War II were predominantly "fallen angels," that is, bonds initially issued with high ratings and subsequently downgraded following firm-specific or macroeconomic distress. As a result, high-yield (speculative-grade, rated BB or below) bonds were rare outside of episodes such as the Great Depression, when widespread downgrades temporarily increased their share. A structural change occurs in the mid-1970s, when speculative-grade bonds begin to be issued directly rather than arising pri-

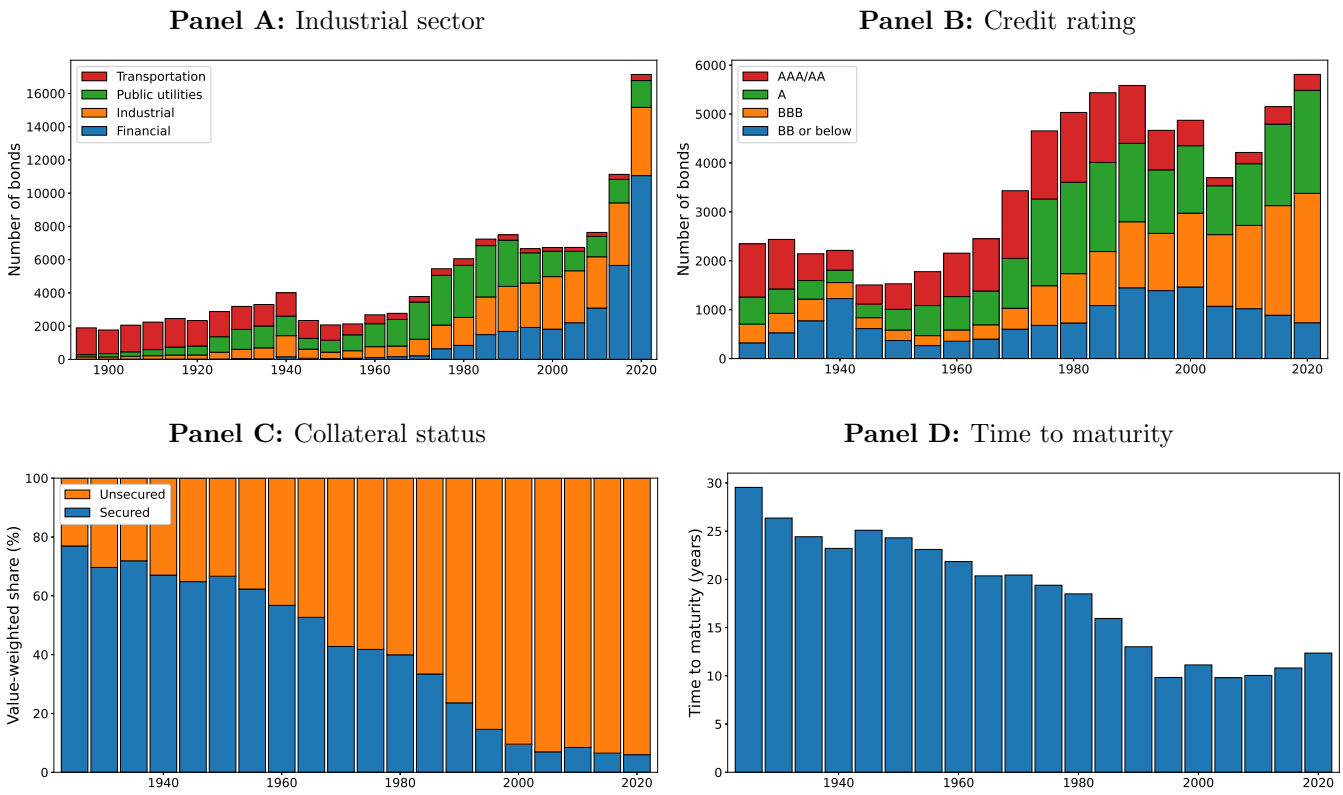


Figure 4: Historical trends in bond attributes. This figure illustrates changes in key characteristics of the U.S. corporate bond market over time using our newly constructed corporate bond database. Bars correspond to December observations shown at five-year intervals. Panel A shows the sectoral composition of outstanding corporate bonds beginning in December 1895. Panels B, C, and D focus on non-financial corporate bonds and are shown from December 1920 onward. Panel B presents the number of bonds by credit rating. Panel C contrasts the notional value-weighted shares of secured and unsecured bonds. Panel D reports the notional value-weighted average time to maturity.

marily through downgrades, following the development of the modern junk bond market and the role of underwriters such as Lehman Brothers (Taggart, 1988). Over the same period, the share of the highest-rated bonds declines after peaking in the 1980s, reflecting the sharp decline in the number of AAA-rated issuers, with only a couple remaining today compared with several dozen in earlier decades.

Panel C contrasts the value-weighted shares of secured and unsecured bonds issued by non-financial firms. In the early part of the sample, secured bonds account for most of outstanding issuance (near 80%). For example, railroad issuers, which were major borrowers at the time, typically issued bonds secured by physical rail assets including tracks, rolling stock, and related infrastructure. Similarly, public utility companies often relied on secured borrowing, with bonds backed by tangible assets such as power plants. Over time, the share of secured

bonds declines steadily, with debentures becoming the dominant form of corporate debt. This gradual but persistent shift toward bond issuance supported by general corporate credit is consistent with prior evidence documenting the declining role of collateral in corporate debt markets (Benmelech, Kumar, and Rajan, 2024).

Lastly, Panel D reports the value-weighted average time to maturity of non-financial corporate bonds. Early in the sample, corporate bonds were issued with very long maturities, often extending several decades. This stems from the prominent use of secured debt by railroad and utility firms, whose financing needs favored long-dated debt that was more closely aligned with the economic lives of their assets. Over time, the average maturity declines steadily, reaching roughly 10 years in the modern era. This trend has important implications for the interpretation of corporate bond returns, as time to maturity is directly related to duration and, hence, exposure to interest rate fluctuations.

3.2 Corporate bond yields

We now turn to pricing patterns observed in our historical sample. We begin with the yield to maturity, defined as the constant discount rate that equates the present value of a bond's promised cash flows to its market price. Before converting prices into yields, we apply several additional filters standard in the literature (see Dickerson, Mueller, and Robotti, 2023), excluding bonds with convertible features, variable coupons, or nonstandard coupon frequencies, as these complicate conventional yield calculation.[20] Bonds missing any of the key inputs for yield calculation, such as the coupon rate, coupon frequency, or maturity date, are removed from the sample, and a minimum time to maturity of one year is imposed to mitigate potential biases associated with short-term securities. We also exclude bonds issued by financial firms. The monthly time series of final bond counts by data source is provided in the Internet Appendix.

Figure 5 plots the monthly time series of median corporate bond yields from May 1895

[20] While our intention is to include both secured bonds and unsecured debentures (with no specific collateral attached), we exclude equipment trust certificates, a type of secured bond collateralized with specific movable physical assets such as railroad cars, ships, or airplanes. This is consistent with the standard filters of Dickerson, Mueller, and Robotti (2023), which drop these bonds using `ASSET_BACKED = N`.

to June 2022, with each data source shown in a different color. Despite patching together data from different sources, the figure shows a relatively smooth transition when moving from one dataset to another, suggesting strong consistency. The near-perfect overlap between Mergent/Moody's Bond Record and the Lehman Brothers dataset offers additional reassurance.

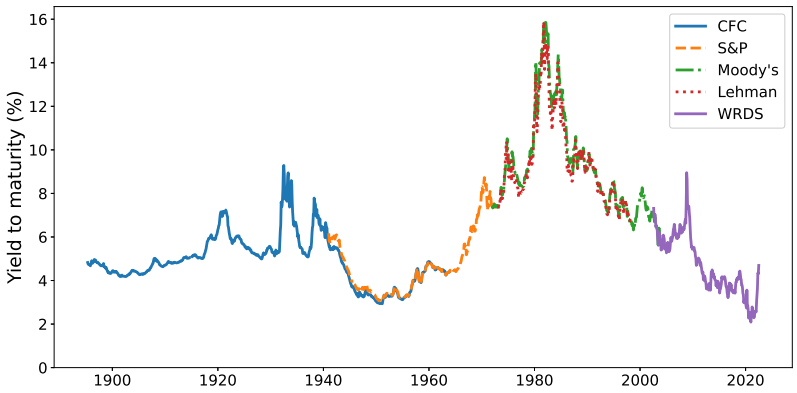


Figure 5: Time series of median bond yields. This figure presents the monthly time series of median corporate bond yields, with each data source represented by a distinct color: CFC (blue), S&P Bond Guide (orange), Mergent/Moody's Bond Record (green), Lehman Brothers (red), and WRDS (purple). All values are expressed in percentages. The sample period is from May 1895 to June 2022.

The figure reveals several important historical patterns in bond yields. A marked increase is observed before and at the beginning of the 1920s, reflecting higher borrowing costs during the post-World War I recessions of 1918-1919 and 1920-1921. This is followed by a sharp spike in yields during the economic downturns of the Great Depression in the 1930s. The most pronounced upward trend begins in the mid-1960s and peaks in 1980, driven by the persistent inflationary pressures of that period. This substantial rise in yields is followed by a gradual decline over the subsequent decades, corresponding to a period of diminishing inflation and sustained decreases in interest rates.

The figure also highlights notable spikes in bond yields associated with recent major economic downturns. An increase is visible around the 2000 dot-com bubble burst. More significantly, the 2008 global financial crisis triggered a substantial rise in yields. In 2020, yields spiked during the COVID-19 pandemic as the market reacted to uncertainty, though it quickly stabilized following monetary easing. Another sharp increase occurred in 2022, driven by the recent inflationary episode and the tightening of monetary policy by the Federal Reserve.

3.3 Credit spreads

Bond yields are influenced by several factors, including the short-term risk-free rate, the term spread, and corporate credit risk. To isolate the role of credit risk, we compute the credit spread for each bond in our database as the difference between its yield and the yield of a hypothetical Treasury bond with identical cash flows, following Gilchrist and Zakrajšek (2012).

To construct this Treasury yield benchmark, we estimate the monthly term structure of zero-coupon Treasury yields over our full sample period. For the post-1961 period, which is covered by the CRSP daily file, we rely on the yield curve estimates of Gürkaynak, Sack, and Wright (2007). Constructing yield curves for earlier periods is more challenging, as Treasury data become increasingly sparse. For the post-gold standard period (1934-1961), we apply the methodology of Gürkaynak, Sack, and Wright (2007) to the CRSP monthly file, since there are sufficient yield observations to support estimation. For the pre-1934 gold standard era, we use the posterior median term structures estimated by Payne, Szőke, Hall, and Sargent (2025). Full implementation details are provided in Appendix A. Finally, using the estimated zero-coupon yield curve, we calculate the price of the hypothetical Treasury bond and back out its implied yield to maturity.

The dotted black line in Figure 6 plots the monthly time series of median credit spreads from April 1895 to June 2022. The figure further reports median credit spreads across four rating categories: (i) AAA/AA (solid blue line), (ii) A (solid orange line), (iii) BBB (solid green line), and (iv) BB or below (solid red line). These rating-specific series begin later, in December 1917, reflecting the availability of credit rating information in our data collection.[21]

Several notable patterns emerge. Credit spreads rise sharply during the Great Depression, reflecting heightened default risk, financial instability, and elevated borrowing costs during this period of severe economic distress. After the 1930s, spreads gradually narrow over the subsequent decades before rising again during the 2008 global financial crisis, when severe market turmoil and tight credit conditions push spreads to levels not observed since the Great Depression. A similar, though shorter-lived, spike appears during the COVID-19 pandemic.

[21] In the early period covered only by the CFC, ratings are updated annually because they are collected from Moody's Manual. In later periods, other sources provide monthly ratings, as described in Section 2.2.

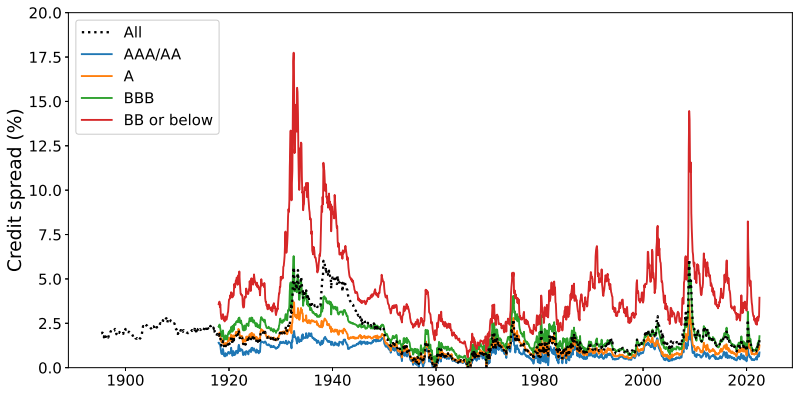


Figure 6: Time series of median credit spreads. This figure presents the monthly time series of median credit spreads (dotted black line) and for four rating categories: (i) AAA/AA (solid blue line), (ii) A (solid orange line), (iii) BBB (solid green line), and (iv) BB or below (solid red line). All values are expressed in percentages. The sample period for the dotted black line is April 1895 to June 2022. The rating-specific series begin in December 1917, reflecting the availability of credit rating information in our current data collection.

The figure also reveals substantial variation across rating categories, with a clear hierarchy in levels. Lower-rated bonds, particularly those of speculative grade, consistently exhibit higher credit spreads than higher-rated bonds. These gaps widen markedly during episodes of economic stress, including the Great Depression, the 2008 global financial crisis, and the COVID-19 pandemic.

3.4 Corporate bond returns

While yields and credit spreads measure the compensation investors expect for holding corporate bonds, realized returns capture the actual performance over a given period. Let $P_t^{i,\text{Clean}}$ denote the clean price of bond i at time t. The dirty price of the bond $P_t^{i,\text{Dirty}}$ is calculated as $P_t^{i,\text{Dirty}} = P_t^{i,\text{Clean}} + \text{AI}_t^i$, where AI_t^i represents the accrued interest from the previous coupon payment date to time t. The holding period return between time t and time $t+1$ is then given by

$$r_{t+1}^i = \frac{P_{t+1}^{i,\text{Dirty}} - P_t^{i,\text{Dirty}} + \text{Cpn}_{t+1}^i}{P_t^{i,\text{Dirty}}}, \tag{1}$$

where Cpn_{t+1}^i is any coupon payment made during this period.

The quotes we collect from the three print sources are either bid, ask, or sales prices.

While most quotes are bids, other types appear frequently, particularly in the earlier months of the sample.[22] Whenever possible, we compute bid-to-bid, ask-to-ask, and sales-to-sales returns, without mixing different price types. When multiple returns are available within a source based on different price types, we take their average. If the same bond's returns can be calculated from multiple sources due to overlapping coverage, we take the average of the within-source averages. When no return can be calculated using identical price types from any source, we instead rely on the return from the average price in one month to the average price in the next month.[23] Again, if such a return is available from more than one source, we take their average. Finally, the excess return is obtained as $rx^i_{t+1} = r^i_{t+1} - r_{f,t}$, where the data on the 1-month risk-free rate $r_{f,t}$ are from Kenneth French's website.

Panel A of Figure 7 presents the value-weighted excess return on the aggregate portfolio of corporate bonds at each point in time. The time series begins in July 1926 to align with the start of the CRSP stock database. Consistent with the literature, value weights are based on the amount outstanding for each bond.[24] For portfolio construction, we adopt the price filters of Dickerson, Mueller, and Robotti (2023), eliminating observations with prices below \$5 or above \$1,000 to prevent extreme values from distorting portfolio returns.[25] During this period, the average excess return on the aggregate corporate bond market is 0.36% per month, corresponding to an annual risk premium of 4.29%. This return is accompanied by an annualized volatility of 7.78%, resulting in a Sharpe ratio of 0.55, which is somewhat higher

[22]Sales prices are available exclusively for exchange-traded securities. While corporate bonds are seldom traded on exchanges in the modern era, they were actively traded on exchanges during the first half of the 20th century. See Biais and Green (2019).

[23]For example, if only a bid price is available in one month and only a sales price in the next, the return is computed from the average price in each month, effectively producing a bid-to-sale return. While this mixes price types, it preserves observations that would otherwise be lost. This approach is relatively innocuous, especially for cumulative returns over multiple periods (the focus of Section 4); using different price types in intermediate months does not affect the overall cumulative return, as it ultimately depends only on the first and last prices. By contrast, missing intermediate observations can distort the cumulative return.

[24]For some bonds, the amount outstanding is reported by multiple sources, and we occasionally observe discrepancies among them. These are typically due to one source lagging a few months in revising the amount. Historically, many bonds included sinking fund provisions, which gradually reduced the amount outstanding over time. To capture this partial debt retirement in a timely fashion, we use the smallest reported value.

[25]These price filters are applied on an ex-ante basis to avoid look-ahead bias. For example, suppose a bond is included in the portfolio at time t, but its price falls below \$5 or rises above \$1,000 at time $t+1$. The bond's return between t and $t+1$ enters the portfolio return. However, when forming the portfolio at $t+1$, the bond is assigned zero weight and therefore does not affect the portfolio return between $t+1$ and $t+2$.

than that of the aggregate stock market (0.43) over the same period.[26]

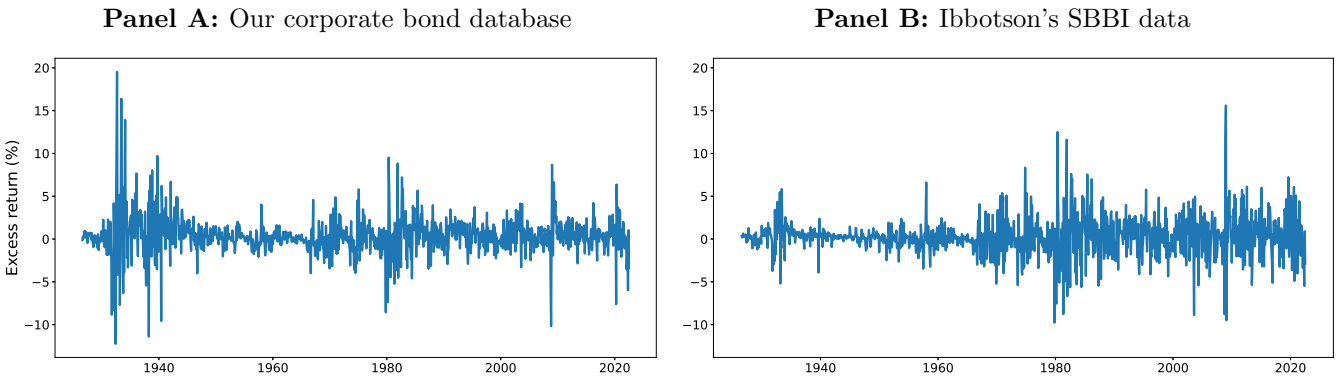


Figure 7: Time series of corporate bond returns. This figure juxtaposes the monthly time series of corporate bond returns from two sources. Panel A reports the value-weighted excess returns on all corporate bonds available in our database at each point in time, with weights based on the amount outstanding for each bond. Panel B reports the corporate bond return series from Ibbotson's SBBI data. All values are expressed in percentages. The sample period is from July 1926 to June 2022.

The figure also demonstrates how the corporate bond market responds to major economic events. The time series highlights periods of extreme volatility, with pronounced spikes in both positive and negative excess returns during economic crises. The Great Depression of the 1930s stands out, with bond market returns showing extreme fluctuations, reflecting severe financial distress and widespread defaults. Similarly, the stagflationary episode of the 1970s is marked by heightened return volatility. A comparable pattern appears during the 2008 financial crisis, particularly around the collapse of Lehman Brothers. In contrast, the 1950s and 1960s exhibit a prolonged period of low return volatility, coinciding with the strong postwar economic expansion.

In comparison, Panel B plots the corporate bond return series from Ibbotson's SBBI data, available on Amit Goyal's website. The most striking difference appears in the prewar period. Whereas our series exhibits sharp swings during the Great Depression, Ibbotson's

[26] A higher Sharpe ratio for corporate debt than for equity is consistent with the predictions of structural credit risk models with priced asset variance risk (e.g., Du, Elkamhi, and Ericsson, 2019). In such models, asset variance has two effects, as analyzed by Doshi, Ericsson, Fournier, and Seo (2024): (i) higher asset variance raises discount rates, lowering the values of both debt and equity; (ii) higher asset variance increases the value of equity, which is effectively a *long* call option on the firm's assets, while decreasing the value of debt, which is essentially a *short* put option. These two effects therefore operate in the same direction for corporate debt, making it more sensitive to variance risk. As a result, debtholders require disproportionately higher compensation for bearing variance risk despite their lower leverage, leading to a higher Sharpe ratio. The Internet Appendix further shows that, due to this relatively high Sharpe ratio, the optimal portfolio allocates the largest weight to corporate bonds when considered jointly with stocks and Treasuries.

shows little movement. This seems implausible, given the extreme volatility observed in the stock market at the time. The discrepancy likely reflects major biases in how Ibbotson's series is constructed. From 1926 to 1945, Ibbotson and Sinquefield (1976) calculate synthetic bond returns from yields, assuming a 20-year maturity and 4% coupons, based on the S&P High-Grade Corporate Composite Bond Index, which included only AAA-rated bonds. Not only is this approach detached from actual bond-level returns, it also introduces a severe quality bias by retaining only the safest bonds that managed to stay AAA through the most severe economic crisis of the century. Figure 6 clearly shows that in our database the median credit spread was far from the AAA rating during that period.

This issue of representativeness extends well beyond the prewar period. From 1946, Ibbotson's return series relies on the Salomon Brothers Long-Term High-Grade Corporate Bond Index all the way until 2017, focusing on AAA- and AA-rated bonds and calculating returns under the assumption of 20-year constant maturity.[27] This explains why Ibbotson's return series appears much more volatile than ours in the postwar sample. As shown in Panel D of Figure 4, the average bond maturity was around 20 years in the 1960s but declined steadily thereafter; as a result, the assumption of a 20-year maturity mechanically inflates volatility in Ibbotson's series.

To the best of our knowledge, our paper is the first to construct a long-run return series for the aggregate corporate bond market from the ground up. We do not rely on ad hoc assumptions about maturity or coupons. Instead, we collect all available bond prices every month and directly compute return series that aggregate up to the market level. This approach provides a more realistic view of how corporate bond risk and return characteristics evolve across different financial and macroeconomic regimes.

[27]Because the index begins in 1969, Ibbotson and Sinquefield (1976) backdate it using Salomon Brothers' yield data. After Salomon Brothers was acquired in the late 1990s, the index was renamed the Citigroup Long-Term High-Grade Corporate Bond Index. In 2017, it was taken over by FTSE Russell.

4 Credit risk premia

Building on the descriptive patterns of the corporate bond market documented in Section 3, we conduct a quantitative assessment of its long-run performance. The central concept in this analysis is the credit risk premium: the compensation corporate bond investors demand for bearing additional risk relative to Treasury securities. To illustrate, we decompose the excess return on a corporate bond $rx^i_{t+1} = r^i_{t+1} - r_{f,t}$ into two parts:

$$rx^i_{t+1} \quad = \quad \left(r^i_{t+1} - r^{i,\text{Trsy}}_{t+1}\right) \; + \; \left(r^{i,\text{Trsy}}_{t+1} - r_{f,t}\right), \tag{2}$$

where $r^{i,\text{Trsy}}_{t+1}$ denotes the return on a "comparable" Treasury bond. Following the literature, we consider two ways to define this Treasury benchmark. The first approach, called *cash flow matching*, uses a hypothetical Treasury bond with identical cash flows, as in the calculation of credit spreads in Section 3.3. Cash flow matching is straightforward and ensures the same maturity. However, it produces a longer duration for the Treasury bond, since its lower discount rate places greater weight on later cash flows. For isolating the pure credit risk component, the second approach, called *duration matching*, is more suitable because it equalizes the sensitivity of the two bonds to interest rate risk. Specifically, we follow van Binsbergen, Nozawa, and Schwert (2025) but refine their method with recursive iterations to construct a portfolio of zero-coupon Treasury bonds whose Macaulay duration is exactly identical to that of the original corporate bond. Appendix B provides the mathematical details of how we compute yields and returns under the two matching methods.[28] In both cases, the literature abstracts away from the common presence of embedded call options, even though this can create a substantial wedge between the Macaulay duration and the effective duration. As we point out later in this section, this can become an important source of bias when interest rates persistently fall and embedded options become in the money, as observed in the secular decline of interest rates during the post-1980 period.

The first component of equation (2) represents the excess return on a corporate bond

[28] We conduct analysis using both methods but report the results based on duration matching as the main ones when there is a space constraint. The results are qualitatively similar.

relative to its Treasury benchmark, which reflects the credit risk premium. The second component represents the return on the Treasury benchmark in excess of the risk-free Treasury bill, which reflects the term premium. We can take the time series average of these two excess returns to obtain estimates of the respective premia. However, tracking a single bond over a long horizon is difficult because most bonds have finite maturities. For this reason, these premia are typically estimated based on portfolios. For a portfolio with weights w_t^i, we take the weighted average of equation (2) across bonds and then average it over time:

$$\frac{1}{T}\sum_{t=1}^{T}\sum_{i} w_t^i rx_{t+1}^i = \underbrace{\frac{1}{T}\sum_{t=1}^{T}\sum_{i} w_t^i \left(r_{t+1}^i - r_{t+1}^{i,\text{Trsy}}\right)}_{\longrightarrow \text{ Credit risk premium}} + \underbrace{\frac{1}{T}\sum_{t=1}^{T}\sum_{i} w_t^i \left(r_{t+1}^{i,\text{Trsy}} - r_{f,t}\right)}_{\longrightarrow \text{ Term premium}}.$$

In other words, as the sample length T increases, the time series average of the corporate bond portfolio return $r_{t+1}^p = \sum_i w_t^i r_{t+1}^i$ in excess of the corresponding Treasury portfolio return $r_{t+1}^{p,\text{Trsy}} = \sum_i w_t^i r_{t+1}^{i,\text{Trsy}}$ converges to the credit risk premium. This points to another potential source of bias: a small-sample problem. If the sample period is too short, the average excess portfolio return might not be close to the true risk premium.

The main puzzle in the literature is that the credit risk premium appears to be very small, if not zero. This finding is largely based on relatively recent samples starting in the 1980s. Evidence from longer periods exists but typically relies on Ibbotson's SBBI data, which suffer from well-documented issues and biases, as discussed in Section 3.4. Since our database spans more than a century and covers the full cross-section of corporate bonds, we can provide more reliable estimates of the credit risk premium and revisit these results.

Section 4.1 examines the performance of various credit portfolios across different sample periods. While the estimates of the credit risk premium differ across samples, Section 4.2 documents that the magnitudes of the average credit spread is comparable. To reconcile these empirical facts, we derive a general relation between the credit risk premium and the credit spread, highlighting the forces that drive the wedge between the two. Potential concerns about the representativeness of recent subsamples are discussed, along with the bias from ignoring embedded calls. Section 4.3 studies the performance of corporate bond portfolios sorted by

their exposures to aggregate risk proxies. These exercises consistently point to the conclusion that the credit risk premium is economically large and that investors require meaningful ex ante compensation for bearing corporate credit risk.

4.1 Performance of corporate bonds relative to Treasuries

We start by examining the performance of corporate bond portfolios sorted by credit rating. Table 2 reports the results for the recent sample beginning in 1986, which mirrors the sample period of van Binsbergen, Nozawa, and Schwert (2025). For each portfolio, we report the average return, duration, and excess return relative to Treasury bills. The average excess return is then decomposed into the credit risk premium and the term premium using comparable Treasuries constructed under both duration matching and cash flow matching. We primarily discuss the results based on duration matching, as it better isolates the credit component, but the estimates under cash flow matching are generally similar. All returns are annualized percentages, and durations are expressed in years. Shown in square brackets are t-statistics, computed using Newey-West standard errors with 12 lags. For now, we focus on value-weighted portfolios with credit ratings from AAA/AA through B; distressed bonds (rated CCC or below) are excluded here and analyzed separately in the Internet Appendix.[29]

Table 2 largely confirms the main finding of van Binsbergen, Nozawa, and Schwert (2025): the credit risk premium is estimated to be small over the last four decades. For example, AAA/AA bonds earned a 6.68% average return, corresponding to a 3.75% excess return over Treasury bills. Only a small fraction of this excess return is attributable to the credit risk premium, which is estimated to be 0.25% and is statistically insignificant (t-statistic of 0.58). As we move from the highest rating toward lower credit ratings, the average return generally rises and the estimated credit risk premia increase monotonically. Within the investment-grade categories, the premium remains very small (0.25% for AAA/AA, 0.34% for A, and 0.78% for

[29] We consider distressed bonds separately because their prices are substantially noisier. They are generally more illiquid, and their returns are highly sensitive to small price movements and to whether coupon payments are made in full. Most of the existing empirical evidence on the credit risk premium focuses on investment-grade bonds. The Internet Appendix shows that, consistent with the BB and B categories, bonds rated CCC or below also exhibit a large (in fact, much larger) credit risk premium.

				Duration matching			Cash flow matching		
	Return	Duration	Excess return =	CRP	+	TP =	CRP	+	TP
AAA/AA	6.68	7.66	3.75	0.25		3.50	0.23		3.52
			[3.92]	[0.58]		[3.23]	[0.51]		[3.19]
A	6.73	7.79	3.81	0.34		3.47	0.29		3.52
			[3.75]	[0.60]		[3.21]	[0.49]		[3.17]
BBB	7.06	7.13	4.14	0.78		3.36	0.68		3.46
			[3.79]	[0.90]		[3.35]	[0.76]		[3.31]
BB	9.16	5.80	6.23	3.22		3.02	3.09		3.15
			[4.88]	[2.59]		[3.42]	[2.45]		[3.38]
B	8.69	4.96	5.77	3.06		2.72	2.85		2.93
			[2.93]	[1.53]		[3.50]	[1.42]		[3.50]
Difference (B − AAA/AA)			2.02	2.80		-0.78	2.62		-0.60
			[1.10]	[1.61]		[-2.08]	[1.50]		[-1.72]
All	7.23	7.11	4.30	0.97		3.34	0.88		3.42
			[3.98]	[1.15]		[3.28]	[1.02]		[3.25]
IG	6.90	7.51	3.97	0.52		3.46	0.45		3.52
			[3.85]	[0.75]		[3.28]	[0.64]		[3.24]
HY	8.90	5.39	5.98	3.14		2.84	2.96		3.02
			[3.73]	[1.97]		[3.42]	[1.84]		[3.41]
Difference (HY − IG)			2.01	2.62		-0.62	2.51		-0.51
			[1.74]	[2.43]		[-2.16]	[2.35]		[-1.83]

Table 2: Corporate bond portfolios sorted by credit rating: 1986-2022. This table reports the average return, average duration, and average excess return relative to Treasury bills for corporate bond portfolios sorted by credit rating, using the sample beginning in January 1986. The excess return is decomposed into the credit risk premium (CRP) and the term premium (TP) using comparable Treasuries constructed under both duration matching and cash flow matching. All returns are annualized percentages, and durations are expressed in years. Shown in square brackets are t-statistics, computed using Newey-West standard errors with 12 lags. Credit rating portfolios are value-weighted and span ratings from AAA through B. "All" is the value-weighted portfolio across all these credit ratings, "IG" includes the investment-grade categories (AAA/AA/A/BBB), and "HY" indicates the high-yield categories but includes only BB and B, excluding bonds rated CCC or lower.

BBB), and none of these estimates is statistically different from zero. The premium increases sharply for high-yield portfolios, reaching 3.22% for BB and 3.06% for B, although only the BB portfolio estimate is statistically significant. The difference between the B and AAA/AA portfolios is 2.80%, which is insignificant (t-statistic of 1.61), so the evidence for compensation for extra credit risk within this recent sample is relatively weak. A similar pattern appears for the broader value-weighted portfolios: the "All" and "IG" (Investment Grade) portfolios exhibit small and statistically insignificant credit risk premia of 0.97% and 0.52%, respectively, whereas the "HY" (High Yield) portfolio earns a much larger and statistically significant premium of 3.14%.

By contrast, the estimated term premia are sizable across all portfolios. This pattern is

not surprising given that the sample period coincides with a secular decline in interest rates, which allowed long-duration bonds to earn high realized returns. Because lower-rated bonds tend to have shorter average durations, the estimated term premium declines as we move from AAA/AA to B. Nevertheless, the term premium remains statistically significant across all portfolios, accounting for the overwhelming majority of the excess return for investment-grade credit portfolios. Taken together, these results reinforce the view that investment-grade bonds offer little compensation for bearing credit risk; investors could have achieved similar excess returns, through term premia, by simply holding Treasuries with comparable duration.

				Duration matching			Cash flow matching	
	Return	Duration	Excess return =	CRP	+ TP =	CRP	+ TP
AAA/AA	5.40	11.20	2.20	0.62	1.58	0.66	1.54
			[3.02]	[1.67]	[1.88]	[1.71]	[1.80]
A	5.64	10.60	2.44	0.86	1.58	0.86	1.59
			[3.03]	[1.69]	[1.99]	[1.66]	[1.91]
BBB	6.17	9.70	2.97	1.40	1.57	1.35	1.62
			[3.13]	[1.92]	[2.11]	[1.85]	[2.05]
BB	7.93	8.64	4.73	3.34	1.39	3.24	1.49
			[3.64]	[2.89]	[1.97]	[2.84]	[1.93]
B	10.29	7.81	7.09	5.88	1.21	5.69	1.40
			[3.86]	[3.31]	[1.88]	[3.26]	[1.84]
Difference (B − AAA/AA)			4.89	5.26	-0.36	5.04	-0.14
			[3.01]	[3.19]	[-1.58]	[3.14]	[-0.91]
All	6.30	10.34	3.10	1.63	1.47	1.57	1.53
			[3.36]	[2.46]	[1.86]	[2.40]	[1.85]
IG	5.67	10.74	2.47	0.91	1.56	0.91	1.57
			[3.13]	[1.87]	[1.93]	[1.83]	[1.87]
HY	8.86	8.30	5.66	4.37	1.29	4.22	1.44
			[3.80]	[3.18]	[1.90]	[3.11]	[1.88]
Difference (HY − IG)			3.18	3.46	-0.27	3.31	-0.13
			[3.09]	[3.32]	[-1.72]	[3.27]	[-1.06]

Table 3: Corporate bond portfolios sorted by credit rating: 1926-2022. This table reports the average return, average duration, and average excess return relative to Treasury bills for corporate bond portfolios sorted by credit rating, using the sample beginning in July 1926. The excess return is decomposed into the credit risk premium (CRP) and the term premium (TP) using comparable Treasuries constructed under both duration matching and cash flow matching. All returns are annualized percentages, and durations are expressed in years. Shown in square brackets are t-statistics, computed using Newey-West standard errors with 12 lags. Credit rating portfolios are value-weighted and span ratings from AAA through B. "All" is the value-weighted portfolio across all these credit ratings, "IG" includes the investment-grade categories (AAA/AA/A/BBB), and "HY" indicates the high-yield categories but includes only BB and B, excluding bonds rated CCC or lower.

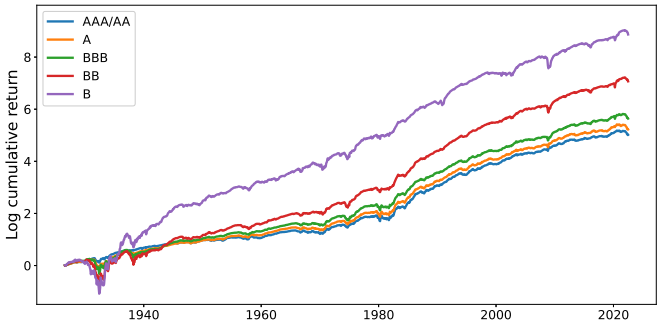
However, these premium estimates are obtained from a relatively short sample. How do the results change when we extend our analysis further back in time? Table 3 paints a strikingly

different picture once the sample is extended back to 1926. Most notably, the estimated credit risk premia are much larger and more statistically significant for every rating category. For AAA/AA bonds, the credit risk premium rises from 0.25% in the recent sample to 0.62%; for A and BBB portfolios, it increases to 0.86% and 1.40%, respectively. The contrast is even stronger for high-yield bonds: the B portfolio now earns a premium of 5.88%, making the difference between the B and AAA/AA portfolios much larger and highly statistically significant (5.26% with a t-statistic of 3.19). We obtain similar magnitudes of the credit risk premium when the sample is restricted to the postwar period beginning in January 1947, as reported in the Internet Appendix.

The behavior of the term premium also differs meaningfully from the recent sample. Because the long sample encompasses multiple interest-rate regimes – including the secular increase in interest rates between the mid-1940s and mid-1980s shown in Figure 5 – the term premia are materially smaller than in the post-1986 period. For example, the AAA/AA portfolio earns a term premium of 1.58% in the long sample, compared with 3.50% in the recent sample, and similar patterns are observed across all other ratings. As a result, the term premium no longer dominates the excess return for investment-grade bonds. The credit risk premium instead accounts for a substantial share of the average excess return for every portfolio, leading to a conclusion quite different from the shorter sample. In other words, the long-run data reveal that credit risk has historically been compensated to a much greater degree than what the recent decades alone would suggest.

Figure 8 offers additional perspective by plotting log cumulative returns for the rating-sorted portfolios (Panel A) and for the broader All, IG, and HY portfolios (Panel B) over the full sample. During major economic downturns (most visibly the Great Depression in the 1930s), lower-rated bonds experience much larger drawdowns than investment-grade bonds: the negative spikes are substantially more pronounced for BB and especially B portfolios. However, following these downturns, higher-yield portfolios recover more strongly and ultimately accumulate much higher returns over the long run. This pattern is evident in Panel B: the HY portfolio both falls more sharply in bad times and rises more quickly thereafter, while

Panel A: Credit rating portfolios



Panel B: Investment grade vs. High yield

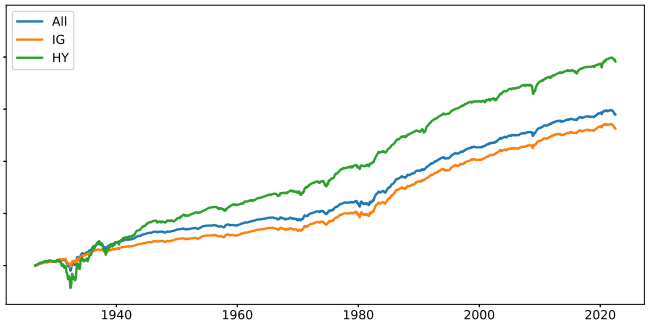


Figure 8: Cumulative corporate bond portfolio returns. This figure plots log cumulative returns for the rating-sorted portfolios (Panel A) and for the broader All, IG, and HY portfolios (Panel B) over the sample period from July 1926 to June 2022. Credit rating portfolios are value-weighted and span ratings from AAA through B. "All" is the value-weighted portfolio across all these credit ratings, "IG" includes the investment-grade categories (AAA/AA/A/BBB), and "HY" indicates the high-yield categories but includes only BB and B, excluding bonds rated CCC or lower.

the IG portfolio exhibits considerably smaller swings.

It is also informative to consider how these plots would look if we restricted the sample to the last four decades. Over this period, the cumulative return paths for the different rating categories run largely parallel to one another, implying that when returns are plotted beginning in the mid-1980s, the performance of the various credit-rating portfolios appears much closer. This highlights the value of our long sample, which reveals a clear, monotonic relation between credit risk and its compensation.

4.2 Credit risk premia vs. Credit spreads

A small credit risk premium, which we document for the post-1986 sample, is puzzling and difficult to reconcile with the well-known credit spread puzzle. It is well established in the asset pricing literature that observed corporate bond spreads are too large to be explained by classic Merton-style structural models when calibrated to empirical default and recovery rates (e.g., Chen, Collin-Dufresne, and Goldstein, 2009; Huang and Huang, 2012; Berndt, Douglas, Duffie, and Ferguson, 2018).[30] How can it be that credit risk premia are estimated to be "too

[30]Structural models of corporate debt build on the contingent claims approach of Black and Scholes (1973), following Merton (1974); Black and Cox (1976); Geske (1977); Longstaff and Schwartz (1995); Leland and Toft (1996); Collin-Dufresne and Goldstein (2001), etc. Quantitatively matching the empirically observed credit spreads is difficult for such models given the relatively low levels of corporate leverage seen in the U.S. data and, consequently, fairly low observed default rates (Jones, Mason, and Rosenfeld, 1984; Eom, Helwege,

low" when credit spreads are "too high"?

Although related, the credit spread and the credit risk premium are conceptually distinct. The credit spread is a promised-yield differential, calculated under the assumption that all contractual cash flows will be paid in full. The credit risk premium, in contrast, is an expected-return differential that reflects the compensation investors ultimately receive after accounting for default losses and other contingencies. Some divergence between the two is therefore natural. However, a small credit risk premium alongside a large credit spread for investment-grade bonds is still difficult to rationalize, especially given that expected default losses in high rating categories are very small. This tension raises concerns about the potential mismeasurement of the credit risk premium, suggesting that the recent short sample may not be fully representative.

			Panel B: Postwar sample					
	Panel A: Long sample		Entire period		First half		Second half	
	(07/1926-06/2022)		(01/1947-06/2022)		(01/1947-12/1985)		(01/1986-06/2022)	
	CRP	CS	CRP	CS	CRP	CS	CRP	CS
AAA/AA	0.62	0.89	0.70	0.74	1.14	0.70	0.25	0.79
A	0.86	1.34	0.93	1.10	1.51	1.11	0.34	1.08
BBB	1.40	1.99	1.38	1.61	1.97	1.52	0.78	1.70
BB	3.34	3.44	3.36	2.78	3.54	2.24	3.22	3.36
B	5.88	6.24	4.43	4.73	5.73	3.65	3.06	5.87
All	1.63	1.97	1.24	1.50	1.53	1.04	0.97	1.99
IG	0.91	1.34	0.95	1.12	1.38	0.94	0.52	1.31
HY	4.37	4.59	3.68	3.68	4.22	2.74	3.14	4.70

Table 4: Credit risk premium vs. Credit spread. This table compares the average realized excess return over the duration-matched Treasury portfolio (i.e., the estimate of the credit risk premium) with the average credit spread across rating categories and sample periods. The long sample in Panel A spans July 1926 to June 2022. The postwar sample in Panel B covers January 1947 to June 2022 and is divided into two subperiods: the first half (January 1947 to December 1985) and the second half (January 1986 to June 2022). All returns and credit spreads are expressed in annualized percentages. Credit rating portfolios are value-weighted and span ratings from AAA through B. "All" is the value-weighted portfolio across all these credit ratings, "IG" includes the investment-grade categories (AAA/AA/A/BBB), and "HY" indicates the high-yield categories but includes only BB and B, excluding bonds rated CCC or lower.

To shed light on this issue, Table 4 provides a direct comparison between the average realized excess return over the duration-matched Treasury portfolio (i.e., the estimate of the credit risk premium) and the average credit spread across multiple sample periods. In the long sample starting in 1926, the credit risk premium and the credit spread are fairly similar

and Huang, 2004). Solutions to the credit spread puzzle typically rely on the business-cycle properties of the default and recovery rates (Bhamra, Kuehn, and Strebulaev, 2010; Chen, 2010).

in magnitude across rating categories. Across all portfolios, credit risk premia are slightly below their corresponding credit spreads, indicating a close alignment between realized excess returns and promised yield differentials. A comparable pattern appears in the postwar sample beginning in 1947, showing that over long horizons the two measures of credit risk tend to track each other closely.

A very different picture emerges once the postwar period is divided into two halves. In the first half, from 1947 to 1985, the average realized excess return exceeds the average credit spread for all portfolios, implying that investors earned substantially more than what promised yield differentials would suggest. In the second half, from 1986 to 2022, the relationship reverses: the average realized excess return is far lower than the credit spread. This latter period corresponds to the recent sample for which we document a low credit risk premium in Section 4.1. What drives the wedge between promised yield differentials and realized excess returns, and why does it behave so differently across historical periods?

4.2.1 Relation between the credit risk premium and the average credit spread

To understand the results we document in Table 4, we first derive a general relation between a bond's excess return and its yield to maturity. This allows us to obtain an explicit expression for the wedge between the credit risk premium and the average credit spread. Let $P_t = P_t^{\text{Dirty}}$ denote the dirty price, which can be viewed as a function of the bond's time to maturity and yield to maturity; that is, $P_t = P(t, y_t)$. For now, assume that the continuously compounded yield y_t follows an Itô diffusion process with continuous sample paths. Between coupon dates, Itô's lemma implies:

$$\frac{dP_t}{P_t} = \underbrace{\frac{1}{P_t}\frac{\partial P_t}{\partial t}}_{=y_t} dt + \underbrace{\frac{1}{P_t}\frac{\partial P_t}{\partial y_t}}_{=-\mathcal{D}_t} dy_t + \frac{1}{2}\underbrace{\frac{1}{P_t}\frac{\partial^2 P_t}{\partial y_t^2}}_{=\mathcal{C}_t}(dy_t)^2, \tag{3}$$

where $\mathcal{D}_t$ and $\mathcal{C}_t$ represent the bond's duration and convexity, respectively.[31]

The first term in equation (3), $\frac{1}{P_t}\frac{\partial P_t}{\partial t}$, captures the return that arises purely from the

[31] When the yield to maturity is continuously compounded, the Macaulay duration is identical to the modified duration. Hence, we refer to $\mathcal{D}_t$ simply as duration without further qualification.

passage of time, holding all else fixed. Since the dirty price is the sum of the clean price and accrued interest, i.e., $P_t = P_t^{\text{Clean}} + AI_t$, this time decay term can be further broken down into two parts: (i) the "pull-to-par" effect, $\frac{1}{P_t}\frac{\partial P_t^{\text{Clean}}}{\partial t}$, as the clean price converges toward the face value; and (ii) the accumulation of accrued interest, which contributes to the return at a rate of $\frac{1}{P_t}\frac{\partial AI_t}{\partial t} = \frac{C}{P_t}$ (the current yield), where C denotes the annual coupon. Together, they sum to the yield to maturity, which bond investors expect to earn when the yield remains constant.[32] When the yield varies, however, the bond price also responds through the duration $\mathcal{D}_t$ in the second term of equation (3), which enters with a negative sign due to the inverse relationship between yields and prices. The third term reflects the bond's convexity $\mathcal{C}_t$, which corrects for the fact that duration alone overstates the price response to yield changes.

Note that at the exact moment of a coupon payment, bond investors earn zero return. Although they receive the coupon, the dirty price drops exactly by the same amount, making the net return zero: $(P_{t^+} - P_{t^-} + \text{Cpn}_t)/P_{t^-} = 0$. In other words, the coupon payment itself is irrelevant for return dynamics as it merely converts interest that had accrued in the dirty price into an actual cash flow. Hence, over an arbitrary discrete period from t to $t+1$, with time interval Δt, we can express the holding period return as

$$r_{t+1} \simeq y_t \Delta t - \mathcal{D}_t \Delta y_{t+1} + \frac{1}{2}\mathcal{C}_t (\Delta y_{t+1})^2,$$

where the approximation error originates from two sources. First, if the time interval is too long, we incur a discretization error. This is not a major concern in our setting, as we focus on monthly intervals. Second, if the yield change dy_t is too large, additional errors may arise because equation (3) assumes continuous sample paths. In the presence of jumps or other discontinuities, the approximation can be refined using higher-order terms.

This general relation holds not only for an arbitrary corporate bond i but also for its

[32] This result follows directly from the present value formula. The dirty price of a bond can be written as $P_t = \sum_{n=1}^{N} CF_n e^{-y_t(t_n - t)}$, where $\{t_n\}$ are future coupon dates and $\{CF_n\}$ are the corresponding cash flows. Taking the partial derivative with respect to time results in $\frac{\partial P_t}{\partial t} = \sum_n CF_n y_t e^{-y_t(t_n - t)} = y_t P_t$.

duration-matched Treasury portfolio:

$$\begin{aligned} r_{t+1}^{i} &\simeq y_t^i \Delta t - \mathcal{D}_t^i \Delta y_{t+1}^i + \frac{1}{2}\mathcal{C}_t^i (\Delta y_{t+1}^i)^2, \\ r_{t+1}^{\text{Trsy}} &\simeq y_t^{\text{Trsy}} \Delta t - \mathcal{D}_t^{\text{Trsy}} \Delta y_{t+1}^{\text{Trsy}} + \frac{1}{2}\mathcal{C}_t^{\text{Trsy}} (\Delta y_{t+1}^{\text{Trsy}})^2. \end{aligned}$$

By construction, we have $\mathcal{D}_t^i = \mathcal{D}_t^{\text{Trsy}}$. As shown in Appendix B, the duration-matched Treasury portfolio is constructed to replicate the present value weights of the bond's cash flows. This implies that convexity is also matched, namely $\mathcal{C}_t^i = \mathcal{C}_t^{\text{Trsy}}$.[33] Subtracting the two return equations therefore gives

$$r_{t+1}^i - r_{t+1}^{i,\text{Trsy}} \simeq s_t^i \Delta t - \mathcal{D}_t^i \Delta s_{t+1}^i + \frac{1}{2}\mathcal{C}_t^i \Delta s_{t+1}^i \Delta \left(y_{t+1}^i + y_{t+1}^{i,\text{Trsy}} \right), \tag{4}$$

where $s_t^i = y_t^i - y_t^{i,\text{Trsy}}$ is the annualized credit spread.

Equation (4) builds a clear connection between the duration-adjusted excess return ($r_{t+1}^i - r_{t+1}^{i,\text{Trsy}}$) and the credit spread ($s_t^i \Delta t$). The remaining terms on the right-hand side capture the potential deviation between the two, which stems from a change in the credit spread. If the credit spread remains unchanged in the next period (i.e., $\Delta s_{t+1}^i = 0$), the excess return over the Treasury portfolio is realized as the credit spread. On the other hand, if the credit spread rises ($\Delta s_{t+1}^i > 0$), the "spread duration effect" $\text{SDE}_{t+1}^i = -\mathcal{D}_t^i \Delta s_{t+1}^i$ pushes the excess return below the credit spread. The "net convexity adjustment" term $\text{NCA}_{t+1}^i = \frac{1}{2}\mathcal{C}_t^i \Delta s_{t+1}^i \Delta \left(y_{t+1}^i + y_{t+1}^{i,\text{Trsy}} \right)$ dampens or amplifies this effect, depending on how the level of yields $\left(y_{t+1}^i + y_{t+1}^{i,\text{Trsy}} \right)$ changes. Taking the average of equation (4) across bonds and over time finally leads to

$$\underbrace{\frac{1}{T}\sum_{t=1}^{T}\sum_i w_t^i \left(r_{t+1}^i - r_{t+1}^{i,\text{Trsy}} \right)}_{\text{Credit risk premium estimate}} \simeq \underbrace{\frac{1}{T}\sum_{t=1}^{T}\sum_i w_t^i s_t^i \Delta t}_{\text{Average credit spread}} + \frac{1}{T}\sum_{t=1}^{T}\sum_i w_t^i \left(\text{SDE}_{t+1}^i + \text{NCA}_{t+1}^i \right), \tag{5}$$

[33] To see this directly, recall that the dirty price can be written as $P_t = \sum_{n=1}^{N} CF_n e^{-y_t(t_n - t)}$. Taking the first and second partial derivatives of P_t with respect to y_t produces duration $\sum_{n=1}^{N} \frac{CF_n e^{-y_t(t_n-t)}}{P_t}(t_n - t)$ and convexity $\sum_{n=1}^{N} \frac{CF_n e^{-y_t(t_n-t)}}{P_t}(t_n - t)^2$. More generally, the k-th derivative takes the form $\sum_{n=1}^{N} \frac{CF_n e^{-y_t(t_n-t)}}{P_t}(t_n - t)^k$. Because the Treasury portfolio replicates the weights $\frac{CF_n e^{-y_t(t_n-t)}}{P_t}$ exactly, all such derivatives are matched.

where the left-hand side represents the empirical estimate of the credit risk premium, and the first term on the right-hand side represents the average credit spread. The residual term captures the wedge between the two, which is driven by changes in credit spreads and their interaction with duration, convexity, and the level of yields.

4.2.2 Two postwar subsamples

What is striking in Table 4 is that the average credit spread remains remarkably stable across the two postwar subsamples, especially for higher rating categories. For example, the average spread for AAA/AA bonds is 0.70% in the first half and 0.79% in the second half; for A bonds, it is 1.11% vs. 1.08%; and for BBB bonds, it is 1.52% vs. 1.70%. In contrast, the estimated credit risk premium differs sharply across the two periods. In the first half of the postwar period, the average realized excess return exceeds the average credit spread, whereas in the second half, it falls well below the average credit spread. This pattern implies that the wedge between the two quantities switches sign across the subsamples. The decomposition in equation (4) clarifies the source of this divergence: the spread duration effect SDE^i_{t+1} and the net convexity adjustment NCA^i_{t+1}, both of which are driven by fluctuations in the credit spread.

To investigate this further, Table 5 decomposes the credit risk premium estimate ("CRP") into the average credit spread ("CS"), spread duration effect ("SDE"), and net convexity adjustment ("NCA") for the two postwar subsamples. The final column ("Error") reports the average approximation error arising from the omission of higher-order terms. The error is negative throughout, which is consistent with the fact that the second-order approximation does not fully capture price discontinuities, typically in the form of downside jumps. The error is negligible for high rating portfolios (around -0.05% for AAA/AA and A) and increases gradually for lower ratings, where yield movements are more extreme and higher-order terms become more relevant. Even for B-rated bonds, however, the residual remains modest (less than -0.70%), indicating that equation (5) provides a good approximation.

The decomposition reveals that the markedly different estimates of the credit risk premium

	Postwar sample	CRP	=	CS	+	SDE	+	NCA	+	Error
AAA/AA	First half	1.14		0.70		0.63		-0.13		-0.06
	Second half	0.25		0.79		-0.47		-0.03		-0.04
A	First half	1.51		1.11		0.46		-0.01		-0.05
	Second half	0.34		1.08		-0.78		0.09		-0.05
BBB	First half	1.97		1.52		0.31		0.21		-0.08
	Second half	0.78		1.70		-1.31		0.51		-0.13
BB	First half	3.54		2.24		0.49		0.93		-0.12
	Second half	3.22		3.36		-1.41		1.43		-0.17
B	First half	5.73		3.65		0.19		2.13		-0.23
	Second half	3.06		5.87		-6.41		4.30		-0.70
All	First half	1.53		1.04		0.52		0.03		-0.07
	Second half	0.97		1.99		-1.69		0.84		-0.17
IG	First half	1.38		0.94		0.55		-0.05		-0.06
	Second half	0.52		1.31		-0.97		0.27		-0.08
HY	First half	4.22		2.74		0.30		1.34		-0.16
	Second half	3.14		4.70		-4.15		3.09		-0.50

Table 5: Decomposition of the credit risk premium. This table decomposes the credit risk premium estimate (CRP) into the average credit spread (CS), spread duration effect (SDE), and net convexity adjustment (NCA) for the first half (January 1947 to December 1985) and the second half (January 1986 to June 2022) of the postwar sample. The decomposition follows equation (5). The final column reports the approximation error arising from the omission of higher-order terms. All values are expressed in annualized percentages. Credit rating portfolios are value-weighted and span ratings from AAA through B. "All" is the value-weighted portfolio across all these credit ratings, "IG" includes the investment-grade categories (AAA/AA/A/BBB), and "HY" indicates the high-yield categories but includes only BB and B, excluding bonds rated CCC or lower.

across the two subperiods, despite very similar average credit spreads, are mainly explained by the spread duration effect $\text{SDE}^i_{t+1} = -D^i_t \Delta s^i_{t+1}$. When the credit spread rises (falls) by 1% point, the corporate bond price decreases (increases) by approximately $D^i_t\%$ relative to the corresponding Treasury portfolio, generating a negative (positive) duration-adjusted excess return. In the first half of the postwar period, the average SDE^i_{t+1} is positive across all rating categories, indicating that credit spread declines and their impact on excess returns dominate. By contrast, in the second half, the average SDE^i_{t+1} is consistently negative across rating portfolios, implying that credit spread increases and their impact now dominate. The net convexity adjustment $\text{NCA}^i_{t+1} = \frac{1}{2}\mathcal{C}^i_t \Delta s^i_{t+1} \Delta \left(y^i_{t+1} + y^{i,\text{Trsy}}_{t+1}\right)$ is typically smaller in magnitude than the spread duration effect and often carries the opposite sign, although it can occasionally become larger in magnitude and share the same sign, depending on changes in the level of yields.

These results suggest that the estimate of the credit risk premium in the short recent

sample may not be close to the true premium. One likely interpretation is that the second half of the postwar period is not representative; credit spread dynamics in that sample generate a large negative wedge on average. The same logic applies to the first half, but in the opposite direction, where the wedge is large and positive on average. In a sufficiently long and representative sample, we would expect the combined effect of spread changes (that is, the sum of SDE^i_{t+1} and NCA^i_{t+1}) to be slightly negative for investment-grade categories, reflecting moderate default losses.[34] The large positive and negative average values of this effect in the two subsamples thus suggest that these periods may not be representative, and that the average realized excess return over the Treasury portfolio may not be a reliable estimate of the true credit risk premium. Given that average credit spreads are similar across the two periods, it is unlikely that investors expected corporate bonds to outperform Treasuries in the first half and underperform in the second half ex ante.

The limitations of these short samples once again underscore the value of our historical corporate bond database. As shown in Table 4, when we consider the full postwar period or the long sample beginning in 1926, the wedge is much smaller and the credit risk premium aligns more closely with the average credit spread. The longer historical time series we construct allows us to obtain a more accurate estimate of the ex ante compensation investors demand for bearing corporate credit risk.

4.2.3 Bias from ignoring embedded calls in duration matching

Besides the small-sample issue discussed above, the estimate of the credit risk premium in the recent sample is also subject to an additional bias rooted in how corporate bonds are matched with their Treasury benchmarks. Historically, a large fraction of corporate bonds has been issued with embedded call provisions. However, the conventional duration matching (and cash flow matching alike) ignores the existence of this option and treats each bond as if it were a straight bond. This simplification largely reflects the fact that the value of an embedded call is highly model dependent and critically influenced by the future dynamics of

[34] Systematic disappearance of bonds from a portfolio, such as through rating changes, lack of trading, or being called, can also influence the wedge.

the entire risky interest rate term structure. Implementing a flexible term structure model and calibrating it properly are nontrivial challenges in financial engineering (see, for example, Brigo and Mercurio, 2006).

Neglecting the call provision becomes particularly problematic in an environment of persistent interest rate declines, which characterizes the second half of the postwar sample beginning in 1986. As rates fall, embedded calls move increasingly in the money because issuers can refinance their debt at lower interest rates. When this occurs, the bond's effective duration becomes substantially smaller than its Macaulay duration, which is computed under the assumption that promised cash flows are paid as scheduled until final maturity. If such a bond is matched to a long-maturity Treasury based on Macaulay duration, the Treasury benchmark will have excessive interest rate exposure. As a result, part of the bond's return that should be attributed to the credit risk premium is instead absorbed by the term premium.

Formally, let the price of a callable bond be written as $P_t^{i,\mathrm{CB}} = P_t^{i,\mathrm{SB}} - P_t^{i,\mathrm{Call}}$, where $P_t^{i,\mathrm{SB}}$ is the price of the corresponding straight bond without a call option. The embedded call option value $P_t^{i,\mathrm{Call}}$ is subtracted because the option is held by the issuer; when interest rates fall, the issuer has the right to call the bond. These prices can be viewed as functions of the yield y_t as well as time-to-maturity. By taking the first derivative of both sides with respect to y_t:

$$\frac{\partial P_t^{i,\mathrm{CB}}}{\partial y_t} = \frac{\partial P_t^{i,\mathrm{SB}}}{\partial y_t} - \frac{\partial P_t^{i,\mathrm{Call}}}{\partial y_t}.$$

Dividing both sides by $P_t^{i,\mathrm{CB}}$ and evaluating at the observed bond's yield to maturity $y_t = y_t^i$, we obtain the following relation:

$$-\frac{1}{P_t^{i,\mathrm{CB}}}\left[\frac{\partial P_t^{i,\mathrm{SB}}}{\partial y_t}\right]_{y_t=y_t^i} = -\frac{1}{P_t^{i,\mathrm{CB}}}\left[\frac{\partial P_t^{i,\mathrm{CB}}}{\partial y_t}\right]_{y_t=y_t^i} - \frac{1}{P_t^{i,\mathrm{CB}}}\left[\frac{\partial P_t^{i,\mathrm{Call}}}{\partial y_t}\right]_{y_t=y_t^i}. \tag{6}$$

The term on the left-hand side, $-\frac{1}{P_t^{i,\mathrm{CB}}}\left[\frac{\partial P_t^{i,\mathrm{SB}}}{\partial y_t}\right]_{y_t=y_t^i}$, represents the observed Macaulay duration $\mathcal{D}_t^i$, which is calculated under the assumption that cash flows are those of the corresponding straight bond and discounted at the observed yield to maturity y_t^i. The first term on the

right-hand side, $-\frac{1}{P_t^{i,\text{CB}}}\left[\frac{\partial P_t^{i,\text{CB}}}{\partial y_t}\right]_{y_t=y_t^i}$, represents the effective duration evaluated at $y_t = y_t^i$. However, this is not the true effective duration of the callable bond; it should instead be evaluated at the true yield $y_t^{i,\text{True}}$, which is lower. Because callability makes the bond cheaper than the corresponding straight bond, the yield to maturity y_t^i (computed from the observed callable bond price while ignoring the call feature) mechanically overstates the true yield $y_t^{i,\text{True}}$ (which is independent of the call value and derived from the straight bond price). Applying a first-order approximation to this term, we obtain:

$$\begin{aligned} -\frac{1}{P_t^{i,\text{CB}}}\left[\frac{\partial P_t^{i,\text{CB}}}{\partial y_t}\right]_{y_t=y_t^i} &\simeq -\frac{1}{P_t^{i,\text{CB}}}\left[\frac{\partial P_t^{i,\text{CB}}}{\partial y_t}\right]_{y_t=y_t^{i,\text{True}}} - \frac{1}{P_t^{i,\text{CB}}}\left[\frac{\partial^2 P_t^{i,\text{CB}}}{\partial y_t^2}\right]_{y_t=y_t^{i,\text{True}}} \times \left(y_t^i - y_t^{i,\text{True}}\right) \\ &= \mathcal{D}_t^{i,\text{CB}} + \mathcal{C}_t^{i,\text{CB}}\left(y_t^{i,\text{True}} - y_t^i\right), \end{aligned}$$

where $\mathcal{D}_t^{i,\text{CB}}$ and $\mathcal{C}_t^{i,\text{CB}}$ are the effective duration and convexity of the callable bond. By defining $\mathcal{D}_t^{i,\text{Call}} = -\frac{1}{P_t^{i,\text{Call}}}\left[\frac{\partial P_t^{i,\text{Call}}}{\partial y_t}\right]_{y_t=y_t^i}$, i.e., the sensitivity of the call value with respect to the yield change, we can rewrite equation (6) as

$$\mathcal{D}_t^i \simeq \mathcal{D}_t^{i,\text{CB}} + \mathcal{D}_t^{i,\text{Call}} + \mathcal{C}_t^{i,\text{CB}}\left(y_t^{i,\text{True}} - y_t^i\right). \tag{7}$$

When the embedded option is likely to be called, the Macaulay duration $\mathcal{D}_t^i$ overestimates the true effective duration $\mathcal{D}_t^{i,\text{CB}}$ for two reasons. First, $\mathcal{D}_t^{i,\text{Call}} > 0$ as the option value to the issuer increases when the yield falls. Second, $\mathcal{C}_t^{i,\text{CB}}\left(y_t^{i,\text{True}} - y_t^i\right) > 0$ because when the option is in the money, the yield to maturity is higher than the true yield ($y_t^{i,\text{True}} - y_t^i < 0$) and the bond convexity becomes negative ($\mathcal{C}_t^{i,\text{CB}} < 0$). In other words, the true effective duration of the bond satisfies $\mathcal{D}_t^{i,\text{CB}} = \mathcal{D}_t^i - \mathcal{D}_t^{i,\text{Call}} - \mathcal{C}_t^{i,\text{CB}}\left(y_t^{i,\text{True}} - y_t^i\right)$, implying that $\mathcal{D}_t^{i,\text{CB}}$ can be substantially smaller than the observed Macaulay duration $\mathcal{D}_t^i$. In the Internet Appendix, we provide a simple illustration in a Black-Scholes framework showing that as the embedded option moves further into the money, the convexity of the callable bond becomes negative and its effective duration declines sharply relative to its Macaulay duration.

Equation (7) clarifies how ignoring callability distorts our return decomposition in equa-

tion (2). In the second half of the postwar sample, the secular decline in interest rates frequently pushed embedded call options into the money, leading to $\mathcal{D}_t^i \gg \mathcal{D}_t^{i,\text{CB}}$. When duration is overstated in this way, the matched Treasury portfolio constructed using $\mathcal{D}_t^i$ has excessively long maturity and therefore excessive interest rate exposure. Naturally, the credit risk component $r_{t+1}^i - r_{t+1}^{i,\text{Trsy}}$ is understated, as a longer-duration Treasury portfolio (incorrectly used as the benchmark) outperforms a shorter-duration one when interest rates persistently decline. In other words, part of the excess return that should be attributed to credit risk is instead attributed to term risk.

To illustrate this mechanism in the extreme, consider a 10-year callable bond whose coupon is far above prevailing rates and is about to be called. Its effective duration is essentially one month, and its appropriate benchmark is a 1-month Treasury bill rather than a 10-year Treasury bond. If the call feature is ignored, the term premium – which should be close to zero – is overestimated by construction, and the credit risk premium is underestimated by the same amount. We believe that this mismeasurement is quantitatively important in the post-1986 subsample and helps explain why the estimated credit risk premium appears unusually small in that period.

4.3 Risk exposures and credit risk premia

Our analysis thus far has focused on the historical performance of corporate bonds sorted by credit rating. While credit ratings capture meaningful cross-sectional variation, what ultimately determines expected returns are exposures to systematic risk. In standard asset pricing theory, an asset earns a risk premium to the extent that its payoff covaries with investors' marginal utility – a relationship that is empirically captured by its factor exposure. Hence, we turn to how corporate bond returns vary with their exposures to underlying economic risks.

Table 6 sorts corporate bonds by their exposures to four financial and macroeconomic factors: (i) stock market returns, (ii) corporate bond market returns, (iii) shocks to industrial production growth, and (iv) shocks to inflation. These variables are commonly used as proxies for marginal utility growth. Stock market returns are given by the CRSP value-weighted

excess return on all publicly traded stocks, and corporate bond market returns are calculated as the value-weighted excess return on all bonds in our database, as described in Section 3.4. The last two factors measure macroeconomic conditions: real economic activity (industrial production growth, downloaded from FRED) and price-level fluctuations (historical inflation rates provided by Amit Goyal). Shocks to these series are extracted by fitting ARMA(1,1) models. For each factor, we construct five quintile portfolios and report the results for the most and least exposed portfolios, as well as the differences between the two.

Panel A: Stock market								
	Beta	Return	Duration	Excess return	=	CRP	+	TP
Least exposed	-0.03	6.47	9.01	3.27		1.98		1.29
Most exposed	0.49	11.42	9.56	8.22		6.75		1.48
Difference (Most − Least)				4.95		4.77		0.18
				[3.37]		[3.24]		[0.60]
Panel B: Corporate bond market								
	Beta	Return	Duration	Excess return	=	CRP	+	TP
Least exposed	0.19	6.19	7.18	2.99		1.81		1.18
Most exposed	1.96	11.23	10.92	8.03		6.43		1.61
Difference (Most − Least)				5.04		4.62		0.43
				[3.14]		[2.96]		[0.91]
Panel C: Industrial production								
	Beta	Return	Duration	Excess return	=	CRP	+	TP
Least exposed	-0.77	7.82	10.07	4.62		3.08		1.54
Most exposed	0.71	10.90	9.25	7.70		6.28		1.43
Difference (Most − Least)				3.08		3.19		-0.11
				[2.92]		[2.99]		[-0.70]
Panel D: Inflation								
	Beta	Return	Duration	Excess return	=	CRP	+	TP
Least exposed	-2.28	8.14	10.83	4.94		3.36		1.58
Most exposed	4.26	10.87	8.68	7.67		6.31		1.35
Difference (Most − Least)				2.73		2.95		-0.22
				[2.60]		[2.88]		[-0.98]

Table 6: Corporate bond portfolios sorted by factor exposures. This table reports the average return, average duration, and average excess return relative to Treasury bills for corporate bond portfolios sorted by exposures to four financial and macroeconomic factors: stock market returns (Panel A), corporate bond market returns (Panel B), shocks to industrial production growth (Panel C), and shocks to inflation (Panel D). For each factor, we construct five quintile portfolios and report the results for the most and least exposed portfolios, as well as the differences between the two. The excess return is decomposed into the credit risk premium (CRP) and the term premium (TP) using comparable Treasuries constructed under both duration matching and cash flow matching. All returns are annualized percentages, and durations are expressed in years. The sample period is from July 1926 to June 2022.

Across all four factor sorts, Table 6 reveals a clear and economically meaningful pattern:

portfolios with higher factor exposures earn substantially higher expected returns. The return spread between the most and least exposed quintiles ranges from 2.73% to 5.04% per year, and these differences are statistically significant in every case. This provides direct evidence that these financial and macroeconomic factors are priced in the cross-section of corporate bond returns and that expected returns increase systematically with factor exposures.[35]

The decomposition of the average excess return into the credit risk premium and the term premium shows that this cross-sectional variation is driven almost entirely by the former. For example, when portfolios are sorted by exposures to the stock market factor (Panel A), the most exposed quintile earns a credit risk premium of 8.22% per year compared to 3.27% for the least exposed quintile, leading to a statistically significant difference of 4.95%. The corresponding difference in term premia is small (0.18%) and statistically insignificant (t-statistic of 0.60). Similar patterns hold across the other three factor sorts in Panels B, C, and D: nearly the entire return spread is accounted for by differences in the credit risk premium, while the term premium plays a minor role.

These results emphasize the importance of credit risk in explaining the cross-section of corporate bond returns. Corporate bonds with high exposures to aggregate financial and macroeconomic risks earn higher expected returns because they command higher credit risk premia – that is, they provide additional compensation beyond what comparable Treasury securities deliver. This finding supports the message from other exercises in Section 4.1: credit risk is a key priced source of compensation for corporate bond investors, and its role becomes fully visible in a sufficiently long sample.

[35]Panel D shows that, like the other three factors, inflation shocks are positively priced. This implies that inflation is procyclical on average in our full sample and that investors prefer high inflation to low inflation, demanding a positive premium for holding assets that perform poorly during low-inflation periods. This result is to be expected, given that the early part of the sample includes the Great Depression, when the economy experienced severe downturns accompanied by deflation. In fact, our subsample analysis reveals that the market price of inflation risk switches sign across different periods, consistent with economic intuition from prominent historical episodes and with empirical evidence on the stock-bond correlation (e.g., Campbell, Sunderam, and Viceira, 2017; Campbell, Pflueger, and Viceira, 2020). In particular, when we consider the subperiod from 1965 (the beginning of the Great Inflation) to 2000 (when the stock-bond correlation turns negative, signaling the end of countercyclical inflation), the return gap between the most and least exposed portfolios becomes negative.

5 Credit risk and business cycles

Our analysis in Section 4 is largely unconditional, focusing on long-run averages and cross-sectional differences. We show that the credit risk premium is economically large and that it varies systematically with factor exposures. These findings, however, have natural conditional implications: if compensation for bearing credit risk is closely linked to broader financial and macroeconomic conditions, then its time variation should contain relevant information about the state of the economy and future asset returns.

In this section, we conduct a conditional analysis of how credit risk relates to market returns and business cycle fluctuations.[36] We first follow Gilchrist and Zakrajšek (2012) and construct an aggregate credit spread measure, extending it back to 1926 (Section 5.1). We then examine its predictive power for future bond market returns (Section 5.2) and for real economic activity (Section 5.3) over longer horizons.

5.1 GZ spreads

A seminal paper by Gilchrist and Zakrajšek (2012) proposes a new measure of aggregate corporate credit spreads, known as the GZ spread. It is constructed as the equally weighted average of credit spreads on senior unsecured bonds issued by U.S. public non-financial firms. The GZ spread time series has proven particularly valuable for understanding future economic activity. It robustly predicts various macroeconomic indicators, such as industrial production, unemployment, and real GDP growth. Follow-up work by Favara, Gilchrist, Lewis, and Zakrajšek (2016a) shows that the GZ spread also effectively predicts the likelihood of an NBER-dated recession occurring within the next 12 months. The series can be decomposed into a predictable component, reflecting expected defaults, and a residual component called the excess bond premium. Gilchrist and Zakrajšek (2012) demonstrate that this excess bond premium is closely linked to fluctuations in credit supply and the financial system's overall risk-bearing

[36] While both the credit spread and the credit risk premium are ex ante measures of credit risk (with the latter, by definition, more accurately capturing the required compensation investors demand), we rely on the former because it has an important advantage: it is directly observed at high frequency. The credit risk premium is not directly observable and can only be estimated over a given sample period, which limits its usefulness for conditional analysis.

capacity, providing significant information for predicting economic outcomes. The original series begins in 1973 and has been continuously updated by the Federal Reserve since 2016.[37]

We closely follow the methodology of Gilchrist and Zakrajšek (2012) to extend the GZ spread series using our corporate bond database. Because the measure is based on bonds issued by public firms, this requires merging our database with the CRSP stock database. The details of this merge, including the construction of issuer-level links, are described in our companion paper (Ghaderi, Plante, Roussanov, and Seo, 2024). Although our corporate bond database begins in 1895, the GZ spread cannot be extended prior to 1926 (i.e., when CRSP data begin), given this constraint. As discussed in Section 3.2, our quantitative analysis already excludes bonds issued by financial firms and bonds with time to maturity of less than one year, consistent with Gilchrist and Zakrajšek (2012). To ensure full comparability, we additionally drop bonds with credit spreads below 5 basis points or above 3,500 basis points, as well as bonds with time to maturity greater than 30 years.

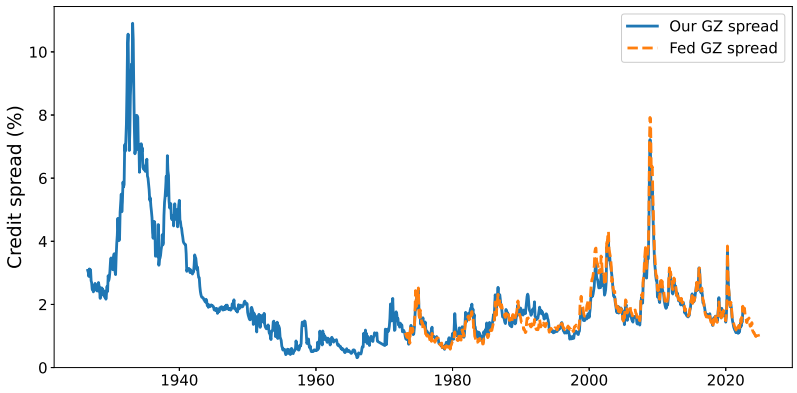


Figure 9: Time series of GZ spreads. This figure presents the monthly time series of the extended GZ spread (solid blue line) alongside the original series from the Federal Reserve for comparison (dashed orange line). All values are expressed in percentages. The sample period is from July 1926 to June 2022.

Figure 9 displays our extended GZ spread series (solid blue line) starting in 1926 and compares it with the original series (dashed orange line) from the Federal Reserve's website. The two series track each other closely pre-1990 and post-2000, though some differences appear in the 1990s, with an overall correlation of 97%. The gap between the two series largely reflects

[37]The updated series is available on the Federal Reserve's website. See Favara, Gilchrist, Lewis, and Zakrajšek (2016b) for further details.

differences in data sources: while Gilchrist and Zakrajšek (2012) construct their series using the Lehman Brothers and Merrill Lynch datasets, our extended series combines print archival sources with the Lehman Brothers data. When we construct the GZ spread using only the Lehman Brothers dataset, we obtain closer values for the 1990s, but the correlation remains similar at around 97%.[38]

5.2 Return predictability

As a first exercise, we examine whether the GZ spread predicts future corporate bond market returns over various horizons. We view this as a basic sanity check. If the GZ spread correctly captures aggregate credit risk in the corporate bond market, it should contain information about subsequent market returns. Intuitively, when credit spreads are elevated, investors require greater compensation for bearing credit risk, implying higher expected excess returns going forward. To formally test this idea, we estimate the following predictive regression:

$$\frac{12}{h}\sum_{n=1}^{h}\log(1+r^{b}_{t+n})-\log(1+r_{f,t+n-1})=\alpha+\beta_h\times \mathrm{GZ}_t+\epsilon_{t+h},$$

where r^{b}_{t+n} denotes the value-weighted corporate bond market return constructed in Section 3.4. The dependent variable represents the annualized cumulative log excess return over an h-month period beginning in month t, while the independent variable is the GZ spread observed in month t. Table 7 reports the slope coefficient β_h and the adjusted R^2 for forecast horizons ranging from 1 month to 60 months. We consider four regression specifications. Specification (i) uses the original GZ spread over the post-1973 sample. Specification (ii) uses our reconstructed GZ spread over the same sample period. Specification (iii) extends our GZ spread back to the postwar period beginning in 1947. Specification (iv) uses the full available sample from 1926 onward. We compute t-statistics using Newey-West standard errors with 12 lags and report them in square brackets.

Across all forecast horizons and specifications, the predictive coefficient on the GZ spread

[38]We thank Yoshio Nozawa for providing information about the Lehman Brothers dataset and additional guidance for its use.

		Forecast horizon h in months					
		$h = 1$	$h = 3$	$h = 6$	$h = 12$	$h = 36$	$h = 60$
(i) Fed GZ: 1973-2022	Slope	4.59	4.52	4.35	3.78	2.51	1.60
		[2.92]	[3.32]	[3.70]	[4.15]	[4.00]	[3.72]
	Adj. R^2	0.03	0.07	0.12	0.16	0.21	0.16
(ii) Our GZ: 1973-2022	Slope	6.59	6.01	5.66	4.88	3.28	1.98
		[3.36]	[3.75]	[4.33]	[4.99]	[4.30]	[3.95]
	Adj. R^2	0.05	0.09	0.15	0.20	0.26	0.18
(iii) Our GZ: 1947-2022	Slope	6.16	5.55	5.24	4.74	3.79	2.81
		[4.36]	[4.84]	[5.58]	[7.34]	[7.51]	[6.87]
	Adj. R^2	0.05	0.10	0.16	0.22	0.34	0.32
(iv) Our GZ: 1926-2022	Slope	2.97	3.16	3.03	2.99	2.82	2.43
		[2.93]	[3.44]	[3.99]	[5.24]	[11.09]	[8.55]
	Adj. R^2	0.03	0.08	0.14	0.23	0.46	0.53

Table 7: Predictive power of the GZ spread for future bond market returns. This table reports estimates from the following predictive regression:

$$\frac{12}{h}\sum_{n=1}^{h}\log(1+r^b_{t+n}) - \log(1+r_{f,t+n-1}) = \alpha + \beta_h \times \mathrm{GZ}_t + \epsilon_{t+h},$$

where r^b_{t+n} denotes the value-weighted corporate bond market return constructed in Section 3.4. The dependent variable is the annualized cumulative log excess return over forecast horizons $h = 1, 3, 6, 12, 36$, and 60 months, while the independent variable is the GZ spread observed in month t. Reported are the slope coefficient β_h and the adjusted R^2. Shown in square brackets are t-statistics, computed using Newey-West standard errors with 12 lags.

is positive and statistically significant.[39] In the post-1973 sample, both the original GZ series and our reconstructed series strongly predict future corporate bond market returns, with our measure exhibiting slightly larger slope estimates and higher adjusted R^2 values. For example, a 1% point increase in our GZ spread predicts a 4.88% higher excess return on the corporate bond market over the following year. This coefficient is highly significant, with a t-statistic of 4.99, and the adjusted R^2 reaches 20%. Extending the sample back to 1947 further strengthens the predictive relationship, particularly at longer horizons. When we use the full sample beginning in 1926, the magnitude of the predictive coefficients declines, but the adjusted R^2 increases substantially at long horizons, reaching 53% at the 60-month horizon.

These results indicate that periods of elevated credit spreads are followed by significantly higher subsequent corporate bond returns, consistent with interpreting the GZ spread as a measure of time-varying aggregate credit risk. The predictive power is economically meaningful at both short and long horizons and remains robust across different sample periods.

[39]The Internet Appendix shows that this return predictability remains strong and significant with similar slope coefficients even after controlling for common predictors such as the term spread and the real short rate.

Overall, the evidence shows that the GZ spread effectively captures variation in expected returns in the corporate bond market.

5.3 Predictive power for real activity

Next, we test the predictive power of the GZ spread for real activity. Given the strong evidence documented in recent samples, it is natural to ask whether this predictability extends to our longer historical sample, which encompasses more recessions and more extreme business cycle fluctuations, including the Great Depression. Following Favara, Gilchrist, Lewis, and Zakrajšek (2016a), we test the GZ spread's ability to predict future recessions using a probit model:

$$\mathbb{1}\left\{\text{Recession in [t, t+12]}\right\} = \begin{cases} 1 & \text{if } \alpha + \beta_{\text{GZ}} \times \text{GZ}_t + \beta_{\text{TS}} \times \text{TS}_t + \beta_{\text{RFF}} \times \text{RFF}_t + \epsilon_{t+12} > 0, \\ 0 & \text{otherwise,} \end{cases}$$

where the dependent variable denotes the NBER recession indicator over the next 12 months. The main independent variable is the GZ spread (GZ_t), with two control variables capturing other financial conditions: the term spread (TS_t), defined as the yield difference between 3-month and 10-year Treasuries, and the real federal funds rate (RFF_t).[40] The error term ϵ_{t+12} is assumed to follow a normal distribution with cumulative distribution function $\Phi(\cdot)$. This model is equivalent to:

$$P\left(\mathbb{1}\left\{\text{Recession in [t, t+12]}\right\} = 1\right) = \Phi\left(\alpha + \beta_{\text{GZ}} \times \text{GZ}_t + \beta_{\text{TS}} \times \text{TS}_t + \beta_{\text{RFF}} \times \text{RFF}_t\right),$$

which directly shows how the GZ spread affects the likelihood of a future recession. We estimate the model via maximum likelihood and report the marginal effects of the three independent variables in Table 8, along with the pseudo R^2. All t-statistics, shown in square

[40] Gilchrist and Zakrajšek (2012) define the real federal funds rate in month t as the average effective federal funds rate during month t minus realized inflation, measured as the log difference of the core PCE inflation rate between $t-1$ and $t-13$. We adopt this definition beginning in February 1960, when both variables are available. For months prior to February 1960, we replace the effective federal funds rate with the 1-month Treasury bill rate and core PCE inflation with CPI inflation. Both series are available back to 1926 from Amit Goyal's website.

brackets, are computed using Newey-West standard errors with 12 lags.

NBER recession	GZ	TS	RFF	Pseudo R^2
(i) Fed GZ: 1973-2022	0.14	0.12	0.04	0.35
	[3.89]	[4.01]	[2.44]	
(ii) Our GZ: 1973-2022	0.19	0.13	0.05	0.39
	[4.63]	[4.45]	[2.66]	
(iii) Our GZ: 1947-2022	0.16	0.18	0.02	0.21
	[3.95]	[5.41]	[1.06]	
(iv) Our GZ: 1926-2022	0.08	0.16	0.02	0.18
	[3.56]	[5.40]	[1.68]	

Table 8: Predictive power of the GZ spread for future recessions. This table reports the estimation results for the following probit model:

$$\mathbb{1}\{\text{Recession in [t, t+12]}\} = \begin{cases} 1 & \text{if } \alpha + \beta_{\text{GZ}} \times \text{GZ}_t + \beta_{\text{TS}} \times \text{TS}_t + \beta_{\text{RFF}} \times \text{RFF}_t + \epsilon_{t+12} > 0, \\ 0 & \text{otherwise,} \end{cases}$$

where the dependent variable denotes the NBER recession indicator over the next 12 months. The main independent variable is the GZ spread (GZ_t), with two control variables capturing other financial conditions: the term spread (TS_t), defined as the yield difference between 3-month and 10-year Treasuries, and the real federal funds rate (RFF_t). The error term ϵ_{t+12} is assumed to follow a normal distribution. We estimate the model via maximum likelihood and report the marginal effects of the three independent variables, along with the pseudo R^2. Shown in square brackets are t-statistics, computed using Newey-West standard errors with 12 lags.

Specifications (i) and (ii) examine the common sample period (i.e., post-1973) where the original GZ spread and our GZ spread coexist. Both series significantly predict the likelihood of future recessions. Specifically, a 1% point increase in our GZ spread is associated with an 19% point increase in the recession probability. The differences between the two series are minor, though our GZ spread shows slightly stronger predictive power with a higher t-statistic (4.63 vs. 3.89) and a larger pseudo R^2 (0.39 vs. 0.35). Most importantly, specifications (iii) and (iv) demonstrate that the predictive power of our GZ spread remains strong in the postwar sample starting in 1947 as well as when we extend the sample as far back as the GZ spread allows.

Taking a step further, we examine the GZ spread's predictive power for future economic activity over our longer historical sample. As in Gilchrist and Zakrajšek (2012), we consider the regression below:

$$y_{t+h} = \alpha + \sum_{k=1}^{p} \beta_k \times y_{t-k} + \beta_{\text{GZ}} \times \text{GZ}_t + \beta_{\text{TS}} \times \text{TS}_t + \beta_{\text{RFF}} \times \text{RFF}_t + \epsilon_{t+h},$$

where y_{t+h} represents the annualized percentage growth rate of two economic variables: indus-

trial production (Panel A) and nonfarm payroll employment (Panel B). For forecast horizon h, the dependent variable y_{t+h} is measured over the $h+1$ periods between $t-1$ and $t+h$. This timing follows Gilchrist and Zakrajšek (2012), accounting for typical reporting lags that make the growth rate between $t-1$ and t unobservable at time t. The number of autoregressive terms p is determined by the Akaike Information Criterion. Table 9 reports the standardized regression coefficients for the three independent variables over 3-month and 12-month horizons, together with adjusted R^2 values. The t-statistics in square brackets are calculated using Newey-West standard errors with 12 lags.

	3-month forecasts				12-month forecasts			
Panel A: Industrial production	GZ	TS	RFF	Adj. R^2	GZ	TS	RFF	Adj. R^2
(i) Fed GZ: 1973-2022	-0.41	-0.24	-0.06	0.20	-0.40	-0.41	-0.07	0.27
	[-4.03]	[-2.52]	[-0.64]		[-3.64]	[-4.07]	[-0.74]	
(ii) Our GZ: 1973-2022	-0.49	-0.28	-0.06	0.24	-0.46	-0.45	-0.07	0.29
	[-4.66]	[-2.87]	[-0.65]		[-4.07]	[-4.44]	[-0.71]	
(iii) Our GZ: 1947-2022	-0.38	-0.19	-0.02	0.20	-0.46	-0.32	-0.03	0.23
	[-5.45]	[-3.11]	[-0.37]		[-5.25]	[-3.90]	[-0.31]	
(iv) Our GZ: 1926-2022	-0.02	-0.07	-0.03	0.16	0.07	-0.12	-0.12	0.08
	[-0.20]	[-1.66]	[-0.49]		[0.66]	[-1.85]	[-1.34]	
Panel B: Employment	GZ	TS	RFF	Adj. R^2	GZ	TS	RFF	Adj. R^2
(i) Fed GZ: 1973-2022	-0.42	-0.11	-0.08	0.15	-0.55	-0.28	-0.18	0.33
	[-3.76]	[-1.06]	[-0.84]		[-5.38]	[-2.24]	[-1.67]	
(ii) Our GZ: 1973-2022	-0.49	-0.14	-0.09	0.19	-0.62	-0.32	-0.18	0.37
	[-3.86]	[-1.34]	[-0.96]		[-5.97]	[-2.64]	[-1.79]	
(iii) Our GZ: 1947-2022	-0.39	-0.14	-0.02	0.14	-0.52	-0.29	-0.02	0.24
	[-3.17]	[-1.93]	[-0.30]		[-5.91]	[-3.42]	[-0.24]	
(iv) Our GZ: 1939-2022	-0.13	-0.08	-0.07	0.09	-0.11	-0.19	-0.06	0.08
	[-1.14]	[-1.52]	[-1.02]		[-0.62]	[-2.76]	[-0.60]	

Table 9: Predictive power of the GZ spread for future economic activity. This table reports the standardized coefficients from the following regression:

$$y_{t+h} = \alpha + \sum_{k=1}^{p} \beta_k \times y_{t-k} + \beta_{\text{GZ}} \times \text{GZ}_t + \beta_{\text{TS}} \times \text{TS}_t + \beta_{\text{RFF}} \times \text{RFF}_t + \epsilon_{t+h},$$

where y_{t+h} represents the annualized percentage growth rate of two economic variables: industrial production (Panel A) and nonfarm payroll employment (Panel B). For forecast horizon h, the dependent variable y_{t+h} is measured over the $h+1$ periods between $t-1$ and $t+h$. The main independent variable is the GZ spread (GZ_t), with two control variables capturing other financial conditions: the term spread (TS_t), defined as the yield difference between 3-month and 10-year Treasuries, and the real federal funds rate (RFF_t). The number of autoregressive terms p is determined by the Akaike Information Criterion. The estimated regression coefficients for the three independent variables over 3-month and 12-month horizons, together with adjusted R^2 values, are reported. Shown in square brackets are t-statistics, computed using Newey-West standard errors with 12 lags.

We again consider four regression specifications. Comparing the first two specifications in the post-1973 sample, our GZ spread robustly predicts declines in the two macroeconomic

indicators at both forecast horizons, with slightly larger t-statistics and adjusted R^2 values relative to the original GZ spread for all cases. While this predictive power persists when we expand our sample to the entire postwar period, the coefficients become statistically insignificant when we extend the sample as far back as the data allow (1926 for industrial production and 1939 for nonfarm payroll employment).

The absence of statistical significance in the full sample is perhaps not surprising. Statistically, the unconditional level of the GZ spread differs markedly across periods: the average GZ spread is 4.09% prior to 1947 but only 1.79% in the postwar period (2.09% over the full sample). Pooling periods with such distinct means makes it more difficult for a simple linear regression to capture a stable covariance between the GZ spread and subsequent economic activity. From an economic perspective, the prewar era features a prolonged episode of elevated credit spreads, followed by a sharp and persistent compression in the postwar period. This shift in the level and dynamics of credit spreads attenuates the estimated predictive coefficients when the entire sample is combined. A similar pattern appears in Table 8, where the predictive strength of the GZ spread for future recessions declines over the full sample, although statistical significance remains. Overall, our analysis provides out-of-sample validation of the GZ spread's economic content while revealing how its predictive power varies across different historical episodes.[41]

6 Conclusion

This paper introduces a novel historical database of corporate bonds spanning 128 years, significantly broadening the scope of research on corporate bonds. By integrating hand-collected archival records with contemporary datasets, our database offers a unique opportunity to examine the corporate bond market through multiple economic cycles. The sheer breadth

[41] One potential refinement would be to isolate the excess bond premium component of the GZ spread, thereby removing the expected default component that may differ across periods. Following Gilchrist and Zakrajšek (2012), this would require estimating firm-level expected default probabilities using a Merton-type distance-to-default framework, which in turn relies on market equity data and detailed balance-sheet information (e.g., current and long-term liabilities). Constructing such measures for the long historical sample would require assembling additional firm-level accounting data from archival sources such as Moody's Manual. We view this extension as beyond the scope of the present paper and leave it for future research.

and granularity of these data make it possible to investigate empirical questions that were previously constrained by data limitations.

Using this expanded historical record, we revisit the longstanding debate on the size of the credit risk premium. While evidence from recent decades suggests that corporate bond excess returns are driven largely by the term premium, our long-sample results point to a fundamentally different conclusion. Over the full historical period, corporate bonds earn a sizable and statistically significant credit risk premium that increases monotonically with credit risk. We show that the small premium estimated in recent samples reflects the unusual behavior of credit spreads during this period and measurement issues related to duration matching, rather than an actual absence of compensation for bearing credit risk.

We believe that our new database can serve as a foundation for future corporate bond studies, filling many crucial gaps in the literature. The corporate bond market has evolved substantially over the past century, experiencing major shifts in issuer composition and bond characteristics that are not visible from recent samples alone. By extending the empirical record back more than a century, the database provides a clearer perspective on the long-run performance and dynamics of corporate bonds and the risks investors bear when holding them. By spanning multiple financial and macroeconomic regimes, it offers a more reliable foundation for evaluating corporate credit risk and paves the way for future empirical research.

Appendix

A Construction of Treasury term structure

Beginning in June 1961, we rely on the standard smooth yield curves constructed using the methodology of Gürkaynak, Sack, and Wright (2007), which builds on the parametric framework of Nelson and Siegel (1987) and its extension by Svensson (1994). For each day, their model is estimated using off-the-run Treasury notes and bonds. The resulting parameters and the implied term structure, beginning at the 1-year horizon, are publicly available and regularly updated on the Federal Reserve's website. We obtain the monthly time series by

selecting the yield curve as of the last trading day of each month. While the parametric form allows for extrapolation beyond observed maturities, we conservatively apply flat extrapolation when necessary. As noted by Gürkaynak, Sack, and Wright (2007), Nelson-Siegel-type specifications can produce unreliable extrapolation outcomes at the long end. Likewise, we avoid extrapolation at the short end due to the well-documented difficulty of capturing Treasury bill rates using yields on longer-term securities – commonly referred to as the "short-rate disconnect" (Duffee, 1996; Lenel, Piazzesi, and Schneider, 2019). Instead, we supplement the curve with 1-month Treasury bill rates from Kenneth French's website and 3-month rates from the Federal Reserve's website.

Constructing the Treasury yield curve for the pre-1961 period is particularly challenging due to limited data availability. Most yield curve estimates in the literature begin in June 1961 (see also Liu and Wu, 2021), which marks the start of the CRSP Treasury daily file. Although the CRSP Treasury monthly file is separately available and extends back to December 1925, constructing a term structure for earlier periods remains challenging, as available yield observations become increasingly sparse further back in time. We address this challenge differently in the following two subsample periods. (i) For the post-gold standard period from January 1934 to May 1961, where there are enough yield observations, we apply the methodology of Gürkaynak, Sack, and Wright (2007) to the CRSP Treasury monthly file to obtain monthly yield curves.[42] (ii) For the pre-1934 period under the gold standard, we adopt the posterior median term structures estimated by Payne, Szőke, Hall, and Sargent (2025) using Bayesian methods.[43] Their approach differs in that the estimation is conducted over the full sample period from 1791 to 1933, rather than period by period, reflecting the very limited availability

[42]In the estimation, we exclude all callable bonds and flower bonds, following Gürkaynak, Sack, and Wright (2007) and Liu and Wu (2021). While these papers also exclude on-the-run and first off-the-run issues, we retain all available issues due to the limited number of observations in earlier periods. Tax status is also handled slightly differently. In the post-1961 sample, nearly all Treasury notes and bonds are fully taxable (coded as `ITAX = 1`), and the standard practice is to focus on this group. However, prior to 1961, this is not feasible: most bonds were either fully or partially tax-exempt, and fully taxable bonds first appear in the data in December 1940. We therefore use June 1942 as a cutoff. From that month onward, we restrict the sample to fully taxable bonds, as there are sufficient observations to estimate yield curves only based on them. For months prior to June 1942, we include both fully taxable and tax-exempt bonds.

[43]Payne, Szőke, Hall, and Sargent (2025) provide the estimated term structures at Harvard Dataverse: https://doi.org/10.7910/DVN/3BLHJA.

of federal debt in earlier years. Hence, our credit spreads for the pre-1934 period should be interpreted with caution. As in the post-1961 period, we supplement these yield curves with 1-month and 3-month Treasury bill rates, using the extended historical series provided on Amit Goyal's website (see Goyal and Welch, 2008).

B Comparable Treasury securities

To define the credit risk premium, we first need to specify Treasury securities that are comparable to corporate bonds. To set the stage, consider a corporate bond i with cash flows $\left\{\mathrm{CF}_{t_n}^i\right\}_{n=1}^N$ paid at times $\{t_n\}_{n=1}^N$. The price of this bond can be expressed as

$$P_t^i = \sum_{n=1}^{N} \mathrm{PV}_t\left(\mathrm{CF}_{t_n}^i; y_t^i\right),$$

where $\mathrm{PV}_t\left(\mathrm{CF}_{t_n}^i; y_t^i\right) = \mathrm{CF}_{t_n}^i \times e^{-y_t^i(t_n-t)}$ represents the time-t present value of cash flow $CF_{t_n}^i$ discounted using bond i's continuously compounded yield to maturity y_t^i.[44] The duration of this bond is calculated as the present-value-weighted average of cash flow timings:

$$\mathcal{D}_t^i = \sum_{n=1}^{N}\left[\frac{\mathrm{PV}_t\left(\mathrm{CF}_{t_n}^i; y_t^i\right)}{\sum_{m=1}^{N}\mathrm{PV}_t\left(\mathrm{CF}_{t_m}^i; y_t^i\right)}\right] \times (t_n - t) = \sum_{n=1}^{N}\frac{\mathrm{PV}_t\left(\mathrm{CF}_{t_n}^i; y_t^i\right)}{P_t^i} \times (t_n - t). \tag{B.1}$$

As described in Appendix A, we estimate the monthly term structure of zero-coupon Treasury yields over our sample period. Let z_{t,t_n} denote the continuously compounded Treasury zero yield observed at time t for maturity t_n.

[44] This present value function can be defined with any compounding frequency. For example, under the market convention of semi-annual compounding, it is written as:

$$\mathrm{PV}_t\left(\mathrm{CF}_{t_n}^i; y_t^i\right) = \frac{\mathrm{CF}_{t_n}^i}{\left(1 + y_t^i/2\right)^{2(t_n-t)}},$$

where the time to each cash flow $t_n - t$ is measured under the given day-count convention (typically, 30/360).

B.1 Cash flow matching

Under cash flow matching, the Treasury benchmark is a hypothetical Treasury bond with an identical series of cash flows, i.e., $\mathrm{CF}_{t_n}^{i,\mathrm{Trsy}} = \mathrm{CF}_{t_n}^{i}$ for all $n \in \{1, \cdots, N\}$. The price of this hypothetical Treasury bond is given by

$$P_t^{i,\mathrm{Trsy}} = \sum_{n=1}^{N} \mathrm{CF}_{t_n}^{i} e^{-z_{t,t_n}(t_n - t)}.$$

Then, the yield to maturity of this bond $y_t^{i,\mathrm{Trsy}}$ is found by solving for the discount rate that equates the present value of its future cash flows with the bond price $P_t^{i,\mathrm{Trsy}}$:

$$P_t^{i,\mathrm{Trsy}} = \sum_{n=1}^{N} \mathrm{PV}_t \left(\mathrm{CF}_{t_n}^{i}; y_t^{i,\mathrm{Trsy}} \right).$$

The return on this hypothetical bond $r_{t+1}^{i,\mathrm{Trsy}}$ is calculated from $P_t^{i,\mathrm{Trsy}}$, $P_{t+1}^{i,\mathrm{Trsy}}$, and any coupon payment between t and $t+1$, according to equation (1). The duration of this bond $\mathcal{D}^{i,\mathrm{Trsy}}$ follows directly from equation (B.1) with y_t^i replaced by $y_t^{i,\mathrm{Trsy}}$:

$$\mathcal{D}^{i,\mathrm{Trsy}} = \sum_{n=1}^{N} \left[\frac{\mathrm{PV}_t \left(\mathrm{CF}_{t_n}^{i}; y_t^{i,\mathrm{Trsy}} \right)}{\sum_{m=1}^{N} \mathrm{PV}_t \left(\mathrm{CF}_{t_m}^{i}; y_t^{i,\mathrm{Trsy}} \right)} \right] \times (t_n - t) = \sum_{n=1}^{N} \frac{\mathrm{PV}_t \left(\mathrm{CF}_{t_n}^{i}; y_t^{i,\mathrm{Trsy}} \right)}{P_t^{i,\mathrm{Trsy}}} \times (t_n - t).$$

The yield of the original corporate bond is generally higher than that of the hypothetical Treasury bond ($y_t^{i,\mathrm{Trsy}} < y_t^i$) due to additional risks, such as default risk and liquidity risk. This makes the Treasury bond place greater weight on later cash flows and less weight on early cash flows, giving it a longer duration ($\mathcal{D}^{i,\mathrm{Trsy}} > \mathcal{D}_t^i$).

B.2 Duration matching

Duration matching requires constructing a Treasury cash flow stream $\left\{ \mathrm{CF}_{t_n}^{i,\mathrm{Trsy}} \right\}_{n=1}^{N}$ whose duration equals that of the corporate bond, i.e., $\mathcal{D}^{i,\mathrm{Trsy}} = \mathcal{D}_t^i$, where

$$\mathcal{D}^{i,\mathrm{Trsy}} = \sum_{n=1}^{N} \frac{\mathrm{PV}_t \left(\mathrm{CF}_{t_n}^{i,\mathrm{Trsy}}; y_t^{i,\mathrm{Trsy}} \right)}{P_t^{i,\mathrm{Trsy}}} \times (t_n - t). \tag{B.2}$$

Comparing equations (B.1) and (B.2), it suffices to find a portfolio of Treasury securities that satisfies:

$$\frac{\mathrm{PV}_t\left(\mathrm{CF}_{t_n}^{i,\mathrm{Trsy}}; y_t^{i,\mathrm{Trsy}}\right)}{P_t^{i,\mathrm{Trsy}}} = \frac{\mathrm{PV}_t\left(\mathrm{CF}_{t_n}^{i}; y_t^{i}\right)}{P_t^{i}}, \text{ for all } n \in \{1, \cdots, N\}. \tag{B.3}$$

We build on van Binsbergen, Nozawa, and Schwert (2025), who consider a portfolio of zero-coupon Treasuries maturing at $\{t_n\}_{n=1}^N$. We demonstrate that their approach delivers close but not exact equality, unless the Treasury term structure is flat. We refine their method with recursive iterations to obtain exact duration matching.

Initial step

van Binsbergen, Nozawa, and Schwert (2025) construct a portfolio that allocates ω_{t,t_n}^i dollars into the zero-coupon Treasury maturing at time t_n, where

$$\omega_{t,t_n}^i = \frac{\mathrm{PV}_t\left(\mathrm{CF}_{t_n}^{i}; y_t^{i}\right)}{P_t^{i}}, \text{ for all } n \in \{1, \cdots, N\}.$$

Since the price of each zero-coupon bond is $e^{-z_{t,t_n}(t_n-t)}$, the portfolio holds $\omega_{t,t_n}^i \times e^{z_{t,t_n}(t_n-t)}$ units of the bond. This implies that the cash flow from the portfolio at time t_n is $\mathrm{CF}_{t_n}^{i,\mathrm{Trsy}} = \omega_{t,t_n}^i \times e^{z_{t,t_n}(t_n-t)}$ for each $n \in \{1, \cdots, N\}$. The time-t price of this Treasury portfolio $P_t^{i,\mathrm{Trsy}}$ equals 1 because $\sum_{n=1}^N w_{t,t_n}^i = 1$.

The duration of a zero-coupon bond maturing at time t_n is simply $t_n - t$ years. Thus, the weighted average duration becomes

$$\sum_{n=1}^{N} \omega_{t,t_n}^i \times (t_n - t) = \sum_{n=1}^{N} \frac{\mathrm{PV}_t\left(\mathrm{CF}_{t_n}^{i}; y_t^{i}\right)}{P_t^{i}} \times (t_n - t),$$

which exactly replicates the corporate bond's duration in equation (B.1). Based on this, van Binsbergen, Nozawa, and Schwert (2025) define the duration-matched Treasury return as the return on this portfolio, which can also be computed as the weighted average return on zero-coupon Treasuries. They also calculate the duration-matched Treasury yield as the weighted average of zero-coupon Treasury yields. While this approach comes close, we argue that it

does not provide exact duration matching. We point out two implicit approximation errors:

(1) The weighted average of zero-coupon yields is not identical to the yield on the entire cash flow stream. To be accurate, the yield to maturity $y_t^{i,\text{Trsy}}$ should satisfy:

$$P_t^{i,\text{Trsy}} = \sum_{n=1}^{N} \text{PV}_t \left(\text{CF}_{t_n}^{i,\text{Trsy}}; y_t^{i,\text{Trsy}} \right). \tag{B.4}$$

The yield to maturity can itself be interpreted as a type of weighted average of zero-coupon yields. The real issue, therefore, is the size of the discrepancy between the two approaches. We find that regressing the approximated yield on the exact yield gives a 99% R^2, a slope coefficient of 0.9876, and a near-zero intercept. Although a difference exists, it is numerically small and easily addressed by computing the exact yield rather than using the approximation.

(2) The weighted average duration $\sum_{n=1}^{N} \omega_{t,t_n}^i \times (t_n - t)$ is not exactly the duration of the cash flow stream. As shown in equation (B.2), the present-value weights in the duration expression are, by definition, based on the single yield to maturity, not maturity-specific zero yields. Therefore, unless the term structure is flat, the duration of the entire cash flow stream calculated using $y_t^{i,\text{Trsy}}$ cannot coincide with the weighted average duration where each weight is based on its corresponding zero rate. More explicitly, since $\text{CF}_{t_n}^{i,\text{Trsy}} = \omega_{t,t_n}^i \times e^{z_{t,t_n}(t_n - t)}$ and $P_t^{i,\text{Trsy}} = 1$, we can show that equation (B.3) does not hold:

$$\frac{\text{PV}_t \left(\text{CF}_{t_n}^{i,\text{Trsy}}; y_t^{i,\text{Trsy}} \right)}{P_t^{i,\text{Trsy}}} = \omega_{t,t_n}^i \times e^{\left(z_{t,t_n} - y_t^{i,\text{Trsy}} \right)(t_n - t)} \neq \omega_{t,t_n}^i = \frac{\text{PV}_t \left(\text{CF}_{t_n}^i; y_t^i \right)}{P_t^i},$$

unless $z_{t,t_n} = y_t^{i,\text{Trsy}}$ for all $n \in \{1, \cdots, N\}$. Put differently, under a non-flat term structure, the portfolio proposed by van Binsbergen, Nozawa, and Schwert (2025) does not generate the same duration as the corresponding corporate bond.[45]

[45] If we redefine duration by discounting individual cash flows with their respective zero yields, this portfolio delivers the exact matched duration value. However, calculating duration this way is difficult for corporate bonds, whose full zero-coupon yield curve is typically not available. Furthermore, under this alternative definition, we can no longer treat duration as the negative of the first derivative of the log bond price with

Recursive iterations

We propose a recursive procedure to achieve exact duration matching. We use the portfolio of van Binsbergen, Nozawa, and Schwert (2025) as the starting point of the iterations, since it already generates a close duration value.

(i) We initialize $\mathrm{CF}_{t_n}^{i,\mathrm{Trsy}} = \omega_{t,t_n}^{i} \times e^{z_{t,t_n}(t_n-t)}$ for all $n \in \{1, \cdots, N\}$, as proposed by van Binsbergen, Nozawa, and Schwert (2025). As shown above, the price of this cash flow stream $P_t^{i,\mathrm{Trsy}}$ equals 1, so we can find the yield to maturity $y_t^{i,\mathrm{Trsy}}$ using equation (B.4). We denote them as $\left\{{}^{(0)}P_t^{i,\mathrm{Trsy}}, {}^{(0)}y_t^{i,\mathrm{Trsy}}\right\}$.

(ii) Given $\left\{{}^{(\mathrm{k})}P_t^{i,\mathrm{Trsy}}, {}^{(\mathrm{k})}y_t^{i,\mathrm{Trsy}}\right\}$ from the previous iteration, we update each cash flow $\mathrm{CF}_{t_n}^{i,\mathrm{Trsy}}$ for $n \in \{1, \cdots, N\}$ so that the duration matching condition in equation (B.3) is met:

$$\mathrm{CF}_{t_n}^{i,\mathrm{Trsy}} = e^{{}^{(\mathrm{k})}y_t^{i,\mathrm{Trsy}}(t_n-t)} \times {}^{(\mathrm{k})}P_t^{i,\mathrm{Trsy}} \times \frac{\mathrm{PV}_t\left(\mathrm{CF}_{t_n}^{i}; y_t^{i}\right)}{P_t^{i}}.$$

The updated cash flow stream implies new values for the price and yield. The updated price ${}^{(\mathrm{k}+1)}P_t^{i,\mathrm{Trsy}}$ is obtained from

$${}^{(\mathrm{k}+1)}P_t^{i,\mathrm{Trsy}} = \sum_{n=1}^{N} \mathrm{CF}_{t_n}^{i,\mathrm{Trsy}} e^{-z_{t,t_n}(t_n-t)},$$

and the updated yield to maturity ${}^{(\mathrm{k}+1)}y_t^{i,\mathrm{Trsy}}$ is backsolved from

$${}^{(\mathrm{k}+1)}P_t^{i,\mathrm{Trsy}} = \sum_{n=1}^{N} \mathrm{PV}_t\left(\mathrm{CF}_{t_n}^{i,\mathrm{Trsy}}; {}^{(\mathrm{k}+1)}y_t^{i,\mathrm{Trsy}}\right).$$

(iii) If $\left\{{}^{(\mathrm{k})}P_t^{i,\mathrm{Trsy}}, {}^{(\mathrm{k})}y_t^{i,\mathrm{Trsy}}\right\}$ and $\left\{{}^{(\mathrm{k}+1)}P_t^{i,\mathrm{Trsy}}, {}^{(\mathrm{k}+1)}y_t^{i,\mathrm{Trsy}}\right\}$ are close within a pre-specified tolerance level, the procedure terminates; otherwise, we return to (ii) and repeat until convergence. In our implementation, convergence is typically reached within a small number of iterations.

respect to the bond's yield to maturity.

Once we obtain the cash flow stream that exactly matches the duration, we can implement it with a portfolio of zero-coupon Treasury bonds. The portfolio weights are now recalculated by

$$\omega^i_{t,t_n} = \frac{\mathrm{CF}^{i,\mathrm{Trsy}}_{t_n} \times e^{-z_{t,t_n}(t_n - t)}}{P^{i,\mathrm{Trsy}}_t}, \text{ for all } n \in \{1, \cdots, N\}.$$

The return on this duration-matched portfolio $r^{i,\mathrm{Trsy}}_{t+1}$ is then calculated as the weighted average return on zero-coupon Treasuries using ω^i_{t,t_n} as weights.

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