Railroad Bailouts in the Great Depression

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Abstract

U.S. railroads received loans from the Reconstruction Finance Corporation starting in February 1932, at below-market rates, primarily to meet interest and principal repayments on their debt. Almost all loan requests were approved. The first loan approval that a railroad received was associated with a 55 basis point increase in the credit spreads of its bonds, even after conditioning on observable determinants of credit risk. The benefit of receiving a loan at concessional interest rates was outweighed by the negative signal that the firm was unable to access credit through regular channels. Subsequent RFC loans are weakly associated with lower credit spreads for the railroad's bonds. Speculative grade railroad bonds are the most affected by news of a government loan, those bonds' spreads increase by over 260 basis points, whereas investment grade bonds' spreads are little changed.

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1 Introduction

In a financial crisis the banking sector is often the recipient of concessional loans, equity infusions, or other transfers from the government. The effects of government bailouts on financial firms, and their desirability, have been extensively studied (see e.g., Diamond and Rajan (2002), Acharya and Yorulmazer (2008), Gorton and Huang (2004), Stern and Feldman (2004), Farhi and Tirole (2012), Leitner (2005), and many others). Such bailouts are understandable, given the multiple connections between the financial and real sectors of the economy and the danger of 'runs' on the banking sector. A crisis in the financial sector can easily spillover into the real sector, as Efraim Benmelech and Ramcharan (2017) demonstrate in the market for automobiles, and automobile loans, during the 2007-08 episode.

Bailouts of non-financial firms, in contrast, have been little studied. Yet, non-financial firms have received large amounts of government largesse during a crisis. One quarter of all Troubled Asset Relief Program (TARP) money went to U.S. auto-manufacturers (see Goolsbee and Krueger (2015) and *U.S. Department of the Treasury* TARP reports). Over half of the value of Reconstruction Finance Corporation (RFC) loans approved during the 1930s went to the non-financial sector: railroads, agriculture, industrial firms and others.

Financial firms are different to non-financial firms when they are in distress. 'Runs' on the demand deposits that support a bank's assets are possible. In addition, a financial firm can dramatically change its business operations - for example, by reducing loans (to preserve cash reserves) or taking on increasingly risky loans to 'gamble on resurrection' (see e.g., Thomas Hellmann and Stiglitz (2000) and Dewatripont and Tirole (2012)). In contrast, non-financial firms face few of these issues. U.S. railroads often issued 50-year bonds to finance their operations, so unless their bonds were nearing maturity there could be no run on the railroad's debt. Taking on increased risk in a crisis is difficult for railroads (or non-financial firms in general), tracks are fixed and costly to divert in the search for new customers. One similarity with banks is that non-financial firms can also conserve cash reserves when in financial distress. Mason and Schiffman (2004) show that railroads retained cash in the early 1930s by reducing maintenance expenditures.

An advantage of studying railroads during the Great Depression is that the market's assessment of the bailout is immediately available - the bonds were traded on the New York Stock Exchange. In contrast U.S. banks in this era were generally not listed on a stock exchange, and bailouts to U.S. automakers in the recent crisis only went to two firms, one of which was a private firm.

We construct option adjusted spreads (over U.S. Treasuries) for industrial, railroad and utility bonds listed on the New York Stock Exchange on a monthly basis. The immediate impact of the granting of an RFC loan is impossible to observe in some sectors - banks, farms, and industrial firms' loans were mostly kept secret, and financial claims on these firms were not traded in liquid financial markets. In contrast, RFC loans to railroads were to some of the largest firms in existence - the Baltimore and Ohio and the New York Central Railroads had balance sheets in excess of one billion dollars and operated more than 5,000 miles of track. Details of government railroad loans were also quickly made public by the railroad regulator, the Interstate Commerce Commission (ICC).

In the month in which a railroad was approved for its first bailout, the spread increased by 55 basis points, on average. This effect is concentrated in the spreads of speculative bonds (with Moody's ratings of Ba or below). Speculative bonds' spreads increased by 286 basis points, whereas spreads for investment grade railroad bonds only rose by 10 basis points. We also test if the impact of such government bailouts was temporary or permanent. We regress OAS levels on bailout dummy variables, while conditioning on characteristics typically used to explain bond yields such as leverage, profitability, equity volatility, and liquidity. From the month in which a railroad was bailed out until the end of 1940, that railroads' spreads were 247 basis points higher than an otherwise identical railroad that had not received a government bailout. However, this effect is most concentrated in investment grade bonds, whose spreads rose by 166 basis points on average. A bailout for an investment grade bond had little immediate impact on spreads, however, after a bailout such bonds began to be downgraded by Moodys and their spreads widened.

The Great Depression was an unprecedented period of economic and financial collapse worldwide. It struck the U.S. particularly severely with peak to trough industrial output falling 40% by late 1931 and GDP still 25% below trend six years after the recovery began (see Cole and Ohanian (2004) and Ohanian (2009)). There were several waves of banking crises in the early 1930s (see Bernanke (1983) and Friedman and Schwarz (1963)). In response to the weak economy and runs on troubled banks, newly-elected President Roosevelt created the Reconstruction Finance Corporation in January 1932, a component of what came to be known as the 'New Deal'. The RFC was initially permitted to loan to financial firms and railroads; lending power was later extended to farms, state and local government, infrastructure projects, and industrial loans. Loans to railroads were available for lengths of up to three years, as long as they were 'adequately secured' and if the railroad was unable to obtain funds on reasonable terms from a bank or via the bond market.

The RFC approved railroad loans of $361 million in 1932, just over 18% of all loans made by the corporation in that year. From 1932 to 1940 the RFC approved $1,752 million in loans to railroads (including roll-overs of existing loans). All RFC loans to railroads needed the approval of the Interstate Commerce Commission (ICC) as well as the RFC. Although disclosure of RFC loans to financial institutions was sporadic, all railroad loans were publicly disclosed at, or near, the time of loan application and approval.[1] The ICC had a policy of virtually full disclosure of railroad loans. The ICC sometimes delayed publication slightly; for example, the Baltimore and Ohio Railroad's loan application was kept secret for 10 days in August 1932, and it would sometimes allow a railroad to quietly drop a loan application without formally rejecting the loan. Although both the RFC and the ICC had to formally approve any railroad loan, *de facto* loan granting approval resided

[1] Initially RFC loans to financial firms were secret, then in August 1932 the recipients were publicly disclosed, and after May 1933, following a Congressional vote, recipients were kept secret.

with the ICC. For example, the *New York Times* reported on August 20, 1932: 'the Interstate Commerce Commission approved today a $31,625,000 loan to the Baltimore and Ohio Railroad.' *De jure* approval by the RFC was not normally considered newsworthy.

The extension of loans to institutions is problematic. All else equal, concessional loan offers to randomly selected recipients cannot harm the intended recipient - since the recipient can always decline the offer. However, in a financial crisis loans are not granted at random, and a request or the offer of a loan may be a negative signal about the quality of the firm's assets in the presence of information asymmetry between management and outsiders. In particular, disclosure of the names of banks that have accepted loans may facilitate a run on demand deposits at a financial institution, even if it is sound (see Diamond and Dybvig (1983)). Indeed the RFC loans were kept secret: 'in the belief that publication, at least in the case of banks, might prove harmful.'[2] During the 2007-08 financial crisis the U.S. Treasury forced nine of the nation's largest banks to accept a government equity infusion, whether they wanted it or not, to prevent markets inferring bank quality from those who did and did not request a government loan.[3]

Richardson and Troost (2009) find that specifically targeted aid to banks reduced financial distress during the Great Depression. Mason (2001) demonstrates that bank recapitalizations were successful in reducing bank distress, although RFC loans may well have made banks more likely to fail. Butkiewicz (1995) finds that RFC assistance to the financial sector during the Depression helped banks which accepted government loans, although he finds that such assistance weakened after lists of the recipients of RFC money were disclosed from August 1932 onwards. Financial institutions differ from other sectors of the economy in that their assets are funded largely via short-term liabilities, demand deposits. A negative signal about a bank, that it has requested government assistance, may be far more damaging to that firm's survival than an equivalent signal about a non-financial firm since banks are vulnerable to runs. Therefore, the large negative response of financial markets to news of the bailouts of non-financial firms suggests that the market's response to an equivalent bailout of a bank would be more severe. Therefore policymakers' intuition that keeping bailout firms' identities secret, in order to contain a crisis, is well founded.

Mason(2003) argues that RFC financing was not overly influenced by the political process, therefore the results we find can reasonably be interpreted as the impact of a government policy that aimed to reduce distress in the economy, rather than signals about which firms or industries were favoured in the political process. Assistance to the railroad industry was not an inconsequential part of the New Deal. The RFC distributed 21.4% of total funds over the 1934-40 period (see Fishback (2017)), and given the heavy lending the RFC was engaged in during 1932 and 1933 this amount is likely an understatement of the RFC's influence. Of the RFC's disbursements, 10.7% of the amount disbursed over the period 1932 to 1940 went to railroads, primarily for assistance with meeting interest and principal repayments.

[2] *New York Times* June 2, 1932

[3] (see http://www.nytimes.com/2008/10/15/business/economy/15bailout.html)

One insight from our study is the effect of government assistance to railroads during the Great Depression. The 'New Deal' has been extensively examined, with papers that study emergency relief, the Works Projects Administration, old-age assistance, relief spending, veterans' bonuses, unemployment insurance, the Tennessee Valley Authority, farm grants, bank loans, and the Home Owners' Loan Corporation (see Fishback (2017)). However, to the best of our knowledge, the only study on assistance to railroads is that of Mason and Schiffman (2004) which finds that railroads that received RFC loans reduced their maintenance expenditure to conserve cash.

Although bank intermediation was the primary means by which consumers and small businesses obtained credit, large firms had the possibility of issuing bonds on the New York Stock Exchange (NYSE). Corporate bonds were an integral part of the NYSE's business on the eve of the Great Depression. Hickman (1958) states that U.S. corporations had a par value of bonds outstanding of \$30.0 billion in 1930. In contrast, the market capitalization of NYSE equities was roughly \$60 billion in December 1928 and had fallen to about \$20 billion in December 1932 (see Graham et al. (2011)). As with other forms of financing, bond markets froze during the worst years of the Depression. From a peak of \$1.29 billion of new bond issues by industrial firms in 1927 the market shrunk so much that during all of 1933 only \$100,000 of industrial bonds were issued throughout the U.S. The experience for railroads and utilities was not so different, these industries were able to issue just 2.0% and 3.7% in 1933 of the amount that they had issued in 1927. This was despite the Federal Funds discount rate declining from 5.0% at the start of 1930 to 1.5% by 1937. Clearly, financing problems were not restricted to those borrowers dependent on bank intermediation.

There was an explosion of corporate debt default during the Great Depression. Giesecke et al. (2011) place the 1933-1935 period as the fourth worst default experience for the U.S. during the past 150 years with 12.88% by par value of corporate bonds defaulting during the period. The performance of the corporate bond market during the Great Depression has been studied by Durand (1942), Durand and Winn (1947), Hickman (1953, 1958, 1960), and Johnson (1967) using the NBER's *Corporate Bond Project* data. The NBER database includes all 'plain vanilla' corporate bonds issued over the 1900 to 1943 period larger than \$5 million, as well as a 10% sample of smaller bonds.

One major problem with these older studies is that there was no way to properly value callable bonds prior to the development of option pricing models by Black and Scholes (1973) and Merton (1973). As a result Durand and Winn's (1947) yield curves from 1900 to 1933 were constructed by excluding (p. 4): "bonds actually selling above call price."[4] In later years there were virtually no 'plain vanilla' bonds or callable bonds selling below their call price so he includes callables and concludes that his yield curves have a 'bias'. A further complication in all of these studies is that corporate bonds were taxable whereas Treasuries were (usually) tax-exempt and no proper tax treatment was attempted. There was great time-series variation in tax rates during this period,

[4]It is not clear if Durand excluded bonds whose market prices were above their call prices only during their call periods, or whether he excluded bonds whose market prices exceeded their call price before their call period had begun.

with the highest marginal tax rate rising from 25% in 1927 to 79% by 1940, and corporate tax rates rising from 13.5% to 50% over the same period. Capital gains are taxed uniformly at 12.5% during this period, although the holding period for assessment of capital gains changes several times in the 1930s. Johnson (1967) constructs yield curves by credit rating annually over the Great Depression. He finds a large widening in spreads, which peak at roughly 8% between Aaa and Baa in 1932. Researchers from Bernanke (1983) onwards have used similar figures, with an Aaa to Baa spread of 7.93% in June 1932, which he takes from the Federal Reserve's *Banking and Monetary History*, which uses data ultimately from *Moody's.* These spreads, as far as we can tell, ignore the callable feature of many bonds, any liquidity effects, as well as the adjustment necessary for corporate bonds being subject to income and capital gains taxes. Callability is more valuable the more volatile are short term interest rates, and not surprisingly volatility increased dramatically during the Great Depression. Correcting for tax and the callable features of bonds reduces the spread to around 2%, which suggests that lower quality bonds were not hit as severely by the crisis as has been previously thought, although of course many more bonds fell into the low rated category as the 1930s progressed.

2 Data

We compile data on every U.S. corporate bond traded on the New York Stock Exchange for which we observe at least 25 monthly price observations between January 1927 and December 1940. We obtain price and turnover data from *The New York Times* on the last trading day of every month, so that our data are contemporaneous with CRSP. These data appear in the *Domestic Bonds* section of *Bond Sales on the New York Stock Exchange.* We classify a bond as being in default if the issuer failed to meet a coupon or principal repayment, or in any way changed the terms of the issue (via negotiations with bondholders) such as extending the maturity of the bond, reducing the coupon rate, or exchanging the initial bond for another security.

We match bond issuers to CRSP data. Since many bond issuers had been taken over by other firms by the time of our sample, or were controlled by parent companies, we track the corporation which had ultimate responsibility for servicing the bond payments. We collect data on bond issuers' financials from the *Commercial and Financial Chronicle* and various issues of *Moody's Manual of Investments: Industrial Securities*, *Moody's Manual of Investments: Public Utility Securities*, and *Moody's Manual of Investments: Railroad Securities.*

We have a total of 905 bonds in our dataset of which 221 are plain-vanilla bonds, 589 are callable (but not convertible), 5 are convertible (but not callable), and 90 are both callable and convertible. We cross-tabulate the bonds by industry and type in Table I. Our sample comprises 423 railroad bonds, 199 utility bonds, 267 industrial bonds, and 16 bank and finance bonds (which come mostly from real estate companies). With the exception of railroad bonds, many of which were issued in the 19th century, almost all bonds are callable.

We present summary statistics of the bonds issued by year of issue in Table II. In Panel A we see that there were many new issues of bonds in the late 1920s followed by a collapse during the Great Depression and a recovery by 1935. After the Wall Street crash of 1929 the bond market began to dry up for lower rated bonds, with the average rating at issue rising from 3.56 (halfway between A and Baa) in 1929 to 1.75 in 1932 (better than Aa). The coupon rates at issue remained roughly constant until the mid 1930s when treasury rates fell to 1-2%, and coupons dropped to roughly 4%. There was much year to year variation in the issue size and maturity of a bond but the long-term average was $25-30 million and 25-30 years respectively. Virtually all new bonds issued in our sample were callable. We have more than 550 bonds with which to estimate yields (see Panel B) with fewer bonds at the beginning and end of our sample. Unsurprisingly, there was a marked deterioration in bond quality over the period, with the average rating dropping from 2.61 in 1927 to 5.20 (worse than Ba) by 1940. The average coupon, size, and maturity are little different between newly issued and all outstanding bonds, with the exception that all outstanding bonds were generally of a longer maturity and less likely to be callable. This is principally due to long maturity railroad bonds, many of which had been issued in the late nineteenth or early twentieth centuries.

To gain an understanding of the overall NYSE bond market we collect data on the value of new bond issues, bond redemptions (which includes bonds called before maturity, but does not include maturing bonds), and all bonds listed on the NYSE from *The New York Times'* annual financial issue.[5] There were a total of 1906 corporate bonds listed at any point in time from 1927 to 1940 on the NYSE according to the annual financial issue. The requirement of at least 25 monthly prices tends to exclude bonds that were present towards the edges of our data sample. The percentage of total NYSE corporate bond turnover accounted for by our 905 bonds ranges from 72.4% in 1927 up to 92.5% in 1933 (see Table II, Panel B).

Due to the difficulties in pricing bonds that are both convertible and callable we delete the the callable and convertible bonds as well as the five convertible bonds which leaves us with 810. We then delete bonds that have 'exotic' call provisions leaving 758.[6] In Table III we present summary statistics of the remaining bonds, split into 'plain vanilla' (Panel A), and callable (Panel B). Since the vast majority of plain vanilla bonds were railroad bonds the differences between vanilla and callable bonds are partly due to the different industries for the firms which issued these bonds. The bonds in our sample were issued between 1868 and 1938, with a time to maturity (at issue) ranging from three to 475 years. Plain vanilla bonds were usually larger when first issued (a mean size of $48.2 million) than callable bonds (with a mean of $27.8 million). The plain vanillas tended to have higher ratings at issue (1.40 vs. 2.91) and throughout the sample (3.27 vs. 3.84) than callable bonds. However, plain vanilla bonds were more likely to be in default throughout our sample, 40.1%

[5] The annual financial issue usually appeared on January 1, 2, or 3.

[6] We keep bonds which are callable on any date (usually after an initial non-call period), that is 'American' style, as well as bonds which are callable only on coupon dates, that is 'semi-Americans'. We exclude 'exotic' bonds which are e.g., callable on the first business day of the month, callable on the 1st of January, and those whose call notice periods vary over time etc.

of all bond-months, than callable bonds, 27.9%. Very few plain vanilla bonds used sinking funds (11.8%) compared to callable bonds (44.2%). The vast majority of plain vanilla bonds (93.5%) were backed by specific collateral whereas it was less common for callable bonds to have collateral (81.0%). Of the callable bonds one quarter were American-style (callable at any time during the call period) and the remainder were semi-American (callable only on coupon dates). 82.7% of the callable bonds were within their call periods in our sample, and the average bond had spent 8.1 years in its call period.

Once a bond has defaulted we drop the bond from the sample in terms of estimating yields and spreads. We also exclude bonds which had more than 50 years to run until maturity, since these maturities vastly exceeded the longest maturity Treasury bonds. We obtain data on Treasury notes, certificates, bills and bonds from CRSP. We thank Steve Cecchetti for his data on bonds' 'exchange privileges' (see Cecchetti (1988)).

We collect data on personal, corporate, and capital gains tax rates from the various *Revenue Acts* passed by the U.S. Federal government. Corporate tax rates were generally flat (above a very low threshold). Capital gains tax rates were steady at 12.5% over the entire sample. However, in the early years of the sample an asset had to be held for at least 2 years to qualify for this rate, by the later period capital gains tax was levied on a sliding scale with reductions in the taxable gain increasing the longer the asset had been held prior to sale. The personal tax rate ranged from 1.5% to 25% in 1927 before ratcheting up to 4% to 79% in 1940. To narrow down the average tax rate paid by corporate bond investors we use *Statistics of Income for (yyyy)* published by the Commissioner for Internal Revenue (see Table IV).

We search the *New York Times*, available via *ProQuest Historical Newspapers*, for the phrases 'Reconstruction Finance Corporation' and 'Public Works Administration' in every edition from January 1932 until December 1940. The Public Works Administration (PWA) also made loans to railroads. PWA loans tended to be smaller and used for capital expenditure rather than to service the railroad's debt. We read the articles returned by those searches for evidence that a RFC or PWA loan had been applied for by a railroad, or had been approved. We collect the date of the application, or approval, the name of the railroad, and the size of the loan. It is impossible to exactly match loan applications and approvals. A railroad would occasionally have several applications outstanding, and the size of the loan could change between the application date and the approval date. We treat an 'approval' as the date on which it became clear that the RFC (or *de facto* the ICC) would approve a loan. Occasionally, informal approval would come before an application - for example, the head of the RFC would occasionally state that the Corporation would be willing to grant a loan to a certain railroad if it were to apply. Loan approvals were quicky, usually taking a couple of weeks to a month or two. Therefore, given we use monthly data, we do not separate our analysis to investigate loan applications and approvals separately.

3 Bond Pricing

3.1 Curve Fitting

We construct yield curves sorted either by issuing firm, or by credit class. In both cases, we price bonds using a discount curve composed of two parts. The first part is generated using Treasury data, and is an appropriate discount curve for valuing a default-free security. We denote this $d_t^0(\tau)$. The second part is a spread curve (denoted $d_t^i(\tau)$ for the ith curve) which is multiplied by the treasury curve to generate a discount curve for a particular subset of bonds. A non-callable bond of category i can then be valued as

$$P_t^j = \sum_{k=1}^{K} CF_{t_k}^j d_t^0(t_k) d_t^i(t_k),$$

where P_t^j is the time t price of bond j and $CF_{t_k}^j$ is the k-th cash flow of the bond, occurring at time t_k. The K-th cash flow is at maturity and consists partly of coupon payment and partly of principal. We construct the curves $d_t^0(\tau)$ and $d_t^i(\tau)$ using cubic splines, with knot points set at 5, 10, 20 and 50 years (see McCulloch (1975)). Cubic splines are fit so as to minimise the squared errors of bond prices, with an additional penalty for curvature at longer maturities (following Waggoner (1997)). This avoids problems where longer maturity bonds are fit well by the curve, at the expense of shorter maturity bonds. Knot points are removed when no bonds mature on a particular segment of the curve.

3.2 Callable Bond Pricing

Over 70% of our data are callable, so we use callable bonds to estimate spreads. Further, the inclusion of callable bonds provides us with insight as to the expectations of market participants for interest rate volatility over the life of these bonds.

We price callable bonds using the lattice method outlined in Daglish (2010). The lattice is formed so as to consistently price zero coupon bonds according to the discount curve outlined in section 3.1. We assume that short rates evolve according to the Black and Karasinski (1991) model:

$$d \log r = (\theta(t) - \lambda \log r)dt + \sigma dz,$$

where $\theta(t)$ is a function which is calibrated to generate discount rates consistent with the yield curve, λ and σ are constants, dt is an increment of time and dz is an increment of a Brownian motion. Implementing the model requires the further input of σ and λ. To calculate these, we follow a similar methodology to Pan (2002). We first calibrate our model using only non-callable debt. Since these bonds' prices depend on neither σ nor λ, we can obtain yield curves without any assumption on interest rate process. We then use the time series of these yield curves to estimate the volatility of log interest rates for two maturities (one year and twenty year, chosen as reasonably liquid maturities). From the Vasicek (1977) model, we know that the volatility of a T period log interest rate in the Black and Karasinski (1991) model with constant $\theta(t)$ is given by:

$$\sigma(T) = \frac{\sigma}{\sqrt{2\lambda}}\sqrt{1 - e^{-2\lambda T}}.$$

We choose σ and λ to match the two volatilities of log interest rates that we have calculated. With these values, we are then able repeat our yield curve fitting, now incorporating the callable bonds. These generate a new time series of yield curves, which allow us to re-calibrate σ and λ to volatility. We repeat this process iteratively until our estimates of σ and λ converge. The resulting parameter estimates generate yield curves (incorporating callable bond data) that are internally consistent: the curves have time series volatility that is consistent with the levels of σ and λ that were used to generate the curves.

A further issue regarding the pricing of callable bonds is the notice requirement. Corporate and treasury bonds routinely required notice to be given to bondholders before the bond was called. Occasionally the notice periods could not be found, therefore we assume a period of one month (this is the minimum notice period we find in our data). After 1934 the SEC required formal notification of a bond call, which added roughly one month's advance warning to bondholders. After 1934 we extend notice periods for corporate bonds by a further month. To account for this mismatch between the decision date of call and the actual date of call, we use the technique outlined in d'Halluin et al. (2001). We effectively keep track of a forward price for the underlying bond, and compare this to a discounted strike price to calculate the payoff from calling.

Bonds can be separated into American and semi-American types. A semi-American bond can be exercised only at specific dates (generally coupon payment dates), while an American bond can be exercised at any date provided notice is served. Calculating the price of a callable Treasury bond requires the solution of two pricing equations (see Daglish (2010) for a semi-American option) one for the bond itself, and one for the current discount factor required to evaluate for early exercise. For an American option, at any point in time, we need to solve one equation for the bond price, and $T_{Notice}/\Delta t$ additional equations (where T_{Notice} is the notice period and Δt is the time step of the lattice) in order to know at any point in time the T_{Notice} discount rate.

3.3 Exchange privileges

Treasury issues during the period we study were generally tax exempt securities. Those that were not tax exempt were generally held by corporations that were themselves tax exempt (see Cecchetti (1988)). Treasury bonds frequently had exchange privileges associated with their maturity. As discussed in Cecchetti (1988), new Treasury issues were made available to subscribers at par value, with coupons chosen to generate a market price slightly in excess of par. Subscribers filled a role similar to initial public offering (IPO) subscribers, making a profit on average. Since this was a profitable activity, issues were frequently oversubscribed, and priority was frequently given to holders of maturing Treasury bond issues, who surrendered their principal repayment in exchange for newly issued bonds. Due to this priority, treasury bonds frequently traded at prices in excess of their terminal payment as maturity approached. Ignoring this effect can result in the calculation of negative interest rates for short maturity Treasuries, and an understatement of longer maturity interest rates.

Following Cecchetti (1988), we calculate implied exchange privileges from bonds with short times to maturity. These reflect 'realised' exchange privileges, since they are privileges inferred from prices pending maturity. Investors prior to maturity may have been unable to anticipate these privilege values exactly (they varied from new issue to new issue and exchange privileges disappeared as a phenomenon in the 1940s). Hence, when pricing Treasury bonds, we calibrate an additional exchange privilege value to be applied to all bonds (taken to be constant across a three month window), chosen along with the yield curve to minimise the squared pricing errors. We constrain this exchange privilege value to be positive and less than or equal to the maximum realised exchange privilege ($1.66 per $100 of principal).

The requirement to estimate an exchange privilege may reduce our degrees of freedom available on any given date. We follow a process to eliminate knot points from our curves to ensure that we have sufficient degrees of freedom to estimate not only the curves themselves, but this additional parameter. To mitigate this simplification of the term structure, we use three month rolling windows for our Treasury estimation, whereby individual curves are fit to each month, but similar tax and dynamics parameters are used across all three months. We remove knots from the first month's curve to ensure identification of parameters, allowing us to retain a complex curve on the third month. Our results report these "third month" curves except for January and February 1927, when we have no preceding data.

3.4 Taxes and Tax Shields

In contrast to Treasury bonds and notes, corporate bonds *were* subject to taxation for investors during the period 1927-1940. This taxation took two forms. First, coupon payments were subject to income tax. Second, capital gains and losses were realised at maturity, call, or sale of the bond.

McCulloch (1975) shows that the presence of a capital gains tax results in an endogeneity with respect to price: cash flows at maturity or call depend on the tax, which in turn depend on the price paid today. Formally, a investor would value a non-callable bond as:

$$\begin{aligned} P_t^j &= \sum_{k=1}^{K-1} CF_{t_k}^j (1 - tax_{income}) d_t^0(t_k) d_t^i(t_k) \\ &\quad + \left[(CF_{t_K} - 100)(1 - tax_{income}) + 100 - (100 - P_t^j) tax_{capital} \right] d_t^0(t_K). \end{aligned}$$

We solve this equation for P_t^j in order to extract tax-consistent valuations of non-callable bonds. For callable bonds, the capital gain is more complicated, since it could either occur at maturity, or, in the event of the bond being called early, at the date of call. In valuing callable bonds, we follow a similar process, but where the discount factor for the capital gains tax is calculated as the value of $1 paid at termination of the bond.

The last consideration for callable bonds is the issue of tax shields. A corporation may face a different tax rate to its bondholders, and therefore there may be a mismatch between call policies which maximise firm value and those which minimise bond value (see Mauer and Lewellen (1987)). We model the firm's decision to call its debt in order to minimise the value of their liability (i.e. maximising the value of the equity component of the firm). We assume that, on call, the firm issues an identical non-callable bond. Effectively we assume that the firm refinances so as to keep the structure of their debt identical to pre-call, presumably resulting in a one-off cash flow since the new issue will be cheaper than the call price paid to retire the old.

The firm's valuation of this noncallable bond is based on the *after tax* coupons (i.e. coupons are deflated by the firm's corporate tax rate). This bond may be issued at a price which differs from par. As a result, the corporation will pay corporate tax (at maturity) if the bond is issued above par (the company will have discharged a debt for $100 which exceeded $100 on its books, and therefore made a profit) or will receive a tax credit at maturity if the bond's value is below par (the company will have paid $100 to discharge a debt with book value less than $100). When deciding whether to call the original, callable, bond, the firm compares its valuation of the new debt to the amount it must pay the existing debtholders to call the bond issue. We assume that all bonds in our data were originally issued at par (a common practice). Therefore the tax due at the time of calling is the corporation's tax rate multiplied by $100 minus the call price of the bond.

Corporate and capital gains tax rates are directly observable. However, income tax rates paid by investors may depend on a particular tax clientele. We use U.S. Treasury annual reports to calculate a weighted average tax rate for non-tax-exempt bond holders (i.e. we weight tax rates by the dollar value of taxable interest earned by that particular tax bracket). We repeat this calculation for each year, and use this as the income tax rate for our bond pricing calculations.

To account for tax shields we need to solve for:

1. The option-free bond that would be issued if the callable was called, both from the perspective of the issuer and the bondholder (two equations).
2. The callable bond from the perspective of the issuer and the bondholder (two equations).
3. The present value of $1 paid at maturity or call of the bond, to determine the effect of capital gains tax (one equation).
4. The present value of $1 paid at the next callable date (for a semi-American callable) or T_{Notice} in the future (for an American callable) (one or $T_{Notice}/\Delta t$ equations).

Hence pricing a callable corporate bond requires the solution of at least six partial differential equations in tandem. This computational cost is mitigated, however, by the fact that the drift term constant ($\theta(t)$) is identical across all the equations, and thus the calibration to the yield curve need only be done once to price a particular bond.[7]

3.5 Option Adjusted Spreads

We now compute a measure of the extent to which an individual corporate bond's value differs from a comparable treasury. We do this by calculating an Option Adjusted Spread (OAS) for the bond. To find the OAS, we begin by pricing the bond using a lattice calibrated to *Treasury discount factors*, using volatility parameters for the bond's particular credit class, and tax effects as discussed above. We then perturb all interest rates in the lattice used to price the particular bond by an identical amount. We vary this spread until the lattice correctly prices the bond. Effectively, we calculate the size of the parallel shift which must be applied to the treasury curve in order for it to be used to price this bond. Positive numbers indicate that the bond is less valuable than a comparable treasury, while negative numbers indicate a greater value. This spread, since callability and tax effects have been accounted for, is a combination of credit risk and liquidity. Since some corporate bonds may in fact be *more* liquid than Treasury bonds, the spread can be negative.[8]

4 Results

4.1 Spreads

In Table V, we show the distribution of bonds in our sample across time and across credit classes. Consistent with the results of Hickman (1958) there is a marked deterioration in the credit quality of bonds, as assessed by Moody's. In 1927 there were 138 Aaa ranked bonds in our sample, by 1940 there are only 12 of this rating. At the other end of the spectrum, in 1927 there were just 6 B ranked bonds, but by 1940 40 bonds were rated in this category. Table VI presents descriptive statistics of all bonds (panel A) and (in Panel B) railroad bonds that we use for our analysis. Equity volatility, debt to total assets, earnings before interest and taxes (EBIT) to total assets, and cash to firm debt are calculated for the firm that services the bond.

[7] In theory we need only calculate this once for a given day/credit class of bond, however since bond maturities are rarely round numbers, we require an uneven first time step for our lattices. Because of this, we calculate $\theta(t)$ for bonds of a particular credit class that mature on a particular day of the month.

[8] Our method differs slightly from a textbook OAS calculation (see e.g. Hull (2006)) in-so-far as we use interest dynamics for corporate bonds rather than for Treasuries, and we incorporate the effects of tax shields, as discussed above. We do this because we believe that many lower rated corporate bonds may have had more volatile interest rate processes than Treasuries, resulting in relatively larger call option values (although this is mitigated by the fact that these options are further out of the money).

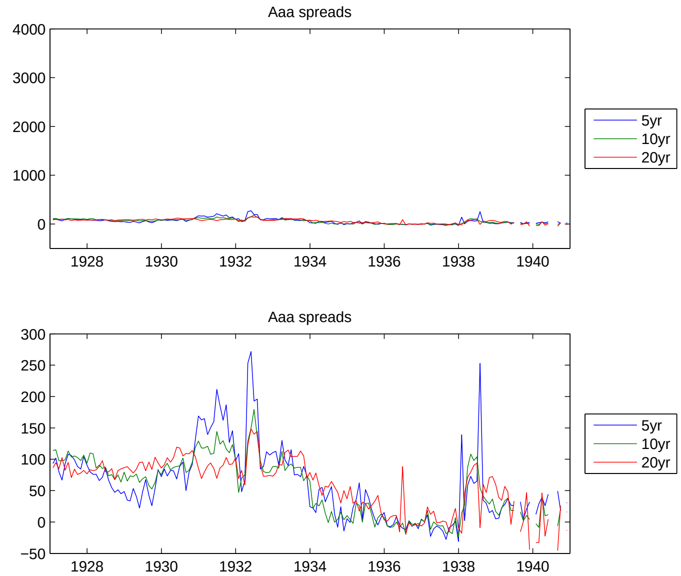

Figure 1: Option Adjusted Spreads, Aaa rated bonds.

In Table VII we present annual data on the OASs of the bonds in our sample. These figures have not been adjusted for liquidity effects, therefore the negative spreads for Aaa bonds may reflect the more desirable feature of them, increased liquidity through trading on the NYSE. In contrast Treasuries were traded via a more opaque dealer market. We see a flare up in spreads on all credit ratings between 1931-1933 and again, following a second recession that began in 1937, from 1938 onwards (see Figures 1 and 2). The average spread over 1931-33 jumped by 47 basis points for the Aaa class over the average level in 1927-29. In contrast the spread for Baa bonds jumped by 91 basis points, and B bonds by 291 basis points over the same time horizon.

Our estimation of yield curves is complicated by the issue that financial distress and eventual default may not occur evenly through a bond's life, but rather there is a concentration of risk at maturity. As Johnson (1967) puts it: "most of them [the firms] refinance in the bond markets - the success of which depends upon the earning power and financial position of the [firm]." Harold (1938) viewed short-maturity bonds as being generally safer than their longer lived cousins although: "short maturities become an element of weakness in crisis periods." Such a phenomenon has become known as 'crisis-at-maturity.' The difficulty of refinancing may differ between credit classes, with higher rated bonds easy to roll-over in times of trouble, but lower rated bonds difficult or impossible to refinance. Johnson finds evidence of such an effect during the Depression with an upward sloping yield curve for high quality bonds from 1933 onwards combined with a downward sloping curve for lower quality bonds. Bondholders anticipated, correctly, major problems for lower rated firms which wished to refinance debt during the Depression. He is however, unable to quantitatively distinguish between rising yields that are due to credit risk and those that are due to liquidity issues.

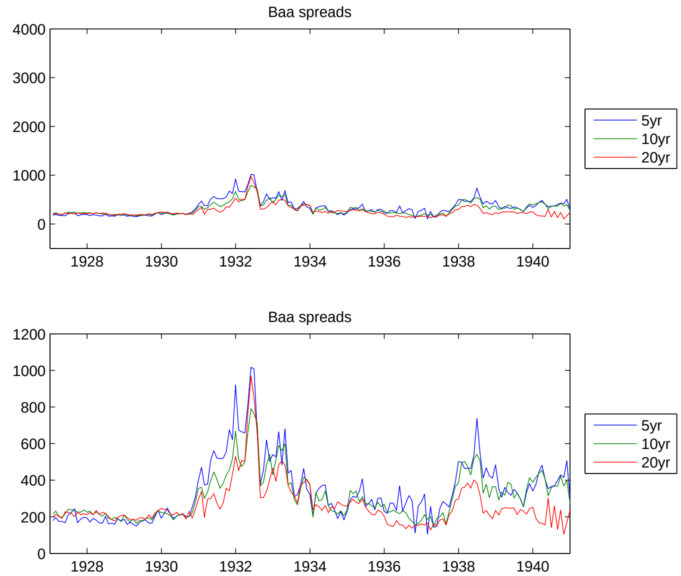

Figure 2: Option Adjusted Spreads, Baa rated bonds.

4.2 RFC loans

We investigate the announcement effect of an RFC loan by examining the change in the option adjusted spread from the end of the month before the loan was approved until the end of the month in which the loan was approved in Table VIII. We measure the impact of all loan approvals, and also the impact of the first loan approval on the OAS. In general, a loan approval results in a decrease in the spread of 40 to 60 basis points, although this effect is never statistically significant.

However, approval of the first RFC loan is clearly different. Uncertainty about whether or not a particular railroad would need to seek government assistance, and if such assistance would be forthcoming, was likely higher than the uncertainty about whether a railroad would receive a second, third, or subsequent loan. The announcement of the first loan is much worse news for bondholders than the second or subsequent loans - spreads widen by 115 to 154 basis points more than they change following the announcement of a subsequent loan, and this difference is statistically significant. The total impact of the first announcement (the sum of the two coefficients) is an increase in spreads of 55 to 65 basis points, depending on which specification is used. This effect cannot be explained by changing bond conditions which are contemporaneous to the announcement of the loan approval. When we condition on changes in the bond's turnover (a measure of liquidity), the change in the volatility of the servicer's common stock, the increase in the debt burden, the change in EBIT to total assets, the change in cash to total assets, and the size of the RFC loan the effect is virtually unchanged.

A concern is that government bailout policy may depend on the state of the railroad *industry* rather than the situation of one or several firms. When times were tough in the railroad industry more

RFC loans may have been forthcoming at the same time as railroad spreads were rising. To address this concern we condition on Railroad Industry times month fixed effects in columns (3) and (6) through (9). These fixed effects allow the overall spreads of railroads to be changing, relative to utilities and industrial firms, on a monthly basis due to industry shocks or political events. Adding interactive fixed effects does not greatly diminish the effect we find of the first loan.

In Table IX we separate the analysis between investment and speculative grade bonds. News of the first bailout for investment grade bonds differs from the (generally positive) news of subsequent bailouts, but the total impact (the sum of the coefficients of *Just Approved* and *First Approved*) is economically trivial. The situation is much different for speculative grade bonds. Railroads whose bonds were rated Ba or below saw their option adjusted spread rise by about 300 basis points upon news of their first bailout. When we condition on the full set of characteristics (column (8)) this imapct of first announcement declines slightly to about 285 basis points.

In Table X we investigate the long run impact of obtaining an RFC or PWA loan. We define a dummy variable, *Approved* which is equal to one in the month of the first loan approval, and every subsequent month. We then regress OASs on *Approved*, an interaction of *Approved* and *Maturity* to allow the long-run effect to differ by the maturity of the bond, and controls at the bond servicer level. An approval of an RFC or PWA loan for an investment grade railroad's bond was to increase the spread (over the remainder of the bond's life) by 166 basis points, for short maturity bonds, or roughly 72 basis points for an average maturity (22.6 year) bond (column (1)). In contrast loan approval for speculative grade bonds had little long-run impact (column (2)). We then allow the long-run impact to differ by the year in which the concessional loan was granted. In columns (4) through (6) we add dummy variables for the year in which the first concessional loan was granted. Initial loans granted at the start of the RFC program (1932 and 1933) resulted in lower increases in spreads for the bailed out railroad's bonds than loans granted later on in the 1930s.

A concern is that our results may be driven by Moody's subjective classification of which credit class a bond falls into. For example, Moody's may delay downgrading the recipient of an RFC loan, even as its price falls (and its spread rises). In Table XI we repeat the regressions of the previous table, except that we drop the dummy variables for credit classes. The results are little changed in Table XI, therefore our results are unlikely to be driven by Moody's ratings policy.

5 Conclusion

We examine the extension of concessional loans by government to non-financial firms during the Great Depression. The announcement that a railroad was approved for an initial Reconstruction Finance Corporation or Public Works Administration loan was associated with that railroad's bonds' spreads increasing by around 55 basis points. As the option to take a concessional loan could not be harmful (the loan could simply be rejected) the increase in spreads must be driven by the release of a negative signal about the situation of the receiving railroad. The long-run impact of government assistance on railroads' bonds was also negative. The mean spread, from the granting of the loan until default or 1940 (whichever came first), was a rise of 72 basis points, for a bond with 22 years to run until maturity, or 166 basis points for a bond about to mature.

Policy makers' intuition, that the identity of firms that receive government assistance in a crisis should be kept secret, appears well founded.

A Interest rate contingent claim pricing

This paper makes use of the Sandmann and Sondermann (1997) model for interest rates. Here

$$dr^* = \lambda(\theta(t) - r^*) + \sigma dz,$$

where dz is the increment of a Brownian motion. The short interest rate (r) is given by $r = \log(1 + \exp(r^*))$. This model has the appealing feature of exhibiting gaussian behaviour as $r \to \infty$ (ensuring that interest rates do not explode), but lognormal behaviour as $r \to 0$ (ensuring that interest rates do not become negative). We make use of two pricing techniques, one based on the Kolmogorov forward equation, and one based on the Kolmogorov backward equation.

A.1 Forward equation pricing

For calibration of σ and λ (see Appendix D), we use the differential equation

$$\frac{\partial \pi_1}{\partial t} + \lambda(\theta - r^*)\frac{\partial \pi_1}{\partial r^*} - \lambda \pi_1 - \frac{1}{2}\sigma^2 \frac{\partial^2 \pi_1}{\partial r^{*2}} = 0 \tag{1}$$

to solve for the ergodic distribution of r^* ($\pi_1(r^*, t)$), assuming θ is constant. Specifically, when $\theta(t)$ is constant. The solution to (1) when $\frac{\partial \pi_1}{\partial t} = 0$ describes the ergodic distribution of r^*. Incorporating $\frac{\partial \pi_1}{\partial t}$ into the equation allows us to iteratively solve for π_1 (see later).

A similar equation is used to derive the state price density of r^*, $\pi_2(r^*, t)$. In calibrating our model to the yield curve, we follow Hull and White (1993) and Daglish (2010), by building a lattice for r^*, assuming mean reversion to zero, and then shifting interest rates up to match zero coupon bond prices. Here, we solve the differential equation for $\theta \equiv 0$

$$\frac{\partial \pi_2}{\partial t} - \lambda r^* \frac{\partial \pi_2}{\partial r^*} - \lambda \pi_2 - \frac{1}{2}\sigma^2 \frac{\partial^2 \pi_2}{\partial r^{*2}} = -\log\left(1 + \alpha(t) e^{r^*}\right)\pi_2 \tag{2}$$

using the initial condition

$$\pi_2(r^*, 0) = \begin{cases} 1 \text{ if } r^* = r_0^* \\ 0 \text{ otherwise,} \end{cases} \tag{3}$$

where r_0^* is the current short rate. In this setting, $r = \log(1 + \exp(\log \alpha(t) + r^*)) \equiv \log(1 + \alpha(t)\exp(r^*))$, allowing $\alpha(t)$ to shift the short rates at time t up or down. The price of a T-period zero coupon bond should satisfy $P(T) = \int_{r^*} \pi_2(r^*, T)$. This relationship allows us to recursively solve for $\alpha(t)$ given a sequence of zero coupon bond prices.

We solve forward equations (1) and (2) using the Crank-Nicholson method, working forward from time zero. We discretise r^* over the range r_0^* to r_N^* ($r_k^* = r_0^* + (k-1)\Delta r^*$), and t over the range

$0 \ldots T$ to create a set of discrete *nodes* on which the equation will be solved.[9] We define the discretised operator:

$$\mathcal{L}_{\mathcal{F}}\pi_j(r^*,t) = \begin{cases} \lambda(\theta - r^*)\frac{\pi_j(r^*+\Delta r^*,t)-\pi_j(r^*-\Delta r^*,t)}{2\Delta r^*} \\ -\frac{\sigma(r^*,t)^2}{2}\frac{\pi_j(r^*+\Delta r,t)-2\pi_j(r^*,t)+\pi_j(r^*-\Delta r,t)}{\Delta r^{*2}} \\ -\left(\lambda + \log\left(1+\alpha(t)e^{r^*}\right)\right)\pi_j(r,t), & \text{if } r_0^* < r^* < r_N^* \\ 0, & \text{if } r^* = r_N^* \\ 0, & \text{if } r^* = r_0^*. \end{cases}$$

Here, for $j = 1$, $\alpha(t) \equiv 0$, and for $j = 2$, $\theta = 0$. We then solve for the vector of values $\pi_{j,l}$ in terms of the previous time-step $\pi_{j,l-1}$:

$$\frac{\pi_{j,l} - \pi_{j,l-1}}{t_l - t_{l-1}} = \mathcal{L}_{\mathcal{F}}\left(\frac{1}{2}\pi_{j,l} + \frac{1}{2}\pi_{j,l-1}\right). \tag{4}$$

Equation (4) defines a system of $N+1$ by $N+1$ equations that can be solved to calculate $\pi_{j,l}$.

For yield curve fitting, we can calculate the implied t_l bond price $P(t_l) = \sum \pi_{2,l}$. We then calculate $\alpha(t)$ by iterating until the implied zero coupon bond price is equal to the observed zero coupon bond price.

By solving this system repeatedly, the state price density (π_2) can be derived from the initial condition (3). Alternatively, an arbitrary initial condition for π_1 can be used, and (4) can be applied repeatedly (with $\alpha(t) = 0$) until $|\pi_{1,l} - \pi_{1,l-1}|$ converges to zero in order to derive the ergodic distribution of r^* for constant θ.

A.2 Backward equation pricing

Here, for time varying $\theta(t)$,

$$\frac{\partial f}{\partial t} + \lambda(-r^*)\frac{\partial f}{\partial r^*} + \frac{1}{2}\sigma^2\frac{\partial^2 f}{\partial r^{*2}} = \log\left(1 + \alpha(t)e^{r^*}\right)f, \tag{5}$$

or, for the case of a constant θ

$$\frac{\partial f}{\partial t} + \lambda(\theta - r^*)\frac{\partial f}{\partial r^*} + \frac{1}{2}\sigma^2\frac{\partial^2 f}{\partial r^{*2}} = \log\left(1 + e^{r^*}\right)f. \tag{6}$$

By applying suitable boundary conditions to (5) or (6), we can price bonds and other contingent

[9] For most applications in this paper, it is convenient to break the time interval into varying sub-intervals, so as to ensure that bond payments occur exactly on a given time step (see Appendix B).

claims on r^*. Similar to the forward equation, we discretise (5) and (6) to become

$$\mathcal{L}_{\mathcal{B}} f(r^*,t) = \begin{cases} \lambda(\theta - r^*)\frac{f(r^*+\Delta r^*,t)-f(r^*-\Delta r^*,t)}{2\Delta r^*} \\ +\frac{\sigma^2}{2}\frac{f(r^*+\Delta r^*,t)-2f(r^*,t)+f(r^*-\Delta r^*,t)}{\Delta r^{*2}} - \log\left(1+\alpha(t)e^{r^*}\right) f(r^*,t), & \text{if } 0 < r^* < r_N^* \\ \lambda(\theta - r^*)\frac{-f(r^*+2\Delta r^*,t)+4f(r^*+\Delta r^*,t)-3f(r^*,t)}{2\Delta r^*} \\ \frac{\sigma^2}{2}\frac{f(r^*+2\Delta r^*,t)-2f(r_N^*+\Delta r^*,t)+f(r^*,t)}{\Delta r^{*2}} - \log\left(1+\alpha(t)e^{r^*}\right) f(r^*,t), & \text{if } r^* = r_0^* \\ \lambda(\theta - r^*)\frac{3f(r^*,t)-4f(r^*-\Delta r^*,t)+f(r^*-2\Delta r^*,t)}{2\Delta r^*} \\ +\frac{\sigma^2}{2}\frac{f(r^*,t)-2f(r^*-\Delta r^*,t)+f(r^*-2\Delta r^*,t)}{\Delta r^{*2}} - \log\left(1+\alpha(t)e^{r^*}\right) f(r^*,t), & \text{if } r^* = r_N^*, \end{cases}$$

where $\theta = 0$ for solving (5) and $\alpha(t) = 0$ for solving (6). Solution follows by using f_{l+1} (the solution at timestep $l+1$) to generate f_l:

$$\frac{f_{l+1} - f_l}{t_{l+1} - t_l} = \mathcal{L}_{\mathcal{F}}\left(\frac{1}{2}f_l + \frac{1}{2}f_{l+1}\right). \tag{7}$$

This also defines a system of linear equations that are solved to step backwards through time to derive an asset's value. As discussed in Appendix B, by varying the boundary conditions, (5) can be sued ot price the components of a callable bond's value.

B Corporate bond pricing

Corporate bond valuation is complicated by the presence of three taxes. Bondholders must pay capital gains taxes τ_G on the capital gain that they realise between purchasing the bond and its maturity/call. They must also pay income tax τ_I on coupon payments. Corporations can avoid corporate tax τ_C on their coupon payments, but must pay corporate tax on capital gains due to calling of bonds.

B.1 Replacement bond: bondholder valuation

As in Sarkar (2001), we assume that if the (callable) bond of interest is called, it will be replaced with a bond with identical maturity and coupon, but *uncallable*. We value the replacement bond, incorporating income taxes and capital gains. At maturity, the bondholder will have to pay capital gains tax $\tau_G(100 - BVN)$, where BVN is the value of the bond at *time of purchase*. To correctly value the bond, we use a two step process: first, we calculate the value of the bond ignoring the fact that the current price will reduce the capital gains payment (BVN^*). Here we assume a capital gains tax payment of $100\tau_G$. We then correct for this to find the true value (BVN). We set a terminal condition of $BVN^*(r^*, T) = 100(1-\tau_G) + c(1-\tau_I)$, with periodic payments of $c(1-\tau_I)$. Coupons are incorporated into the valuation by solving (7) at each time step, and then adding coupons if a t_l is a coupon date. The value BVN^* has accounted for a capital gains tax payment of $100\tau_G$ at maturity. However, a buyer at time t knows that this payment (at maturity) will be offset by an amount $BVN(r^*, t)\tau_G$. Hence the amount a bondholder would actually pay at time t ($BVN(r^*, t)$) must satisfy:[10]

$$BVN(r^*, t) = BVN^*(r^*, t) + PVM(r^*, t)BVN(r^*, t)\tau_G \quad \Rightarrow \quad BVN(r^*, t) = \frac{BVN^*(r^*, t)}{1 - \tau_G PVM(r^*, T)},$$

where PVM is the present value of \$1 paid at maturity of the bond. To calculate this, we solve (5) subject to the boundary condition $PVM(r^*, T) = 1$.

B.2 Replacement bond: corporate valuation

The corporation's valuation of the replacement (non-callable) bond has two tax considerations (analogous to the bondholder valuation): income effects and capital gains effects. The income effect is that the corporation can claim coupon payments against its income (the net effect of this is to reduce the payment from c to $(1 - \tau_C)c$). The capital gains effect is that the issuer will have to pay $\tau_C(BVN - 100)$ at maturity, where BVN is the issue price (the *bondholder* valuation of the bond). If $BVN > 100$, the firm will have made a capital gain (by eliminating a piece of debt with book value BVN by paying \$100), while if $BVN < 100$, the firm will have made a book loss on paying the principal. We handle this in a similar fashion to the bondholder valuation, but in this case, we must use the *bondholder* valuation (BVN) to calculate the capital gain effect (rather than the corporate valuation). We value the replacement bond from the *corporate* perspective initially ignoring capital gains tax, setting the terminal value $CVN^*(r^*, T) = 100 + c(1 - \tau_C)$, and setting periodic payments to $c\tau_C$. To make the adjustment for capital gains, we set

$$CVN(r^*, t) = CVN^*(r^*, t) + PVM(r^*, t)\tau_C(BVN(r^*, t) - 100).$$

B.3 Callable bond: corporate valuation

Having derived the value (to the issuer) of the replacement bond, we can now derive the optimal call strategy for the issuer. We solve for the issuer's value of the corporate bond ($CVO(r^*, t)$) by solving (5), subject to an optimal exercise condition. If callability were instantaneous (no notice was required) then the complementary slackness condition would be:

$$CVO(r^*, t) \leq CVN(r^*, t) - BVN(r^*, t) + K(t) + (100 - K(t))\tau_C.$$

The right hand side of this equation consists of two parts. The first ($CVN - BVN$) is the cost of servicing the new bond issue, less the money raised from the issue (the negative of the *tax shield* value of the new bond). The second part is the direct effect of calling the bond: the outlay required

[10] A discussion of treatment of taxes for *non-callable* bonds can be found in Liu et al. (2007).

(K), plus the tax due ($(100 - K(t))\tau_C$).[11] The firm will call the bond if the call payment, less the new bond's tax shield value, exceeds the value of continuing to service the bond.

The presence of notice requirements slightly complicates the analysis (see d'Halluin et al. (2001)). With a notice period of N, the bond will be called if $CVO(r^*, t) \leq PVEC_{t+N}(r^*, t)$ on any call date, where $PVEC_\vartheta$ is the expected present value of the cost of calling at date ϑ. $PVEC_\vartheta$ is a solution of (5), with boundary condition at the actual call date of

$$PVEC_\vartheta(r^*, \vartheta) = CVN(r^*, \vartheta) - BVN^*(r^*, \vartheta) + K(\vartheta) + (100 - K(\vartheta))\tau_C.$$

For the case of a semi-american call option, we need only consider callability at $\vartheta - N$ for each call date ϑ, and therefore track only one instance of $PVEC$ in solving for CVO. However, for *American* callable bonds, any date (during the call period) is a valid call date. Hence at each date during the callable period, $CVO(r^*, t) \leq PVEC_{t+N}(r^*, t)$.

As is the case for the replacement bond, we incorporate coupon payments by increasing the value of CVO by $c(1 - \tau_C)$ on coupon payment dates.

B.4 Callable bond: bondholder valuation

Once the optimal strategy for the issuer to call the bond, we can value the callable bond from a bondholder perspective. As is the case in Section B.1, we must account for income and capital gains taxes, and this requires a two step calculation: first ignoring the effect of the current price on the terminal capital gains tax, and then correcting for this. The terminal condition for the first valuation is $BVO^*(r^*, T) = 100(1 - \tau_G) + c(1 - \tau_I)$. To incorporate issuer call policy, we examine all the nodes at which the issuer would have *given notice* to call (as described in Section B.3). Since the bondholder's payout at these nodes is known with certainty, we can find the present value of one dollar paid at *call date*, valued at *time of notice*. We denote this value as $PVEB$. $PVEB$ is the solution to (5) with boundary condition $PVEB_\vartheta(r^*, \vartheta) = 1$. Knowing $PVEB$, we can then set $BVO(r^*, \vartheta - N) = K(\vartheta)(1 - \tau_G)PVEB_\vartheta(r^*, \vartheta - N)$, for nodes where notice is given (i.e. where $PVEC_\vartheta(r^*, \vartheta - N) > 0$).

Lastly, we must correct for the fact that the bondholder can apply the price that he/she paid for the bond against its principal payment in calculating the capital gain (as in Appendix B.1). To do this, we track the present value of \$1 paid at maturity *or* call of the bond ($PVMC$). To calculate $PVMC$, we solve (5) with terminal condition $PVMC(r^*, T) = 1$, and setting $PVMC(r^*, \vartheta - N) = PVEB_\vartheta(r^*, \vartheta - N)$ on any node where the firm gives notice. This allows us to calculate the true

[11] We assume that all bonds were originally issued at par, so that the firm will realise a capital gain if it calls a bond below par, and a capital loss if it calls a bond above par.

bondholder's value (BVO) as:

$$BVO(r^*,t) = BVO^*(r^*,t) + PVMC(r^*,t)BVO(r^*,t) \quad \Rightarrow BVO(r^*,t) = \frac{BVO^*(r^*,t)}{1-PVMC(r^*,t)}.$$

This *bondholder* valuation of the bond is the price that we compare to the market price in our estimation.

C Treasury bond pricing

Treasury bond pricing can be seen to be a special case of Corporate bond pricing where all tax values are zero. This follows since the government (the issuer) does not pay tax, and (as argued by Cecchetti (1988)) most holders of government bonds are able to avoid income taxation on even partially tax-exempt bonds. This eliminates consideration of tax shields, and therefore does not require consideration of the replacement bonds. The only complication that is peculiar to Treasury bond pricing is the consideration of exchange premia (see Cecchetti (1988)). Given exchange premium X, the terminal payoff to the treasury bond is $CVO(r^*,T) = BVO(r^*,T) = 100+X+c$. The government's optimal call policy is calculated based on $PVEC_\vartheta(r^*,\vartheta-N) > 0$, but where the boundary condition for $PVEC_\vartheta(r^*,\vartheta) = K(\vartheta)+X$. Since there is no tax shield, $PVEB = PVEC$, and does not need to be calculated separately. BVO is calculated as in Section B.4, using $PVEB$. However, since there are no capital gains considerations, $BVO(r^*,t) = BVO^*(r^*,t)$.

D Calibration of σ and λ

We estimate σ and λ to match the observed term structure of yield volatility. Given our fitted yield curves, we can calculate yield volatility for different maturities T. For a given level of r^*, we can calculate the model-implied volatility of the *yield* of a zero coupon bond as:

$$\sigma_T(r^*) = \frac{\partial P(T)}{\partial r^*}\frac{\sigma}{P(T)T}.$$

$\frac{\partial P(T)}{\partial r^*}$ can be calculated by pricing a zero coupon bond using (6) and then calculating $(P_T(r_0^*+\Delta r^*,0) - P_T(r_0^*-\Delta r^*,0))/(2\Delta r^*)$. However, since we only observe (empirically) a single level for term T volatility, we must combine this with the ergodic distribution of r^*. Specifically, we follow the technique in Section A.1 to back out the ergodic distribution of r^* (π_1). Finally, we calculate:

$$\bar{\sigma}_T^2 = \int \pi_1(r^*)\sigma_T^2(r^*)dr^*. \tag{8}$$

$\bar{\sigma}_T$ is a function of θ, λ, and σ. These three values can be calibrated to ensure (8) matches observed yield volatilities.[12]

[12] In our empirical work, we fix θ as the average of 20 year zero coupon bond yields, and use the 5 year and 20 year volatilities to calibrate σ and λ. The integral (8) is approximated with a summation across the discrete points of our finite difference grid, where the numerical solution gives the ergodic probability of being at each discrete point.

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Table I - Bond types, by industry

We define a bond's industry by the volume of Moodys in which it appeared.

	Railroad	Utility	Industrial	Financial	Total
Straight	178	27	15	1	221
Convertible (only)	3	1	1	0	5
Callable (only)	220	164	198	7	589
Convertible and Callable	22	7	53	8	90
Total	423	199	267	16	905

Table II - Bond characteristics

Bond ratings are from Moody's, where 1=AAA, 2=AA, … 9=C, and 10=not rated. % of NYSE is the percentage of the total NYSE bond turnover (in $) accounted for by our sample. Callable = 1 if the bond is callable, and zero otherwise.

Panel A : Newly Issued Bonds

Year	Number	Rating	Coupon (%)	Size ($m)	Maturity (years)	Callable
1927	61	3.00	5.17	24.90	28.50	0.98
1928	45	3.08	5.08	19.60	29.00	0.98
1929	35	3.56	5.28	34.80	23.90	1.00
1930	46	3.00	5.05	25.00	29.30	0.98
1931	29	2.62	4.97	30.40	34.80	0.90
1932	9	1.75	5.33	16.80	23.60	1.00
1933	1	n.a.	5.00	5.30	50.00	1.00
1934	4	3.50	5.12	37.50	16.00	1.00
1935	32	3.00	4.24	31.00	22.60	0.97
1936	50	2.88	3.75	42.30	22.90	1.00
1937	19	3.53	3.74	35.90	19.50	1.00
1938	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1939	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1940	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Panel B : All Bonds

Year	Number	% of NYSE	Rating	Coupon (%)	Size ($m)	Maturity (years)	Callable
1927	615	72.4	2.61	5.08	23.00	34.60	0.65
1928	656	80.1	2.70	5.08	23.00	34.30	0.67
1929	685	92.0	2.75	5.09	23.40	33.70	0.69
1930	728	91.6	2.83	5.07	23.00	33.50	0.70
1931	742	90.0	3.21	5.05	23.50	34.00	0.71
1932	744	90.9	3.93	5.04	23.30	34.00	0.71
1933	728	92.5	4.13	5.02	23.20	34.50	0.71
1934	721	89.1	4.10	5.01	23.40	34.90	0.71
1935	722	87.2	4.27	4.95	23.80	34.90	0.71
1936	673	86.5	4.32	4.78	25.50	35.50	0.70
1937	629	87.5	4.32	4.68	26.10	36.20	0.68
1938	610	82.4	4.72	4.64	26.50	36.70	0.68
1939	592	79.8	5.09	4.63	26.60	37.00	0.67
1940	552	79.7	5.20	4.62	26.60	37.80	0.65

Table III - Bond summary statistics

Each observation is a bond-year. Sinking Fund equals one of there is a sinking fund, and zero otherwise. Collateral equals one if collateral was pledged with the bond, and zero otherwise. In Default equals one if the bond had defaulted on the principal or interest or had changed its characteristics (e.g., maturity extension, reduced coupon), and zero otherwise. American Call equals one if the bond is callable on any day, and zero otherwise. Callable period is the number of years between when first callable and maturity.

	Min	Mean	Max	St. Dev.	Observations
Panel A : Plain vanilla bonds					
Year of Issue	1868	1902	1935	11.55	2713
Maturity at Issue (years)	3	58.7	475	39.45	2713
Maturity (years)	0	27.9	434	36.45	2713
Size at Issue ($m)	14.88	48.2	70	19.31	64
Size ($m)	0.02	23.44	151.93	24.52	2713
Rating at Issue	1	1.4	5	0.97	53
Rating	1	3.27	10	2.08	2697
In Default	0	0.4	1	0.49	2713
Sinking Fund	0	0.12	1	0.32	2713
Collateral	0	0.94	1	0.25	2713
Panel B : Callable bonds					
Year of Issue	1889	1921	1938	8.99	5056
Maturity at Issue (years)	3	36.4	133	19.63	5056
Maturity (years)	0	24.9	120.5	18.3	5056
Size at Issue ($m)	2.5	27.79	175	24.75	1678
Size ($m)	0.41	25.06	175	24.72	5056
Rating at Issue	1	2.91	7	1.2831	1632
Rating	1	3.84	10	2.1025	4956
In Default	0	0.28	1	0.449	5056
Sinking Fund	0	0.44	1	0.497	5056
Collateral	0	0.81	1	0.392	5056
American Call	0	0.25	1	0.431	5056
Currently callable	0	0.83	1	0.378	5056
Years until callable	0	10.75	40.42	8.735	4185
Years since callable	0.085	8.13	31.33	6.552	871
Callable period	2.9979	32.39	133	18.041	5056

Table IV - Tax Rates

Income tax rates are the weighted average tax rates paid by U.S. taxpayers on taxable interest. We present the marginal income tax for a household earning $10,000 and $100,000 per year.

Year	Corporate Tax	Capital Gains	Income Tax (average)	Income Tax ($10,000)	Income Tax ($100,000)
1927	13.50%	12.50%	8.18%	6%	25%
1928	12.00%	12.50%	8.54%	6%	25%
1929	12.00%	12.50%	8.26%	6%	25%
1930	12.00%	12.50%	6.59%	6%	25%
1931	12.00%	12.50%	5.53%	6%	56%
1932	13.75%	12.50%	9.55%	10%	56%
1933	13.75%	12.50%	8.90%	10%	56%
1934	13.75%	12.50%	10.66%	11%	56%
1935	13.75%	12.50%	11.02%	11%	62%
1936	15.00%	12.50%	13.26%	11%	62%
1937	15.00%	12.50%	13.23%	11%	62%
1938	15.00%	12.50%	9.30%	11%	62%
1939	15.00%	12.50%	9.73%	11%	62%
1940	33.00%	12.50%	10.26%	14%	62%

Table V - Bonds by credit class

Panel A - All Industries

	Aaa	Aa	A	Baa	Ba	B	Total
1927	138	89	124	69	38	6	464
1928	143	97	131	83	47	6	507
1929	159	94	137	85	55	13	543
1930	173	86	146	83	61	20	569
1931	176	100	144	106	75	28	629
1932	136	124	123	158	122	46	709
1933	86	104	85	131	127	49	582
1934	54	82	79	135	98	41	489
1935	45	66	75	119	78	35	418
1936	45	61	77	102	69	29	383
1937	42	62	82	110	55	30	381
1938	39	67	78	123	89	24	420
1939	24	46	46	82	91	39	328
1940	12	38	38	67	77	40	272

Panel B - Railroads

	Aaa	Aa	A	Baa	Ba	B	Total
1927	83	45	62	25	14	3	232
1928	76	48	59	24	12	3	222
1929	83	46	69	27	13	4	242
1930	89	50	78	25	17	7	266
1931	85	55	77	45	30	9	301
1932	56	57	57	79	62	14	325
1933	34	51	44	72	69	15	285
1934	20	37	40	76	50	10	233
1935	18	31	42	67	50	12	220
1936	12	30	46	59	40	10	197
1937	15	29	48	58	26	11	187
1938	17	36	50	71	53	9	236
1939	6	17	30	49	57	16	175
1940	1	10	26	41	57	21	156

Table VI - Summary Statistics

Summary statistics by bond-year.

Panel A - All Industries							
	Mean	Median	Std. Dev.	Skew	Kurt	Minimum	Maximum
OAS (basis points)	1002.7	168.6	35232.9	70.9	5354.3	-131244	3246690
Turnover (??)	0.113	0.085	0.134	20.568	930.388	0.000	6.850
Age (years)	15.35	11.17	12.44	0.92	3.00	0.08	69.91
Coupon (%)	4.94	5.00	0.82	0.74	3.85	2.75	8.00
Maturity (years)	20.24	18.67	11.83	0.49	2.55	0.00	49.92
Equity Vol. (??)	0.037	0.029	0.032	3.564	32.306	0.001	0.634
Debt / TA	0.442	0.425	0.182	0.967	5.515	0.003	1.616
EBIT / TA	98.86	0.04	972.70	11.82	160.33	-0.34	16908.70
Cash / Debt	0.094	0.049	0.172	46.047	4978.648	-0.366	19.769
Panel B - Railways							
OAS (basis points)	1613.3	181.3	48504.1	53.2	2988.1	-131244	3246690
Turnover (??)	0.108	0.077	0.154	25.760	1091.645	0.000	6.850
Age (years)	20.46	19.58	13.44	0.40	2.25	0.17	69.91
Coupon (%)	4.63	4.50	0.73	0.97	4.31	3.00	7.50
Maturity (years)	22.63	21.50	13.13	0.24	2.14	0.00	49.92
Equity Vol. (??)	0.038	0.030	0.031	2.602	15.544	0.001	0.396
Debt / TA	0.480	0.454	0.148	2.019	12.683	0.122	1.616
EBIT / TA	0.041	0.038	0.019	0.444	3.078	-0.039	0.124
Cash / Debt	0.058	0.040	0.057	3.130	29.316	0.000	1.089

Table VII - Option Adjusted Spreads

We present median option adjusted spreads by credit class and year.

Panel A - All Industries

	Aaa	Aa	A	Baa	Ba	B
1927	22	34	60	110	175	267
1928	6	13	64	99	188	234
1929	-3	16	53	85	214	368
1930	27	33	74	126	295	987
1931	54	96	101	274	970	1396
1932	12	335	184	441	929	1763
1933	27	82	920	283	462	1233
1934	-28	19	120	142	276	703
1935	-53	-6	82	123	364	601
1936	-60	-22	24	47	233	514
1937	-53	14	30	89	267	562
1938	-55	41	59	333	1453	926
1939	-69	66	73	250	483	744
1940	-59	346	75	253	540	771

Panel B - Railways

	Aaa	Aa	A	Baa	Ba	B
1927						
1928						
1929						
1930						
1931						
1932						
1933						
1934						
1935						
1936						
1937						
1938						
1939						
1940						

Table VIII - Immediate Bailout Impact, All Bonds

We regress Delta OAS (the change in the option adjusted spread from one month to the next) on bailout variables and controls. Just Approved = 1 in the month when an RFC loan was approved and zero otherwise. First Approval = 1 in the month when the first RFC loan was approved and zero otherwise. Loan / Debt is the approved loan size divided by the railroad's outstanding debt. T-stats in parentheses.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Bonds	All	All	All	All	All	All	All	All	All
Just Approved	-69.32	-43.87	-40.65	-86.52	-59.98	-53.24	-60.34	-58.91	-59.60
	(-1.36)	(-0.96)	(-0.95)	(-1.52)	(-1.17)	(-1.13)	(-1.00)	(-0.97)	(-0.99)
First Approved				154.20**	142.62**	118.82**	118.01**	117.01**	114.80**
				(2.16)	(-2.38)	(-2.22)	(-2.25)	(-2.22)	(-2.19)
Loan / Debt							191.52	188.08	191.23
							(0.50)	(0.49)	(0.51)
Δ Turnover								-122.44	-83.93
								(-1.47)	(-0.99)
Δ Equity Vol.								668.35***	446.50**
								(3.04)	(2.25)
Δ Debt / TA									274.82**
									(2.01)
Δ EBIT / TA									-0.007***
									(-3.67)
Δ Cash / Debt									-30.71
									(-0.46)
Constant	-1.03	4.90	-0.65	-1.03	4.89	-0.69	-0.70	-0.47	5.56***
	(-0.19)	(1.61)	(-0.13)	(-0.19)	(1.61)	(-0.13)	(-0.14)	(-0.09)	(4.29)
R^2	0.000	0.017	0.020	0.000	0.017	0.020	0.020	0.021	0.122
N	25529	25529	25529	25529	25529	25529	25529	24641	22613
Month FE	NO	YES	NO	NO	YES	NO	NO	NO	NO
Firm FE	NO	YES	NO	NO	YES	NO	NO	NO	NO
Railroad * Month FE	NO	NO	YES	NO	NO	YES	YES	YES	YES

Table IX - Immediate Impact of Bailout, Investment vs. Speculative Grade

We regress Delta OAS (the change in the option adjusted spread from one month to the next) on bailout variables and controls. Just Approved = 1 in the month when any RFC loan (including the first) was approved and zero otherwise. First Approval = 1 in the month when the first RFC loan was approved and zero otherwise. Loan / Debt is the approved loan size divided by the railroad's outstanding debt. T-stats in parentheses.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bonds	Invest.	Spec.	Invest.	Spec.	Invest.	Spec.	Invest.	Spec.
Just Approved	-73.01	12.23	-91.05	-1.77	-117.05	19.49	-116.01	25.59
	(-1.14)	(0.28)	(-1.23)	(-0.04)	(-1.20)	(0.38)	(-1.19)	(0.53)
First Approved			128.36*	301.33***	125.54*	312.13***	126.14*	260.97***
			(1.74)	(2.97)	(1.75)	(3.04)	(1.76)	(2.99)
Loan / Debt					671.58	-445.90	660.57	-377.28
					(1.03)	(-1.28)	(1.02)	(-1.21)
Δ Turnover					-41.35	-543.68	-31.82	-446.72
					(-1.33)	(-1.38)	(-1.03)	(-1.09)
Δ Equity Vol.					258.78*	803.62**	148.92**	473.68
					(1.91)	(2.49)	(2.09)	(1.56)
Δ Debt / TA							47.20	1608.85**
							(0.50)	(2.19)
Δ EBIT / TA							-0.09	-0.01***
							(-1.07)	(-3.61)
Δ Cash / Debt							39.54	-557.04
							(1.38)	(-0.86)
Constant	-6.00	45.27***	-6.04	44.89***	-6.34	45.49***	0.97	42.37***
	(-0.93)	(7.61)	(-0.93)	(7.54)	(-0.92)	(7.31)	(1.30)	(7.48)
R^2	0.019	0.282	0.019	0.283	0.020	0.284	0.067	0.296
N	19426	6103	19426	6103	18646	5995	16995	5618
Month FE	NO	NO	NO	NO	NO	NO	NO	NO
Firm FE	NO	NO	NO	NO	NO	NO	NO	NO
Railroad * Month FE	YES	YES	YES	YES	YES	YES	YES	YES

Table X

We regress OAS on bailout variables and controls. Approved = 1 in every month on or after the first RFC loan was approved and zero before any loans were granted. (yyyy) Approved = 1 if a railroad's first RFC loan was approved in (yyyy) and zero otherwise. Loan / Debt is the approved loan size divided by the railroad's outstanding debt. T-stats in parentheses.

	(1)	(2)	(3)	(4)	(5)	(6)
Bonds	Invest.	Spec.	All	Invest.	Spec.	All
Approved	165.72***	-23.22	246.93***			
	(5.53)	(-0.15)	(7.29)			
Approved*Maturity	-4.13***	5.33	-5.45***	-4.12***	3.24	-5.38***
	(-3.63)	(0.94)	(-4.61)	(-3.63)	(0.54)	(-4.52)
Loan / Debt	-387.87**	-227.97	-559.91***	-351.07**	-145.64	-539.33**
	(-2.38)	(-0.32)	(-2.68)	(-2.36)	(-0.21)	(-2.54)
Turnover	-88.62	318.00***	-103.50	-86.90	382.40***	-100.07
	(-0.77)	(4.07)	(-1.64)	(-0.75)	(4.85)	(-1.59)
Age	0.44**	5.18***	-0.37	0.43**	5.95***	-0.43
	(2.23)	(2.68)	(-1.18)	(2.1340)	(3.1084)	(-1.3788)
Coupon	35.84***	19.34	27.50***	35.67***	31.33*	27.85***
	(5.98)	(1.07)	(5.82)	(5.93)	(1.76)	(5.90)
Maturity	-1.55*	-39.06***	-5.39***	-1.57*	-39.49***	-5.51***
	(-1.76)	(-15.03)	(-7.40)	(-1.78)	(-15.20)	(-7.53)
Equity Vol.	2760.7***	3846.2***	3465.9***	2710.2***	3426.2***	3328.9***
	(12.95)	(7.86)	(16.35)	(12.56)	(7.01)	(15.81)
Debt / TA	205.9***	639.1***	441.4***	196.1***	663.3***	441.3***
	(10.02)	(7.93)	(16.16)	(9.41)	(8.04)	(16.31)
EBIT / TA	-0.11	-3175.1***	-1265.6**	-0.11	-2922.9***	-1256.8**
	(-1.24)	(-4.91)	(-2.57)	(-1.24)	(-4.49)	(-2.55)
Cash / Debt	-41.9***	-1687.7***	-28.8	-51.0***	-1696.2***	-33.8
	(-3.07)	(-11.96)	(-0.95)	(-3.65)	(-12.03)	(-1.12)
1932 Approved				175.75***	-66.83	247.90***
				(5.54)	(-0.40)	(7.02)
1933 Approved				123.74***	-100.69	149.73***
				(4.72)	(-0.58)	(4.54)
1935 Approved				307.28***	673.10***	384.53***
				(4.49)	(2.61)	(5.96)
1938 Approved				271.15***	582.58***	647.75***
				(4.36)	(3.78)	(11.79)
1939 Approved				266.41***		306.23***
				(5.83)		(5.65)
Aaa	-216.08***		-112.92***	-209.49***		-107.64***

	(-5.45)		(-4.37)	(-5.21)		(-4.13)
Aa	-188.92***		-113.33***	-182.90***		-109.16***
	(-5.18)		(-4.49)	(-4.94)		(-4.30)
A	-142.53***		-80.61***	-134.50***		-72.40***
	(-4.09)		(-3.00)	(-3.77)		(-2.68)
Baa	-9.22		42.88	0.09		53.98**
	(-0.24)		(1.62)	(0.00)		(2.03)
Ba		931.50***	316.83***		867.78***	322.16***
		(7.65)	(11.66)		(7.29)	(11.87)
B		1379.75***	716.53***		1310.16***	712.33***
		(10.92)	(22.49)		-10.62	-22.46
R^2	0.2129	0.6174	0.459	0.2132	0.6216	0.4608
N	20300	6235	26535	20300	6235	26535
Month FE	NO	NO	NO	NO	NO	NO
Firm FE	NO	NO	NO	NO	NO	NO
Railroad*Month FE	YES	YES	YES	YES	YES	YES

Table XI

We regress OAS on bailout variables and controls. Approved = 1 in every month on or after the first RFC loan was approved and zero before any loans were granted. (yyyy) Approved = 1 if a railroad's first RFC loan was approved in (yyyy) and zero otherwise. Loan / Debt is the approved loan size divided by the railroad's outstanding debt. T-stats in parentheses. These regressions do not control for credit class.

	(1)	(2)	(3)	(4)	(5)	(6)
Bonds	Invest.	Spec.	All	Invest.	Spec.	All
Approved	157.03***	-48.29	263.09***			
	(5.10)	(-0.30)	(7.41)			
Approved*Maturity	-3.91***	6.51	-4.53***	-3.97***	4.80	-4.48***
	(-3.38)	(1.13)	(-3.73)	(-3.43)	(0.79)	(-3.65)
Loan / Debt	-255.16	-72.66	-469.22**	-291.96*	-19.45	-460.46**
	(-1.40)	(-0.12)	(-2.18)	(-1.67)	(-0.03)	(-2.31)
Turnover	195.14*	582.11***	505.62***	196.52*	642.67***	508.22***
	(1.75)	(7.51)	(6.62)	(1.76)	(8.14)	(6.65)
Age	-0.72***	5.16**	-1.27***	-0.75***	5.88***	-1.37***
	(-3.52)	(2.58)	(-3.74)	(-3.63)	(2.98)	(-4.03)
Coupon	45.52***	22.73	52.18***	45.30***	33.56*	53.02***
	(7.63)	(1.22)	(10.86)	(7.57)	(1.84)	(11.05)
Maturity	-1.93**	-40.97***	-6.48***	-1.95**	-41.44***	-6.61***
	(-2.19)	(-15.18)	(-8.64)	(-2.2079)	(-15.3512)	(-8.8004)
Equity Vol.	4339.01***	4909.18***	6287.24***	4320.84***	4441.77***	6096.84***
	(19.55)	(9.69)	(26.24)	(19.30)	(8.85)	(25.67)
Debt / TA	295.64***	669.48***	589.58***	296.23***	689.16***	597.17***
	(16.34)	(8.15)	(20.46)	(16.18)	(8.19)	(20.81)
EBIT / TA	-0.10	-4266.60***	-2524.45***	-0.10	-3991.87***	-2493.94***
	(-1.14)	(-6.80)	(-5.35)	(-1.13)	(-6.35)	(-5.27)
Cash / Debt	-59.17***	-1812.27***	-106.58***	-57.94***	-1824.05***	-106.67***
	(-4.08)	(-11.97)	(-3.25)	(-3.98)	(-12.06)	(-3.33)
1932 Approved				157.86***	-101.26	256.85***
				(4.85)	(-0.61)	(6.92)
1933 Approved				149.96***	-170.40	158.07***
				(5.51)	(-0.97)	(4.66)
1935 Approved				329.53***	567.05**	481.45***
				(4.85)	(2.16)	(7.16)
1938 Approved				364.74***	609.84***	838.48***
				(5.53)	(3.88)	(13.85)
1939 Approved				286.22***		129.22**
				(5.99)		(2.17)
Constant	-255.16	973.18***	-187.51***	-244.99***	921.45***	-185.06***
	(-1.40)	(7.78)	(-6.84)	(-6.20)	(7.53)	(-6.68)
R^2	0.2019	0.605	0.4142	0.2021	0.6096	0.4175
N	20300	6235	26535	20300	6235	26535
Month FE	NO	NO	NO	NO	NO	NO
Firm FE	NO	NO	NO	NO	NO	NO
Railroad*Month FE	YES	YES	YES	YES	YES	YES