

Firm Debt Covenants and the Macroeconomy: The Interest Coverage Channel

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Abstract

Interest coverage covenants, which set a maximum ratio of interest payments to earnings, are among the most popular provisions in firm debt contracts. For affected firms, the amount of additional debt that can be issued without violating these covenants is highly sensitive to interest rates. Combining a theoretical model with firm-level data, I find that interest coverage limits generate strong amplification from interest rates into firm borrowing and investment. Importantly, most firms that have interest coverage covenants also face a maximum on the ratio of the stock of debt to earnings. Simultaneously imposing these limits implies a novel source of state-dependence: when interest rates are high, interest coverage limits are tighter, amplifying the influence of interest rate changes and monetary policy. Conversely, in low-rate environments, debt-to-earnings covenants dominate and transmission is weakened.

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1 Introduction

Corporate investment has long been considered a principal driver of the business cycle, and one of the central pathways through which monetary policy affects real activity.¹ Of particular interest to the literature has been the vast market for corporate debt — measured at over \$6T in 2018.² To date, a wide body of work has studied how firm borrowing capacity is influenced by monetary policy, a mechanism known as the “financial accelerator” after the seminal paper by Bernanke, Gertler, and Gilchrist (1999).

The traditional approach in this literature has been to model a firm’s debt capacity based on its market leverage, which is the solution to a particular limited commitment problem.³ In practice, firms face a number of explicit constraints on how much they can borrow, many of which are quite different from caps on market leverage. In particular, I study implications of debt covenants — provisions in debt contracts that constrain future lending — with a particular focus on *interest coverage* (“IC”) covenants that cap the ratio of a firm’s interest payments to its earnings or EBITDA. Although IC covenants, and financial covenants more generally, are extremely common, much remains to be learned about how the structure of these real-world constraints influences macroeconomic dynamics.⁴ In this paper, I argue that the functional form of these covenants can have important effects on how interest rates transmit into firm borrowing and investment.

To motivate my analysis, I present a set of facts from the Dealscan database of syndicated loans. First, interest coverage is the most prevalent type of covenant, present in over 80% of firms with covenants, and its incidence is high and stable over the past 20 years. Second, the majority of firms with any covenants have multiple covenants, and in particular simultaneously face both a limit on interest coverage and a limit on stock of debt as a fraction of their earnings. Third, the maximum ratios that firms face on these covenants have been highly stable over time, even as the underlying economic variables have undergone substantial fluctuation, implying that the maximum ratios allowed by these financial covenants can be treated as fixed over business cycle frequencies.

With this motivation, I study the effects of these covenants using a combined theoretical and empirical approach. On the theoretical side, I develop a simple model in which firms prefer to finance themselves with debt, due to its tax-preferred status, and

¹See e.g., Bernanke and Gertler (1995).

²Source: Federal Reserve Board of Governors. Series is Nonfinancial Corporate Business, Debt Securities (Liability), FRED code NCBDBIQ027S.

³Specifically, the costly state verification model of Townsend (1979).

⁴Important recent contributions on this topic include Lian and Ma (2018) and Drechsel (2018).

face incentives to smooth dividends over time. The key innovation of the model is to impose debt limits consistent with the most common covenants observed in the data, and to tractably aggregate over firms with multiple types of covenants and heterogeneous covenant ratios. On the empirical side, I use merged Dealscan and Compustat data to directly study the influence of firm debt covenants on interest rate transmission. While the empirical results provide the paper's most compelling evidence, the model is used both to guide intuition and to generate predictions in support of the empirics, a particularly important exercise given that covenants are not randomly assigned.

My approach yields two novel findings. First, the presence of interest coverage covenants can greatly amplify transmission from interest rates into firm debt and investment, a pathway that I refer to as the interest coverage channel.⁵ The key to this transmission is that IC covenants introduce debt limits that are highly sensitive to interest rates, so that a 100bp fall in rates typically relaxes the additional borrowing capacity of a firm with a binding IC limit by around 20%. In the presence of financial frictions, the model predicts that this relaxation of debt limits leads to a large increase in debt accumulation and more than triples the change in investment relative to firms with alternative covenants.

Turning to the empirics, I estimate how firms with different covenant types respond to changes in interest rates, after controlling for firm and time effects, as well as other key covariates. My results show strong evidence for the interest coverage channel in the data. The estimates imply that over the 8Q following a 100bp drop in treasury rates, firms with IC covenants display an additional approximately 5.2% in debt growth and 9.5% in asset growth, measured as a share of initial assets, relative to their peers with the most common alternative covenant (a cap on the ratio of debt to EBITDA). These responses are significant at most horizons, highly persistent, and largely consistent with the predictions of the model.

My second main finding builds on these results, suggesting that the interest coverage channel is in fact *state dependent*, with its strength varying with the level of interest rates. This state dependence follows from the simultaneous presence of both interest coverage and debt-to-earnings ("DE") covenants in the typical firm with covenants. Since the ratio of interest payments to earnings is simply the ratio of the stock of debt to earnings multiplied by the interest rate, which of these two covenants is tighter depends uniquely on the level of interest rates, and not on the level of firm earnings or leverage.

As a result, when rates are high, more firms with both IC and DE limits will find

⁵This term is inspired by discussion of the "coverage channel" in Bernanke and Gertler (1995).

interest coverage to be their tightest covenant. The relevant debt limit for these firms is therefore highly sensitive to interest rates, activating the interest coverage channel, and implying strong transmission from interest rates into debt and investment. In contrast, when rates are low, firms' interest coverage limits become slack for most firms, and debt-to-earnings instead becomes the tightest covenant. Since debt-to-earnings limits are not directly shifted by interest rates, this shuts off the interest coverage channel, and implies weaker transmission of interest rates and monetary policy.

To begin to quantify these effects, I develop a methodology to determine the relative tightness of alternative covenants, and estimate large variation over the sample 1997 - 2007 in the share of firms for which interest coverage was the tighter covenant, ranging from 7% to over 59% of firms as interest rates fluctuated over the sample. Calibrating the model to match this observation implies strong state dependence, with 8Q capital growth more than tripled and 8Q debt growth amplified by more than ten times for firms with both covenants in a high-rate environment (250bp above average) relative to a low-rate environment (250bp below average), corresponding to the high and low range of interest rates observed over my sample.

To test for these phenomena in the data, I augment the initial empirical specification to allow the coefficients to vary across interest rate regimes, and find that the resulting estimates support the hypothesis of state dependence. Firms with both interest coverage and debt-to-earnings covenants display an additional 2.1% growth in assets when 3-Month T-Bill for each 1ppt the lagged rate r_{t-1} is increased. This rise in investment is financed by a parallel rise in debt of 1.5% of initial assets. The sign of this response matches the model's predictions, while the absolute magnitude is in fact around three times larger than predicted. Perhaps most compelling, this increased sensitivity is only present for firms with *both* covenants, and is not observed for firms with debt-to-EBITDA covenants alone, exactly as implied by the theory.

All told, these theoretical and empirical findings point to the interest coverage channel as a salient and state-dependent source of interest rate transmission, with potentially important implications for monetary policy.

Literature Review. Broadly speaking, this paper links to two large branches of the literature. The first branch, in the finance and accounting space, considers the role of debt limits on firm behavior, often focusing on if and when they are binding, and the consequences if a firm violates those limits. Examples include Almeida and Campello (2007),

Almeida, Campello, and Weisbach (2004), Chaney, Sraer, and Thesmar (2012), Chava and Roberts (2008), Chodorow-Reich and Falato (2017), Cloyne, Ferreira, Froemel, and Surico (2018), Demerjian and Owens (2016), Diamond, Hu, and Rajan (2017), Donaldson, Gromb, and Piacentino (2018), Green (2018), Murfin (2012), Nini, Smith, and Sufi (2009), Roberts and Sufi (2009a), and Roberts and Sufi (2009b). This paper adds to this literature by considering the particular channel of interest rate transmission induced by the structure of interest coverage covenants. Future work could connect these literatures further by analyzing the role of interest rate fluctuations in driving interest coverage-driven covenant violations.

The second branch comprises macroeconomic models in which corporate debt plays an important role in amplifying and propagating shocks to the economy. This branch contains a vast number of aggregated DSGE models, perhaps most famously Kiyotaki and Moore (1997), Bernanke et al. (1999), and Christiano, Motto, and Rostagno (2014), among many others. More recently, an alternative literature has sprung up using heterogeneous firm models to study the transmission of monetary policy, including Jeenas (2019) and Ottonello and Winberry (2018). While I build on these works in constructing the model, the relative contribution of this paper is to impose a realistic covenant structure with novel implications for the strength of interest rate transmission and its variation with economic conditions.

More narrowly, my work is directly related to recent papers by Lian and Ma (2018) and Drechsel (2018). Both papers emphasize that firm debt covenants are often written proportional to firm earnings or EBITDA, instead of the traditional market leverage limit, with Lian and Ma (2018) focusing on the empirical evidence and implications, and Drechsel (2018) building a DSGE model with earnings-based debt limits. This paper complements these works by focusing on two additional properties of debt covenants. First, I focus on interest coverage covenants, which crucially depend not only on firm earnings, but also on the firm's interest rate. This distinction is central for the results on interest rate transmission, which show that the response of firms with interest coverage covenants is dramatically different from the response of firms with debt-to-earnings covenants, despite the fact that both depend on earnings in the same way. Second, I allow for firms to be limited by multiple covenants at the same time, which drives my finding of state dependence.

Overview. The rest of this paper proceeds as follows. Section 2 describes the data construction. Section 3 provides background on debt covenants, and presents the key stylized facts motivating the paper. Section 4 estimates the share of firms that find interest coverage to be their tightest covenant. Section 5 constructs the theoretical model, while Section 6 presents the parametric forms and calibrates the model. Section 7 displays the theoretical and empirical results behind the first main finding: amplified interest rate transmission through the interest coverage channel. Section 8 builds on these results with the second main finding: state dependence of the interest coverage channel depending on the level of interest rates. Section 9 concludes.

2 Data Construction

I construct a data set at the firm-quarter level by merging syndicated loan data from Dealscan with firm data from Compustat, following the linking procedure in Chava and Roberts (2008). The Dealscan data contains covenant information for syndicated loans, which is used to classify the firms into different covenant categories, while Compustat provides the other firm-level variables used in the regressions.

Sample Selection. I restrict the sample in several ways. First, I limit analysis to the dates 1997 Q1 to 2007 Q4. This starting date is chosen to ensure that Dealscan contains good coverage of covenant variables throughout the sample. The ending date is chosen to avoid the financial crisis, since Chodorow-Reich and Falato (2017) document that the enforcement of covenant violations changed dramatically during this period, potentially altering the responses of interest. This end date also avoids the zero lower bound period, when the interest rate displays little variation, making the effects on transmission more difficult to measure. After restricting to this period I keep only firms that report a nonmissing, nonnegative value for assets in nine consecutive quarters.

Next, I restrict by industry following Chaney et al. (2012), dropping firms in mining and building construction (SIC codes 10, 12, 13, 14, 16, 17), public utilities (SIC code 49), and financial, insurance, and real estate (SIC codes 60-67).⁶ I also drop firms in public administration (SIC codes 91-98), firms that cannot be classified (SIC code 99) and firms

⁶While the motivation in Chaney et al. (2012) to drop building and construction firms may be to avoid firms that are overly sensitive to real estate or land prices — a consideration is not relevant for my analysis — I also find such firms display unusual and volatile rates of covenant incidence as well as unusual covenant ratio limits, making them good candidates to be dropped.

with missing SIC codes.

Finally, for most of my analysis I consider what I will denote the “selected sample,” consisting of firms in the top half of the asset and profit margin (sales / EBITDA) distribution for a given quarter. This is motivated by the evidence presented in Lian and Ma (2018) that earnings-based covenants like interest coverage and debt-to-EBITDA limits are much less relevant for small and low margin firms, whose earnings are low and volatile enough that any reasonable covenant limit would be highly likely to be violated in the near future. Although these firms may technically have covenants attached to their debt, they are much less likely to be sensitive to moderate changes in their covenant limits due to e.g., interest rates. Although this restriction drops 70% of the observations, the remaining firms are disproportionately large, accounting for 63% of total assets and 70% of total sales, limiting the information loss from an economic perspective.

Variable Definitions. While most of the variables are used “as-is,” the covenant-related variables require some manipulation, due to the fact that Dealscan reports many different but highly similar variations on the same general type of covenant. To simplify the environment, I define the following families that summarize these groups (which I will describe in more detail in Section 3):

1. Interest Coverage (IC) covenants: includes Min. Interest Coverage, Min. Fixed Charge Coverage, Min. Cash Interest Coverage, and Min. Debt Service Coverage).
2. Debt-to-EBITDA (DE) covenants: includes Max. Debt to EBITDA, Max. Senior Debt to EBITDA.
3. Leverage (LEV) covenants: includes Min. Current Ratio, Min. Quick Ratio, Max. Leverage Ratio, Max. Debt to Tangible Net Worth, Max. Debt to Equity, Max. Senior Leverage.

To put the covenant ratios on level footing within each family, I adjust them following Demerjian and Owens (2016) so that they are all represented in the form used in the model (see equation (7)).

I assign a firm to have a given covenant type if it has any active Dealscan packages (i.e., the current date is between the start and end dates on the package) containing that covenant. However, to avoid covenants that have already been violated with high probability, I ignore any IC or DE covenants on a given package on all dates after a firm’s

EBITDA goes negative. Since firms may have multiple covenants of the same type, I set a firm's active covenant ratio for each family to be the lowest ratio among all covenants of that type in that quarter.

3 Background: Debt Covenants

In this section, I provide some background on the structure of debt covenants, and present summary statistics and stylized facts using the data set constructed in Section 2.

Definition of Debt Covenants. Debt covenants set conditions in credit agreements that the firm is obligated to satisfy, as well as the consequences of violation. While credit agreements typically include many covenants with a variety of purposes, the covenants relative to this paper are "financial covenants," which specify that the firm must maintain financial statistics within certain bounds (e.g., a maximum on the ratio of interest payments to EBITDA). Importantly, these statistics are usually measured at the firm level, implying that covenants related to debt or interest payments restrict a firm's *total* borrowing from all sources, not only the borrowing on that particular credit facility.

The consequences for violation can vary, and often depend on the type of credit instrument. For corporate loans, considered in the empirical analysis of this paper, a violation typically gives the lender the right, but not the obligation, to demand immediate repayment of the loan.⁷ In practice, lenders typically do not demand full repayment upon violation, but instead renegotiate the terms of the loan, often extracting some concession in the form of a higher interest rate or up-front fee in exchange for waiving the covenant violation.⁸

While covenants do not provide a hard cap on borrowing, and in fact are violated with some frequency, violation is costly for firms, typically leading to adverse outcomes, as found in Roberts and Sufi (2009a). Correspondingly, Lian and Ma (2018) find evidence of bunching before financial ratios that would induce violation. These findings support the interpretation of covenants as setting limits that, while not unbreakable, are costly enough that firms seek to avoid crossing them.

⁷In contrast, corporate bonds typically impose constraints on firm behavior, for example limits on investment or the payment of dividends while a firm is in violation, as discussed in e.g., Chava and Roberts (2008). This structure is due to the dispersed ownership of bonds, making renegotiation difficult in case of violation.

⁸An important exception evidenced by Chodorow-Reich and Falato (2017) is the behavior of financially unhealthy lenders during the financial crisis, who in many cases did demand immediate repayment.

Covenant Types. Most financial covenants that limit debt accumulation fall in one of three categories.

1. *Interest coverage (IC)* covenants set a maximum on the ratio of interest payments to a measure of firm earnings, usually EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization). These limits are also frequently expressed as an equivalent minimum on the ratio of earnings to interest payments. This type of covenant can also go by alternative names, such as fixed charge coverage, debt service coverage, and cash interest coverage, which can vary slightly in how the ratio is computed.
2. *Debt-to-earnings (DE)* covenants limit the *stock* of firm debt to be no less than some multiple of earnings (typically EBITDA). Crucially, unlike interest coverage covenants, debt-to-earnings covenants do not directly depend on the interest rate.
3. *Leverage (LEV)* covenants limit firm debt to be no more than some multiple of firm assets. Variations on this theme include limits on the Current Ratio, Quick Ratio, Debt to Equity Ratio, Equity to Asset Ratio, and Debt to Tangible Net Worth Ratio. In contrast to many macroeconomic models, these covenants are typically measured using book values, not market values, preventing feedback through the market price of capital or the market value of equity.

Simple Example of Interest Rate Transmission. Most important for this analysis, interest coverage covenants imply debt limits that are highly sensitive to interest rates, with a firm's additional borrowing capacity moving by around 20% in response to a one percent change in interest rates. To see this, consider a firm that is currently paying a 6% interest rate, which might be typical in an environment with a 3.5% risk-free rate and a 250bp spread. Let's further suppose that the firm's covenants allow a maximum ratio of interest payments to EBITDA of 40%, and that the firm's EBITDA is \$10M. The firm's IC covenant then implies a maximum of \$4M in annual interest payments, which at a 6% interest rate corresponds to $\$4M / 0.06 = \$66.7M$ of debt. If the interest rate now falls from 6% to 5%, the firm's maximum interest payment remains unchanged at \$4M per year. However, at the reduced interest rate, this same interest payment is associated with a larger debt balance of \$80M, an increase of 20%.

It is worth noting that this channel can be active even if a firm only uses fixed rate debt, although the channel is stronger under floating rate debt. For example, if this same firm

already has \$20M in debt with a fixed 8% interest rate, the interest on this debt exhausts \$1.6M of the firm's interest payment cap. At a 6% interest rate on *new* debt, the firm can borrow an additional $(\$4M - \$1.6M) / 0.06 = \$40M$ in debt without violating its covenant. If the rate on new debt fell to 5%, the firm's capacity for new debt would rise to $(\$4M - \$1.6M) / 0.05 = \$48M$, which is again an 20%. The key idea is that the firm's capacity for *new* debt is still influenced by the interest rate on that debt, even if existing debt has a fixed rate. However, the response of the firm's total (new + existing) debt capacity is indeed smaller, rising from \$60M to \$68M, for an increase of 13.3%.

To consider the floating-rate case, assume that the firm's has \$30M in existing debt at the same 6% floating rate. Before the drop in rates, this firm could take on $(\$4M - 0.06 \times \$30M) / 0.06 = \$36.7M$ of new debt at a 6% rate without violating its covenant. However, after a 1% drop in rates, the firm's capacity for new debt increases to $(\$4M - 0.05 \times \$30M) / 0.05 = \$50M$ — an increase of over 36%. This larger proportional increase occurs because not only does each dollar of new debt now count less against the firm's interest cap, but the existing dollars of debt also exhaust less capacity, increasing the overall effect. Of course, this channel can operate in reverse if interest rates rise, severely squeezing a firm's ability to borrow, or even pushing it into an unintentional covenant violation, if the firm has enough floating-rate debt. At the same time, the change in total (new + existing) debt capacity is still 20%, just as in the first case considered.

Covenant Prevalance by Type. To give a sense of the prevalence of different covenant types, Figure 1 shows the equally-weighted share of firms with alternative covenant configurations. Since Dealscan covers only a fraction of firms in the market, the unconditional shares confound the relative popularity of each covenant with the overall coverage of the Dealscan data. To avoid this, I plot prevalence of each covenant or covenant pair firms that have at least one Dealscan covenant. Thus, Figure 1 shows time variation in the relative popularity of various covenants, rather than the absolute probability of using any covenants at all.

Panel 1a shows the relative prevalence of each type of covenant. Since a firm can have more than one covenant, the shares do not add to unity. As can be seen, covenants in the interest coverage family are the most popular, trailed closely by debt-to-earnings covenants. Although leverage covenants were more popular in the first years of the sample, their appearance in this data declines over time, accounting for only a small fraction of covenants in recent years. Overall, this pattern is consistent with the findings of Lian

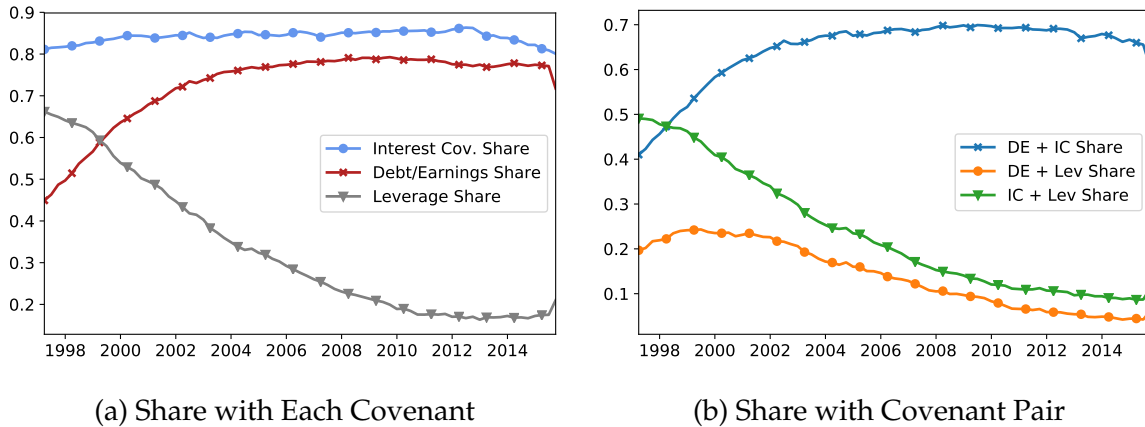


Figure 1: Covenant Prevalence Over Time

Note: Data source is Dealscan. Each series is the equally weighted share of firms with that particular covenant configuration among firms that Dealscan reports has at least one covenant.

and Ma (2018), who document the prevalence of “earnings-based covenants” such as interest coverage and debt-to-earnings.

Next, Panel 1b documents the prevalence of covenant pairs. As can be seen, multiple covenants is the norm, not the exception, in corporate borrowing. In fact, the majority of firms with *any* covenant in this data have a specific covenant pair, possessing both debt-to-earnings and interest coverage covenants. The prevalence of this combination is stable over time in the data, and does not vary with economic conditions. The popularity of this pair will motivate further analysis in Section 8. The other two possible covenant pairs have appeared less frequently over time, simply due to the fact that they both include leverage covenants, which become less popular over the sample.

Firm Characteristics by Covenant. The assignment of covenants to firms is not random, making it important to analyze the difference between firms with and without each covenant type. In this section, I present summary statistics suggesting that, while firms with and without covenants appear quite different, firms with different covenants appear similar to each other, especially interest coverage and debt-to-earnings covenants. This finding motivates the empirical cross-covenant comparisons in Section 8.2.

Table 1 provides the typical (median) value for a number of firm variables for firms with different covenant configurations. The top panel statistics are measured across all Compustat firms, while the bottom panel statistics are computed using only firms in the selected (high-asset, high-margin) sample described in Section 2. Additional groupings by covenant type can be found in Appendix Table A.1.

Table 1: Firm Medians by Covenant Type

	None	IC	DE	Lev	IC + DE	IC Only	DE Only
Full Sample							
Sales	10.45	138.73	135.58	82.47	141.42	156.76	112.61
EBITDA	0.33	18.56	18.71	8.65	20.66	16.40	11.16
Assets	50.53	508.75	514.35	290.40	543.38	545.63	432.43
PPE	6.26	117.44	113.78	63.94	121.24	153.90	86.02
Debt	2.41	142.74	151.34	54.05	161.62	201.07	150.00
ST Debt	0.49	5.00	5.37	3.37	5.09	7.47	10.26
LT Debt	0.70	125.00	133.86	38.87	146.63	180.98	119.70
Cash	7.42	16.93	17.07	14.14	17.59	17.05	16.54
Debt/EBITDA	0.00	7.89	8.08	5.43	8.04	11.98	9.60
Debt/Assets	0.114	0.289	0.299	0.225	0.301	0.339	0.321
EBITDA/Assets	0.013	0.036	0.036	0.031	0.037	0.029	0.029
Market-to-Book	1.54	1.15	1.16	1.12	1.19	1.03	1.01
N	99,669	36,522	29,132	24,237	24,401	4,137	3,334
Selected Sample							
Sales	172.37	196.75	182.88	225.76	180.72	243.32	210.25
EBITDA	24.42	28.08	27.35	28.14	27.80	26.59	23.79
Assets	574.59	691.63	668.32	699.31	668.53	796.01	714.71
PPE	139.39	186.00	166.43	202.10	165.40	246.60	198.61
Debt	94.85	215.66	215.93	163.44	214.71	338.10	252.44
ST Debt	5.50	7.10	7.17	8.03	6.43	12.00	16.17
LT Debt	70.03	196.11	194.93	141.00	196.60	298.70	201.31
Cash	61.90	25.52	24.07	30.83	23.71	28.73	28.02
Debt/EBITDA	3.61	7.77	7.96	5.97	8.01	11.16	8.42
Debt/Assets	0.175	0.307	0.315	0.243	0.320	0.373	0.310
EBITDA/Assets	0.043	0.040	0.040	0.039	0.040	0.034	0.035
Market-to-Book	1.61	1.27	1.28	1.24	1.30	1.15	1.19
N	18,131	20,881	17,271	10,339	15,143	2,007	1,582

Note: Data sources are Dealscan and Compustat. The sample is 1997 Q1 - 2007 Q4. All entries are sample medians. All variables are measured in million USD except for the ratios Debt/EBITDA, Debt/Assets, EBITDA/Assets, Market-to-Book, and the number of observations N . Covenant categories are as follows: "None" firms have no Dealscan covenants, "IC" firms have an interest coverage covenant, "DE" firms have a debt-to-earnings covenant, and "Lev" firms have a leverage covenant. The remaining categories are for multiple covenants, so that e.g., "IC + DE" firms have both an interest coverage and debt-to-earnings covenant. Variable definitions and Compustat codes are as follows. Sales (code SALEQ), EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization, code OIBDPQ), Assets (code ATQ), PPE (Property, Plant, and Equipment, code PPENTQ). Debt (sum of short-term debt, code DLCQ, and long-term debt, code DLTTQ), Cash (code CHEQ), Market-to-book (ratio of market equity plus book debt to book assets). N is the number of variables with a non-missing value for Assets in the sample.

Starting with the full sample panel, this table shows substantial differences between firms with and without covenants, and to some degree across covenant types. First, firms

with covenants are much larger in scale than firms without covenants, both in terms of sales, as well as in the size of their balance sheets. Firms with covenants are also much more highly levered than firms with no covenants. These facts are consistent with larger firms selecting into the syndicated loan market, as well as with the analysis of Lian and Ma (2018), who argue that constraints that depend on firm earnings, such as interest coverage and debt-to-earnings covenants, are not practical for very small or young firms that do not have consistent earnings, and which generally find it more difficult to borrow. This implies that interest rate transmission may be quite different for firms with and without covenants due to their size or business model, and not due to the covenants themselves.

On the other hand, among firms with earnings-based covenants, differences across firms are more muted. The main discrepancy that firms with leverage covenants tend to be smaller than firms with other covenants, again consistent with the idea that earnings-based covenants are a better fit for larger firms. Firms with interest coverage and debt-to-earnings covenants appear quite similar, but this is in part because these covenants are very frequently observed together (see Figure 1b), so that these statistics are largely drawn from the same firms. However, the columns labeled “IC-Only” and “DE-Only,” showing firms who have one of these covenants but not the other, show that the firms with each covenant in isolation are reasonably similar with one important exception: IC-Only firms have more debt relative to assets or EBITDA relative to their DE-Only counterparts. This is unsurprising given that IC limits were on average looser than DE limits over the sample, especially in periods with low rates. Both types with a single covenant have higher debt/EBITDA relative to firms with both covenants, consistent with either single constraint being looser than a joint constraint, but are otherwise by and large similar on other variables.

Turning to the lower panel, we observe that many of these disparities are substantially smaller in the selected sample, with much smaller disparities across sales, EBITDA, and assets. The groups are also more balanced in their number of observations. However, differences remain in firm leverage, with firms with earnings-based (IC or DE) covenants more levered than the other firms, and firms with IC covenants only especially levered. I attempt to address this remaining difference through the use of controls for lagged debt, assets, and EBITDA in the empirical results.

Covenant Ratios. Next, we can examine how these covenant ratios have evolved over time. Overall, the data, plotted in Figure 2, indicate that the ratio limits used in debt

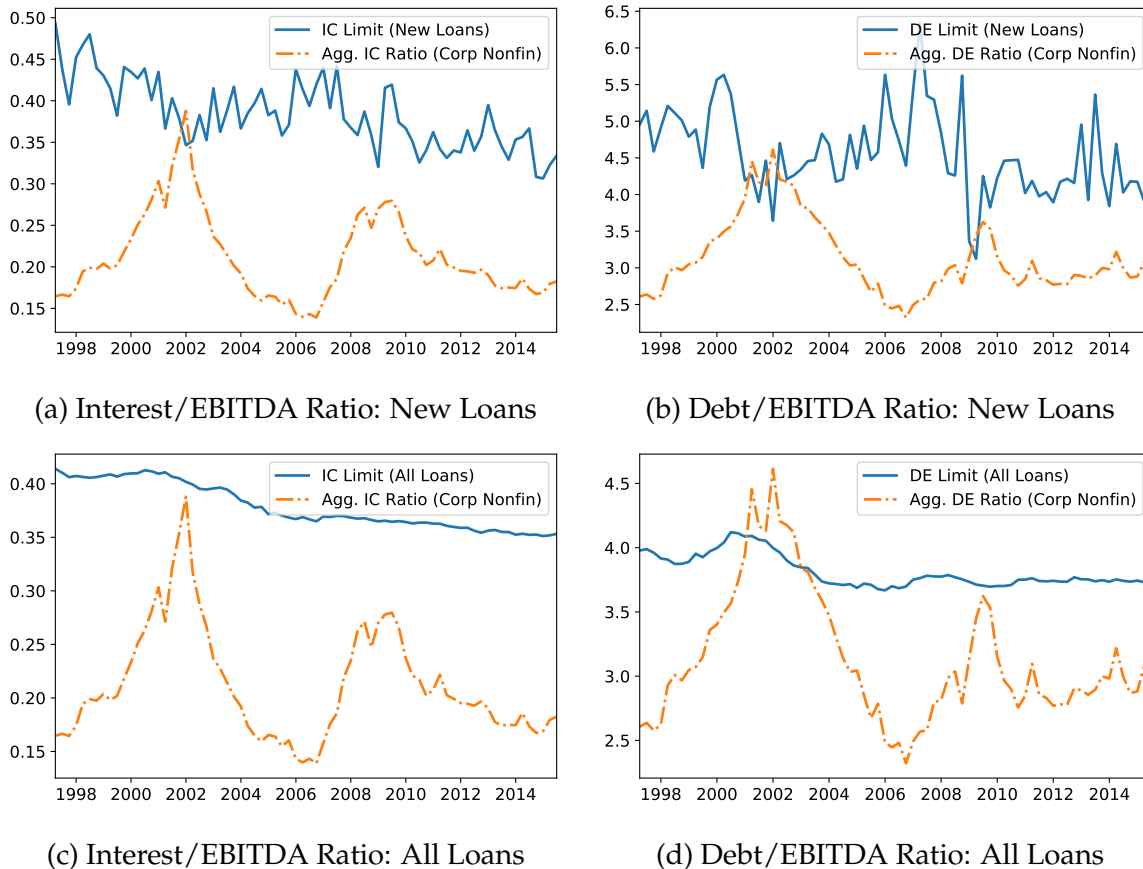


Figure 2: Covenant Ratios Over Time

Note: Data sources are Dealscan, Compustat, and the National Income and Product Accounts. The variable “IC Limit” and “DE Limit” display weighted means (weighted by deal amount) of the Dealscan covenant thresholds for “Max. Debt to EBITDA” and “Min. Interest Cov.” The values for “Min. Interest Coverage” thresholds are inverted so they are expressed as limits on interest payments to EBITDA.

covenants are stable over time, implying that debt limits can be reasonably treated as fixed at business cycle frequencies. Panels 2a and 2b show the maximum debt-to-EBITDA ratios and minimum interest coverage (EBITDA to interest payment) ratios on newly originated deals only, weighted both by the sales of the borrowing firm and by the size of the deal. The series are somewhat noisy, since the subset of firms obtaining new deals varies from quarter to quarter, but neither of the series show substantial time variation, with the exception of a slight downward trend in the allowed interest coverage ratio.

A possible concern is that lenders use these simple covenant ratios to dynamically implement some more complex limit policy, and simply change the ratios limits imposed by the covenants to keep the overall limit unchanged. If this were the case, we should expect to see that the ratio limits imposed on new loans vary with the actual ratios observed in

firms. For example, if lenders were using interest coverage limits as a proxy for another policy, we should expect that lenders would tighten interest coverage requirements as interest rates fall so that overall debt limits remain unchanged, perhaps explaining the trend in Figure 2a.

To address this concern, panels 2b and 2a plot the covenant ratios on new loans, weighted by deal amount, against measures of the overall debt-to-EBITDA and interest coverage ratios among corporate nonfinancial firms in the NIPA data. These plots show that the imposed limits do not co-move at all as the underlying variables change, despite substantial variation in the underlying fundamentals. For example, despite the large increase in the ratio of corporate profits to interest payments, due to falling interest rates, minimum interest coverage ratios do not rise nearly enough to keep debt limits constant.

Finally, while the previous discussion considers the covenant ratios on *new* loans, covenants on existing debt continue to constrain firms throughout the life of the loan. To show firms' actual constraints, Figures 2d and 2c compare covenant limits on *all* active Dealscan loans to the same aggregate fundamentals. These plots show that overall covenant limits are extremely smooth. Intuitively, active covenants in aggregate are a weighted average over past covenants at origination, generating a highly persistent series. The key takeaway from this analysis is that neither active nor newly originated covenants appear to vary systematically with economic conditions at business cycle frequencies, allowing them to safely be treated as fixed in the theoretical model presented below.

4 Measuring Covenant Tightness

From Section 3, it should be clear that IC covenants are both highly prevalent and generally imposed at stable ratios. However, since most firms with IC covenants simultaneously have DE covenants, it is also important to determine how often the IC covenants are in fact the tightest (most binding) covenants for such firms.

For this exercise, we can begin with the Dealscan data, which already contains measures of the limiting ratios for each covenant. I first adjust the relevant ratios to make them comparable across variations within a covenant family, following Demerjian and Owens (2016), and then take the tightest covenant ratio in each family to obtain values $\theta_{i,t}^{IC}$ and $\theta_{i,t}^{DE}$ for each firm for which both ratios are nonmissing. Given these ratios, determining covenant tightness requires (i) determining the typical interest rate on debt for the

relevant firms, and (ii) determining which covenant is closer to violation, which follows below.

Measuring the Typical Interest Rate. Given these ratios, we next need to determine what rate the firm typically pays, since this determines the tightness of its IC limit. To measure this, I obtain for each Dealscan package the spread relative to LIBOR inclusive of fees on drawn commitments (Dealscan variable *AllInDrawn*), taking a weighted average by facility amount for packages with multiple facilities.⁹ I drop any facilities that do not have a fixed spread ($\text{MinBps} \neq \text{MaxBps}$), then average over all packages that contain either an IC or DE covenant over my sample period (1997 - 2007) to obtain a typical spread of 190bp over LIBOR, or an average of 248bp over the 3-Month T-Bill rate. Adding in the average LIBOR rate over the sample period yields a typical interest rate of 6.11%.

Evaluating Covenant Tightness. With this typical rate in hand, the final step is to determine which covenant is tighter. In the data, few firms bunch at their exact IC or DE limits for precautionary reasons, since even a slight drop in EBITDA would push them into violation. Therefore, for each firm we must determine which covenant it is closer to violation. As noted by e.g., Murfin (2012), however, this distance may not be measured appropriately in raw dollars or percentages, since different types of covenants impose different degrees of risk. Most important for this analysis, the risk posed by DE covenants for a given level of debt stems only from unforecastable changes in EBITDA, with a sufficiently large fall in EBITDA pushing the firm into violation. IC covenants, in contrast, carry not only EBITDA risk but also interest rate risk, where a large enough rise in rates could potentially push a firm into violation. This additional risk implies that IC covenants may be closer to violation even when the IC and DE covenants have similar percentage buffers.

I now formalize this intuition using an approach similar to Murfin (2012). In a nutshell, this method measures covenant tightness as the number of standard deviations to violation, where the standard deviations for the two covenants will differ based on the risks faced.

To be precise, given a (fixed) level of debt today B_t , a firm's DE limit will be violated

⁹This data is drawn from the *CurrFacPricing* dataset in Dealscan.

over the next four quarters if

$$B_t > \theta^{DE} X_{t+4}^{4Q}$$

where X^{4Q} denotes a 4Q moving average of EBITDA (assuming annual evaluation of the covenant ratios). Taking logs and rearranging, this implies that violation occurs if

$$\Delta_4 \log X_{t+4}^{4Q} < \log B_t - \log \theta^{DE} - \log X_t^{4Q} \quad (1)$$

where Δ_4 indicates the 4Q difference. Assuming that this growth rate on the left hand side is approximately Gaussian, with

$$\Delta_4 \log X_{t+4}^{4Q} \sim N(\mu_X, \sigma_X^2)$$

then (1) implies that violation will occur if and only if the firm receives a draw of 4Q EBITDA growth of at least

$$Z_t^{DE} = \frac{\log B_t - \log \theta^{DE} - \log X_t^{4Q} - \mu_X}{\sigma_X} \quad (2)$$

standard deviations below its mean. We can now repeat this exercise for an IC limit, which will be violated if

$$r_{t+4}^{4Q} B_t > \theta^{IC} X_{t+4}^{4Q}$$

where r^{4Q} denotes a 4Q moving average of the interest rate. Taking logs and rearranging implies violation if and only if

$$\Delta_4 \left(\log X_{t+4}^{4Q} - \log r_{t+4}^{4Q} \right) < \log B_t - \log \theta^{IC} - \log X_t^{4Q} + \log r_t^{4Q}.$$

Again assuming a Gaussian process

$$\Delta_4 \left(\log X_{t+4}^{4Q} - \log r_{t+4}^{4Q} \right) \sim N(\mu_{rX}, \sigma_{rX}^2)$$

we obtain that default occurs if and only if the firm receives a draw of this growth rate of

at least

$$Z_t^{IC} = \frac{\log B_t - \log \theta^{IC} - \log X_t^{4Q} + \log r_t^{4Q} - \mu_{rX}}{\sigma_{rX}}. \quad (3)$$

I compute these quantities directly in the merged Dealscan/Compustat data, taking θ^{IC} and θ^{DE} directly from Dealscan, and B_t and X_t directly from Compustat (DLTTQ + DLCQ and OIBDPQ, respectively). For r_t , I use the implied interest rate of T-Bill plus 248bp described above. Using these variables, I compute the μ and σ variables as the relevant population moments over the sample. However, due to some extreme outliers, the raw standard deviation is very large and not representative of the true risk faced by the typical firms, since it is heavily influenced by huge proportional drops in EBITDA that would be sure to trigger both covenants. Instead, for purposes of covenant tightness, much more relevant are modest size shocks that are likely to trigger one covenant but not the other.

To better capture the variation relevant for this exercise, I estimate a robust version of the standard deviation. Specifically, I compute the exact standard deviation that would generate the observed interquartile range if the distribution were truly Gaussian. Applying this methodology (alongside the raw mean) for my selected (high-asset and high-margin) sample yields

$$\begin{aligned} \mu_X &= 0.103 & \sigma_X &= 0.189 \\ \mu_{rX} &= 0.107 & \sigma_{rX} &= 0.291. \end{aligned}$$

The key result of importance here is that the standard deviation including interest rate growth is larger, consistent with the greater risk faced under IC limits. I then classify a firm as being IC constrained if $Z_t^{IC} > Z_t^{DE}$.

Results: Covenant Tightness. Applying the methodology applied above, I find that fraction 32.9% of firms in my selected (high-asset and high-margin) sample that have both IC and DE covenants find the IC covenant to be tighter — a statistic that will be used to calibrate the model in Section 6. The adjustment for risk is important, as an unadjusted computation assuming $\sigma_{DE} = \sigma_{IC}$ would imply that only 6.4% of firms find their IC limit to be tighter.

Next, we can turn to variation in the IC-constrained share over time. Figure 3 displays the estimated shares for each period over my sample, alongside the assumed interest rate. Comparing (2) and (3) shows that nearly all the terms determining covenant tightness

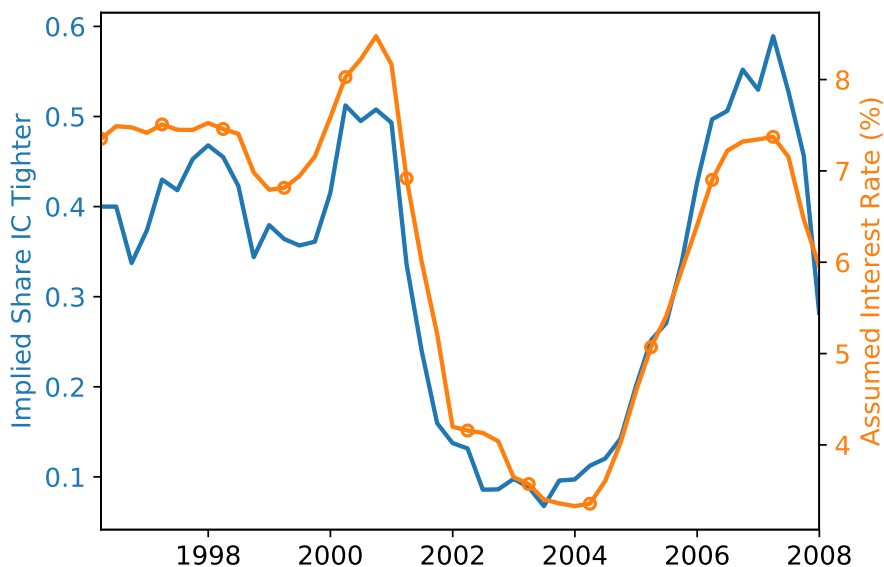


Figure 3: Implied Share with Tighter Interest Coverage Covenant

Note: Source: Dealscan and the Federal Reserve Board of Governors. The blue line with no marker displays the share of firms, among firms with both covenants, for which their IC covenant is implied to be tighter, while the orange line with circular marker displays the assumed interest rate (the 3-month T-Bill rate plus a 248bp spread) used in this calculation.

are identical except for the interest rate, which uniquely shifts the tightness of the IC limit. Correspondingly, nearly all the variation in the implied IC-tighter share comes from movements in the interest rate, with more firms IC-constrained in periods when rates are high. This variation is large and economically important, ranging from a high of 58.9% in 2007 Q1, to a low of 6.8% in 2003 Q2. Extending the sample would display even lower implied IC-constrained shares as the economy hovered near the zero lower bound.

For reference, I also include the implied IC-constrained share without the standard deviation adjustment in Appendix Figure A.1. Although this estimation yields a much lower average share constrained by IC, it nonetheless displays substantial, albeit smaller, variation in the IC-constrained share, implying that the general result of state dependence should not be overly sensitive to the particular methodology I have employed.

5 Model

This section lays out a simple model in which firms face the covenant-induced debt limits presented in Section 3. The model demonstrates the key economic mechanisms at work

and provides a benchmark for comparison with the empirical results in Sections 7 and 8.

Demographics. The model is populated by two types of infinitely-lived households: savers, denoted S , and entrepreneurs, denoted E . Entrepreneurs consume dividends produced by the economy's firms, while savers lend to the firms in addition to providing the economy's labor. Each household can trade a complete set of contingent contracts with the other members of their type, but cannot trade these contracts across types, allowing for aggregation to a representative household for each type.

Preferences. Both types of household have time-separable expected utility, defined by

$$V_t^S = E_t \sum_{j=0}^{\infty} \left(\prod_{k=0}^{j-1} \beta_{t+k} \right) \left[u^S(C_{t+j}^S) - v(N_{t+j}) \right] \quad (4)$$

$$V_t^E = E_t \sum_{j=0}^{\infty} \left(\prod_{k=0}^{j-1} \beta_{t+k} \right) u^E(D_{t+j}) \quad (5)$$

where C^S represents the saver's nondurable consumption, N represents labor supply, D represents aggregate dividends (consumed by the entrepreneur), and where the utility functions u^S and u^E are allowed to differ across types. This flexibility allows the curvature of the entrepreneur's utility function to provide a dividend-smoothing motive for the firm. The economy-wide discount factor β_t , shared by both types, follows

$$\log \beta_t = (1 - \rho_\beta) \log \bar{\beta} + \rho_\beta \log \beta_{t-1} + \varepsilon_{\beta,t}, \quad \varepsilon_{\beta,t} \sim N(0, \sigma_\beta^2).$$

This shock to the discount factor will provide the main variation in the interest rate used in the theoretical analysis of transmission.

Productive Technology The productive technology in the economy is defined by

$$F(K_{t-1}, N_t) = Z_t K_{t-1}^\alpha N_t^\gamma$$

with $\alpha + \gamma < 1$, implying diminishing returns to scale. Unlike a traditional constant returns to scale technology, this production function allows for nonzero profits (markups). This feature helps the model to match the data, since profits are an important source of

EBITDA, which in turn determines the tightness of a firm's covenants.¹⁰

Productivity Z_t follows an autoregressive process in logs:

$$\log Z_t = (1 - \rho_Z) \log \bar{Z} + \rho_Z \log Z_{t-1} + \varepsilon_{Z,t}, \quad \varepsilon_{Z,t} \sim N(0, \sigma_Z^2).$$

Firm investment in capital is also subject to adjustment costs, so that expending I_t units of resources results in $\Phi(i_t)K_{t-1}$ new units of capital being produced, where $i_t = I_t/K_{t-1}$. Existing capital depreciates at rate δ , leading to the law of motion

$$K_t = \left(\Phi(i_t) + (1 - \delta) \right) K_{t-1}. \quad (6)$$

Covenant Types. The main modeling innovation of the paper is to consider the three main types of covenants imposed on firm debt. Consistent with the definitions in Section 3, I impose interest coverage, debt-to-earnings, and leverage limits as

$$\bar{B}_t^{IC} = \frac{\theta^{IC} X_t}{r_t} \quad \bar{B}_t^{DE} = \theta^{DE} X_t, \quad \bar{B}_t^{LEV} = \theta^{LEV} BV_{t-1} \quad (7)$$

where X_t denotes EBITDA, defined in the model as

$$X_t = Y_t - w_t N_t.$$

The IC limit caps interest payments $r_t B_t$ as a fraction of EBITDA, while the DE limit caps the stock of debt B_t as a fraction of EBITDA. The leverage limit caps the stock of debt as a fraction of book value, defined by

$$BV_t = i_t + (1 - \delta) BV_{t-1}. \quad (8)$$

Combining Covenants. Firms in the data often face multiple covenants at once, with the combination of IC and DE covenants particularly common. The joint incidence of these two constraints is implemented in the model, allowing for heterogeneity in the covenant limits by firm as observed in the data, so that an endogenous and time-varying fraction of firms finds each covenant to be their tightest constraint.

To implement this, I assume that all firms in the economy share the same debt-to-

¹⁰This specification is much more parsimonious than monopolistic competition, the traditional source of markups in the literature, which becomes unwieldy when multiple types of firms are asymmetrically producing intermediate goods.

earnings limit $\bar{\theta}^{DE}$. However, each firm draws a firm-specific interest coverage limit $\theta_{i,t}^{IC} = e_{i,t} \bar{\theta}^{IC}$, where $\log e_{i,t} \sim N(-\sigma_e^2/2, \sigma_e^2)$. If we define

$$\bar{B}_t^{DE} = \bar{\theta}^{DE} X_t, \quad \bar{B}_t^{IC} = \frac{\bar{\theta}^{IC} X_t}{r_t}$$

to be the average values of the these limits, then a firm will have a binding IC constraint if and only if $e_{i,t} \leq e_t^* = \bar{B}_t^{DE} / \bar{B}_t^{IC}$. The overall debt limit for a given firm is

$$\bar{B}_{i,t} = \min(\bar{B}_t^{DE}, e_{i,t} \bar{B}_t^{IC}) \quad (9)$$

which is equivalent to a representative firm facing the overall debt limit

$$\bar{B}_t^{DE/IC} = \bar{B}_t^{IC} \int^{e_t^*} e_{i,t} \Gamma_e(e_{i,t}) + \bar{B}_t^{DE} (1 - \Gamma_e(e_t^*)). \quad (10)$$

Collateralizability in this case is equal to

$$\frac{\partial \bar{B}_t^{DE/IC}}{\partial K_{t-1}} = \frac{\partial \bar{B}_t^{IC}}{\partial K_{t-1}} \int^{e_t^*} e_{i,t} \Gamma_e(e_{i,t}) + \frac{\partial \bar{B}_t^{DE}}{\partial K_{t-1}} (1 - \Gamma_e(e_t^*))$$

while the fraction of borrowers with binding interest coverage constraints is equal to $\Gamma_e(e_t^*)$.

Debt Limit Smoothing. To accommodate the fact that covenants are often written at the annual rather than the quarterly frequency, I assume that the overall debt limit is a moving average of the current covenant limits \bar{B} defined above. Specifically, I set firms' overall debt caps to be

$$B_t^* = (1 - \rho_B) \bar{B}_t + \rho_B \pi_t^{-1} B_{t-1}^*. \quad (11)$$

This smoothing is a parsimonious approximation of the fact that covenants are often written on annual rather than quarterly ratios, so that total debt limits are mixed over current and past conditions. To stay consistent with the notion of these limits as covenants, I require that they be satisfied not at time t , but in expectation at time $t + 1$, so that the firm's time t debt limit is defined by

$$B_t \leq E_t [B_{t+1}^*]. \quad (12)$$

Firms. Firms own the economy's productive capital and produce using the production function $F(K_{t-1}, N_t)$. Firms are owned by the household, which receives dividends D_t . Firms are also able to borrow in the form of debt, denoted B_t , whose interest payments are tax deductible, generating a tax shield and a preference for debt finance.

Government The government applies a proportional tax at rate τ to labor income and firm profits (earnings before taxes). The government then rebates the collected funds lump-sum to the household using a transfer T_t , maintaining a balanced budget at all times. The government issues a riskless short-term bond in zero net supply.

Monetary Policy and Price Setting For simplicity, I assume a flexible price environment, with a monetary policy rule such that the government sets rates as needed to exactly hit its inflation target of $\pi_t = \bar{\pi}$ in all periods.

Representative Firm's Problem. The representative firm solves

$$V_t^F = \max_{D_t, N_t, B_t, i_t} D_t + \beta E_t \left[\Lambda_{t+1}^E V_{t+1}^F \right]$$

where Λ_{t+1}^E is the representative entrepreneur's stochastic discount factor, subject to the budget constraint

$$D_t \leq \underbrace{(1 - \tau) \left[F(K_{t-1}, N_t) - w_t N_t - r_t \pi_t^{-1} B_{t-1} \right]}_{\text{earnings}} + \underbrace{\tau \delta K_{t-1}}_{\text{depreciation}} - \underbrace{i_t K_{t-1}}_{\text{investment}} + \underbrace{(B_t - \pi_t^{-1} B_{t-1})}_{\text{net new debt}}$$

the borrowing constraint (12), and the laws of motion (6) and (11). The firm's optimality condition with respect to labor is the standard

$$F_{N,t} = w_t. \quad (13)$$

In principle, the firm's labor decision could be distorted through incentives to influence the debt limit. However, in this paper, the debt limits considered either do not depend on labor (leverage covenants) or depend on labor only through EBITDA (debt-to-earnings and interest coverage covenants). Since EBITDA is already maximized by (13), any additional term due to the constraint is zero at equilibrium through the envelope theorem.

Next, the firm's optimality condition for debt is

$$1 - \mu_t = E_t \left\{ \Lambda_{t+1}^E \pi_{t+1}^{-1} [1 + (1 - \tau)r_t] \right\}$$

where μ_t is the multiplier on the debt limit. Finally, the firm's investment optimal investment rate is determined by

$$q_t = \Omega_t + \mathcal{M}_t E_t \left[\frac{\partial \bar{B}_{t+1}}{\partial K_t} \right]$$

where $q_t = 1/\Phi'(i_t)$ is Tobin's q , \mathcal{M}_t is the present discounted value of future debt multipliers, defined by

$$\mathcal{M}_t = (1 - \rho_B) \sum_{k=0}^{\infty} E_t \left[\left(\prod_{j=0}^k \Lambda_{t+j}^E \pi_{t+j}^{-1} \right) \rho_B^k \mu_{t+k} \right]$$

which takes into account that increasing covenant ratios today relaxes debt limits both today and in the future, through the law of motion (11), while Ω_t is the firm's marginal continuation value of capital, defined by

$$\Omega_t = E_t \left\{ \Lambda_{t+1}^E \left[(1 - \tau)F_{K,t+1} + \tau\delta + \left(\Phi(i_t) + (1 - \delta) \right) \Omega_{t+1} \right] \right\}. \quad (14)$$

In the case where firms were never borrowing constrained, we would have $\Omega_t = q_t$, equating the marginal cost of producing capital today with the marginal benefit of future dividends. However, when firms are borrowing-constrained, we have $q_t > \Omega_t$, implying that firms continue investing beyond the unconstrained level in order to relax their borrowing limits, taking advantage of the strictly positive values of $\partial \bar{B}_{t+1}/\partial K_t$. I refer to this term $\partial \bar{B}_{t+1}/\partial K_t$ as the *collateralizability* of investment, so that investment is more collateralizable when an extra unit of installed capital can be financed by more new borrowing due to its relaxation of the debt limit.

Collateralizability of Covenants. Applying the definition of collateralizability to the covenants described earlier, we obtain

$$\frac{\partial \bar{B}_t^{DE}}{\partial K_{t-1}} = \theta^{DE} F_{K,t}, \quad \frac{\partial \bar{B}_t^{IC}}{\partial K_{t-1}} = \frac{\theta^{IC} F_{K,t}}{r_t}, \quad \frac{\partial \bar{B}_t^{LEV}}{\partial K_{t-1}} = \theta^{LEV}.$$

These expressions show that collateralizability depends both on the covenant being imposed and potentially on the state of the economy. While leverage covenants are always equally collateralizable, both debt-to-earnings and interest coverage covenants become more collateralizable when the marginal product of capital is high, such as after a positive productivity shock. Most important, however, is that interest coverage covenants, but not debt-to-earnings or leverage covenants, are influenced by interest rates, increasing when interest rates are low. Due to the structure of the constraint, this effect can be quite strong — for example, a fall in the loan rate r_t from 10% to 9% would increase collateralizability by 10%.

Representative Saver's Problem. The representative saver chooses B_t and N_t to maximize (4) subject to the budget constraint

$$C_t \leq \underbrace{(1 - \tau)w_t N_t}_{\text{labor income}} - \underbrace{\left(B_t^S - (1 + r_{t-1})\pi_t^{-1} B_{t-1}^S \right)}_{\text{net debt issuance}} + \underbrace{T_t}_{\text{transfer}}$$

where the superscript on B_t^S indicates that the household can hold both corporate and government bonds, which it considers to be identical. The household's resulting optimality conditions are

$$\begin{aligned} (N_t) : \quad & w_t u'(C_t^S) = v'(N_t) \\ (B_t^S) : \quad & 1 = (1 + r_t) E_t \left[\Lambda_{t+1}^S \pi_{t+1}^{-1} \right] \end{aligned}$$

which define the labor demand and debt supply curves in the economy.

Equilibrium. A competitive equilibrium consists of allocations $(C_t^S, B_t, D_t, N_t, K_t, i_t)$ and prices (r_t, π_t, w_t) such that households and firms optimize, the monetary policy rule is satisfied, the bond and labor markets clear, and the market clearing conditions for labor, government bonds, and the resource constraint

$$F(K_{t-1}, N_t) = C_t^S + D_t + i_t K_{t-1}$$

are satisfied.

6 Model Parameterization

This section lays out the parametric forms used in the quantitative implementation of the model, as well as the calibration of the model parameters.

Parametric Forms. For the utility functions I set

$$u^S(C^S) = C^S, \quad v(N) = \eta N.$$

This risk-neutral parameterization keeps interest rates pinned down by the discount factor, and abstracts from smoothing motives other than dividend smoothing. The linear labor disutility is chosen to avoid dampening effects due to changes in labor supply. These assumptions, which shut down a general equilibrium response of interest rates and wages to credit demand and labor demand, are useful for comparing results from models with different individual constraints, since in reality firms with different constraints coexist in the same credit and labor markets and should not face different levels of general equilibrium feedback.

For the entrepreneur's utility function I assume log utility

$$u^E(D) = \log(D).$$

This EIS of unity corresponds to a moderate intertemporal dividend smoothing motive, and implies the stochastic discount factor

$$\Lambda_{t+1}^E = \beta_t \left(\frac{D_{t+1}}{D_t} \right)^{-1}$$

and provides a motive for the firm to smooth dividends over time. This smoothing motive plays the same role as the dividend adjustment cost in e.g., Jermann and Quadrini (2012), but is more convenient in an environment with heterogeneous constraints.

For simplicity, in the baseline calibration I ignore capital adjustment costs, so that $\Phi(i_t) = i_t$, implying that Tobin's q is equal to unity, and that book value is equal to the capital stock ($BV_t = K_t$).

Calibration. The model is calibrated at quarterly frequency to my sample period 1997 - 2007, with the full set of parameter values displayed in Table 2.

Table 2: Parameter Values: Baseline Calibration

Parameter	Name	Value	Internal	Target/Source
<i>Demographics, Preferences, and Government</i>				
Discount factor mean	$\bar{\beta}$	0.990	N	Typical Dealscan rate
Discount factor persistence	ρ_{β}	0.969	N	Autocorr. of 3-Mo. T-Bill
Labor disutility scale	η	1.408	Y	$N_{SS} = 1$
Tax rate	τ	0.350	N	Corporate tax rate
Inflation rate	$\bar{\pi}$	1.005	N	2.03% inflation
<i>Productive Technology</i>				
Capital share	α	0.360	N	Standard
Labor share	γ	0.630	N	1% markup
Depreciation	δ	0.025	N	Standard
Dividend cost elasticity	ζ_D	1.000	N	Moderate smoothing
<i>Single Covenant Economy Limits</i>				
Max interest coverage ratio	θ^{IC}	0.169	Y	Debt/EBITDA = 11.16
Max debt-to-earnings ratio	θ^{DE}	8.548	Y	Debt/EBITDA = 8.42
Max leverage ratio	θ^{LEV}	0.227	Y	Debt/EBITDA = 5.42
<i>Benchmark (IC + DE) Economy Limits</i>				
Max interest coverage ratio	θ^{IC}	0.154	Y	Debt/EBITDA = 8.01
Max debt-to-earnings ratio	θ^{DE}	8.613	Y	$F^{IC} = 32.9\%$
<i>Other Debt Parameters</i>				
Borrowing limit smoothing	ρ_B	0.250	N	Annualized ratios
IC vs. DE st. dev.	σ_e	0.301	N	Dealscan

To begin, I set $\bar{\pi}$ to generate an annual inflation rate of 2.03%, equal to the average PCE inflation over the sample period. For the discount factor, I target the typical rate on Dealscan loans. To compute this rate, for each Dealscan package I compute the spread inclusive of fees on drawn commitments (Dealscan variable AllInDrawn), taking a weighted average by deal amount for packages with multiple facilities. I drop any facilities that do not have a fixed spread ($\text{MinBps} \neq \text{MaxBps}$), then average over all packages that contain either an IC or DE covenant over the sample period to obtain a typical spread of 190bp over LIBOR, or an average of 248bp over the 3-Month T-Bill rate. Adding in the average LIBOR rate over the sample yields a typical interest rate of 6.11%. Removing average inflation over the sample yields a real rate of 3.97%, which directly pins down $\bar{\beta}$.

The tax rate is set to 35%, which was the standard corporate rate over the sample period. Following Jermann and Quadrini (2012), I set the capital share to 0.360 and the depreciation rate to 0.025, both of which are standard values. For the labor share, I set

$\gamma = 0.630$ which implies a constant markup of $1 - \alpha - \gamma = 1\%$. This token markup, following Bernanke et al. (1999), is smaller than the usual estimated markup, but allows for a closer match of the steady state debt/EBITDA ratio to the typical values in Table 1.

For the covenant ratios, I consider two calibrations, with one set of parameters for each of the experiments in Sections 7 and 8, respectively. For the first set of results, I consider separate economies which each feature a single type of covenant in isolation. For this case, I calibrate each limit $\theta^{IC}, \theta^{DE}, \theta^{LEV}$ so each economy with that debt limit only has steady state ratio of debt to EBITDA equal to 11.16, 8.42, and 5.42, respectively — the median values for firms in the selected sample with these covenants only, as found in Table 1. For the second set of results, I consider an economy with simultaneously imposed IC and DE limits. In this case, I calibrate θ^{IC} and θ^{DE} to again match the selected sample median ratio of debt to EBITDA of 8.01, and to additionally match that the share of firms who find IC covenants to be tighter is equal to 32.9%, the mean share computed in Section 4.

Turning to the other debt limit parameters, I choose the smoothing parameter $\rho_B = 0.250$, consistent with annual evaluation of the statistics used for debt covenants. Finally, for the model with multiple covenants, the standard deviation of the log ratio of covenant limits, σ_e , is computed directly from the distribution of values $e_{i,t} = \log(\theta_{i,t}^{DE}/\theta_{i,t}^{IC})$ for firms where both observations are available. Since the distribution of $e_{i,t}$ is noisy and highly fat-tailed, containing many extreme outliers that are almost sure to be inframarginal (i.e., will never change their binding limit), the raw standard deviation would overstate the relevant dispersion in the sample. As in Section 4, I address this by computing the robust standard deviation (as in Section 4) so that the model and data IQR match exactly.

7 Results: The Interest Coverage Channel

This section presents the first main set of results, demonstrating how the presence of interest coverage covenants can amplify transmission from interest rates into corporate debt and investment — the interest coverage channel. I first use the model to generate predictions and demonstrate the underlying mechanisms, then turn to the data for direct cross-sectional evidence for this channel.

7.1 Interest Coverage Channel: Model Predictions

Interest Transmission by Covenant. The first set of results show how the different covenants types influence transmission. For this exercise, I compare an Interest Coverage

(IC) economy, a Debt-to-Earnings (DE) economy, and a Leverage economy, where each imposes its respective covenant as the sole limit on firm borrowing. Figure 4 contrasts the response to an interest rate (discount factor) shock across each of the three economies. While interest rates fall identically in all three economies, we observe a much larger rise in debt in the Interest Coverage economy (20.7% after 8 quarters), where the fall in rates has substantially loosened borrowing limits, relative to either of the alternative economies (increases of 0.5% and 0.5% in the DE and Leverage economies, in which limits are left largely unchanged).

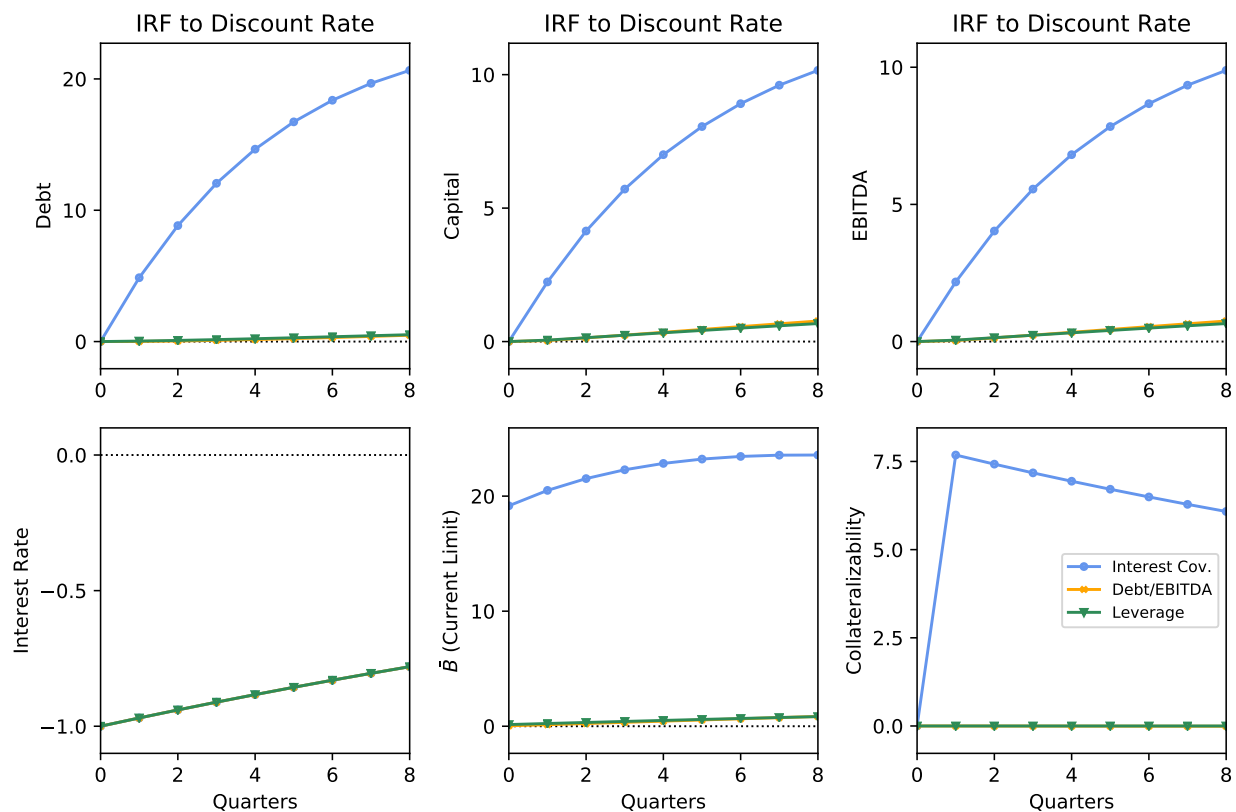


Figure 4: Model Interest Rate Transmission by Covenant

Turning to investment, while firms in all three economies accumulate capital in response to a fall in discount rates, this increase is much larger for firms in the IC economy. This stronger reaction in the IC economy is due to a combination of two factors: a sharp rise in collateralizability unique to this economy, and dividend issuance costs that discourage the IC-constrained firms from immediately paying out their newly acquired debt to shareholders. While this dividend friction is present in all three economies, its effect depends on the amount of new debt received, and is much stronger in the IC economy.

In total, IC-constrained firms increase their capital by 10.2% after 8 quarters, far outstripping the DE economy (0.8%) or the Leverage economy (0.7%), where investment is almost exclusively driven by the increased saving motive rather than by changes in financing conditions.

Importantly, part of the increased investment in the IC economy occurs due to a feedback loop that has further amplified transmission. Recall that while IC constraints can be loosened by a fall in interest rates, they can also be relaxed by a rise in EBITDA. As a result, the initial investment due to the fall in rates causes a rise in output and EBITDA, further loosening credit limits, which in turn allows for additional investment. All told, this feedback loop contributes nearly half (9.9%) of the overall rise in debt. This exact feedback loop is also present in the DE economy, where debt limits are similarly relaxed when EBITDA increases, while a parallel mechanism is present in the Leverage economy, where debt limits are directly relaxed by investment. However, these alternative economies lack the initial impulse to these feedback loops through the direct effect of interest rates on the debt limit, diminishing the role of feedback in their responses.

Taking stock, these results demonstrate that a calibrated model with a tax shield motive for debt and a modest degree of dividend smoothing can produce greatly amplified transmission from interest rates into debt and investment when firms are limited by IC covenants.

7.2 Interest Coverage Channel: Empirical Evidence

Empirical Strategy The overall empirical approach is to compare the response of measures of firm capital and debt to a change in interest rates. To do so, I run the regression

$$y_{i,t+h} = \alpha_i + \phi_{j,t} + \sum_{\text{cov}} \mathbb{I}_{\text{cov},t-1} \cdot (\beta_{0,\text{cov}} + \beta_{1,\text{cov}} \Delta r_t) + \gamma' X_{t-1} + \delta'(X_{t-1} \cdot \Delta r_t) + \varepsilon_{i,t} \quad (15)$$

for each horizon h between 0 and 8 quarters, where α_i is a firm effect, $\phi_{j,t}$ is an industry-time effect, $\mathbb{I}_{\text{cov},t-1}$ is an indicator for the firm's covenant status, Δr_t is the change in the 3-Month T-Bill rate, and X_{t-1} is a vector of firm-level controls: cash, EBITDA, assets, long-term debt, short-term debt, and CAPX. After normalization, I winsorize all y and X variables at the 5% level, and then drop to the selected (high-asset and high-margin) sample described in Section 2. For the covenant status, I classify firms as having an interest coverage covenant only, which I label "IC-only," as having a debt-to-EBITDA covenant but not an IC covenant, which I label "DE-only", or as having both an IC and a DE covenant,

which I label as “Both.” The residual group of firms, against which these coefficients are measured, have either no covenants or leverage covenants only.

Regression (15) faces two serious endogeneity challenges. First, covenant assignment is nonrandom, meaning that firms whose business models face differential exposure to aggregate interest rates may systematically select into different covenants, or into obtaining syndicated loans in the first place, confounding the effect of covenant structure on interest rate transmission. Second, as discussed extensively in the macroeconomic literature, the change in interest rates Δr_t is typically not an exogenous impulse, but instead a systematic response to some other macroeconomic shock, which may have confounding effects on the dependent variables. While the use of identified monetary policy shocks might be ideal for this application, in practice they are too weak to generate precise results in any direction — a drawback denoted the “power problem” by Nakamura and Steinsson (2018).

I attempt to address these concerns in several ways. First, to help with both issues above, I include industry-time dummies at the SIC-2 \times quarter level. Absorbing this variation to focus on comparisons between firms in the same two-digit industry controls for background macroeconomic conditions that may have driven the interest rate change, even if they have differential effects by industry. Moreover, including these dummies should alleviate covenant selection issues to the extent that they occur at the industry level.

Next, to further address selection issues, I include interactions between the firm-level controls X_{t-1} and the change in rates Δr_t , allowing for firms with different observables to react differently to the same change in rates, which should help control for selection to the extent that is correlated with my controls. Finally, the results below will focus on comparisons between firms with different covenant structures (IC-Only, DE-Only, Both) that are similar on key variables (see Table 1), and all of which by construction hold syndicated loans.

Transmission by Covenant Given this motivation, we can now turn to the results of regression 15, displayed graphically in Figure 5 for the outcome (y) variables total firm debt, measured as the sum of short-term and long-term debt, and firm capital, measured as total assets.¹¹ The primary statistic of interest is the difference between the coefficients on the IC-only and DE-only firms. To stay consistent with the theoretical results, I consider

¹¹Compustat codes are DLCQ for short-term debt, DLTTQ for long-term debt, ATQ for assets.

the response to a 100bp interest rate *decline*, meaning that I plot the negative difference

$$y_h = -(\beta_{1,IC\text{-only}} - \beta_{1,DE\text{-only}})$$

on the y -axis each horizon h .

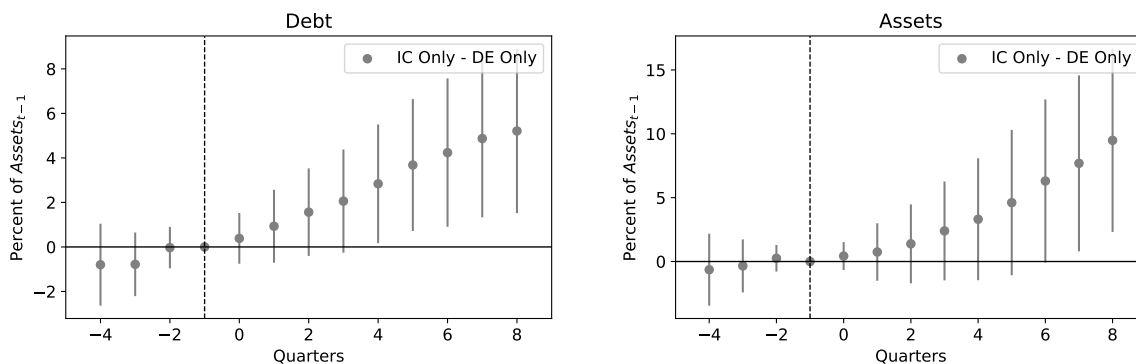


Figure 5: Estimated Response to Interest Rate ↓ 100bp by Covenant

Note: The dots labeled “IC - DE” plot the difference $-(\beta_{1,IC} - \beta_{1,Other})$ in equation (15). Bars indicate 95% confidence bands. Standard errors are double clustered at the firm and industry-time level.

Figure 5 presents these results, plotting the response of firms with IC covenants only relative to firms with DE covenants only. As conjectured, firms with only IC covenants display a stronger response in both debt and investment to the same movement in rates, relative to their DE-only peers. In terms of point estimates, firms with only IC covenants display an additional 8Q growth in debt of 5.2%, and 8Q growth in assets of 9.5%, measured as a share of $Assets_{t-1}$, relative to their DE-Only peers. It is worth noting that, since these numbers are expressed as a share of $Assets_{t-1}$, the *proportional* response of debt is much larger, since the typical firm in the sample has debt equal to around 1/3 of assets.

For comparison, the predicted model responses, also expressed as a share of $Assets_{t-1}$, are 9.6% for debt and 9.7%). The point estimate matches the model prediction almost exactly for assets, and is slightly smaller than the implied response of debt. This difference may be due to the absence of default risk in the model. Lacking explicit default risk or distress costs, the model firms take on essentially an identical amount of assets and debt, increasing their leverage by 4.8ppt. The implied response in the data indicates a more balanced approach, where new assets are financed roughly half by debt and half by equity, keeping overall leverage much more stable. Overall, however, these results are consistent with a starkly increased response for IC-only firms relative to their DE-only peers, as predicted by the theoretical framework.

The responses of additional variables are displayed in Figure A.2 in the Appendix. These results show excess 8Q growth of long-term debt (3.2%), short-term debt (1.2%), and EBITDA (0.3%), again measured as a share of $Assets_{t-1}$. Most important for the model's mechanism is the estimated response for EBITDA. While imprecise, the point estimate is close to the model's prediction of 0.4%), consistent with the model's feedback channel. Again, the magnitudes of these numbers are expressed as a fraction of $Assets_{t-1}$, implying a vastly larger proportional change in EBITDA, which is typically equal to around 4% of assets (see Table 1).

Finally, while the comparison of IC-Only firms to DE-Only firms provides the cleanest comparison, it ignores the (larger) fraction of firms who have both covenants simultaneously. Since some fraction of firms with both covenants will find their IC constraints tighter, while others will find their DE constraints tighter, we should expect responses for the Both group that are intermediate relative to their IC-only and DE-only peers. Indeed, Figure A.3 in the Appendix shows estimates that, while less precise, are consistent with IC-only firms accumulating more debt and assets than firms with both covenants (8Q point estimates of additional 1.6% and 3.2% debt and asset growth, respectively) while providing stronger evidence that firms with both covenants in turn react more than DE-only firms (8Q point estimates of additional 3.6% and 6.2% debt and asset growth, respectively).

8 Results: State-Dependent Interest Rate Transmission

I now turn to the second main insight of the paper: that the strength of the interest coverage channel is state dependent, with stronger transmission when rates are high relative to when rates are low. I once again use the model to generate theoretical predictions, then validate them directly using an augmented version of the empirical specification in Section 7.2, allowing for coefficients that vary with the interest rate regime.

8.1 State-Dependent Transmission: Model Predictions

To explore this potential for state dependence, Figure 6 compares three versions of an economy in which all firms face both DE and IC covenants, as described in equations (9) and (10). These economies differ only in their steady state interest rates ($\bar{\beta}$), with the Low Rates economy assigned a steady state discount rate 250bp lower than the benchmark, while the High Rates economy has a steady state discount rate that is 250bp above the

benchmark. This range is chosen to match the variation in the T-Bill rate over the sample, for which maximum and minimum values differed by 5.1ppt over the sample.

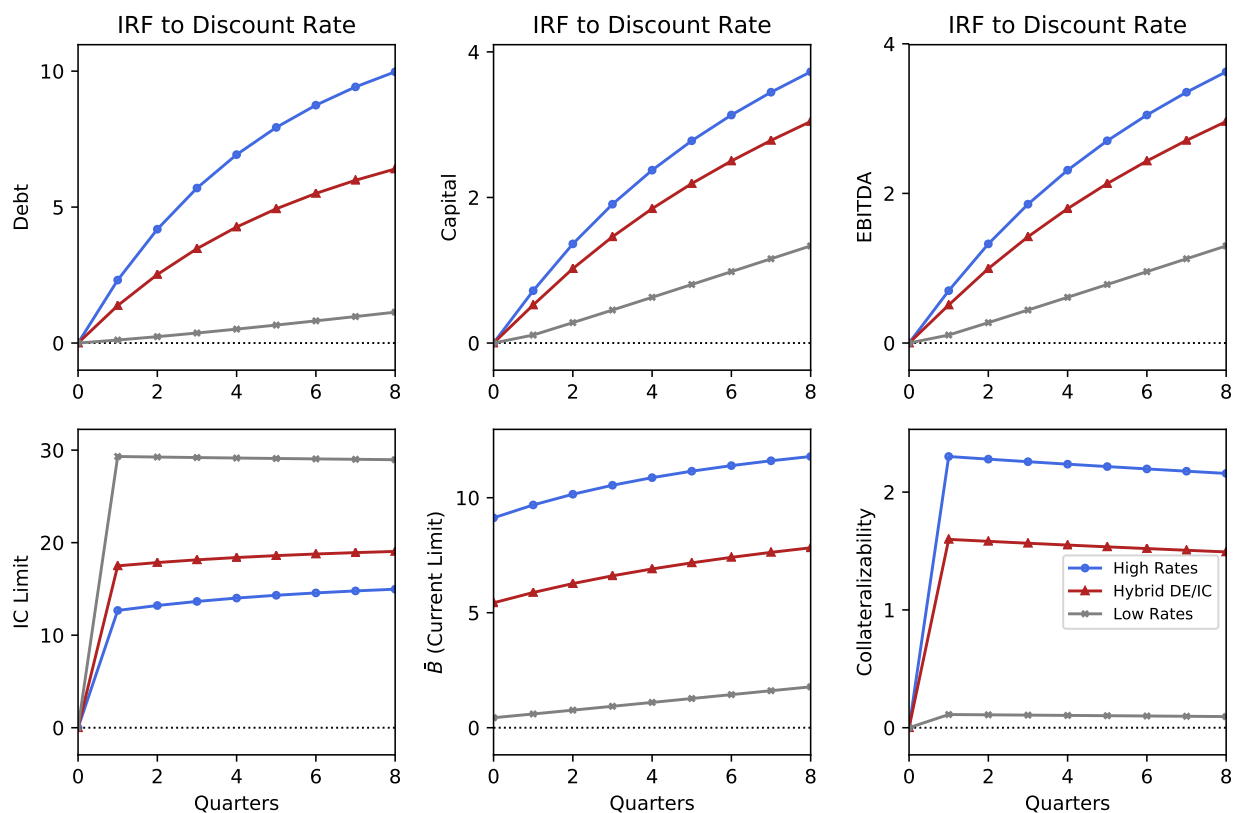


Figure 6: Transmission with Debt/Earnings and Interest Coverage Covenants

To begin, note that the Hybrid DE/IC economy unsurprisingly displays results between the IC and DE economies in Figure 4, with debt and capital increasing after 8Q by 6.4% and 3.0%, respectively. These results are naturally much closer to the DE economy, given that only 32.9% of firms find their IC constraints to be tighter at steady state. While IC limits are substantially loosened for all firms in this economy, this limit is only relevant for this minority of firms, while the rest are inframarginal.

From this starting point, we can consider how the results vary when at high and low initial interest rates. In the High Rate economy, large interest payments tighten interest coverage limits, implying that more firms (73.4%) find interest coverage to be their tightest covenant. The marginal relaxation of IC limits as rates fall now directly affects more firms, leading to larger responses of debt and investment. In contrast, only a tiny minority of firms in the Low Rate economy (1.3%) find interest coverage to be their tightest

covenant, while the rest find it slack. Since the tightest covenant for these firms is their debt-to-earnings covenant, which is not directly influenced by rates, this regime exhibits much weaker transmission. Quantitatively, the 8Q response of debt is more than ten times higher in the High Rate vs. Low Rate economy (10.0% vs. 1.1%) while the 8Q growth of capital is more than tripled (3.7% vs. 1.3%).

It is worth noting that the much larger response in the High Rate economy occurs even though IC limits have been proportionally loosened by much less, as shown in the bottom-left panel of Figure 6. This occurs because the same 100bp change in rates corresponds to a different *proportional* change depending on the initial level of rates: a fall from 8.6% to 7.6% in the High Rate economy is a proportional drop of 12%, compared to a fall from 3.6% to 2.6% in the Low Rate economy, corresponding to a proportional drop of 28%. Since IC limits are proportional to the net interest rate r_t , this means that IC limits are moving by less than half as much in the High Rate economy relative to the Low Rate economy. Nonetheless, the much greater share of IC-constrained firms at the extensive margin more than compensates for the smaller IC relaxation per firm at the intensive margin, leading to the amplified total response.¹²

8.2 State-Dependent Transmission: Empirical Evidence

To test this state dependence in the data, I augment regression (15) to interact all variables other than fixed effects with the lagged interest rate r_{t-1} :

$$y_{i,t+h} = \alpha_i + \phi_{j,t} + \sum_{\text{cov}} \mathbb{I}_{\text{cov},t-1} \cdot \left(\beta_{0,\text{cov}}^0 + \beta_{1,\text{cov}}^0 \Delta r_t \right) + \gamma'_0 X_{t-1} + \delta'_0 (X_{t-1} \cdot \Delta r_t) \quad (16)$$

$$+ \sum_{\text{cov}} \mathbb{I}_{\text{cov},t-1} \cdot \left(\beta_{0,\text{cov}}^1 + \beta_{1,\text{cov}}^1 \Delta r_t \right) \cdot r_{t-1} + \gamma'_1 X_{t-1} \cdot r_{t-1} + \delta'_1 (X_{t-1} \cdot \Delta r_t) \cdot r_{t-1} + \varepsilon_{i,t}$$

The empirical procedure is otherwise identical to that of Section 7.2, this time focusing on how interest rate transmission varies with the level of the lagged interest rate r_{t-1} .

Figure A.4 displays the results of regression (16). The top row shows the negative coefficient $-\beta_{1,\text{Both}}^1$, corresponding to the estimated change in the response of firms with Both covenants to a 100bp interest rate shock Δr_t as the lagged interest rate r_{t-1} is varied. The sign is again set to correspond to an interest rate decrease, so that a positive coefficient indicates a stronger response when rates are high. These results show responses for firms

¹²This proportionality effect also explains why the High Rate response is closer to the benchmark than the Low Rate response. At extremely high interest rates we would eventually see further increases in r_{t-1} dampen, rather than amplify, the response to a 100bp fall in rates.

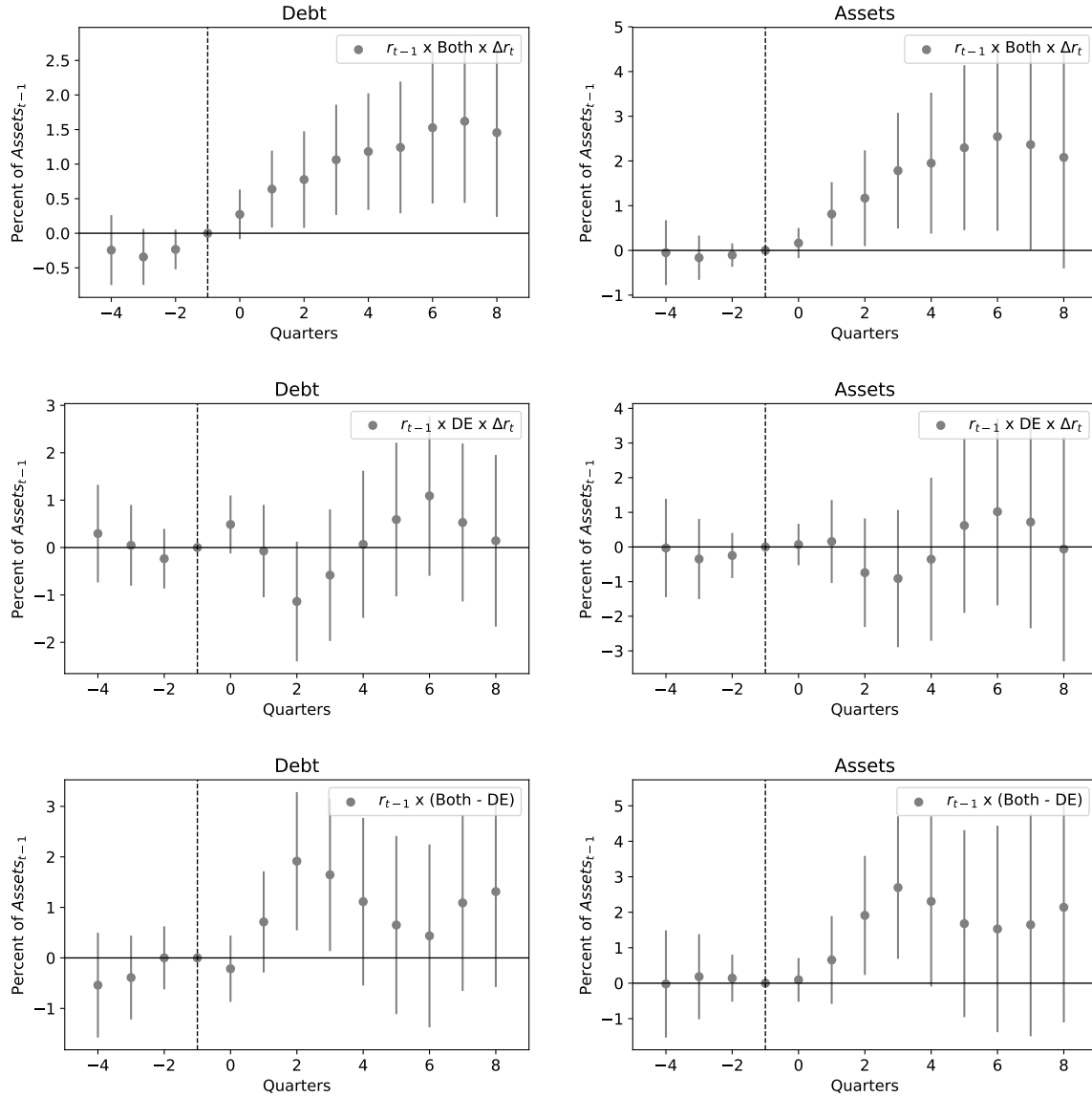


Figure 7: Estimated Response to Interest Rate \downarrow 100bp, Interaction with Rate

Note: The plots display $-\beta_{1,\text{cov}}^1$, which are the coefficients on the interaction between r_{t-1} , covenant type, and Δr_t in equation (16). Bars indicate 95% confidence bands. Standard errors are double clustered at the firm and industry-time level.

with both IC and DE covenants that become significantly stronger, both statistically and economically, as interest rates rise. Specifically, for every 1ppt that r_{t-1} is increased, firms with both covenants accumulate an additional 1.5% of debt and 2.1% of assets after 8Q in the high rate regime, measured as a share of Assets_{t-1} .

To interpret these magnitudes, we can again compare to the model predictions. Running an analogue of the experiment in Section 8.1, but restricting the comparison to a

100bp differential (economies with interest rates 50bp above and below the baseline), implies 8Q growth of 0.6% for debt and 0.6% for assets, expressed as a share of $Assets_{t-1}$. As in Section 7.2, we see firms adjust debt by proportionally less than assets, compared to equal growth in the model. More strikingly, however, the magnitude of these empirical responses is roughly three times that of the model. This is perhaps surprising given that the model's assumptions generally lean on the side of potentially overstating the response, e.g., by assuming that firms have exclusively floating rate debt, and are always at a binding debt limit. While the bands are wide enough that the model predictions cannot be rejected, the point estimates would seem to point toward some additional source of amplification.

While merely speculative, I offer here two possible sources of such amplification. First, it may be the case that spreads co-move positively with the risk-free rate, implying that the overall movement in corporate rates is larger than that implied by the movement in the 3-Month T-Bill rate, whereas these would be identical in the model. Second, a standard term structure model, such as Cox, Ingersoll Jr, and Ross (1985), would imply that the volatility of interest rates is increasing in the level of rates. Under such a model, the risk of violating IC covenants would rise disproportionately as interest rates rise, leading to an amplified reaction by firms.

To augment these findings, I now perform an important placebo test. While the model predicts stronger reactions from firms with Both covenants when interest rates are higher, this effect should be unique to firms with both covenants, and should not be present for firms with either covenant in isolation. To test this, coefficients interacting r_{t-1} and Δr_{t-1} for DE-Only firms are displayed in Figure A.4. Most important is the second row, which shows that state dependence is *not* present in firms with DE covenants only, whose additional growth in debt and assets is minimal (8Q point estimates of 0.1% and -0.1%, respectively) and cannot be rejected from zero, exactly as implied by the theory.¹³

To control for any differential variation influencing firms with syndicated loans or covenants, the third row of Figure A.4 shows the difference-in-difference estimate

$$- \left[\left(\beta_{1,Both}^{hi} - \beta_{1,Both}^{lo} \right) - \left(\beta_{1,DE-Only}^{hi} - \beta_{1,DE-Only}^{lo} \right) \right]$$

which shows the differential response of firms with both covenants relative to firms with

¹³I focus on DE-Only firms rather than IC-Only firms because IC-Only firms actually face much tighter covenant limits when rates are high, while the covenant limits for DE-Only firms are not directly affected. While this has little impact in the model, to the extent that not all firms with IC covenants only are credit constrained in the data, it is not clear that a rise in rates should indeed be neutral.

DE covenants only. While these estimates are noisier, largely due to the imprecision of the DE-Only estimates, they again show a similar quantitative response, implying a relative difference of 1.3% debt and 2.1% asset growth (as a fraction of lagged assets) for Both firms relative to DE firms in high-rate vs. low-rate environments, similar to the baseline results.

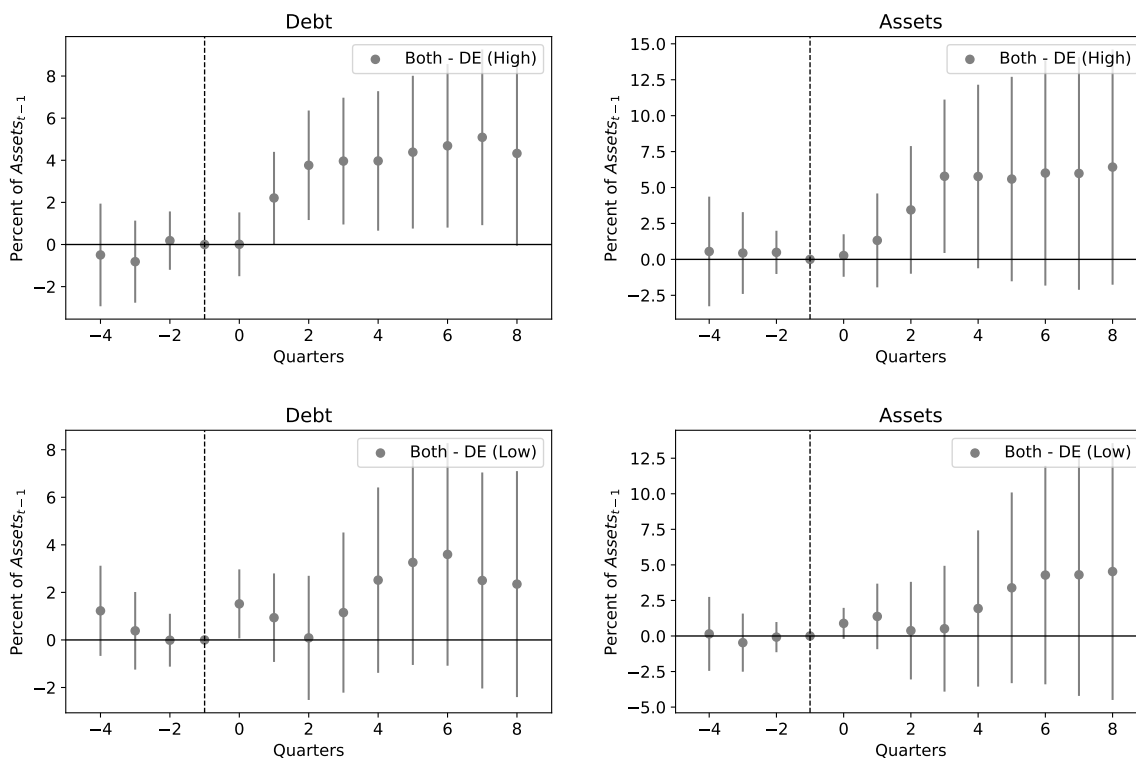


Figure 8: Estimated Response to Interest Rate \downarrow 100bp, Additional Results

Note: The plots display the differenced coefficients $-\left(\beta_{1,\text{cov}_1}^s - \beta_{1,\text{cov}_2}^s\right)$ in equation (17). Bars indicate 95% confidence bands. The labels “Low Rates” and “High Rates” refer to lagged 3-Mo T-Bill rates being below and above 4.56%, respectively. Standard errors are double clustered at the firm and industry-time level.

Beyond predicting more state dependence for Both firms, the model makes a sharper prediction that the responses of Both and DE-Only firms should be nearly identical when rates are low, but differ when rates are high. To investigate this, I run the regression

$$\begin{aligned}
 y_{i,t+h} = \alpha_i + \phi_t + \sum_{s \in \{hi, low\}} \mathbb{I}_{s,t-1} \left\{ \sum_{\text{cov}} \mathbb{I}_{\text{cov},t-1} \cdot (\beta_{0,\text{cov}}^s + \beta_{1,\text{cov}}^s \Delta r_t) \right. \\
 \left. + \gamma'_s X_{t-1} + \delta'_s (X_{t-1} \cdot \Delta r_t) \right\} + \varepsilon_{i,t}
 \end{aligned} \tag{17}$$

where \mathbb{I}_s is an indicator for regime s , so that all variables other than fixed effects now have coefficients that are allowed to vary with the interest rate regime. Responses by regime, shown in Figure 8 show that this indeed appears to be the case, excess 8Q responses of Both firms relative to DE-Only in the low-rate regime (2.3% for debt and that are smaller and insignificant in the low-rate regime 4.5% for assets), but larger and significant in the high-rate regime (4.3% for debt and 6.4% for assets).

Overall, these results are consistent with the presence of state dependence in the manner predicted by the model.

9 Conclusion

In this paper, I argued that interest coverage covenants can greatly amplify interest rate transmission. The data indicate that these covenants are extremely common, and are imposed at stable ratios over time, implying substantial variation in debt limits as interest rates fluctuate. Combining a simple model where firm borrowing is limited by realistic covenants with regressions on firm-level covenant data, I showed that the presence of IC covenants can dramatically increase the response of firm investment and borrowing to interest rate changes, a pathway I denoted as the interest coverage channel. Moreover, when, as is typical, firms face both IC and non-IC covenants, state dependent transmission emerges, such that the response of firm debt and capital is stronger when existing rates are high (and IC covenants are more likely to bind) than when they are low. Both of these findings are robustly supported by firm-level empirics.

Looking ahead, there are a number of avenues open for additional study. First, while I treat debt covenants as imposing hard limits that cannot be exceeded, in reality firms often violate and renegotiate their covenants. Modeling a penalty for violation in place of a hard limit, and investigating the empirical properties of violation in the data, could yield additional insights. Moreover, many debt contracts specify financial ratios like interest coverage limits that do not trigger violation, but instead automatically change the firm's interest rate. These "performance pricing" triggers could not only amplify transmission but also interact with debt covenants, since an elevated interest rate would mechanically tighten firms' IC limits. Overall, the study of firm debt and covenant structure appears to be fertile ground for future research.

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A Appendix: Additional Tables and Figures

Table A.1: Firm Medians by Covenant Type (Additional Groupings)

	None	IC	Non-IC	IC + Lev	DE + Lev	Lev Only
Full Sample						
Sales	10.45	138.73	58.41	117.11	110.28	36.54
EBITDA	0.33	18.56	4.57	13.48	12.47	1.69
Assets	50.53	508.75	215.05	381.46	367.54	142.35
PPE	6.26	117.44	43.14	88.15	81.50	25.24
Debt	2.41	142.74	41.72	76.60	69.38	21.00
ST Debt	0.49	5.00	4.43	3.53	3.31	3.00
LT Debt	0.70	125.00	22.64	62.88	58.75	9.37
Cash	7.42	16.93	15.30	13.80	12.60	15.91
Debt/EBITDA	0.00	7.89	5.29	6.15	6.35	3.06
Debt/Assets	0.114	0.289	0.230	0.238	0.240	0.200
EBITDA/Assets	0.013	0.036	0.024	0.035	0.036	0.019
Market-to-Book	1.54	1.15	1.08	1.13	1.14	1.12
<i>N</i>	99,669	36,522	12,481	15,090	8,503	7,750
Selected Sample						
Sales	172.37	196.75	270.93	208.60	172.04	412.45
EBITDA	24.42	28.08	32.14	26.00	22.78	53.11
Assets	574.59	691.63	864.68	639.57	573.83	1499.83
PPE	139.39	186.00	272.32	177.27	140.55	417.30
Debt	94.85	215.66	253.19	149.10	132.81	287.50
ST Debt	5.50	7.10	19.56	6.04	5.21	30.00
LT Debt	70.03	196.11	200.00	130.73	118.26	230.00
Cash	61.90	25.52	39.78	25.92	20.68	63.00
Debt/EBITDA	3.61	7.77	6.35	6.10	6.55	5.42
Debt/Assets	0.175	0.307	0.253	0.248	0.260	0.230
EBITDA/Assets	0.043	0.040	0.038	0.039	0.039	0.041
Market-to-Book	1.61	1.27	1.23	1.24	1.23	1.29
<i>N</i>	18,131	20,881	4,082	7,839	4,654	1,954

Note: Data source is DealScan and Compustat. The sample is 1994Q1 - 2007Q4. All entries are sample medians. All variables are measured in million USD except for the ratios Debt/EBITDA, Debt/Assets, EBITDA/Assets, Market-to-Book, and the number of observations *N*. Covenant categories are as follows: “None” firms have no DealScan covenant, “IC” firms have an Interest Coverage covenant, “Non-IC” firms have at least one DealScan covenant but not an IC covenant, “IC Only” firms have only an Interest Coverage covenant and no other covenants, with “DE Only” and “Lev Only” symmetrically defined for Debt/Earnings and Leverage covenants. Variable definitions and Compustat codes are as follows. Sales (code: SALEQ). EBITDA is Earnings Before Interest, Taxes, Depreciation, and Amortization (code: OIBDPQ). Assets (code: ATQ). PPE is Property, Plant, and Equipment (code: PPENTQ). Debt is the sum of ST (short-term) debt (code: DLCQ) and LT (long-term) debt (code: DLTTQ). Cash (code: CHEQ). Market-to-book is the ratio of market assets (market equity plus book debt) to book assets. *N* is the number of variables with a non-missing value for Assets (ATQ) in the sample.

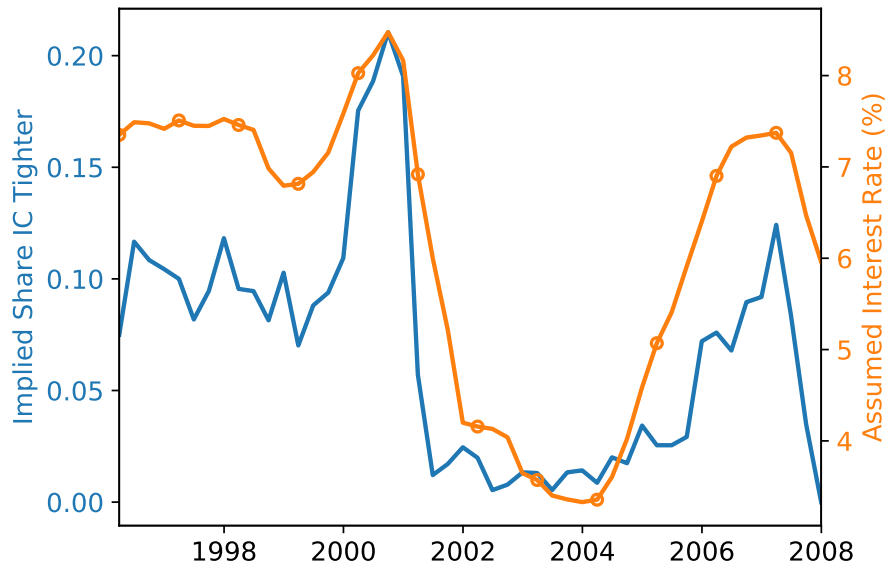


Figure A.1: Implied Share with Tighter Interest Coverage Covenant (No Risk Adjustment)

Note: Source: Dealscan and the Federal Reserve Board of Governors. The blue line with no marker displays the share among firms with both covenants for which their IC covenant is implied to be tighter, while the orange line with circular marker displays the assumed interest rate (the 3-month T-Bill rate plus a 248bp spread) used in this calculation.

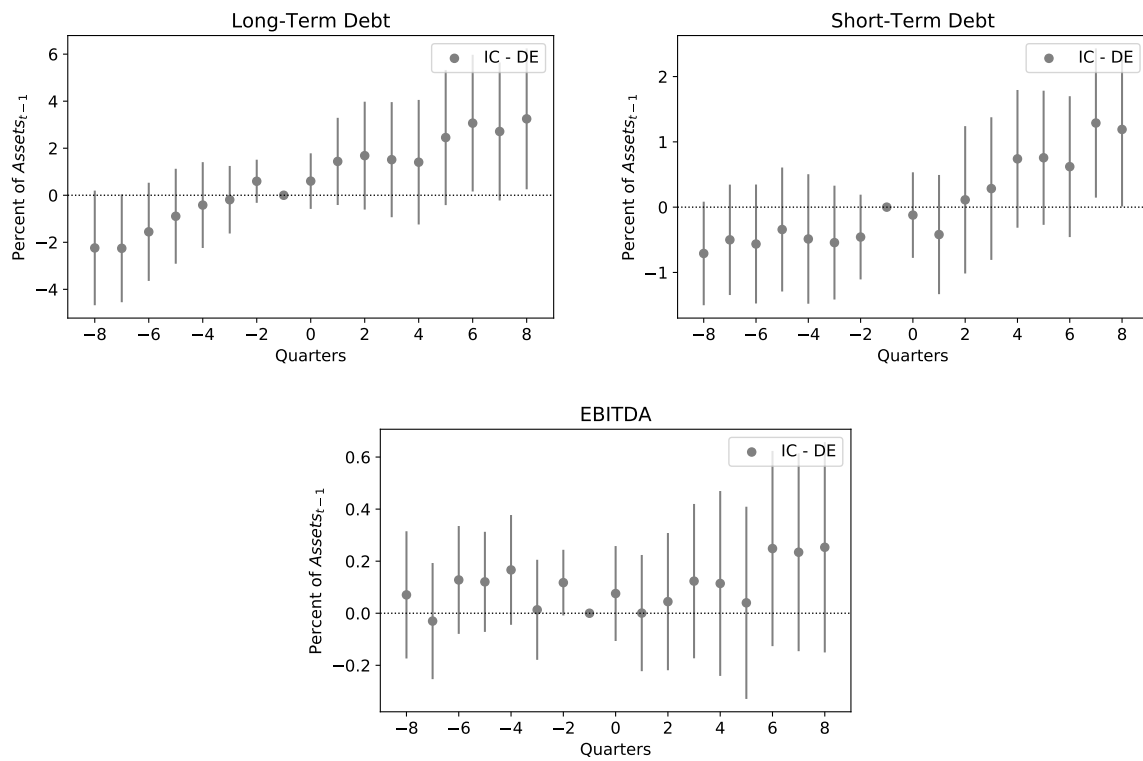


Figure A.2: Estimated Response to Interest Rate ↓ 100bp by Covenant (Addl. Vars)

Note: The lines labeled "IC - DE" plot the difference $-(\beta_{1,IC} - \beta_{1,Other})$ in equation (15). Bars indicate 95% confidence bands. Standard errors are double clustered at the firm and industry-time level.

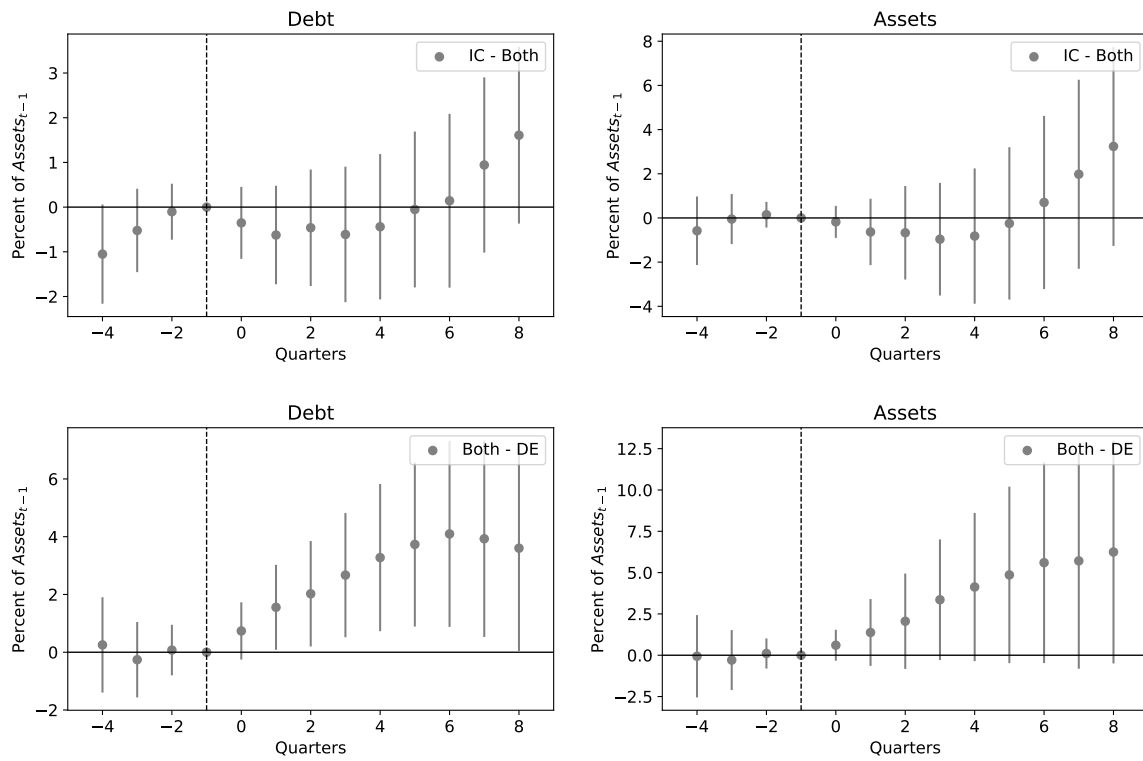


Figure A.3: Response to Interest Rate ↓ 100bp by Covenant

Note: The lines labeled “IC - Both” and “Both - EBITDA” plot the difference in negative coefficients in equation (15). Bars indicate 95% confidence bands. Standard errors are double clustered at the firm and industry-time level.

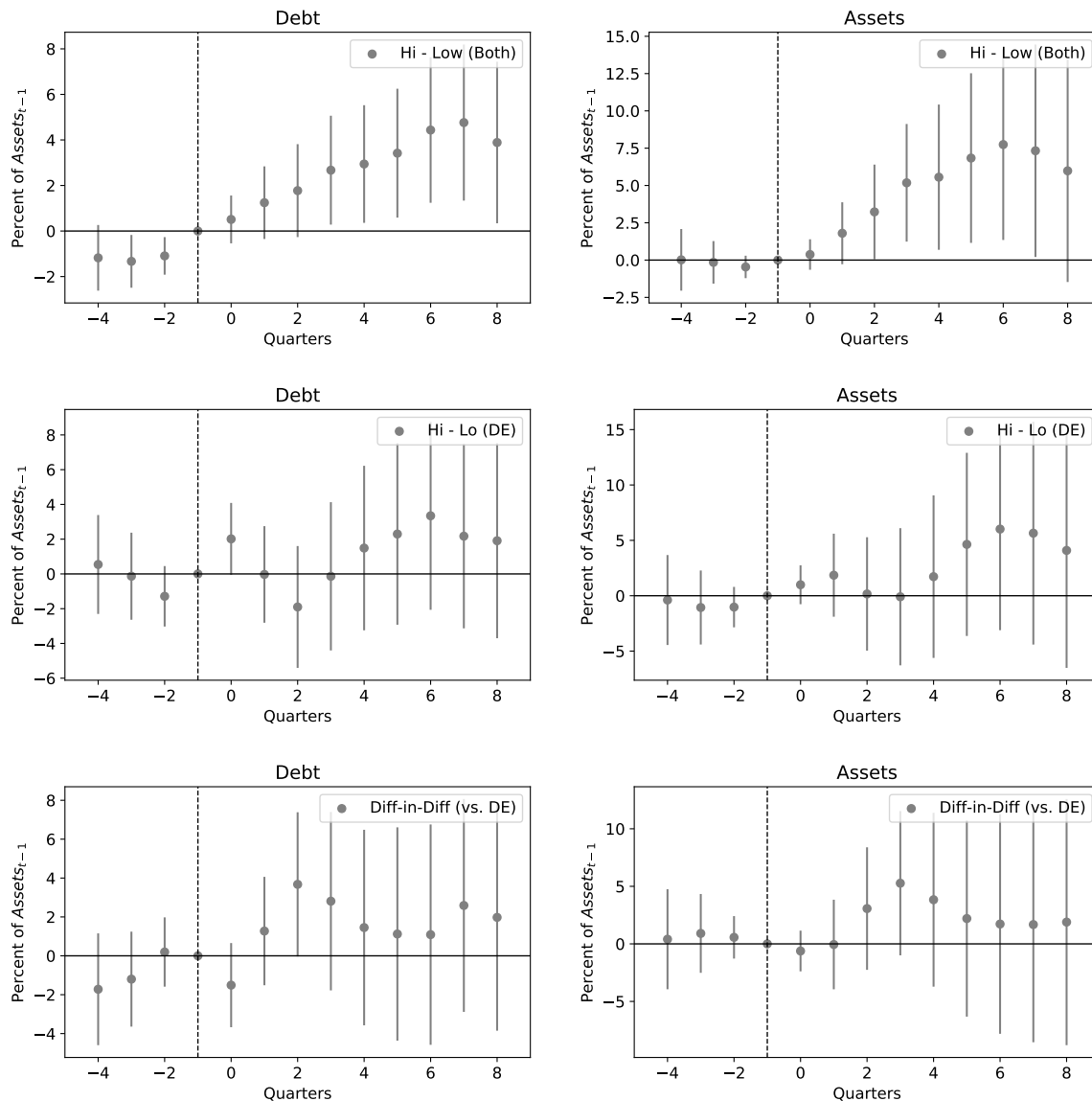


Figure A.4: Estimated Response to Interest Rate ↓ 100bp, by Current Rate Regime

Note: The plots display the differenced coefficients $-\left(\beta_{1,\text{cov}}^{\text{hi}} - \beta_{1,\text{cov}}^{\text{lo}}\right)$ in equation (17). Bars indicate 95% confidence bands. The labels “Low Rates” and “High Rates” refer to lagged 3-Month T-Bill rates being below and above 4.56%, respectively. Standard errors are double clustered at the firm and industry-time level.