Financial Covenants and the Business Cycle*

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Abstract

This paper studies how financial frictions amplify TFP shocks. Using hand-collected data, I document that during the Great Recession income covenants were the most frequently binding constraint in my sample of US public firms. Banks have used these income covenant breaches to cut credit to firms and these credit cuts have lowered firms' employment. I then show that during normal times firms which perform better than expected after loan origination accept tighter covenants. I use these two empirical facts to build a quantitative model, where in equilibrium good firms select into loan contracts with tightly set income covenants to signal their unobservable quality. The distribution of income covenants and their tightness emerges as an important state variable for how exposed firms' access to external financing is to TFP shocks. When an unexpected TFP shock hits, high productivity firms are more affected as they breach their covenants. Calibrating the model to my sample of public US firms, I find that income covenants contributed 16% to the fall in investment and 5% to the fall in output during the Great Recession. Furthermore, the model can generate the observed firm-level pattern of income, net worth and credit.

JEL Classification: E32, E44, G31, G32

Keywords: Financial Constraints, Debt Contract, Covenants, Non-Price Terms, Investment, Employment

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1 Introduction

How are financial frictions amplifying real shocks? In standard financial accelerator models borrowing is directly linked to a firm's net worth. But during the Great Recession the largest decrease in loans and unused commitments happened when firms experienced a large drop in income and only a relatively small drop in net worth (Figure 1).

In this paper I build a dynamic model in which heterogeneous firms can choose loan contracts with income constraints. When income constraints become binding after a TFP shock hits, the model generated firm-level data can qualitatively replicate the observed pattern of income, net worth and credit in the actual data. My first contribution is empirical: Using hand-collected firm-level data in combination with loan contract data, I document that a decrease in a firm's income was enough to trigger a decrease in credit supply during the Great Recession. I find *income covenants*[1] to be the most common constraint in loan contracts as well as the one that binds most frequently during the Great Recession. Furthermore, I document that firms with improving productivity select into stricter covenants, thus signaling their quality. Based on these findings, I propose a general equilibrium dynamic heterogeneous firm model with income covenants. Firms with high unobservable productivity select into tight income covenants. In the model income covenants increase steady state output but amplify TFP shocks. The frequency and tightness of income covenants determine the exposure of firms' external financing capacity to TFP shocks.

Empirics At the beginning of the Great Recession only around 10% of US public firms had a large fraction of their debt maturing (Almeida et al., 2012). All other firms had loan contracts with an average remaining maturity of four years. The financial crisis should not have affected the access to bank finance of those firms. But virtually all loan contracts contain minimal financial conditions, called covenants, which the firm must satisfy, otherwise the bank has the right to cancel the contract.

Covenants can be broadly classified into flow constraints, depending on income, and constraints on stock variables, depending on a firm's net worth. To understand which type of constraint matters more I collect data on covenant breaches and, importantly, the type of covenant breached. I find that during the Great Recession firms have breached income covenants much more often than net worth covenants. This is at odds with numerous models, in which a firm's borrowing capacity depends only on net worth.

What are the consequences of covenant breaches? I combine the covenant breach data with hand-collected data on credit limits for a sub sample of firms. Chodorow-Reich and Falato (2017) document how banks have frequently used covenant breaches to cut credit to firms during the Great

[1] Loan covenants are conditions in credit contracts a firms must satisfy in order to maintain access to credit. When a firm breaches a covenant the bank has the right to cancel the credit contract. During normal times, however, a large fraction of breaches are waived.

Recession. I refine their results by showing that even firms breaching "only" an income covenant experienced sizable cut-backs of their credit limits. For these firms credit supply decreased after a large drop in income even though their net worth did not fall by much. The decrease in credit limits affected firms' employment.

Given the potentially harsh consequences following the breaching of a covenant, the question arises why firms accept tight income covenants in their credit contract? Based on the model by Garleanu and Zwiebel (2009) and the empirical findings of Demiroglu and James (2010), I provide further evidence that firms use income covenants to signal their unobservable quality to the bank. Firms accepting tighter covenants have higher productivity shocks in the years following the contract initiation relative to firms with loose covenants. This signaling mechanism backfires when an aggregate TFP shock hits. During recessions the covenant breach frequency increases by more for firms with tighter covenants than for other firms.

In addition to covenants, loan contracts contain many other pricing or quantity constraints that depend on the firm's performance, such as borrowing base formulas or state-contingent interest rates. Covenants differ from those other constraints in the sense that they give banks discretion in their reaction. Therefore I focus only on covenants in this paper.

Quantitative model Based on my empirical findings I build a dynamic general equilibrium model with heterogeneous firms and loan contracts featuring income covenants. Firms enter two-period loan contracts with banks. The contract defines the maximal amount of credit the firm can use, the credit limit, and an income covenant in terms of firm productivity. When the firm's productivity is below a pre-specified threshold, the bank gets the right to cut the credit limit before the loan matures.

There are two key assumptions: (i) firms can run away with the credit line limit (ii) firms' productivity type is unobservable for banks in the short-run. Covenants have two functions in the model: first, they relax the bank break even constraint similar to state-contingent interest rates. Second, they allow high productivity types to signal their unobservable quality to the bank. The signaling works because high productivity types will breach covenants less often than low productivity types.

I calibrate the model to the sample of US-public firms. The model is calibrated to match the share of firms with income covenants, the covenant breach frequency, the average covenant tightness, the ratio of debt to assets and the default rate. The model generates a realistic firm size distribution and the negative correlation between size and credit limit to asset ratio observed in the data.

I shock the model with an unexpected temporary drop in firm level TFP. The drop is calibrated to generate the increase in covenant breach frequency during the Great Recession observed in the data. Through the lens of the model I find that income covenants contribute 5% to the aggregate fall in GDP and 16% to the fall in investment. I conclude that income covenants can generate a

sizable amplification of TFP shocks.

As in the actual data, the model generated firm-level data shows a large drop in income and a relatively small drop in net worth around covenant breaches.

Related literature This paper contributes to the literature studying the interaction of financial frictions and real shocks in models with heterogeneous firms. In Khan and Thomas (2013) and Buera et al. (2015) firms face borrowing constraints on net worth which limits the amount of the one-period loan they may use. In both models an unanticipated tightening of the borrowing constraint can generate a recession similar to the Great Recession whereas a TFP shock has milder consequences. This paper differs from these models in two important ways: first, firms face income constraints because they are much more frequent in loan contracts and bind more often. Second, the constraints come in the form of loan covenants which allows banks to cut credit supply even when the firm has a long-term loan contract. As a consequence TFP shocks can generate a large recession in my model without shocking the financial sector directly and even though firms have long term contracts.

The importance of covenants as a way for banks to cut credit supply when firms have long term contracts has been documented by Chodorow-Reich and Falato (2017) for the Great Recession. They use administrative data to show that lenders in bad health used covenant breaches to cut back lending. For a subset of public US firms I refine their finding by showing that most covenant breaches during the Great Recession were triggered by drops in income.

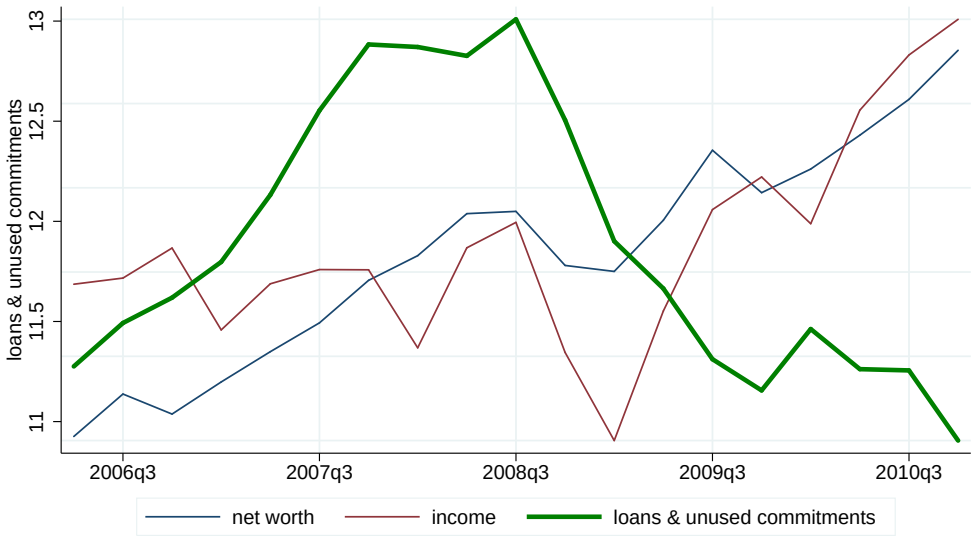
The importance of income covenants has been well known in the finance literature[2]. In macroeconomics Drechsel (2018) investigates the aggregate implications of income and net worth constraints, but does not explicitly model the constraints as covenants.

This paper shares the approach to use micro-evidence to discipline the importance of financial frictions in a quantitative model with Zetlin-Jones and Shourideh (2017). They find that public firms rely mostly on internal funds to finance investment. A tightening of the collateral constraint in their model has therefore only a small aggregate impact. In my model and similar to Ajello (2016) even large firms are constrained occasionally.

The signaling mechanism of covenants is based on a simplified version Garleanu and Zwiebel (2009). They propose a model in which the borrower has private information about the potential for asset substitution. They find that lenders receive control rights more often relative to a symmetric information benchmark ex-ante and give them up in renegotiations ex-post. The mechanism is also similar to costly collateral pledging models in Tirole (2006). Empirically, I find that firms selecting into tight covenants improve in unexpected productivity subsequently, confirming Demiroglu and James (2010) findings.

[2]Papers explicitly discussing the difference between income and net worth covenants: in Demerjian (2011), Christensen and Nikolaev (2012)

Figure 1: Firm Net Worth, Income and Bank Loans during the Great Recession



Notes: Income, the red line, and net worth, the blue line, of the median Compustat firm. Green line: core loans outstanding and unused commitments at all US commercial banks from Call Reports.

The rest of the paper is organized as follows: section 2 presents the empirical evidence about loan covenants highlighting the importance of income covenants both at contract initiation and during the Great Recession. In section 3 I build a dynamic heterogeneous firms model with income covenants and then present the details of the calibration. Section 4 shows the effects of a TFP shock in the calibrated model both at the aggregate and the firm-level and compares model generated to actual data. Section 5 concludes.

2 Empirical evidence

In this section I first define financial terms, provide the data sources and descriptive statistics. In the second part I document how the decrease in loans during the Great Recession happened mainly through income covenant breaches. I also show how firms which breached a covenant and had their credit limit cut decreased their employment and investment more than other firms. In the third part I show how firms accepting tight covenants at loan origination experience financial improvement subsequently during normal times. The last part shows that net worth covenants are different from income covenants.

Financial terms First I define specific financial terms used in this paper for readers who are unfamiliar with them:

- *Covenants* are conditions in loan contracts the borrower must satisfy. If they are not fulfilled

the creditors can ask for the immediate repayment of the loan. In practice this rarely happens and a renegotiation takes place. The outcome can vary between full cancellation of the loan and a waiver of the breach. There are three main types of covenants: informational covenants, requiring the borrower to provide detailed financial reports to the lender. Negative covenants prohibit the borrower from selling assets, for example, to avoid a costly redistribution from debt- to shareholders. Financial covenants are accounting ratios the borrower must satisfy. In this paper I only focus on financial covenants.

- *Covenant tightness* measures how close the firm is to breaching a covenant. I follow the finance literature and use the distance between covenant and actual accounting ratio divided by the standard deviation of the accounting variable.

- *Credit line* is a loan which can be used and repaid several times until its maturity. Firms usually pay a fixed fee and variable interest depending on their usage.

- *Net worth* in covenants is defined as the book value of assets minus the book value of liabilities. I use this accounting definition of net worth throughout the paper.

Data I use a data set of US public firms from 1997 until 2014. The data come from three sources: accounting data come from Standard & Poor's Compustat, loan-level data are from Thomson Reuter's DealScan and the self-collected data directly from SEC filings. Using a modified text search algorithm based on Nini et al. (2012) I extract a dummy for covenant violations for the entire SEC-Computstat sample. Where available I also collect the type of covenant the firm has breached.

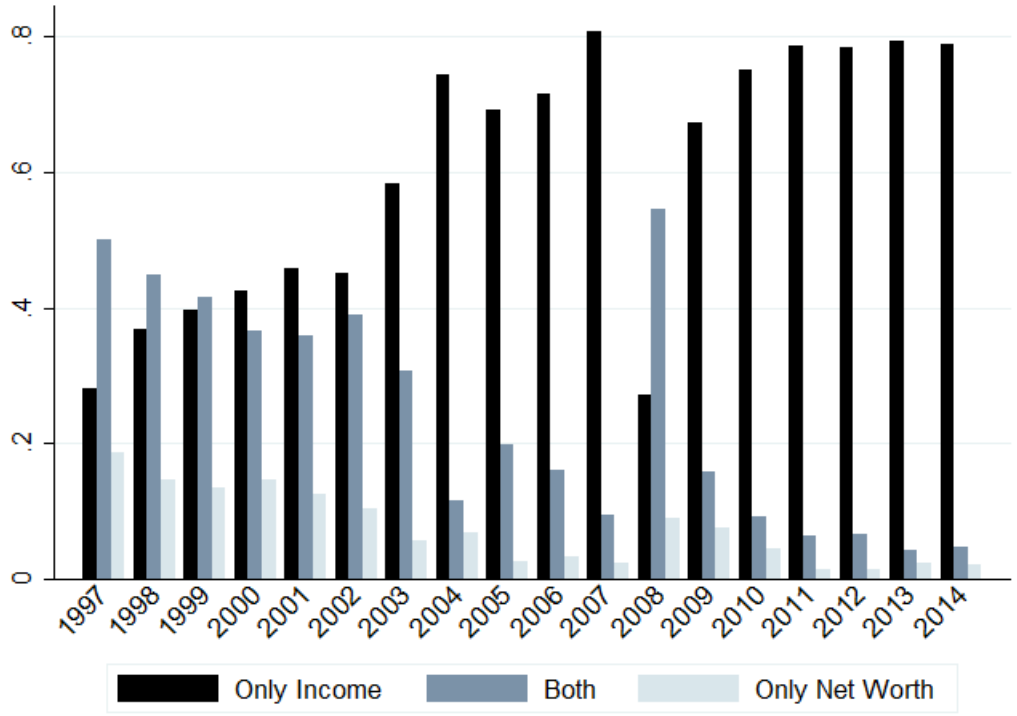
The renegotiation outcome after a firm has breached a covenant can potentially change any part of the loan contract: the credit limit, the interest rate, required collateral, maturity, amendment fees, a change in covenants or a complete waiver. In this paper I focus only on cuts in credit limits because they are easier to observe than other contract changes and they have been used in the previous literature.

To obtain information about firms' credit limits I extract parts of the filings related credit lines and then verify the information manually for a sub sample of 1238 firms from 2007 until 2009. Details of the data treatment are provided in Appendix A.1. Appendix A.2 provides the details of the search algorithms used for the data I collected myself.

Descriptives Credit lines are very common: 77% of firms have a credit line in my full sample and almost all credit line contracts contain covenants. I classify covenants into income and net worth covenants[3] and use the covenant information of more than 15'000 contracts from over 5500 different firms to compute the frequency of the different types. Figure 2 shows how contracts containing

[3] see Appendix A.3

Figure 2: Fraction of New Loan Contracts and Covenant Types



Notes: Fraction of new contracts containing either only income, only net worth or both types of covenants in a given year. The sample is limited to firms with data in both DealScan and Compustat.

only income covenants have been by far the most frequent arrangement between 2003 and 2007. Overall around 80% of contracts contain income covenants. How frequent are covenant breaches? About 10% of firms in my sample are breaching a covenant in a given year. This makes covenant breaches a much more frequent event than actual default.

2.1 The decrease in loans during the Great Recession

I now use the manual sub sample to understand how banks were able to cut loans & unused commitments of firms during the Great Recession. Among the 1168 firms[4] in my sample 224 (19%) breach a covenant at least once during the Great Recession. To understand which type of constraint firms were facing I then search for the covenant type breached. Table 1 reports the results: Almost 40% of firms in breach were breaching an income covenant making this by far the most frequent reason why a firm was breaching a covenant.

The second coulmn in table 1 reports the aggregate change in credit limits for all firms of a category. All firms breaching an income covenant experienced a credit limit decrease by 17%. This

[4]I exclude firms with a loan size larger 1.8 billion which reduces the sample size from 1238 to 1168

Table 1: Covenant Type Breached and Change in Credit Limit, Net Worth and Income

Covenant type	**# of firms**	**Credit limit**	**Ebitda**	**Net worth**
No Breach	944	2		
Call Reports		-13		
Income	87	-17	-138	-35
Unknown	53	-15	-65	-18
Non-Financial	25	13	-14	-10
Leverage	21	-24	-187	-94
Net Worth	17	9	19	-136
Working Capital	16	-28	96	-32
Income + Net Worth	4	-22	2	-168
Several	1	-40		
Breach	224			
Total	1168			

Notes: Credit limit is the percentage change of the aggregate credit limit 2007-2009 for firms depending on whether they breached a covenant and separately for each type of covenant breached. The second row reports the change in aggregate loans as reported in Call Reports. *Ebitda* and *Net worth* are the median changes in EBITDA*100 and net worth*100 between the quarter of covenant breach and four quarters before divided by the 12-quarter backward looking standard deviation. Note: Only firms with a maximal loan size below 1.8 billion are included and the number of observations for *Ebitda* and *Net worth* is lower than for *Credit Limit*.

decrease is in the same range as changes for other type of covenant breaches. Therefore it does not seem that banks treated income covenant breaches differently from other type of breaches. As a comparison firms not breaching a covenant increased their credit limit by 2%.

Columns three and four in table 1 show the median change in income and net worth between the quarter of the covenant breach and four quarters before divided by the 12 quarter standard deviation of each variable. The median firm breaching an income covenant experienced a large 1.4 standard deviations drop in income and a moderate 0.4 standard deviation drop in net worth. Net worth drops by 1.4 standard deviations for a firm breaching a net worth covenant whereas for those firms income increased by 0.2 standard deviations. Combined, these results suggest different roles for income and net worth constraints.

The firm level results reported here seem to confirm the link between loans and unused commitments and income suggested by the aggregate data in figure 1.

As a next step I will assess the impact of covenant breaches on real outcomes.

Impact on real variables Covenant breaches and the subsequent credit limit cuts had real consequences. Table 2 compares employment growth of firms depending on whether they have

breached a covenant during the Great Recession and whether the credit limit was lowered. The second column of table 2 shows that firms experiencing a cut of their credit line after a covenant breach lowered their employment between 2007 and 2009 twice as much as firms not in breach of a covenant but decreasing their credit limit and ten times more compared to firms breaching a covenant without a subsequent cut. This suggests that cuts following covenant breaches were at least in part involuntary and had an impact on firm's employment in addition to demand effects. Firms experiencing a cut of more than the median cut of 32% had an 8 basis points lower employment growth relative to firms experiencing a mild cut.

What if firms breaching a covenant during the Great Recession are just generally worse than other firms? As an attempt to control for time-invariant heterogeneity the first column of table 2 shows employment growth between 2005 and 2007. Firms experiencing credit line cuts during the Great Recession had lower employment growth relative to firms which kept access to their credit line. But firms breaching a covenant and experiencing a cut during the Great Recession did better before the Great Recession relative to firms without covenant breach during the Great Recession. Similarly firms with large cuts had the same employment growth before the Great Recession when compared to firms with small decreases.

Table 2: Employment Growth by Change in Credit Limit and Covenant Breach

Employment Growth

Covenant	*Credit Limit*	*2007*	*2009*	*N*
Breach				
	Large Decrease	7	-28	35
	Small Decrease	7	-20	30
	No Decrease	14	-2	103
No Breach				
	Decrease	5	-10	134
	No Decrease	10	-2	682
Total		9	-4	984

Notes: This table reports the median symmetric employment growth rate over two years $\Delta emp_{t,t-2}/emp_{t,t-2}$ for a balanced sample of firms in my manual sample. Employment growth is multiplied by 100 for better readability. *Breach* means the firm has breached a financial covenant during the Great Recession. *Credit limit* depends on the change of the firm's credit limit during the Great Recession. *Large decrease* means firms had between 100 and 32% of their credit limit cut. *Small decrease* means firms experienced a credit line cut of less than 32%.

2.2 Why are firms accepting tight income covenants?

Given the potentially potentially harsh consequences of tightly set covenants why are firms accepting loan contracts containing tight income covenants? In this subsection I provide evidence that firms use covenants to signal unobservable productivity.

While net worth is slow-moving and firms have at least some control over their asset value and debt, income is closely related to sales over which firms have only limited influence. Tight income covenants are therefore well suited as signals for unobservable future productivity. This idea is based on the theoretical work of Garleanu and Zwiebel (2009) and the empirical findings of Demiroglu and James (2010).The mechanism works as follows: Firms have more information about the future of their business than the bank but might not always be able to convince the bank of their positive outlook. By accepting tight income covenants a firm can obtain a larger loan ex-ante while the bank keeps the right to cut the loan ex-post in case things go worse than what the firm expected.

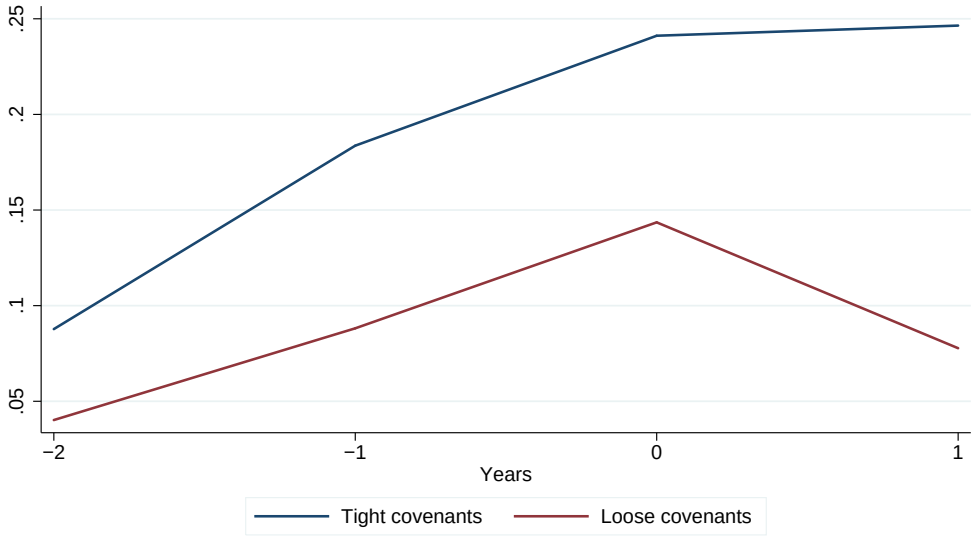
As a proxy for the unexpected productivity expectations I use the realized innovations from the firm's productivity process. I then cumulate the productivity innovations starting at each loan initiation. Figure 2.2 shows the average cumulated productivity innovations from loan initiation until three years later. I separate firms into two bins depending on whether tightest covenant in their loan contract was above or below the median tightness. Firms with tighter covenants have unexpected productivity growth than relative to firms with looser covenants. The median productivity shock growth (not reported) is lower than the average. The difference therefore comes from firms which do unexpectedly very well, from the upside risk. This finding is robust to the sample period chosen and the definition of tightness used.

An unexpected aggregate fall in TFP could disturb this signaling mechanism. When a recession hits and firms with tightly set income covenants breach them, banks suddenly have the right to cut credit limits of those firms. Table 3 shows how often firms breach a covenant depending on the tightness of their covenants at loan initiation. Both in recessions as well as in normal times firms with tighter covenants breach them more often. The change in breach frequency however is much larger for firms with tight covenants than those with loose covenants. Firms with tight covenants breach covenants 50% more during recessions than during normal times. For firms with intermediate and loose covenant tightness the increase is only 20% and 5%.

In the appendix A.7 I provide descriptive statistics by covenant tightness. Firms accepting tight covenants are younger, smaller and in worse financial condition relative to firms with looser covenants. This signaling motive for low quality borrowers and the associated additional negative effect during recessions adds to the large literature on small firms and lending[5].

[5] Chodorow-Reich and Falato (2017) write that "[...] lower quality borrowers are more likely to violate covenants, the covenant channel also offers a novel explanation for the common empirical finding that the effects of bank health concentrate on smaller, lower quality borrowers."

Figure 3: Cumulated Productivity Innovations



Notes: This graph plots the sum of productivity innovations after loan initiation depending on the initial covenant tightness. The blue line are firms with covenants tighter than the median, the red line are firms with covenants looser than the median covenant in the year of contract initiation. The sample is based on DealScan-Compustat intersection from 2004 until 2009. I drop firms with missing productivity or contract tightness data to obtain a balanced sample over the period. I include only contracts which are in place more than two years and limit the computation to the first three years. *Tightness* is based on the tightest covenant of a contract, where I have excluded covenants which appear to be in breach at loan initiation, divided by the 8-quarters backward looking standard deviation of the variable. *Productivity innovations* are the residual of an AR regression of the firm's productivity.

Table 3: Covenant Breach Frequency and Covenant Tightness

Breach Frequency	*Tight*	*Intermediate*	*Loose*
Normal	6.7	5.4	4.0
Recession	10.6	6.6	4.2

Notes: This table shows the covenant breach frequency for firms depending on the tercile of the initial tightness of the strictest covenant in their loan contract. The sample is based on DealScan-Compustat intersection from 2004 until 2009. I drop firms with missing data on covenant breaches and firms for which the last contract intiation is more than five years ago. *Normal* 2004-2006, *Recession* 2007-2009

3 Quantitative Model

In this section, I develop a dynamic heterogeneous firms model in which firms can choose credit lines with income covenants. The non-financial part of the model shares most features with other models of firm dynamics with financial constraints such as Buera et al. (2015) and Bassetto et al. (2015).

General setup There is a continuum of firms and a competitive banking sector. Firms have access to a decreasing returns production function which takes capital as its only input. Investment is financed using either equity or a credit line. Time is discrete and there are three sub-periods within each period. Firms are infinitely lived but credit lines have a fixed maturity of three sub-periods or, equivalently one period. The bank can cut the credit line during the second sub-period if the firm's income falls short of the contract's income covenant.

Heterogeneity Firms are heterogeneous in their wealth a, productivity z and short-run productivity type $s \in \{H, L\}$. Firms draw a new short-run productivity type at the beginning of each period. With probability $1-\tau$ the firm is a high type, with probability τ a low type. The short-run productivity type is not observable to lenders and only affects the transition probabilities of z. In equilibrium firms with high short-run productivity will choose stricter income covenants to signal their quality.

Frictions There are two main frictions keeping firms from reaching the first-best level of investment. First, there is limited commitment by firms. Firms can run away with their credit line and default on the repayment. Banks will take this into account and limit the initial size of the credit line below the first-best level. Second, firms cannot issue equity and instead accumulate earnings to escape financing constraints. This assumption is standard in the firm dynamics literature.

Credit line contract A credit line contract specifies the maximal amount in case of no covenant breach available $\bar{b}$, the income covenant threshold $\hat{z}$ and the lending rate r_F. As in actual loan contracts the lending rate equals the deposit rate plus a risk premium:$r_F = r + \rho$. Banks observe a firm's net worth a and productivity z (but not their short-run productivity type) and offer contracts $(\bar{b}, \hat{z})$ contingent on both variables. I assume r_F to be constant spread over the deposit rate r and to be the same for all firms for the model to be tractable. To keep the notation concise I omit the dependence of the contract on the firm's net worth and productivity.

Timing Firms consume only during the first sub-period. Production takes place during the second and third subperiod. Firms know the realization of the productivity shock when they take their investment decision. A firm enters the new period with net worth a and productivity z. After

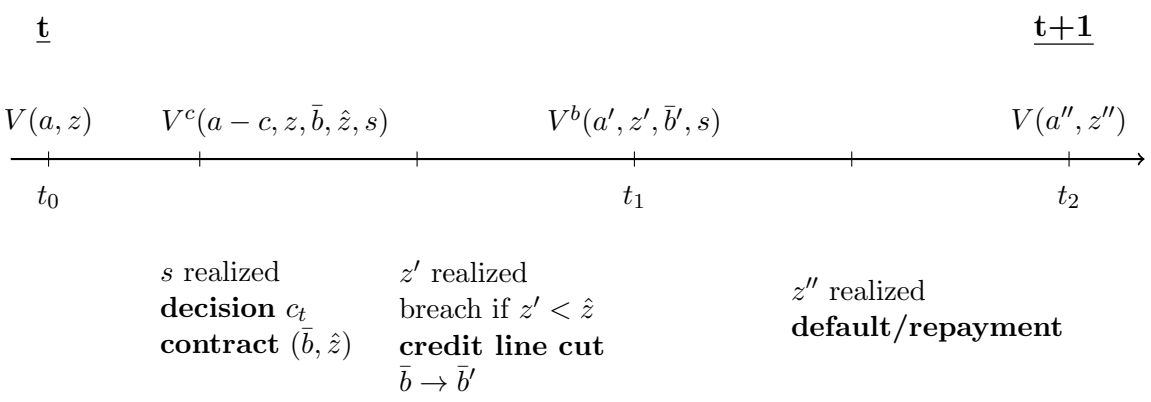


Figure 4: Timing

the short-run productivity type s has been realized the firm decides about consumption c_t and the credit line contract.

The second sub-period starts with the realization of z'. I assume that firms then invest using only their own funds. If z' is below the income covenant threshold $\hat{z}$ the bank can decide to change the maximal credit limit $\bar{b}$ available for the firm in the last sub-period. In the last sub-period z'' is realized and the firm decides whether to run away with the entire credit line $\bar{b}$ or produce and repay the drawn amount. Figure 4 summarizes the timing.

To keep firms from saving enough to avoid external finance completely I assume that a fraction γ of firms looses all their assets at the beginning of a period and can only produce again next period starting with zero assets.

3.1 The firm's problem

In this subsection I discuss the choices of an individual firm in each sub-period taking the lending arrangements offered by banks as given. I start backwards with the firm's default or repayment decision.

Last sub-period: Repayment or default Given z'' and their t_1 assets a' firms decide whether to invest and potentially draw from their available credit line $\bar{b}'$ or run away with the entire credit line and default. In case of default the bank can seize the firm's assets a'. Firms start into the next period with assets equal to the credit limit and face no other punishment from banks than losing their assets. Because firms know z'' when deciding about investment, the choice of k'' in case of no

default is static:

$$\max_{k''} a_{ND}^{''} = z''k''^{\alpha} + (1-\delta)k'' - (1+r_F)b_{z'}$$
$$k'' \leq \bar{b}' + a'$$

Firms maximize end of period wealth which consists of production and the undepreciated capital stock net of the repayment of the drawn portion of the credit line $b_{z'}$ at the lending rate r_F. Investment is limited by the firm's net worth and the credit line limit.

$$k'' = \min\left(k_{FB}(z'', r_F), a' + \bar{b}'\right)$$

Firms default whenever the continuation value from running with the entire credit line is larger than the continuation value after producing and repaying the credit line:

$$V(\bar{b}', z'') > V(a_{ND}^{''}, z'')$$

Second subperiod: Covenant compliance or breach Firms invest after observing the z' productivity realization. To avoid assumptions about the repayment schedule of the credit line I assume that firms can only rely on their net worth, which consists of initial wealth a minus consumption, for t_1 investment. Any excess funds not invested will be saved at the deposit rate r such that the static problem is now:

$$\max_{k'} a' = z'k'^{\alpha} - (r+\delta)k' + (1+r)(a-c)$$
$$k' \leq a - c$$

which yields the following investment:

$$k' = \min(k_{FB}(z', r), a - c)$$

When the firm breaches the income covenant the bank gets the right to reduce or cancel the credit line. In my model lenders reduce a firm's credit with probability ϕ^s to a fraction ξ of the inital credit limit. The credit limit available to the firm at t_2, $\bar{b}'$ is therefore given by:

$$\bar{b}' = \begin{cases} \bar{b} & \text{if } z \geq \hat{z} \\ \bar{b} & \text{if } z < \hat{z} \text{ with probability } 1 - \phi(s) \\ \xi\bar{b} & \text{if } z < \hat{z} \text{ with probability } \phi(s) \end{cases}$$

First subperiod: Loan arrangment and consumption Given their initial wealth a, their producitivty z and their short-run productivity type s, firms decide about consumption c_t and select a credit line contract from the set of contracts $\mathcal{S}(a,z)$ offered by the bank. Firms discount future consumption at rate β and take expectations over the realization of t_1 productivity z'. The short-run productivity type s matters only for the productivity transition probability $\pi^s_{z'|z}$ and the probability ϕ^s.

$$V(a,z,s) = \max_{c,\ (\bar{b},\hat{z})\in\mathcal{S}(a,z)} \frac{c^{1-\sigma}}{1-\sigma} + \beta V^c(a-c,z,\bar{b},\hat{z},s)$$

with

$$V^c(.) = \sum_{z'>\hat{z}} \pi^s_{z'|z} V^b(a',z',\bar{b},s) + \sum_{z'\leq\hat{z}} \pi^s_{z'|z} \left(\phi^s V^b(a',z',\xi\bar{b},s) + (1-\phi^s)V^b(a',z',\bar{b},s)\right)$$

Depending on the z' realization the firm is in compliance with its income covenant $\hat{z}$ and can borrow up to $\bar{b}$ in t_2 or face the possibility of a credit line cut.

3.2 Banks

In this subsection I discuss how the set of credit line contracts $\mathcal{S}(a,z)$ offered by banks is found.

Banks take deposits from firms with excess funds and pay them the deposit rate r. They earn money by charging firms r_F on the used part of the credit line. When a firm defaults the banks looses the principal $\bar{b}$ plus interest but can seize the firm's assets a'. The banking sector is competitive and banks do not make any profit.

Observable types When the short-run productivity type is observable and without income covenant banks offer any contract to a firm with wealth a and productivity z that satisfies their break-even condition:

$$\sum_{z'} \pi_{z'|z} \left(\sum_{z''>z^D} \pi_{z''|z} \max(0, k''-a')(r_F - r) + \sum_{z''\leq z^D} \pi_{z''|z}(a' - \bar{b}(1+r)) \right) \geq 0$$

with z^D the default threshold. The expected earnings from the used credit line must make up for expected losses from default. I have omitted the dependence of z^D on other variables to keep the notation short.

Unobservable types With unobservable short-run productivity types banks face a lemons problem as in Akerlof (1970). Both high and low types prefer a contract with a higher credit limit. They can either use it in high productivity states to invest or run away with it in low productivity states. When banks do not know the short run productivity type the low type would mimic the

high type. Banks anticipate this behavior and offer a pooling contract. Under the pooling contract the low type is better off than when types are observable and the high type is worse off.

Income covenants will allow high type firms to improve over the pooling solution. High productivity firms can offer banks the right to cut credit in low productivity states by accepting tight income covenants. This will discourage low productivity type firms from mimicking the high type because the low productivity firms are more likely to face a binding income covenant.[6] This separating equilibrium allows the high type to have a higher credit limit ex-ante at the cost of credit line cuts in low productivity states.

In addition to the signaling mechansim of income covenants banks have a monitoring technology available to determine a firm's type. Monitoring costs a fraction $\bar{c}$ of a' and gives a signal $t \in \{H, L\}$ with the following precision:

$$Pr(t = H|s = H) = (1 - \phi) \; Pr(t = L|s = H) = \phi$$
$$Pr(t = H|s = L) = (1 - \phi') \; Pr(t = L|s = L) = \phi'$$

I now describe under which conditions banks offer the three different types of credit line contracts. I define $BC(a - c, z, \bar{b}, \hat{z}, s)$ as the value of the bank's break even constraint if a firm with net worth $a - c$, productivity z and type s enters a contract with credit limit $\bar{b}$ and income covenant $\hat{z}$.

First-best The first best contract for type s $(\bar{b}^{FB,s}, \hat{z}^{FB,s})$ is feasible when the bank breaks even when only type s chooses this contract:

$$BC(a - c, z, \bar{b}^{FB,s}, \hat{z}^{FB,s}, s) \geq 0$$

Whenever the high productivity type wants to borrow the first best contract is not possible because the low type would mimick the high type, that is:

$$V^c(a - c, z, \bar{b}^{FB,H}, \hat{z}^{FB,H}, L) < V^c(a - c, z, \bar{b}^{FB,L}, \hat{z}^{FB,L}, L)$$

Pooling A pooling contract $(\bar{b}^P, \hat{z}^P)$ is feasible when the bank breaks even although both high and low types choose the pooling contract :

$$(1 - \tau)BC(a - c, z, \bar{b}^P, \hat{z}^P, H) + \tau BC(a - c, z, \bar{b}^P, \hat{z}^P, L) \geq 0$$

[6] Tirole (2006) describes the same mechanism but instead of accepting income covenants high type firms pledge collateral ("costly collateral pledging").

with τ the proportion of low productivity types in the population.

Separating A separating contract $(\bar{b}^S, \hat{z}^S)$ is feasible when the low productivity type prefers not to mimic the high productivity type and the bank breaks even when only the high type chooses this contract:

$$V^c(a-c, z, \bar{b}^{FB,L}, \hat{z}^{FB,L}, L) > V^c(a-c, z, \bar{b}^S, \hat{z}^S, L)$$
$$BC(a-c, z, \bar{b}^S, \hat{z}^S, H) > 0$$

These three contract types form the set $\mathcal{S}(a, z)$ of feasible credit line contracts offered by banks.

Why would banks offer different contracts if they just break even in any case? The assumption of a competitive banking sector simplifies the model. Giving banks a small share of the firm's surplus would provide incentives for the bank to offer surplus maximizing contracts. Therefore I will let the high type choose the separating contract if both pooling and separating contracts are feasible and she prefers the separating contract.

3.3 Competitive equilibrium

Using the decision rules that solve the firm's maximization problem, the exogenous Markov productivity process for z and the initial states a, z I can derive a transition function $M_t(a, z, .)$ which provides a mapping from the current to next period's distribution of net worth and productivity.

A competitive equilibrium is given by an interest rate r, allocations $c_t(a, z, s), \bar{b}_t(a, z, s), \hat{z}_t(a, z, s)$, investment $k'(.)$ and $k''(.)$ and the firm distribution over net worth and productivity G(a,z), such that:

1. The functions $c_t, \bar{b}_t, \hat{z}_t$ solve the firm's maximization problem
2. Banks break even
3. The capital market clears
4. The distribution of firms evolves according to:

$$G_{t+1} = M_t(a, z, .)G_t$$

At steady state $G_t = G^*$. G^* is the time-invariant distribution of firm net worth and productivity.

3.4 Calibration

This section describes how I set the parameters for the baseline calibration of the model. Table 4 provides all parameter values.

Non-calibrated parameters I set the discount factor β, returns to scale α, depreciation δ, exit rate γ and relative risk aversion σ at values commonly used in the literature. Productivity follows an AR1 process where the average productivity μ_z^i depends on the short-run productivity type:

$$log(z') = (1 - \rho_z)\mu_z^i + \rho_z log(z) + \epsilon$$

with $\epsilon \sim N(0, \sigma_z^2)$ and $i \in \{H, L\}$

I estimate the productivity process parameters[7] on the full Compustat sample between 2004 and 2007 and find a persistence parameter ρ_z of 0.7 and a standard deviation of productivity shock σ_z to be 0.23. The difference between high and low short-run productivity types $\mu_z^H - \mu_z^L$ is used in the calibration. In the Compustat sample 7-8% of firms exit the sample every year. Because some firms delist from the stock exchange and continue to exist as private firms I set the exit rate at 5%.

Calibrated parameters I calibrate the six remaining parameters to target the share of firms subject to income covenants, the covenant breach frequency, the average distance of income covenants from the threshold, the ratio of debt (drawn part of the credit line) to assets and the default rate. A final restriction is based on Sufi (2009) who has collected data on covenant breaches and subsequent credit line cuts. The average decrease in the credit limit in his sample after a covenant violation is 25%. This implies that $\phi\xi + (1 - \phi)$ should equal 0.75. The other data moments are based on firm-level data from 2004 until 2007.

The share of firms subject to income covenants is found by multiplying the share of firms with credit lines in the full sample 0.8 times the fraction of credit line contracts containing income covenants 0.8 which yields 0.64. The average covenant breach frequency in my manual sub-sample is 9%.

The average distance of income covenants at loan initiation is sensitive to the window length of the backward looking standard deviation. Additionally the distance differs between covenants based on ratios and covenants on the level of ebitda. In the model covenants are written in terms of productivity levels. The closest data counterpart is the ebitda covenant. Therefore I take the median distance of ebitda covenants at loan initiation divided by a 12 quarter backward looking standard deviation from the data. In the model I compute the distance as follows:

$$\frac{z_t - \hat{z}}{\frac{\sigma_z}{(1-\rho_z^2)^{\frac{1}{2}}}}$$

[7] For details see Appendix A.5

Total debt to assets are on average 30% in my manual firm-level data. Because the firms in the model can only use credit lines as debt, total debt is the relevant data counterpart. Model debt to assets are computed as:

$$\frac{\text{Drawn credit line}}{\text{Net worth} + \text{Drawn credit line}}$$

.

The default rate is set at 0.004% which corresponds to the share of firms having a Standard & Poor's "D" in a given year but not the year before using the full sample.

Table 4: Parameters

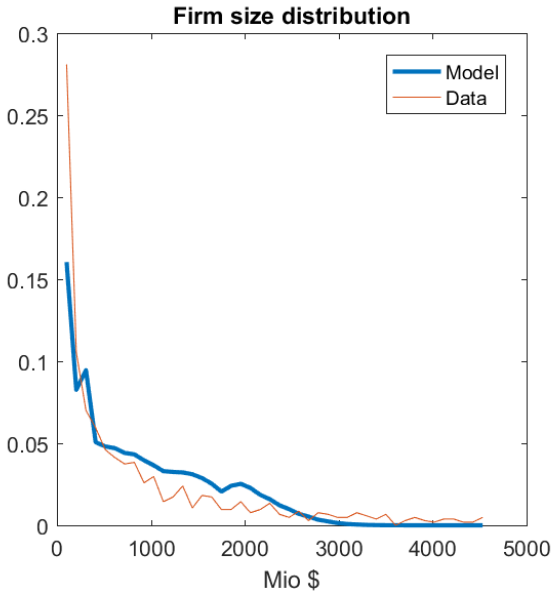
Parameter	Value
Estimated & fixed parameters	
Persistence of productivity process	$\rho_z = 0.70$
Standard deviation of productivity process	$\sigma_z = 0.23$
Discount factor	$\beta = 0.93$
Returns to scale	$\alpha = 0.60$
Depreciation	$\delta = 0.06$
Exit rate	$\gamma = 0.05$
Relative risk aversion	$\sigma = 1.50$
Calibrated parameters	
Probability of credit line cut	$\phi = 0.50$
Pr of credit line cut if mimicking good type	$\phi' = 0.90$
Remaining fraction of credit line	$\xi = 0.50$
Spread	$r_f - r = 0.03$
Fraction of low type firms	$\tau = 0.25$
Difference in mean productivity	$\mu_z^H - \mu_z^L = 2.00$

Table 5: Data Moments for Calibration

	Model	**Data**
Firms with income covenant	62.4	64.0
Covenant breach frequency	9.1	9.3
Average distance to covenant	71.1	240.0
Drawn credit to Assets	24.9	30.0
Default rate	2.2	0.4

Notes: Data moments and their model counterpart used to calibrate the second set of parameters. Data moments are based on firm-level data 2004-2007.

Figure 5: Firm size distribution at steady state



Notes: Total assets in 2006 for data (manual Compustat sample), net worth for model. Dashed line: data; Solid line: model

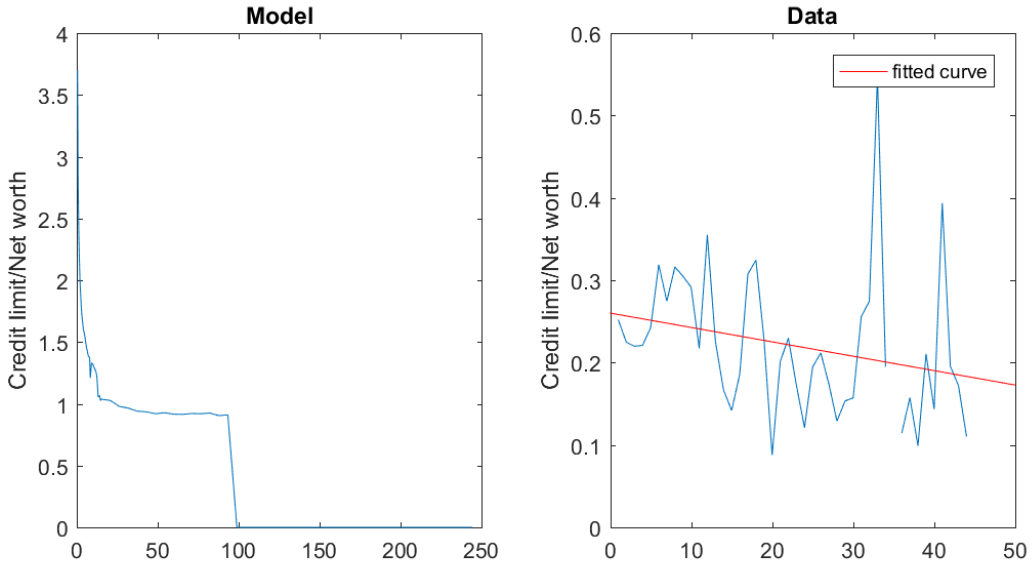
4 Results

4.1 Stationary equilibrium

This subsection discusses the fit of the model at steady state and the role of the different model ingredients. Then I show how the elasticity of covenant breach frequency with respect to TFP shocks varies under different parameters. Finally I discuss how model-generated firm level data can be used to separate credit demand from credit supply in the data.

Fit of the model I compare different moments not targeted and distributions generated by the model against firm-level data. Figure 5 compares the steady state firm size distribution against the data. The model size distribution is slightly too thick in the middle and has too few firms at the lower and upper tails. Figure 6 compares the size of the credit limits in the model against the data. Low net worth firms have much higher credit lines in the model than in the data. This is because in the model firms can only borrow using credit lines whereas real firms have other types of debt available. Both in the model and the data larger firms tend to have lower credit lines. In the model the largest firms do not use any external finance.

Figure 6: Credit Limit to Net Worth



Notes: Left hand side panel: Credit limit to net worth for firms with low short run productivity. Right hand side panel: Median credit limit to net worth for firms in different size bins in the manual sample in 2007

Role of model ingrediences The income covenants in this model have two purposes: first, they give lenders the right to cut the credit line in low productivity state, thus relaxing the bank's break even constraint. Second, high productivity firms signal their quality by accepting stricter covenants. To better understand why firms choose income covenants I first solve the model when banks can observe short-run productivity types.

The second column in table 6 reports that even with observable types 34% of firms choose contracts with covenants because covenants allow them to increase their borrowing. The third column of table 6 reports how much worse off the economy is when types are not observable and covenants cannot be used to signal. Steady state output is almost 5% lower and 6% of firms become constrained.

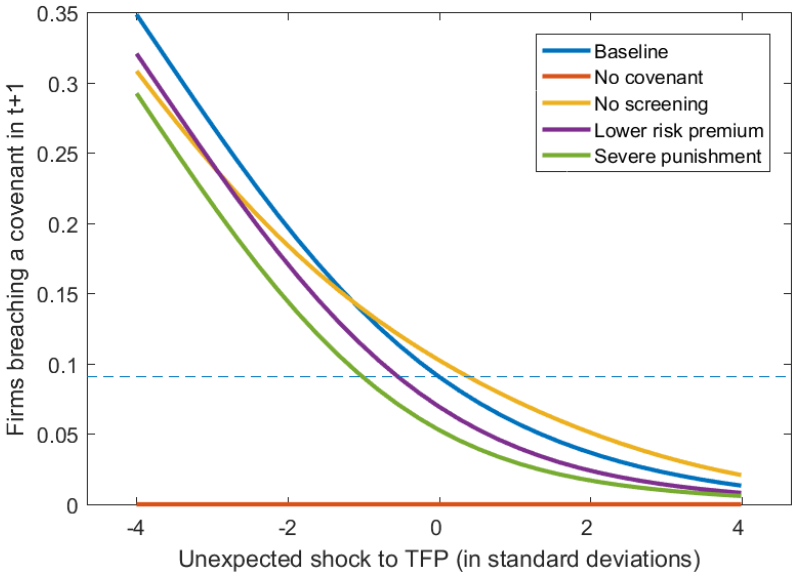
Results in the last column are from a model where banks cannot distinguish between high and low type firms but high type firms can signal their type by accepting tight income covenants. Relative to the baseline version slightly fewer firms have income covenants and when they do they are more loosely set. The breach frequency is slightly higher than in the baseline version. This is because without screening by banks fewer high and more low productivity types accept income covenants. When the difference between ϕ and ϕ' is high more high productivity type firms choose a separating contract. This in turn reduces the breach frequency for given distance to covenant and frequency of covenants.

Table 6: Model Ingredience

	Baseline	**Observable types**	**No covenant**	**No screening**
			$\hat{z} = 0$	$\phi = \phi'$
Firms with income covenant	62.4	34.2	0.0	60.0
-among high type	56.3	32.5	0.0	48.3
-among low type	6.1	1.8	0.0	11.7
Covenant breach frequency	9.1	5.0	0.0	10.3
Average distance to covenant	71.1	42.8	0.0	131.1
Drawn credit to Assets	24.9	24.5	23.9	24.5
Constrained	44.7	38.7	44.3	45.0
Default rate	2.2	2.9	2.7	3.4
Output	95.8	100.0	95.4	95.0
Credit limit	86.6	100.0	84.5	85.1

Notes: Model generated moments of baseline model compared to the first-best with observable types, a model without income covenants and a model in which banks cannot distinguish between high and low types. Output and credit limit are in % of first-best model.

Figure 7: Covenant Breach Frequency and TFP Shock



Notes: The thick solid lines report the fraction of firms breaching a covenant after a shock to average TFP. The dashed line is the breach frequency at steady state in the baseline case.

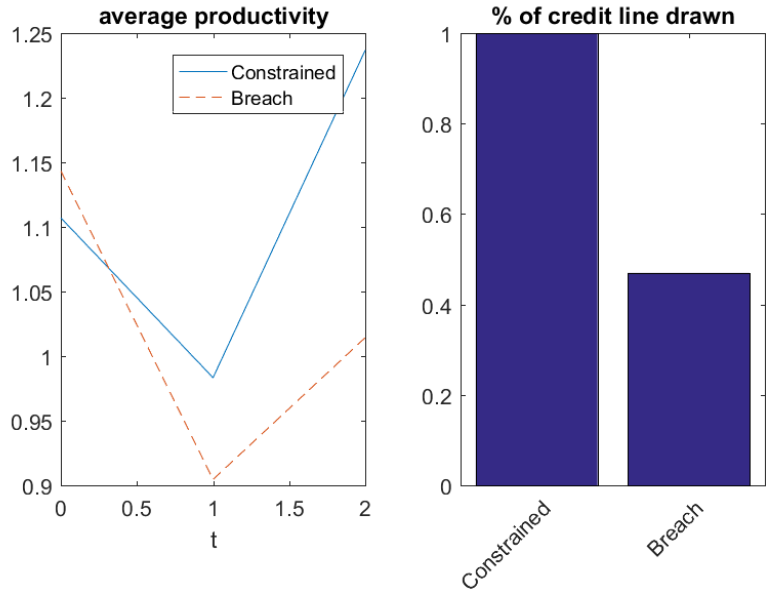
Elasticity of covenant breach frequency to TFP The elasticity of covenant breach frequency with respect to TFP shocks is crucial to assess the importance of the covenant channel. Figure 7 shows by how much the covenant breach frequency changes after a change in average TFP holding everything else constant for the benchmark calibration and small changes in parameters.

In the "Severe punishment" calibration I keep the expected credit line cut $\phi\xi + (1-\phi)$ fixed but lower both ξ and ϕ, i.e. banks cut credit lines rarely but when they do they cut it by a lot. Then fewer firms choose contracts with income covenants relative to the baseline calibration because for the risk-averse firms severe cuts are costlier than mild ones.

For very large negative shocks almost all firms under covenants would breach them, whereas for a large positive shock the breach frequency goes down to zero. The shape of the curve depends on two factors: first, the number and type of firms subject to covenants at steady state and the tightness of their covenants and second, how the TFP shock affects the productivity transition matrix. This curve only shows how much more often banks get the right to change the contract. The total impact depends crucially on whether the banks use this option or not.

In the no screening version of the high productivity type firms have looser covenants on average. This is because they choose pooling contracts more often.

Figure 8: Productivity and Credit Usage around Covenant Breaches



Notes: Left panel: compares the change in firm level productivity of firms breaching a covenant in t_1 against the subset of firms that are constrained because of the credit limit cut after the covenant breach in t_2. Right panel: compares the fraction of the credit line used in t_2

Real consequences of covenant breaches In the model it is straightforward to compute to separate demand from supply side effects after a firm breaches a covenant. In the data this is more difficult, because the threshold data are missing[8] and even if the threshold were known firms with different thresholds might not be comparable. Therefore I use the model to characterize the set of firms affected by the reduced credit supply and then find the same set in the real data. Firms which become constrained after breaching a covenant experience a larger drop in TFP relative to all firm breaching a covenant and a sharper increase in TFP subsequently (see figure 8). Constrained firms in the model fully draw their credit line whereas the average firm breaching a covenant only uses more than 60% of its credit line.

[8]Only the initial and final covenant thresholds are known and in addition there are frequent amendments to contracts which are not recorded in DealScan.

4.2 The covenant channel during the Great Recession

This section shows the effects of an unexpected shock to average firm-level TFP in my model with income covenants on aggregate and firm-level variables. I then discuss the trade-off raised by tight income covenants in steady state and larger amplification of TFP shocks.

The shock I shock the economy with an unexpected and temporary drop in average firm level TFP of 0.64, this corresponds to 1.9 standard deviations of the productivity process, to match the observed covenant breach frequency of 19% during the Great Recession. The timing is as follows: the economy starts at a steady state. Firms enter credit line contracts expecting the economy to remain at steady state. During the covenant breach sub-period realized TFP is lower than expected causing more firms to breach a covenant. After this, average TFP immediately returns to its steady state value and firms know the path of the recovery.

In the model I keep the banks' reaction to covenant breaches at the steady state level. Because in reality banks are likely to have cut credit lines more often during the Great Recession, as shown by Chodorow-Reich and Falato (2017), the drop in output and investment in the model should be seen as a lower bound.

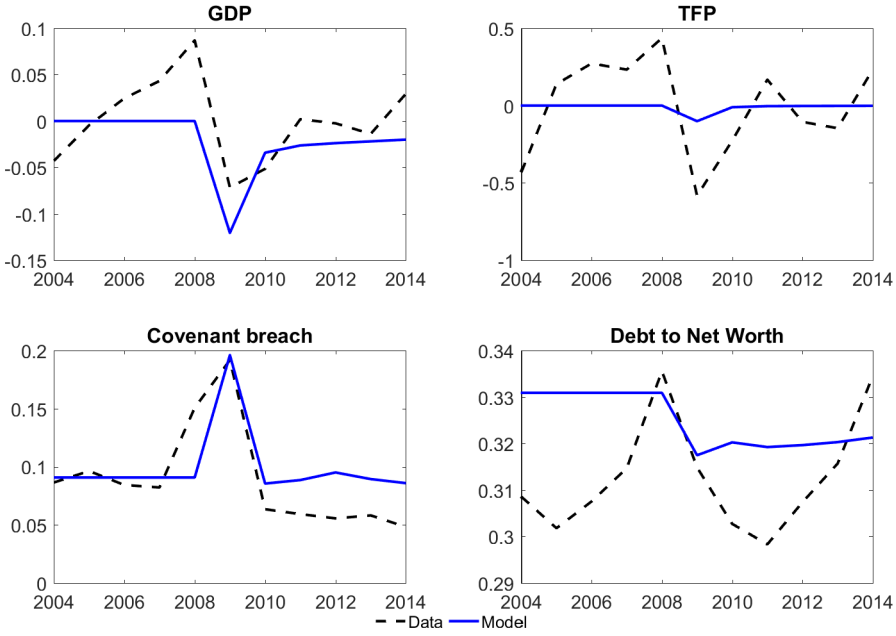
Impact on aggregate outcomes Figure 9 shows the impact of a surprise firm-level TFP reduction. Output decreases by 12% in the model and 15% in the data between 2008 and 2009. TFP drops by 10% in the model and 60% in the data. The TFP drop is calibrated to match the covenant breach frequency in the Great Recession. Debt to net worth drops from 33% to 31% in the model which is very close to the change in leverage in the data. Because the TFP shock in the model is only during one period, in the model leverage increases after 2009 whereas in the data the decline continues.

Covenant breaches during the Great Recession had real consequences: table 7 compares growth rates between breaching and non-breaching firms for actual and where available model generated data. The decrease in credit limits for firms breaching a covenant in the model of 25% is almost double compared to actual firms. In the data 7% (83 firms) breach a covenant and have their credit line cut, in the model the corresponding number is almost 10%. Among those firms, the median firm in the data has her credit line cut by 35%, at the 25 percentile the cut is almost 60% and at the 75 percentile the cut is still 17%.

In the data firms breaching a covenant during the Great Recession had the same pre-crisis employment growth and slightly lower investment growth, but decreased their employment almost four times as much and decreased investment twice as much compared to firms not breaching a covenant.

After a bad income shock a firm breaching a covenant might reduce investment and employment because it either has lost access to its credit line and becomes financially constrained or because

Figure 9: Aggregate Series



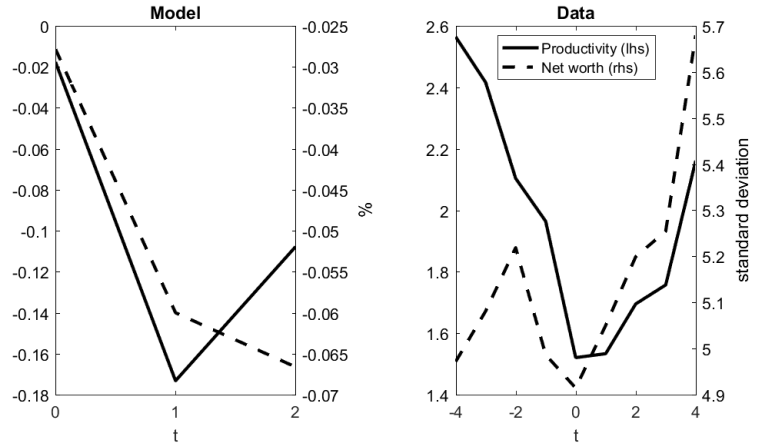
Notes: Dashed line: data; Solid line: model. Model TFP and GDP in percentage deviation from steady state. GDP and TFP data are in percentage deviation from a quadratic trend. TFP data is aggregate firm level TFP weighted by total assets. Covenant breach frequency in percent, actual data are cumulated between 2007-09.

it updated its belief about future demand downward. In the model I can easily separated credit supply from credit demand. Under the baseline calibration 16% of the investment decline and 5% of the output decrease can be attributed to income covenant breaches and the subsequent cut in credit limits.

		Model		**Data**	
$\Delta y_{t,t-x}/y_{t,t-x}$		Breach	No Breach	Breach	No Breach
Credit Limit	08-09	-0.25	0.00	-0.12	-0.02
Investment	05-07			0.50	0.59
Investment	07-09	-0.04		-0.30	-0.15
Employment	05-07			0.07	0.07
Employment	07-09			-0.11	-0.03

Table 7: Model generated data compared to actual data. All numbers are percentages

Figure 10: Income and Net Worth during the Great Recession



Notes: Firm-level income (solid line) and net worth (dashed line). Left hand side panel: the model-generated firm-level data is the percentage difference between firms subject to income covenants and firms breaching a covenant when the TFP shock hits. Right hand side: actual quarterly data of firms with non-missing data breaching a covenant in the manual sample. Time $t = 0$ is the quarter of the covenant breach. I divide ebitda and net worth by the 12-quarter backward looking standard deviation and take the median of all firms.

Impact on firm-level outcomes Now I turn to firm-level data. In the model the shock hits all firms simultaneously whereas in the data firms breach covenants at different moments during the Great Recession. Therefore I center the actual data around the quarter of the covenant breach. Figure 10 compares both income and net worth of the model generated data and actual data. Both in the model and the data firms breaching a covenant experience a large drop in income, about one standard deviation in the actual data, and a relatively small drop in net worth (0.3 standard deviations in the data).

5 Conclusion

Income covenants were the most frequently binding constraint for firms in my sample during the Great Recession. This is the main empirical finding of this paper. I then show that banks have used covenant breaches to reduce firms' credit lines, which subsequently lowered firms employment.

The second empirical finding is that firms signal unobservable productivity improvements by choosing loan contracts with tight covenants. When a recession hits this mechanism backfires and firms with tightly set covenants experience a much larger increase in covenant breaches than firms with loose covenants.

Based on these two findings I build a dynamic general equilibrium model with heterogeneous firms and loan contracts with covenants. Banks offer loan contracts with different credit limits and income covenants. In equilibrium firms with high unobservable productivity signal their type by

choosing tight income covenants. I calibrate the model to the firm-level data used in the empirical part and shock the model with an unexpected temporary firm-level TFP shock.

The model provides a mapping between TFP shocks and the exposure of firms' access to external financing which could be of interest to policy makers. Holding banks' reaction to covenant breaches constant I show how the distribution of covenants and their tightness matters for the impact of a TFP shock.

The model can generate the observed pattern of firm-level income and net worth when exposed to a TFP shock similar to the Great Recession.

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A Appendix

A.1 Data: details

- **Compustat** Firm accounting data are from Compustat. I keep only firms incorporated in the US and I drop all financial firms with SIC codes 6000-6999.

- **SEC filings** The covenant breach data and the credit limit data are based on SEC filings. The quarterly SEC filings are downloaded from EDGAR `https://www.sec.gov/edgar/searchedgar/companysearch.html`. For reports filed 1996-2008 I use the Compustat-SEC link provided by Nini et al. (2009): `faculty.chicagobooth.edu/amir.sufi/data-and-appendices/CSTATSEC_NSS_20091005.dta`. For the period 2009-2015 I follow their procedure and build a bridge.

- **DealScan** I use the covenant thresholds provided by DealScan to compute covenant tightness and to complement the hand-collected data about the type of covenant breached. DealScan data provides information about covenant at the *Package* level. Data about maturity, spreads and the participating banks are at the *Facility* level[9]. I merge the DealScan data with Compustat by using the bridge provided by Chava and Roberts (2008).

- **Call Reports** To compute total loans and unused commitments I use Call Reports data that can be found here: `https://cdr.ffiec.gov/public/`

A.2 Description of hand-collected data

- **Covenant breaches & reason of breach** I have extended the search alghorithm for covenant breaches by Nini et al. (2012) to include the type of covenant breached and changed the search terms to reduce the number of false positives. I start by extracting all text parts in quarterly and annual filings containing the word "covenant". My search algorithm then has three steps:

  - Filter out conditional statements, for example: "in the event of a covenant violation", "would have been in violation" , "whether or not in compliance" etc[10]
  - Check if the firm reports being in compliance: "in [a-z] compliance", "the company is presently in complicance" etc.
  - Check if the firms is in breach of a covenant: "failed to meet", "in technical violation", "out of compliance" etc.

[9] I want to thank Sebastian Doerr for providing codes for the data treatment
[10] Full regular expressions are available upon request

When the code finds a covenant violation then, only within the same sentence, I look for an indication of the date, because firms often report covenant breaches that have happened in the past. Also within the same sentence I search for the type of covenant breached.

- **Credit limit**
  - I search all annual and quarterly SEC filings for the following terms:
    - "(revolving"+s+")\{0,1\}credit"+s+"(line|facility)"
    - "working"+s+"capital"+s+"(facility|line)"
    - "(equipment"+s+")\{0,1\}(line|lines)\{1\}"+s+"of"+s+"credit"
    - "revolving"+s+"(loan|credit)"

    and extract and save the part of the filing around these terms. The search terms are loosely based on Sufi (2009).
  - Then I search for the sentences providing the information about the firm's credit limit(s), for example:
    - "the company's $30 million credit line"
    - "revolving credit line of $20 millions"

    and verify manually that the extracted information is correct.

A.3 Classification of covenants

I use the covenant definitions provided by Demerjian and Owens (2014) to map covenants into Compustat accounting data in table 8.

How reliable is the classification into income and net worth covenants? Most covenants can be unambiguously classified into one of the three groups below."Leverage ratio" can be either debt to net worth or debt to earnings. I therefore checked all occurences of "Leverage ratio" separately for the specific definition. For "Minimum net worth" the amount is often computed using a formula that adds a fraction of income to a fixed amount:

```
(a) tangible net worth not at any time, less than eighty-five percent
(85%) of tangible net worth as of the date hereof (plus seventy-five percent
(75%) of cumulative net income after the date hereof, excluding any fiscal
quarters in which net income is negative
```

A final caveat concerns limits on indebtedness which are not formulated as financial covenants.

Name	Compustat data	Search terms
Income		
Minimum ebitda	$ebitda_t = \sum_{t=-2}^{1} oibdpq_t$	
Debt to ebitda	(dlttq + dlcq)/ebitda	
Interest coverage	ebitda/intexp	
Fixed charge coverage	ebitda/(intexp + l1.dlcq + xrent)	
Debt service coverage	ebitda/(xintq + l1.dlcq)	
Net worth		
Net worth	atq - ltq	
Minimum tangible net worth	atq - intanq - ltq	
Debt to net worth	(dlttq + dlcq)/networth	
Leverage ratio	(dlttq + dlcq)/atq	
Other		
Current ratio	actq/lctq	
Quick ratio	(rectq + cheq)/lctq	

Table 8: Covenant classification

A.4 Covenants for small businesses and firms outside the US

A large number of websites filled with advice for small business owners of how to cope with covenants suggests that covenants are not only used in loans to large firms. Below is an example from a Forbes article[11] "Bank loan covenants and clauses entrepreneurs regret most":

"[...] Debt Service Coverage Ratio Bank Loan Covenant: To satisfy the bank's level of risk, the bank will set forth a cash flow requirement such as a ratio of income to debt payments which must be maintained by the business throughout the term of the line of credit or loan. For example, the bank may set a debt service coverage ratio of 1.2 which means that the net operating income for a period must exceed the total debt payments (interest and principal) payable to the bank during the same period by 20%. If the total debt payments for the period were $100,000.00, then the business would need to have income equal to $120,000.00 during the same period in order to maintain the bank's debt service coverage ratio covenant. In many cases, the entrepreneur agrees to this covenant and does not understand its meaning or implications should the business have a year with reduced net profit or a loss."

Are loan covenants specific to US banking market? Covenants are common also in France as the following information of a French consulting firm[12] shows:

[11] https://www.forbes.com/sites/hollymagister/2014/01/21/bank-loan-covenants-and-clauses-entrepreneurs-regret-most visited on 30.08.2018

[12] https://www.cabinet-oreco.fr/actualites/les-covenants-bancaires-ou-clauses-imposant-a-lemprunteur-de-respecter visited 30.08.2018

"Dans le contexte économique actuel de dégradation de la situation financière des entreprises, celles-ci éprouvent les plus grandes difficultés à respecter les covenants figurant dans leurs contrats de prêts. Les covenants sont des clauses, insérées dans des contrats de prêts conclus entre une banque et une entreprise, qui imposent au débiteur le respect de certains engagements spécifiques et notamment de ratios financiers. Le remboursement anticipé du prêt pouvant être la conséquence la plus fréquente du non-respect des objectifs fixés contractuellement."

A.5 Firm level productivity

I estimate firm level productivity from Solow residuals by running the following regression using the entire Compustat sample:

$$log(y_{ist}) = \alpha_i + \beta_s^k log(k_{ist}) + \beta_s^l log(l_{ist}) + z_{ist}$$

with y_{ist} sales deflated by GDP deflator, k_{ist} the capital stock computed using the perpetual inventory method and l_{ist} the number of employees. I allow factor shares to vary across Fama-French 30 industries indexed by s. I exclude financial firms and utilities as well as firms with negative sales or assets or firms which report an acquisition larger than 5% of their assets.

For the estimation of the productivity process parameters ρ_z, σ_z I then winsorize z_{ist} at 1% and drop all firms with missing values between 2004 and 2010.

Table 9:

	(1)	(2)	(3)
	04-07	08-09	04-09
l1tfp_fe	0.684***	0.727***	0.698***
	(35.27)	(29.73)	(45.72)
Constant	0.0582***	0.0150*	0.0404***
	(9.05)	(1.84)	(7.96)
r2	0.506	0.487	0.493
N	1216	933	2149

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Both the persistance parameter ρ_z and the standard deviation of innovations σ_z remained relatively stable during the Great Recession whereas average productivity fell to about one quarter, or 43% of the standard deviation of the AR1, of its pre-crisis level. Mean productivity (without taking into account persistence) fell only by about 5%.

Table 10:

stats	**sigma1**	**sigma2**	**sigma3**
sd	0.22	0.23	0.23
N	1216.00	933.00	2149.00

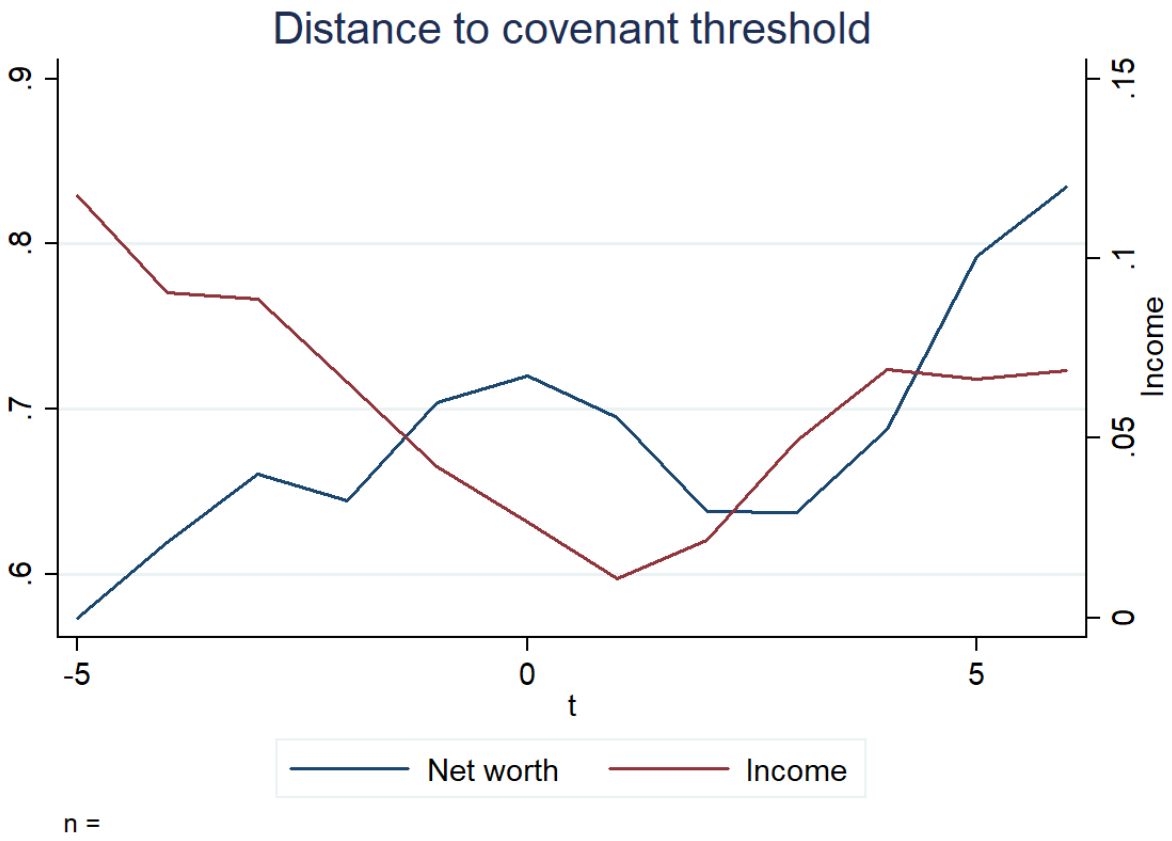

Figure 11: Tightness of net worth and income covenants around aggregate downturns. When industry output growth falls below 1.25 standard deviations below its 1993-2014 average a downturn happens. I take the most stringent covenant of each type for each firm, then compute the median across firms.

A.6 Are income and net worth covenants equivalent?

This paper stresses the importance of financial constraints based on income instead of net worth. But because net worth consists also of retained earnings income shocks will affect net worth too. A very tightly set net worth covenant should be equivalent to an income covenant. In this subsection I provide evidence that the two constraints are not equivalent.

Figure 11 shows that during downturns income covenants become binding before net worth covenants. Income covenants reach their minmal distance to the threshold one quarter after the downturn started, for net worth covenants this happens two quarters later.

Among the firms breaching an income covenant during the Great Recession six are subject to net worth covenants as well. For two there is no missing data about the distance to the threshold. They are 25% and 43% below the standard deviation of their tightest income covenant and 77%

and 19% above the standard deviation of their tightest net worth constraint[13].

[13]Thresholds measured at contract beginning, difference threshold minus actual accounting ratio divided by standard deviation of accounting ratio (by firm for net worth and earnings, for ratios across all firms).

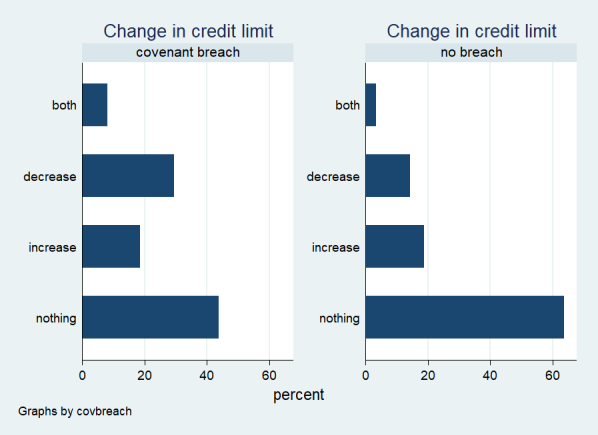

Figure 12: Change in credit limit at firm level during the Great Recession depending on whether the firm has breached a covenant or not.

A.7 Additional empirical results

t	age	logat	opCash s	leverage	intExp s	netWor s	curren o
1 tight	15.00	6.65	0.07	0.32	0.02	0.39	1.58
2 intermediate	17.00	6.88	0.08	0.25	0.02	0.45	1.78
3 loose	17.00	7.17	0.11	0.19	0.01	0.50	1.87
Total	16.00	6.88	0.09	0.24	0.02	0.45	1.69

Table 11: Firm characteristics by tightness of covenants at loan initiation. This table compares firm observables by covenant tightness. Firms with tighter covenants tend to be younger, smaller, have higher leverage and lower operating cashflows than firms with loose covenants.

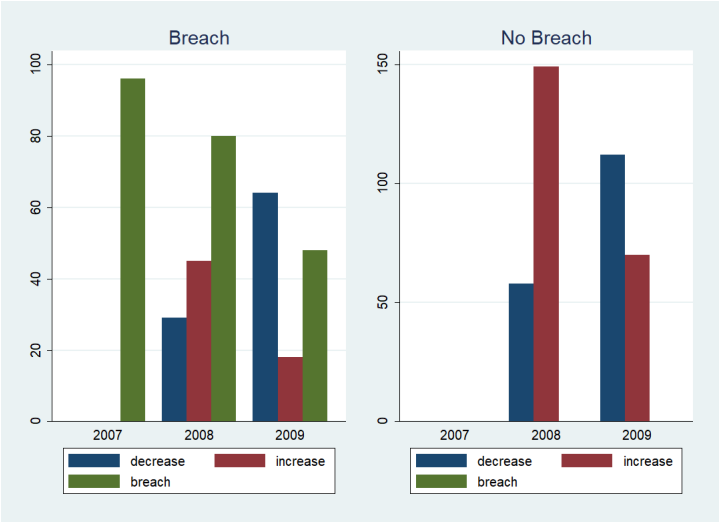

Figure 13: Timing of change in credit limit at firm level during the Great Recession depending on whether the firm has breached a covenant or not.

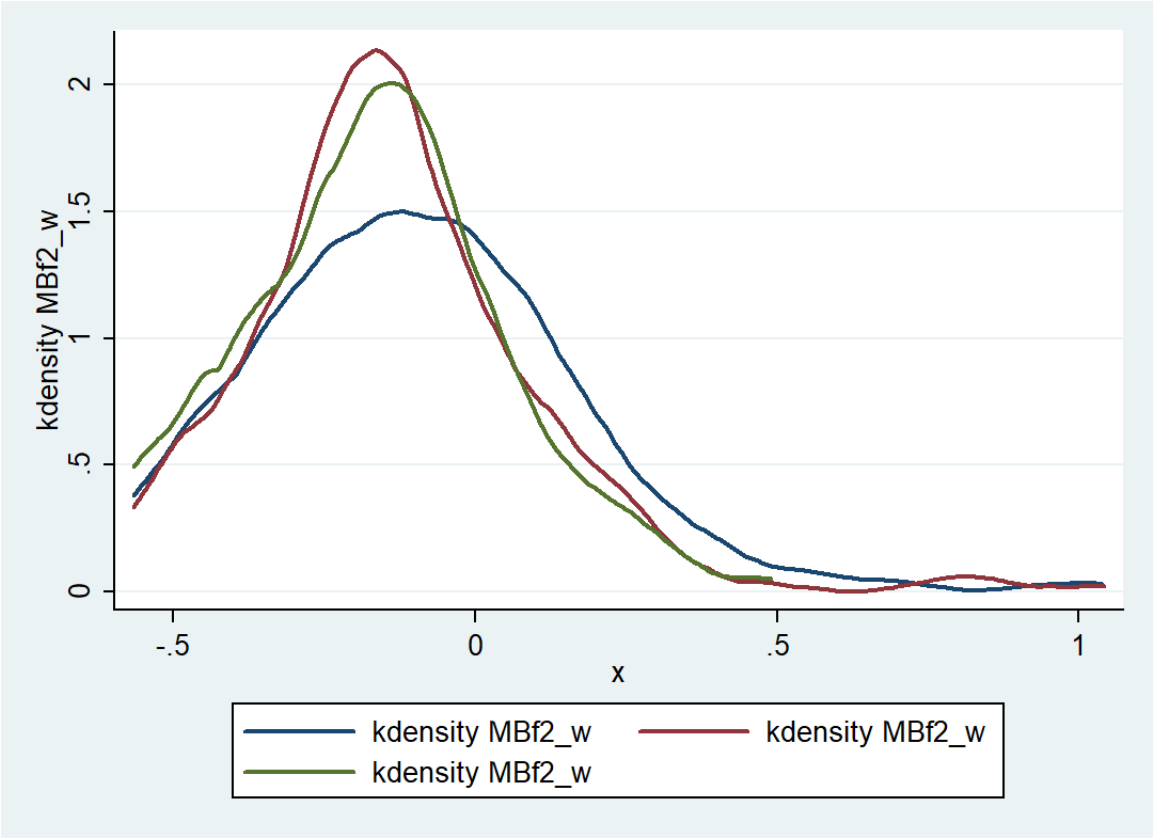

Figure 14: This graph plots the two year ahead growth in market-to-book value by initial covenant tightness for firms obtaining a new contract between 2004 and 2006. Blue line = tight covenants, red line = intermediate, green line = loose covenants. The pattern looks similar when controlling for industry and year FE as including all other years.