Do bond covenants prevent asset substitution - using a novel structural estimation approach

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Abstract

This paper addresses an important source of conflict between stock- and bondholders: asset substitution. We explore whether bond covenants can mitigate this conflict and identify the mechanisms at work. Using the simple intuition that such an agency conflict is most likely to occur in times of financial distress, we examine a comprehensive sample of defaulted companies. In order to identify risk-shifting behavior, we incorporate two decisive features into our empirical methodology. First, we employ a structural corporate finance model which allows us to detect the degree of risk-shifting and separate two different mechanisms through which covenants work. Covenants can either directly restrict the behavior of the management (e.g., covenants restricting the investment decisions of the firm), or affect the risk-shifting incentives by changing the curvature of the stockholders' value function. (e.g., net-value covenants). Second, we develop a novel simulated methods of moments approach for such conditionally sampled data sets. Our results indicate that bond covenants are indeed beneficial: Compared to companies whose outstanding bonds do not have any covenant associated, companies with protective covenants are in general less likely to engage in risk-shifting just prior to bankruptcy and if they do so, the increase their cash-flow risk by less, since covenants have made the equity value much less convex. Nonetheless, issuing bonds without covenants can be optimal as well. We find that for the average firm with no covenants attached to its bonds the agency cost from asset substitution is lower than the inefficiency the firm would incur had it included covenants in its bond contracts.

JEL classification: G30, G33

Keywords: asset substitution, bankruptcy, bond-covenants, risk-shifting

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1 Introduction

In how far do companies engage in risk-shifting activities[1] and can different types of bond covenants help mitigate such behavior? While the general theoretical concept of risk-shifting is well established in the literature (since e.g. Jensen & Meckling (1976)), empirical papers have traditionally experienced a more difficult time finding appropriate answers to these questions. One of the main reasons for the troublesomeness is that a number of key factors, such as a direct measure of the intensity and the timing of the companies' risk taking behavior, are generally unobservable to the outside researcher and are therefore hard to identify empirically.

In this paper, we seek to overcome such challenges by employing a simple structural model of a firm via which we are able to estimate several of those unobservable parameters. Using the simple intuition that risk-shifting is most likely to occur in times of financial distress, the analysis focuses on a sample of defaulted companies and examines the firm behavior in the years prior to the bankruptcy filing. By analyzing defaulted companies only, one aspect to realize is that such a sample is a conditional sample since eventually all firms go bankrupt at some point in time. Hence not all companies in the economy are included in the analysis. If one wants to bring any theoretical model to such data, for example with the help of a simulated methods of moments estimation, one cannot simply use the standard techniques. Instead, what we do is to develop a novel empirical estimation approach to deal with such conditional samples. The main advantage of this method is that it can be applied to data that is conditionally sampled without introducing a selection bias. We are thus able to estimate the unobservable structural parameters of the model and to answer our research question in how far companies engage in asset substitution. In addition, we can employ the structural model to test whether firms that have issued debt without covenants attached have chosen the optimal debt contract by conducting a counterfactual excercise.

One possible way to mitigate managers' risk-shifting incentives may be to limit their set of feasible actions which they can undertake. A popular example of such constraint is the usage of bond covenants. The underlying idea is that when bonds are issued, managers may agree to prospective behavioral restrictions, such as pay-out or investment limitations, in exchange for more favorable financing terms. Even though covenants are typically not effectual upon the date of the security issuances, they may become binding at some future point in time. For example in times of financial distress, when managers have an incentive to engage in risky activities and to gamble

[1] *Risk-shifting* is often referred to as *asset substitution* in the literature and both terminologies are used interchangeably in the paper.

for resurrection, bond covenants can influence managers' actions.

An additional advantage of using a structural estimation approach to analyze the asset substitution problem is that it allows us to disentangle two decisions that are potentially jointly made: On the one side managers reflect about the usage of bond covenants and on the other side they also contemplate about the general willingness to potentially alter the company's risk profile in the future. These fundamental decisions are also likely to occur at some earlier and unknown point in time. Hence, the ex-post identification of the underlying relationships by outside observants can be non-trivial and possible endogeneity concerns could be raised.

To analyze in how far bond covenants are able to mitigate managers' potential expropriation of bond-holders in times of financial distress, we apply our novel empirical estimation technique in combination with a simple structural model to a comprehensive sample of defaulted U.S. companies between 2000 and 2013. We subsequently examine whether the existence of different types of bond covenants has a pronounced effect on a firm's pre-default behavior and thus on the timing and on the severity of the asset substitution problem. Finally, we conduct a counterfactual exercise and derive the valuation consequences for firms that have chosen debt contracts without cashflow covenants to examine whether these contract is optimal.

The main finding of this paper is that bond covenants can indeed be helpful in mitigating the asset substitution problem. We examine empirically the firm behavior in the final seven years before the bankruptcy filing occurs and compare two sub-samples: On the one hand companies whose outstanding bonds have at least one covenant associated and on the other hand companies without any bond covenant. The estimation first reveals that firms belonging to the latter group are more likely to alter their risk profile just prior to default. Additionally, the cash-flow volatility increases more heavily for companies without covenants. These findings thus indicate that the usage of protective covenants can help diminish managers' risk-shifting incentives. Furthermore, examining the estimation results for the bankruptcy boundary also leads to interesting insights: First, companies without bond covenants are found to default at a lower bankruptcy threshold and hence at a later stage in time compared to companies with covenants. Second, for companies with bond covenants, the estimated bankruptcy threshold lies very close to the one implied by exogenously specified cash-flow covenants. On the contrary, the estimated bankruptcy boundary for firms without covenants is considerably lower and much closer to the one which equity maximizing managers would choose endogenously. Hence, the usage of bond covenants has important implications on the default decision of managers. Finally, our counterfactual exercise reveals that for firms belonging to the no-covenant sample the inefficiency costs which would be generated by the restrictive covenants exceed the agency costs from asset substitution. Thus, as predicted by the theoretical model, this type of firm has chosen its debt contract optimally. To summarize, these results indicate that bond covenants are one possible way to overcome agency conflicts.

This paper is organized as follows: Section 2 reviews the related literature of risk-shifting and of bond covenants. Section 3 depicts a simple structural model of a firm having the possibility to engage in risk shifting. Section 4 describes the conditional simulated methods of moments estimation approach. Section 5 describes the data and Section 6 discusses the main results. Last, Section 7 concludes.

2 Related literature

Risk-shifting or asset substitution

It is well-known that the equity of a firm can be regarded as a call option on its underlying assets. As a consequence, when companies are in financial distress managers, who are commonly assumed to be acting in the interests of equity-holders, may have an incentive to engage in risky projects. The simple intuition is that equity-holders benefit when risky projects pay off whereas debt-holders bear the costs when such projects do not materialize and the company goes bankrupt.[2] The underlying reason is the limited-liability aspect of equity and such behavior has been termed asset substitution or risk-shifting in the literature.

While the theoretical foundations for the asset substitution problem are well understood since e.g. Jensen & Meckling (1976), traditionally however relatively few papers have focused the economic relevance or even the overall existence. One reason behind this is that risk-shifting is typically hard to identify in the data as it is not easily observable when firms are increasing their risk above the regular or 'normal' level. Some early empirical analyses include Andrade & Kaplan (1998), Graham & Harvey (2001) or de Jong & van Dijk (2001), and these papers typically find little or even no direct evidence of the such agency conflict. Besides the empirical identification challenges, however, different authors have argued that when one examines a longer time frame (using e.g. a multi-period instead of a single-period setting), other aspects such as reputational costs may prevent managers from actually engaging in risk shifting (e.g. Diamond (1989)). As a consequence, it may be difficult to know precisely whether not finding anything is caused by some identification problem or by other factors, e.g. risk-shifting not existing. In a recent empirical paper, Gilje (2013) seeks to overcome

[2]We do not focus on the (legal) mechanisms underlying the different stages of the bankruptcy process. Hence, in the paper, the expressions *bankruptcy* and *default* are used interchangeably.

the problem of identifying an appropriate measure of investment risk by using the standardized risk classifications of the Financial Accounting Standards Board. The author examines the investment behavior for different levels of leverage and documents that for companies in the oil and gas industry, the investment risk is not increased but rather reduced as leverage increases. Gilje (2013) concludes that risk-shifting does not seem to occur and this finding is attributed to possible concerns regarding the financing of future investments.

Analyzing a related research question, Eisdorfer (2008) compares financially healthy and distressed companies and examines the relationship between investment and volatility. The author points out that while an increase in volatility leads to a higher value of waiting and delaying the investment decision from a real-options perspective, a higher volatility can be desirable from the equity-holders risk-shifting perspective and can thus lead to earlier investments. Eisdorfer (2008) finds empirical support for the latter argument for distressed firms and shows that the level of uncertainty does in fact have a lower or even positive effect on the investment decision of those companies.

However, despite the well-known theoretical foundations, the empirical evidence of risk-shifting documents remains generally rather mixed.

Bond covenants

One possible and also popular way to mitigate the potential expropriation of bond holders by managers is the usage of bond covenants.[3] The general intuition is that covenants may limit the possible actions of managers in times of financial distress since they are typically imposed ex ante at the time of the security issuances. Empirical discussions in this area have begun early, one of the primary papers being the analysis of Smith & Warner (1979). In this paper, several different types of bond covenants are examined and a number of agency conflicts which these covenants are designed to mitigate are discussed. Among other aspects, the authors highlight that the degree of covenant tightness is positively related to the possibility of equity-holders to expropriate bond-holders, and this effect has been termed the 'costly contracting hypothesis' in the literature.

More recently, Bradley & Roberts (2003) examine the relationship between the firms' cost of debt and the usage of bond covenants. Consistent with the costly contracting hypothesis, the promised yield on corporate debt issues is found to be negatively related to the presence of covenants. The authors conclude that covenants are priced. Similarly, Wei (2005) documents a negative relationship between the firms'

[3]In addition, companies frequently hold bank loans and such loans may also be subject to various different covenants. Due to data limitations our analysis however does not include bank loans.

credit spreads and the strength of the covenant protection. These findings provide a rational why managers are willing to agree to covenants and to limit part of their future action set. Moreover, after the recent financial crisis, several papers have started to re-examine bond covenants in more detail. Chava et al. (2010) for example document that the risk of both managerial entrenchment and fraud significantly influences the covenant usage. Additionally, in a recent working paper, Mansi et al. (2011) differentiate between the predicted and the actual usage of covenants and show that while the empirically predicted one is associated with a higher probability of bankruptcy, this relationship reverses for the actual usage. The authors thus conclude that the observed frequent usage of bond covenants reduces the bankruptcy risk of companies. Last, using a new database called Moody's Covenant Quality Assessment Service to evaluate the covenant restrictiveness, Franco et al. (2013) discuss different factors that determine the strength of bond covenant packages in protecting bond-holders' interests. One main conclusion is that the restrictiveness of a bond is typically highly persistent over time.

To summarize, several empirical studies have examined the determinants and the strictness of bond and loan contracts. However, at the same time relatively few papers have focused on analyzing the conditions under which it is optimal to use different covenants. A recent exception is the paper of Lowery & Wardlaw (2012) in which the authors highlight that the usage of alternative covenants is not necessarily monotonic in the firm characteristics (e.g. risk).

The relationship between covenants and risk-shifting

Starting with papers such as by Chava & Roberts (2008), a number of empirical corporate finance studies have used a regression discontinuity design framework to analyze several capital structure adjustments around different covenant violations.[4] The authors highlight that the capital investment declines sharply following a loan covenant violation. Similarly, Nini et al. (2012) depict that besides changes in the investment behavior, also the financing of firms is altered around covenant violations. Firms tend to use less leverage and a decline acquisitions and capital expenditures occurs. However, the documentations of capital structure changes occurring around covenant violations mostly do not discuss the asset substitution problem.

One notable exception is a recent working paper by Esmer (2012) which focuses on the relationship between different sorts of covenant violations and managerial risk

[4]The main idea underlying the regression discontinuity framework is that an observable threshold is used to analyze the firm behavior on either side of the threshold. Such framework can thus be helpful in identifying causal relationships.

taking. The author highlights that while in the year prior to a covenant violation, the relationship between the asset volatility and firms' investments is negative, this relationship actually reverses subsequent to a violation. Hence, despite other papers' previous documentations that covenant violations are often associated with an increase in managerial control, Esmer (2012) depicts that firms' investments are increased when uncertainty is high. The latter behavior is thus consistent with the general notion of managerial risk-shifting.

To conclude, the majority of the empirical studies either directly analyzes the usage and characteristics of different bond covenants or alternatively focuses on identifying the asset substitution problem. Few papers however discuss the direct link or the interrelation between these two related fields. Moreover, one major focus has so far been put on analyzing the firm behavior around covenant violations. Nevertheless, when one examines the pre-default period, the basic question in how far the ex ante existence of different bond covenants helps mitigate the ex post risk shifting behavior has not yet been fully analyzed.

3 A simple structural model

In order to uncover a firm's risk-taking behavior we need a structural corporate finance model that links a firm's unobservable risk-shifting decision to its observable equity prices. This link is established in a parsimonious extension of the basic Leland (1994) capital structure model in which a company has a single possibility to alter its risk profile prior to default.[5] The operating cash-flow of a firm is assumed to follow a geometric Brownian motion, where W_t^P denotes the systemic risk factor which requires a constant market price of risk λ.

$$dX_t = \alpha_i X_t dt + \sigma_i X_t dW_t^P \tag{1}$$

Under risk neutral pricing, the drift is given by $\mu_i = \alpha_i - \lambda\sigma_i$ and the $\mathbb{Q}$ dynamics can therefore be written as:

$$dX_t = \mu_i X_t dt + \sigma_i X_t dW_t \tag{2}$$

In order to allow the company to engage in risk shifting, both the drift as well

[5]The model is related to a working paper by Ericsson (2000) which also discusses risk-shifting in a structural model. The author examines the finite maturity structure of debt and discusses the relevancy of deviations from the absolute priority rule of debt in case of bankruptcy. For simplicity reasons, we abstract from such extensions.

as the volatility of the firm's cash-flow may take two values, either high (H) or low (L). Risk shifting is costly. Such costs can take the form of higher production or management costs, increased depreciation of the assets, or simply a higher discount rate if the company increases its exposure to systematic risk. The consequence is a drop in the growth rate of the cash flow under the $\mathbb{Q}$-measure:

$$\sigma_i \in \{\sigma_L, \sigma_H\} \quad \text{where} \quad 0 < \sigma_L < \sigma_H < \infty$$
$$\mu_i \in \{\mu_L, \mu_H\} \quad \text{where} \quad 0 < \mu_H < \mu_L < \infty$$

The Hamilton-Jacoby-Bellman equation for the firm's equity value can thus be depicted in Equation (3) below, where $\tau_e = 1-(1-\tau_c)(1-\tau_d)$ denotes the effective tax rate (τ_c & τ_d are the corporate & personal tax rates) and C is the aggregate coupon of all debt outstanding. Depending on whether the company has not yet altered its risk-return profile (its time t cash-flow has not reached the high risk region) or whether it has, equity takes two different values.

$$rE_i(X_t) = (1-\tau_e)(X_t - C) + \mu_i X_t \frac{\partial E_i}{\partial X_t} + \frac{1}{2}\sigma_i X_t^2 \frac{\partial^2 E_i}{\partial X_t^2} \qquad i = L, H \tag{3}$$

The general solution to the above ODE can be analyzed separately for each of the two regions. Let $\delta_i = r - \mu_i$. The constants γ_i and θ_i are the usual roots of the fundamental quadratic equation and are given by $\frac{-(\mu_i - 0.5\sigma_i^2) \pm \sqrt{(\mu_i - 0.5\sigma_i^2)^2 + 2r\sigma_i^2}}{\sigma_i^2}$.

$$E_L(X_t) = (1-\tau_e)\left(\frac{X_t}{\delta_L} - \frac{C}{r}\right) + A_L X_t^{\gamma_1} + B_L X_t^{\gamma_2} \qquad \text{where} \quad X_t \in (X_{RS}, \infty) \tag{4}$$
$$E_H(X_t) = (1-\tau_e)\left(\frac{X_t}{\delta_H} - \frac{C}{r}\right) + A_H X_t^{\theta_1} + B_H X_t^{\theta_2} \qquad \text{where} \quad X_t \in (X_D, X_{RS}) \tag{5}$$

Equations (4) and (5) are subject to the standard boundary conditions: First, the exclusion of speculative bubbles condition implies that A_L and A_H are zero. Second, two no-arbitrage conditions restrict the equity value at the risk-shifting and the default threshold and thereby determine B_L and B_H. Equation (6) makes sure that the equity value does not jump when the firm changes its risk-strategy when the cash-flow processes reaches the risk-shifting threshold X_{RS}. Equation (7) captures the limited liability aspect of equity which implies that upon default, the equity value needs to be zero (Equation (7)).

$$E_L(X_{RS}) = E_H(X_{RS}) \tag{6}$$
$$E_H(X_D) = 0 \tag{7}$$

In the absence of bond covenants that stipulate conditions for technical default, equityholders pursue an optimal risk-shifting and default strategy which takes the form of a threshold policy. The optimal bankruptcy and risk-shifting barriers, X_D^* and X_{RS}^*, are determined via two smooth pasting conditions:

$$E'_H(X_t)|_{X_t=X_D} = 0 \tag{8}$$

$$E'_L(X_t)|_{X_t=X_{RS}} = E'_H(X_t)|_{X_t=X_{RS}} \tag{9}$$

Solving these two optimality conditions, X_D^* and X_{RS}^* are:

$$X_D^* = \frac{\theta_2}{\theta_2 - 1}\frac{C}{r}\delta_H \tag{10}$$

$$X_{RS}^* = \left[\left(\frac{1}{\delta_L} - \frac{1}{\delta_H}\right)\left(\frac{X_D^*}{\delta_H} - \frac{C}{r}\right)^{-1}\left(\frac{1}{X_D^*}\right)^{-\theta_2}\left(\frac{1-\gamma_2}{\theta_2-\gamma_2}\right)\right]^{\frac{1}{\theta_2-1}} \tag{11}$$

Last, as it is standard in those kinds of structural models, the optimal capital structure is implemented at time $t = 0$ by choosing the coupon C which maximizes the overall equity value.

3.1 Cash-flow based covenant

As discussed in Section 2 above, protective covenants are in general a very popular and frequently used instrument aiming to mitigate the asset substitution problem. In the following analysis we will focus on covenants that are based on the firm's cash-flows or net worth and that trigger technical default when violated. If bond indentures contain a cash-flow covenant, then the company must make sure that its cash-flow does not fall short of covering the interest payments of the outstanding debt. A net-worth covenant requires the asset value of the firm[6] to surpass a predetermined minimum level that is usually connected to the principal of the bond. This type of covenant is very similar to a cash-flow covenant since the value of the assets is given by the present value of the future cash-flows. If such a covenant is violated, debt-holders can file for bankruptcy and if no renegotiation of the debt contract or no restructuring occurs, then debt-holders will take over and equity-holders will lose control of the company.[7]

The potential application of such a covenant raises two interesting questions: First, are such covenants able to destroy the risk-taking incentives of equity-holders or stated

[6]In our model, the value of the unlevered assets corresponds to $(1-\tau_e)\frac{X_t}{r-\mu_i}$ and is thus dependent on the risk strategy of the firm.

[7]Recent empirical evidence discussing the popularity of using such cash-flow based covenants in credit lines of banks is provided by Sufi (2009).

differently, in how far can the costs of the asset substitution problem be reduced? Second, even if these types of covenants are able to reduce or eliminate the risk-shifting incentives should equityholders make use of them and tie their hands or do they destroy more value than risk-shifting.

We will address these two questions with the help of the theoretical model introduced above. In this framework, cash-flow or net-worth based covenants can easily be included:[8] Instead of managers choosing the optimal bankruptcy threshold which maximizes the equity value, as in Equation (8), bankruptcy occurs exogenously whenever a default triggering threshold is reached. In the case of a cash-flow based covenant the threshold is given by X_t failing to cover interest expenses C and hence $X_D = C$. An example for a new-worth based covenant is given by $(1-\alpha)(1-\tau_e)\frac{X_D}{r-\mu_i} = \frac{C}{r}$. In that case, debt is entirely secured and therefore riskless.

A simple way to assess the effectiveness of covenants in mitigating or preventing risk-shifting is to check whether they turn the equity value into a concave function of the cash-flow process. Since it is exactly the convex nature of the equity contract that induces risk-taking behavior, a covenant that makes the equity value concave will be sufficient to prevent such behavior. In our framework, the equity value will be concave if $\frac{X_D}{r-\mu_L} - \frac{C}{r} > 0$. Thus, a cash-flow covenant setting $X_D = C$ will definitely destroy risk-taking incentives as long as $\mu_L > 0$. The loss of convexity is sufficient but not necessary as long as asset substitution is costly. These costs make risk-shifting already unattractive at a less stringent default threshold.

We can identify the lowest possible default threshold, $\bar{X}_D$, such that equityholders will not find it optimal to engage in risk-shifting prior to X_t reaching this threshold. By rising the default threshold slightly higher, risk-shifting is prevented altogether. The value of $\bar{X}_D$ is found by setting $X_{RS} = X_D$ in the smooth pasting condition (9). Solving for X_D we get

$$\bar{X}_D = (\theta_2 - \gamma_2)\frac{C}{r}\frac{(r-\mu_L)(r-\mu_H)}{(1-\gamma_2)(r-\mu_H)-(1-\theta_2)(r-\mu_L)} \tag{12}$$

A cash-flow covenant is likely to be a tougher threshold than required (in particular if $\mu_L > 0$) and leads to value losses due to inefficiently early default. In reality, however, we find no such covenant as this threshold is hard to determine and agree upon while the simple cash-flow based covenants are much easier to implement. However, there exits a way to decrease the loss resulting from an inefficiently high covenant. Equity-holders and debt-holders can renegotiate the terms of the debt contract when the default event

[8] Theoretical papers analyzing some of the aspects of such covenants include Fan & Sundaresan (2000), who study a setting where debt can be renegotiated and examine the firm's pay-out policy or the above mentioned paper by Ericsson (2000).

has happened and thereby soften the covenant, something that often occurs in reality.

Interestingly, even if no covenants are in place, risk-shifting might not take place as long as the costs of asset substitution are high enough compared to the possible change in the riskiness of the firm. This case is summarized in a simple condition: If from the perspective of equity-holders the optimal default threshold of the low risk firm is lower than the corresponding default threshold of the high risk firm, then there are no gains to risk-shifting. Intuitively, equity-holders would like to hold on longer to the low-risk firm than to the high-risk firm. This condition is in accordance with the definition of (12) from above because if parameters are such that $X_D^L = X_D^H$, then $\hat{X}_D = X_D^L = X_D^H$.

To analyze the overall benefit of such cash-flow or net-worth based covenants, the ratio between the firm value if risk may be increased at some point and the firm value if risk remains fixed at the low level is calculated. Panel A of Table 1 depicts that risk-shifting is indeed costly for companies if no covenant is in place. Given some exogenously specified parameter values, risk-shifting bears a cost of roughly 3% if no covenants are used.[9] Introducing a covenant both eliminates the risk-shifting incentives and increases the overall firm value.

Panel B highlights how various parameters affect the optimal firm behavior. First, analyzing only the no covenant situation one can observe that the cost of risk-shifting is negatively related to increases in σ_L and μ_L.[10] The intuition is that an increase in these variables has a more positive impact on the firm value when risk-shifting is allowed, compared to the base case scenario. The reverse effect holds for σ_H and μ_H. Second, for firms without a covenant, a higher initial cash-flow growth rate and volatility (σ_L and μ_L) lead to a lower risk-shifting threshold on the one side but a higher bankruptcy trigger on the other side. A reverse effect is documented for σ_H and μ_H. The intuition behind this is that as the equity value decreases, bankruptcy becomes more likely and the gains from risk-shifting become more attractive, causing it to occur earlier. If a cash flow covenant is in place, however, risk-shifting is no longer optimal and an increase in σ_L causes the equity option to be more valuable and hence leads to a lower coupon and bankruptcy threshold.

The impact of firm characteristics on a firm's decision whether to engage in risk-shifting or to tie its hands via bond covenants is illustrated in Figure 1. This decision is based on the comparison of the agency costs arising from asset substitution with the efficiency losses caused by cash-flow covenants. The left column shows the equity,

[9]The following parameter values are used in the calibration: The risk-neutral drift and volatility are set to $\mu_i \in \{0.04, 0.038\}$ and $\sigma_i \in \{0.1, 0.2\}$, the risk-free rate r is 0.05, taxes τ_c and τ_d are 0.25 and bankruptcy costs are also 0.25.

[10]For the case of no-covenants, the ratio of the firm value if risk-shifting is allowed to the firm value if no risk-shifting is allowed actually increases but since it is smaller than unity, this implies that risk-shifting is less costly.

debt, and security value as a function of the state variable operating cash-flow or income (X) when the firm is subject to high risk-shifting incentives. Equityholders are very tempted to increase the riskiness of the firm if on the one hand the costs in terms of lower operating income growth rates are modest and on the other hand the volatility of the cash-flows can be increased considerably. In that case risk-shifting occurs relatively early (high X_{RS}). The blue line depicts the security values for a firm without covenants and the dashed green line shows the security values if a firm attaches a cash-flow covenant to its bonds. Such covenant induces technical default if the operating income falls below $X_D(cov)$. The upper left panel shows that, at the time of the debt issuance (X_0), equityholders would prefer to commit to not increase the risk because the firm value at the issuance date which goes to the equityholders is higher for a firm that does not engage in risk shifting. However, equityholders could never credibly commit to default at $X_D(cov)$ since they can immediately transfer wealth from debtholders by increasing the firm's risk. This can be seen from the fact that the equity value is always higher for the firm without covenant in the upper left panel. Thus, a default threshold that deters equityholders from risk shifting has to be stipulated in a contract that is enforceable in court which is why the firm would choose to attach it as a covenant to the bond indentures.

The right column of Figure 1 depicts the case of low risk-shifting incentives. Due to the fact that increasing the firm's cash-flow risk is relatively costly, equityholders would do so rather late, i.e. at a comparably low threshold X_{RS}. Still, equityholders would always benefit from risk-shifting (upper right panel). Since the firm only engages in risk shifting if its economic situation deteriorates drastically (an event with low probability), the overall agency costs of asset substitution are low. In fact, they may even be lower than the efficiency costs incurred through a cash-flow covenant which demands too early default. The value of a firm that engages in risk shifting is always larger than the value of a firm that restricts itself via a cash-flow covenant. Consequently, managers of such a firm find it optimal to issue debt without covenants.

4 Conditional simulated methods of moments

To be able to apply the above described theoretical model and to examine empirically in how far bond covenants can mitigate the managers' risk-shifting incentives prior to default, we develop a novel conditional simulated methods of moments estimation technique. The main advantage of this approach is that is can be applied to data that is conditionally sampled without introducing a selection bias.

Sub-Section 4.1 first describes briefly the main intuition behind the derivation of the conditional density which is needed to simulate the model. Sub-Section 4.2 subsequently discusses the details of our estimation technique.

4.1 Conditional density

Our empirical sample will consist of the last seven years of defaulted companies. We will denote the first time point, which lies seven years ahead of default, by t_0. t_k, $k = 1, \ldots, n-1$ represent the observation dates between t_0 and the default time τ_D. s denotes the total length of the observed period, i.e., $s = \tau_D - t_0$. To be able to analyze such a conditional sample of companies which eventually all go bankrupt, we need to determine the probability density of X_{t_0} and all following observations X_{t_k}, $k = 1, \ldots, n-1$ conditional on the default event $\tau_D = t_0 + s$ which we denote by $P(X_{t_k} \mid \tau_D = t_0 + s, X_{t_0}, ..., X_{t_{k-1}}, \tau_{RS} > t_{k-1})$. Hence, we are interested in the probability of X_{t_k} conditional on the following: The future default time τ_D occurring s periods after the initial starting point, the past realizations of the random variable X_{t_k} (hence on $X_{t_0}, ..., X_{t_{k-1}}$, where the subscript k denotes current point in time) and, last, the fact that risk shifting has not yet occurred ($\tau_{RS} > t_{k-1}$). Using Bayes' law, this conditional probability of X_{t_k} can thus be expressed as:

$$
\begin{aligned}
&P(X_{t_k} \mid \tau_D = t_0 + s, X_{t_0}, ..., X_{t_{k-1}}, \tau_{RS} > t_{k-1}) = \\
&= \frac{P(X_{t_k}, \tau_D = t_0 + s \mid X_{t_0}, ..., X_{t_{k-1}} \tau_{RS} > t_{k-1}) \; P(X_{t_0}, ..., X_{t_{k-1}}, \tau_{RS} > t_{k-1})}{P(\tau_D = t_0 + s \mid X_{t_{k-1}}, \tau_{RS} > t_{k-1}) \; P(X_{t_0}, ..., X_{t_{k-1}}, \tau_{RS} > t_{k-1})} = \\
&= \frac{P(X_{t_k}, \tau_D = t_0 + s \mid X_{t_{k-1}}, \tau_{RS} > t_{k-1})}{P(\tau_D = t_0 + s \mid X_{t_{k-1}}, \tau_{RS} > t_{k-1})} \qquad (13)
\end{aligned}
$$

As a next step, the two unknown conditional probabilities of the numerator as well as the denumerator of Equation (13) are determined separately. The reformulation of e.g. the numerator of is helpful since the product of the individual densities is more easily calculated.[11]

$$
\begin{aligned}
&P(X_{t_k}, \tau_D = t_0 + s \mid X_{t_{k-1}}, \tau_{RS} > t_{k-1}) = \\
&= \quad \underbrace{P(\tau_D = t_0 + s \mid X_{t_k}, \tau_{RS} > t_k)}_{(15)} \ \underbrace{P(X_{t_k}, \tau_{RS} > t_k \mid X_{t_{k-1}}, \tau_{RS} > t_{k-1})}_{\textit{absorbed Browinan motion } (17)} \\
&+ \quad \underbrace{P(\tau_D = t_0 + s \mid X_{t_k}, \tau_{RS} \leq t_k)}_{(16)} \ \underbrace{P(X_{t_k}, \tau_{RS} \leq t_k \mid X_{t_{k-1}}, \tau_{RS} > t_{k-1})}_{(18)}
\end{aligned} \tag{14}
$$

$$
\begin{aligned}
&P(\tau_D = t_0 + s \mid X_{t_k}, \tau_{RS} > \tau_k) = \\
&= \int_0^{s-(t_k-t_0)} P(\tau_D = t_0 + s \mid \tau_{RS} = t_k + z) \ P(\tau_{RS} = t_k + z \mid X_{t_k}) \ dz
\end{aligned} \tag{15}
$$

The individual densities of Equations (14) and (15) can be expressed in the following way: Using Karlin & Taylor (1975) (Theorem 5.3, pg. 363), the probability of the τ_{RS} being the timing of the default conditional on the current realization of X_{t_k}, $P(\tau_{RS} = t_k + z \mid X_{t_k})$, is depicted in Equation (16), where z denotes the incremental time period until bankruptcy:

$$
P(\tau_{RS} = t_k + z \mid X_{t_k}) = \frac{X_{t_k} - X_{RS}}{\sigma_L \sqrt{2\pi z^3}} \ e^{\frac{-(X_{RS} - X_{t_k} - \mu_L^P z)^2}{2\sigma_L^2 z}} \tag{16}
$$

Moreover, Equation (17) illustrates the joint probability of X_{t_k} and of the fact that risk-shifting is not going to happen within the next time interval ($\tau_{RS} > t_k$), conditional on the past realizations of X and of the fact that risk-shifting has not yet occurred. We are thus interested in the density of an absorbed Brownian motion, where the absorbing barrier is the risk-shifting threshold X_{RS}. This density is provided in Björk (2009) (Proposition 18.31, pg. 266), where $X_{t_{k-1}}$ is the starting point and Δt denotes the time interval of one simulation step.

$$
\begin{aligned}
&P(X_{t_k}, \tau_k > t_{k-1}; \Delta t, X_{t_{t-1}}) = \phi(X_{t_k}; \mu_L \Delta t + X_{t_{k-1}}; \sigma_L \sqrt{\Delta t}) \\
&- e^{-\frac{2\mu_L (X_{t_{k-1}} - X_{RS})}{\sigma_L^2}} \ \phi(X_{t_k}; \mu_L \Delta t + 2 \ X_{RS} - X_{t_{k-1}}; \sigma_L \sqrt{\Delta t}).
\end{aligned} \tag{17}
$$

Last, the transition density around the risk-shifting threshold needs to be identified. Hence, we are interested in the probability that the next step of the simulation is the one which causes the firm to alter its risk profile. Using again Bayes rule, this can be

[11] Appendix A depicts the details of the calculation.

written in the following way:

$$
\begin{aligned}
&P(X_{t_k}, \tau_{RS} \leq t_k, \tau_D > t_k \mid X_{t_{k-1}}, \tau_{RS} > t_{k-1}) = \\
&= \int_0^{\Delta k} P(X_{t_k}, \tau_{RS} = t_{k-1} + z, \tau_D > t_k \mid X_{t_{k-1}}, \tau_{RS} > t_{k-1})\; dz = \\
&= \int_0^{\Delta k} P(\tau_{RS} = t_{k-1} + z \mid X_{t_{k-1}}, \tau_{RS} > t_{k-1})\; dz \\
&\qquad P(X_{t_k}, \tau_D > t_k \mid \tau_{RS} = t_{k-1} + z)
\end{aligned} \tag{18}
$$

To conclude: This sub-section determines the conditional probability density of $P(X_{t_k} \mid \tau_D = t_0 + s, X_{t_0}, ..., X_{t_{k-1}}, \tau_{RS} > t_{k-1})$. Such a density is interesting as it enables the simulation of a sample of companies, all of which will eventually default and all of which have the possibility to alter their risk profile prior to the default. Hence, the simulated sample of companies resembles outcome of the above described theoretical model and as described below, is in turn necessary in our empirical estimation procedure. In order to calculate the conditional density, the joint product of the above described individual probabilities needs to be integrated.

4.2 Empirical estimation

As discussed above, one of the main difficulties with analyzing empirically whether companies engage in risk shifting is that a number of key parameters and variables are typically unobservable from the outside. To overcome this challenge, a novel conditional simulated methods of moments estimation is developed.

A. Simulated methods of moments

As a first step, the above described structural model as well as the conditional density is used to generate a simulated sample of defaulted firms.[12] Michaelides & Ng (2000) notice that the simulated sample should be approximately ten times as large as the actual data sample to generate unbiased results. For each artificial firm i in our simulated sample, $y_{is}(b)$ denotes a simulated data vector, where $i = 1, ..., N$ and s is the number of times the model is simulated ($s = 1, ..., S$). Similarly, x_j denotes the vector real data, where $j = 1, ..., n$ and n is thus the total number of defaulted companies in

[12] This broad description of the general simulated methods of moments estimation approach as well as the specifications and notations of the variables and formulas largely follows the description in Appendix A3 of DeAngelo et al. (2011). Additionally, a thorough description about different structural estimation methodologies is provided in Strebulaev & Whited (2012).

the real data. Importantly, the vector of simulated data, $y_{is}(b)$, depends crucially on the different structural parameters of the model, which are denoted by b and which are described in more detail below.

The aim of any simulated methods of moments (SMM) procedure is to estimate b by minimizing the distance between the model-generated, and hence simulated, moments and their empirical counterparts. We denote the vector of simulated moments by $h(y_{is}(b))$ and the one of the actual moments by $h(x_j)$. What is essential is that in both the simulated data sample as well as the real world data sample, all definitions and calculations for all moments need to be identical. In order to match these moments as closely as possible, a matrix $g_n(b)$ is defined as follows:

$$g_n(b) = n^{-1} \sum_{i,j=1}^{n} \left[h(x_j) - S^{-1} \sum_{s=1}^{S} h(y_{is}(b)) \right] \tag{19}$$

The simulated moments estimator of b is consequently determined as the solution of the following minimization,

$$\hat{b} = \arg\min_{b} Q(b, n) \equiv g_n(b)' \hat{W}_n g_n(b) \tag{20}$$

where $\hat{W}_n$ represents a positive definite weight matrix that converges in probability to a deterministic positive definite matrix W. As discussed in more detail below, the calculation of some of the empirical moments depends on the values of the simulated cash-flow y_{is} which does not allow us to calculate the weight matrix $\hat{W}_n$ using the influence function approach as in Erickson & Whited (2000). Instead, we employ a two stage procedure that is analogous to the standard general methods of moments approach. In the first stage, we minimize $Q(b, n)$ which incorporates the identity matrix as the weight matrix. We subsequently use the resulting first stage estimate $\hat{b}$ to calculate the weight matrix for the second stage. The second stage weight matrix is the N times the inverse of the covariance matrix of the moment conditions.

One further aspect with applying a SMM estimation approach is that it typically leads to a sample of *i.i.d.* firms. Therefore, it is important to remove as much heterogeneity from the data as possible. As a consequence, both year and firm fixed effects are used in the moments estimation.

B. *Stationary distribution*

Our main research interest lies in analyzing firms' behavior in the last years prior to their bankruptcy filing. To balance off the issue of data availability on the one side and giving firms enough time to engage in risk shifting on the other side, a seven year pre-default period is chosen for the analysis.

However, before the conditional simulated methods of moments estimation technique can be applied, a final question needs to be resolved: What are the appropriate starting values for the simulation? Traditional, and thus non-conditional, SMM estimations typically do not rely on a starting distribution.[13] Instead, in most papers the simulation begins at an arbitrary point in time and a so called burn-in period is allowed. This implies that the first couple of periods of the simulation are disregarded to avoid the impact of the starting values. Yet, at the case at hand, such technique is not applicable, the main reason being that the above determined conditional probability $P(X_{t_k} \mid \tau_D = t_0 + s, X_{t_0}, ..., X_{t_{k-1}}, \tau_{RS} > t_{k-1})$ depends on some starting value X_{t_0}.[14] Hence, an appropriate stationary distribution of the equity or cash-flows values, via which the simulation starts, needs to be determined.

We opt for the Gamma distribution as the starting distribution. The motivation behind this choice is its flexibility and that it is a conjugate prior of other distributions, for example the Normal one. In general, any Gamma distribution is parameterized by two unobservable parameters, a shape k and a scale θ parameter, both of which are positive real numbers. To determine k and θ, a separate, basic, simulated methods of moments routine is applied. First, the theoretical model is used to back out the values of the firms' cash-flows $\tilde{X}_{t_0}$ which correspond to the empirically observed equity values.[15] In a second step, the first three moments of the theoretical and the quasi-empirical cash-flow processes are matched.[16]

C. *Parameters used in the estimation*

Applying the above described model of a firm, we are mainly interested in estimating several structural parameters, which can be informative in how far companies engage in risk shifting activities: First, the mean and the volatility of the cash-flow process in both the low as well as the high risk region. Second, the risk-shifting boundary and third the default boundary. In total, we estimate the following vector of eight model

[13] One very recent exception is Li et al. (2014) in which the authors estimate a dynamic contracting model and differentiate between young and old firms.

[14] Technically speaking, X_{t_0} is only important if $k = 2$ since for later simulations, the Markov Property of a Geometric Brownian Motion can be applied. Nevertheless, a starting distribution is always needed for the first simulation step.

[15] To make use of as much firm specific information as possible when calculating the corresponding equity values, we use the firm-specific interest rate as measured by the monthly 1 year T-bill rate which is retrieved via the homepage of the Governors of the Federal Reserve System.

[16] Alternatively, one can use the simulated cash-flow values to calculate the corresponding equity values. The simulated and empirically observed equity values can subsequently be matched. Both methods lead to comparable results.

parameters:

$$b = [\sigma_L, \sigma_H, \delta_L, \delta_H, \alpha_L, \alpha_H, \zeta_{RS}, \zeta_D] \tag{21}$$

While the parameters of the cash-flow volatility (σ_L and σ_H) and ones that include the $\mathbb{Q}$ and $\mathbb{P}$ drift ($\delta_L, \delta_H, \alpha_L$ and α_H) can easily included in the estimation, the remaining parameters, ζ_{RS} and ζ_D, are a bit more challenging. Structural models of companies typically assume that the capital structure is determined at the outset, thus at time t_0, and remains stable over time.[17] Nevertheless, in the real world, companies do alter their decisions regularly. Moreover, the bankruptcy decision of the company may not always be chosen optimally by the equity-holders and may instead be triggered by other exogenous events, one example being covenant violations. To account for these possibilities, we therefore do not directly analyze the endogenous, model determined, values of the X_{RS} and X_D thresholds. Rather, we use the intuition that the firm's coupon is proportional to the its debt service payment. The bankruptcy boundary is subsequently assumed to be an affine function of a company's empirically observed debt service payment which we proxy via the interest expenses.[18] A similar reasoning applies to the risk-shifting threshold. Therefore, some unobservable multiples of companies coupon payments, denoted by ζ_D and ζ_{RS}, determine the bankruptcy as well as the risk-shifting thresholds.[19] In the conditional simulated methods of moments estimation, these parameters are subsequently estimated.

In addition to those eight model parameters, the shape and the scale parameters of the stationary Gamma distribution are also unobservable and hence need to be determined. Therefore, we look for parameter values that make the theoretically determined Gamma distribution and the empirically observed one fit best.

One challenge with the above described approach of estimating the parameters ζ_D and ζ_{RS} is that in the real world, the interest expenses of companies are time varying. However, in the simulated methods of moments estimation, all thresholds and parameters need to remain stable through time. To overcome this problem, the time zero equity values, which describe the stationary distribution, are scaled by companies' interest expenses.[20] This implies that a sample of scaled firms is simulated. One further

[17] Dynamic capital structure models such as Fischer et al. (1989) assume that refinancing occurs at fixed intervals. Such modeling framework is not used for simplicity reasons.

[18] A related approach has been applied in the prior literature by e.g. Elkamhi et al. (2012) or Reindl et al. (2013).

[19] The bankruptcy threshold is estimated as: $X_D = X_D^* + \zeta_D\ (\bar{X}_D - X_D^*)$. Similarly, the risk-shifting threshold is: $X_{RS} = X_D + \zeta_{RS}\ (\bar{X}_{RS} - X_D)$. Given the exogenous parameters of the model, X^* and X^{max} denote the model implied optimal and maximal values of the respective thresholds.

[20] In general, this is possible since the equity value of the theoretical model is homogenous with respect to the coupon.

challenge remains: The simulated equity value can be determined in closed using the model, yet this calculation relies on the optimally chosen time $t = 0$ coupon. This is problematic, since the stationary distribution of X_0 is unknown since, as discussed above, the parameters describing the stationary distribution of X_0 are only determined within the SMM procedure. As a consequence, the optimal coupon cannot be calculated. Instead, we have to rely on the simplifying assumption of a fixed coupon which is chosen exogenously as $C = 1$.

While the above parameters are estimated using our conditional simulated methods of moments estimation technique, the following ones are determined exogenously: The risk free rate, r, is set to 0.05. Both the corporate and the personal tax rate, τ_C and τ_d, are assumed to be 0.35. The bankruptcy costs, α, are set to 0.35, broadly consistent with the recent empirical findings of Reindl et al. (2013) who show that bankruptcy costs estimates typically lie within a 20-30% range. Table 2 summarizes our choice of the parameters.

D. Description of the moments

The overall success of any SMM estimation relies crucially on the selection of the appropriate moments. In general, the matching can only be beneficial in correctly identifying the parameters if the chosen moments are 'meaningful'. This implies that one needs to pick moments that vary with the underlying parameters.For the above described eight unknown parameters we thus seek to match the following empirical and theoretical moments.

Our first two moments are the time-series mean and variance of the quarterly equity returns. Using firms' market capitalization between the default date and a maximum of seven years prior to this date, for each firm i in our sample we first calculate the firm-specific time-series moments of the continuous equity return. We subsequently take the cross-sectional average. These, admittedly rather broad, moments are beneficial as they help to pin down the overall level and volatility of the unobservable cash-flow process.

However, both in the model as well as in the real world, companies have the possibility to alter their risk-profile prior to default. Therefore, in order to examine whether there actually exist notable differences between e.g. the volatility in the low and the high risk region (σ_L vs. σ_H), the overall pre-default period is split into two sub-periods. The cut-off is chosen to be the endogenous risk-shifting threshold X_{RS}. Using simulated data, the optimal X_{RS} can easily be determined from the model and hence the moment calculation poses no challenge. However, in the real world, the precise point in time when companies change their risk profile is obviously unobservable. Nevertheless, applying the above described model, one can again can back out the quasi-empirical cash-flow values (the X_t values) from our observable equity prices. Using these cash-flow values, the corresponding optimal risk-shifting threshold can in turn be calculated. Subsequently the time-series mean and variance of the equity returns are compared separately for either region, hence either before the company altered its risk profile or alternatively after it did so. Calculating the mean and variance of equity returns separately in the two sub-periods is helpful in finding reliable estimates for the means and especially the volatilities of the cash-flow.

The next two moments that help identify the parameters of the model are the cross-sectional variance, averaged over the seven years, as well as the serial correlation of equity, over the seven year pre-default period.[21] The former moment condition facilitates the identification of the bankruptcy parameter, whereas the later is helpful at identifying the dynamics of the cash-flow process.

Last, we re-calculate the time-series mean and variance, the cross-sectional variance and the serial correlation using the simulated and the inverted cash-flow values instead of the equity values. While the original moments are very similar, one additional advantage is that the cash-flow based moments are less sensitive to extreme values. The intuition is that when the firm is close to bankruptcy, equity may be very close to zero resulting in volatile returns.

Finally, in order to determine the unknown shape and the scale parameter of the stationary Gamma distribution, the cross-sectional mean, variance and skewness of the model generated and of the quasi-empirical cash-flow values are matched. The quasi-empirical cash-flow value is again obtained by backing X_{t_0} out of the observable equity values E_{t_0}. As discussed above, to preclude a time-changing coupon, the scaled cash-flow is used where the scaling variable are the firms' interest expenses.

To summarize, in total twelve distinct moments are used to identify our six unobservable parameters of the model. Moreover an additional three moments are used to pin down the two stationary distribution parameters. This implies that our conditional simulated methods of moments estimation is actually over-identified. In general, however, such over-identification should not cause a concern since the additional moments help in the identification. Additionally, to ensure overall validity of the moments, we also employ a Hansen J-test of over-identification.

[21] The mean of the cross-sectional variance is conceptually related to the mean of the time-series variance and hence the overall pre-default time period is not split up.

E. Evaluation of risk-shifting

How can the above described theoretical model and our empirical estimation technique be used to identify both the severity of the asset substitution problem and whether covenants are helpful? In general, different possibilities open up: First, the estimation of the risk-shifting thresholds X_{RS} can be compared across the two samples of companies, those with covenants vs. those without covenants. On the one side, the advantage of this is method is its simplicity. On the other side however, a potential drawback could be that despite the fact that the conditional simulated methods of estimation is done separately for both samples, some unobservable firm characteristics may still bias the results. Second, one can also compare the empirical estimation of risk-shifting threshold with the optimal model implied one. This method is beneficial as it allows an inference about strength of the asset substitution problem. Moreover, is does not require the comparison of different samples of data. Third, estimates of the volatility of the cash-flow process in the low-risk region can be compared to the one in the high-risk region. Risk-shifting would imply a significant increase in the volatility. All of those methods are used in the analysis below.

5 Data

5.1 Sample selection

We examine all Chapter 11 and Chapter 7 bankruptcies of U.S. companies whose bankruptcy announcement date lies between the first quarter of 2000 and the second quarter of 2013. The bankruptcy date, the quarterly balance sheet data as well as the monthly share prices are retrieved via a database called Capital IQ. Moreover, the data about the individual bond issuances and the corresponding covenants is collected via the Fixed Income Securities Database (FISD) of the Wharton Research Data Services web-page and consists of all bonds outstanding with the exception of convertible bonds. The matching of the two databases is based on the CUSIP number, the bankruptcy date and the name of each defaulted company and is checked manually to ensure that any change of these variables does not influence the overall validity. Unfortunately however, a large number of the defaulted companies are small and/or private companies that are mostly traded over-the-counter and for many of such companies the bond data is unavailable in the FISD database.[22] Hence, our sample focuses on those companies for

[22] Five years prior to the bankruptcy filing, the mean (median) size of total asses for these companies is 110 (20) million USD. Instead of bond financing, such companies may rely on bank debt or other sources of funding.

which we have bond data available. Following the literature, all companies that are either part of the regulated or the financial industry (SIC codes 4900-4999 or 6000-6999) are disregarded. Subsequent to the matching, different balance sheet variables, (such as total equity, total liabilities, shares outstanding etc.) are collected for the 28 quarters (84 months) prior to default for each company. Companies which have less than eight consecutive quarters of data available prior to bankruptcy are disregarded. As a result of this data cleaning, the final sample consists of an unbalanced panel of 4089 (11987) observations for 176 firms between 1993 and 2013 at the quarterly (monthly) frequency.

For each bond outstanding, the FISD database reports up to 54 possible bond covenants. In the overall sample of defaulted companies, 69% of all firms have at least one bond with one or more covenants associated. We use the Smith & Warner (1979) framework and closely follow Chava et al. (2010) to classify these different covenants into four distinct groups: Investment restrictions, subsequent financing restrictions, event-related restrictions and dividend and other payment restrictions. Table 3 provides a detailed description of the classification.

5.2 Descriptive statistics

A. Firm characteristics

For each defaulted firm, a number of different balance sheet variables are analyzed separately for the seven years prior to the bankruptcy date.[23] To mitigate the effect of outliers, all balance sheet variables used in this sub-section are winsorized at the top and bottom 1% of their respective distribution. Table 4 depicts the overall descriptive statistics separately for companies whose bonds have at least one covenant associated (121 companies) and for the smaller sample of those companies which do not have any bond covenants (55 companies).

The analysis highlights that irrespective of the existence of bond covenants, in the last years prior to the bankruptcy filing, the companies' market capitalization as well as their market-to-book ratio decrease rapidly. While the average market capitalization for firms with covenants is roughly 50% of total assets five years before bankruptcy, this ratio falls to 21% during the last year. This effect which is mainly driven by a sharp decrease in the market value of equity prior to default is even more pronounced for companies having no bond covenants. Moreover, those pre-default years are also characterized by a decline in the companies' operating cash-flow as well as the amount

[23] The pre-default time period of seven years is chosen as a result of the trade-off between data availability on the one side and giving firms enough time to alter their risk profile on the other side.

of cash held. At the same time, prior to bankruptcy, companies tend to borrow more: For the sub-sample of firms with at least one (no) bond-covenant, the average leverage ratio increases sharply from 50% (72%) three years prior to bankruptcy to 70% (84%) one year before default.[24] Two notable differences between those two sub-samples are that companies without bond-covenants are both smaller and tend to invest more.[25]

To summarize, these simple descriptive statistics highlight the economic and financial distress which defaulted companies experience prior to their final bankruptcy filing. One potential reaction of managers to such difficulties might be to engage in risk shifting activities and thus the question whether the managers behavior differs according to the existence of bond covenants arises.

B. Bond covenants

Examining the above described sample of defaulted companies in more detail, Table 5 depicts the descriptive statistics for the firms' outstanding bonds. As can be seen in Panel A, the average firm has roughly 12 bonds outstanding (the median is 6 bonds) prior to default. Moreover, the mean offering amount per individual bond is 233 million USD with an average maturity of 127 months and an average yield to maturity at the time of issuance of more than 9.6%. Interestingly, most bond issuances occur rather early, the average (median) bond is issued 109 (82) months ahead of default. This finding indicates that in the imminent years before bankruptcy, and hence in times of financial distress, new bond financing is less likely as it may be expansive for companies to do so.

In general, 59% of all bonds outstanding have some sort of bond covenant associated, whereas the other 41% do not have any covenant. Panel B depicts that bonds with covenants are in general larger (256 vs. 201 million USD), have a longer maturity (129 vs. 124 months), a slightly lower offering yield (9.50% vs. 9.70%) and a considerably lower treasury spread (138 vs. 346 b.p.). Moreover, the seniority of these bonds is also slightly lower, yet this difference is relatively small.[26] Hence, broadly speaking, bonds which may be more risky seem to be more likely to have covenants associated. Looking at the timing of issuance time, one can further observe that bonds which have at least one covenant associated are issued closer to bankruptcy (101 vs. 120 months ahead of default). This finding further indicates that in times of financial distress, which is

[24] We follow Morellec et al. (2012) in calculating the leverage of the firm: (total liabilities + preferred stock - deferred taxes)/(total assets - book equity + market equity).

[25] Investments are calculated as in Nikolov & Schmid (2012): Capital expenditure minus sale of property plant and equipment divided by total gross property plant and equipment.

[26] In general, the overall seniority structure of the bonds in our sample is high: More than 55% of the bonds are senior bonds and another 13% and 29% are either senior secured or senior subordinate.

likely to be the case the closer the firm is to the bankruptcy filing, bond-holders try to protect themselves via an increase covenant usage.

Looking at the sub-sample of bond with covenants in more detail, we can classify the different types of bonds according to the Smith & Warner (1979) framework. Panel C highlights some notable differences among the four distinct groups: Subsequent financing as well as event-related restrictions are observed in the vast majority of all cases, 89% and 86% of all bonds have covenants belonging to these groups. Similarly, investment restrictions are also used very frequently in 83% of all cases. On the contrary, however, dividend or other payment restrictions are used less often, only 66% of all bond have such rules. However, while the avoidance of excessive dividend payouts seems to be less important than other restrictions, this number is still high in relative terms. Chava et al. (2010) for example document that in their sample of non-defaulted companies between 1997 and 2007, dividend restrictions are only used in 14% of all cases. In line with this, other restrictions are also used more frequently in our sample of defaulted companies. The intuition behind this is that these companies may implicitly be regarded as being more risky compared to the overall sample of firms in the economy.[27] Hence this descriptive evidence suggests that in times of financial distress, bond-holders seek to protect themselves from the possible expropriation of equity-holders.

6 Main results

To analyze in how far companies engage in risk-shifting activities prior to default and whether bond covenants can help mitigate such agency problem, the unobservable parameters of the model are identified with the help of the the above described theoretical framework and our conditional simulated methods of moments estimation approach.

6.1 Parameter estimates and discussion

The main analysis is performed separately for the two sub-samples of companies: those whose bonds have at least one covenant associated as well as those without protective covenants. For each unknown parameter, a 'meaningful' range is determined first.[28] Subsequently, 120 companies are simulated for various different parameter combinations. Last, the optimal combination of the eight model parameters which minimizes

[27] In line with this interpretation, the offering yield and treasury spread are both considerably lower in Chava et al. (2010).

[28] For example ζ_{RS} can only take values which satisfy the constraint that the minimum level of the resulting risk-shifting boundary is larger than the maximum value of the bankruptcy threshold as determined in the model.

the distance between the simulated and the real data moments is determined.[29]

A. *Firms with covenants*

Table 6 depicts our estimation results for the sub-sample of companies which have at least one covenant associated to their outstanding bonds. Panel A compares the different empirical moments with their model-simulated counterparts and Panel B below highlights the optimally chosen parameter estimates.

As described above, the unobservable shape and scale parameters describing the stationary distribution need to be determined first. These two parameters describe the Gamma distribution which in turn is required for the starting values of the cash-flow process (X_{t_0}). As can be seen in the top part of Panel A, the cross-sectional mean, variance and skewness of the simulated and of the quasi-empirical cash-flow values (scaled by the company's interest payments) are of similar magnitude.

As a next step, the general fit of the structural estimation is analyzed. To do so, the remaining moments that are connected to the parameters of the theoretical model are compared. Generally speaking, the different moments fit well, both with regards to the equity values as well as the model-implied cash-flow values. However, one drawback is that the model fails to match the overall time-series mean of the equity returns. While the empirically observed growth rate is roughly 3.9%, our model underestimates it to be -2.2%. This effect is mainly driven by the returns calculated for the period starting with the risk-shifting threshold until bankruptcy. The simulated firms are moving more directly towards the bankruptcy threshold and thus our model under-estimates the firms' growth rate.[30] In general however one can still conclude that the overall empirical and the simulated moments match well.

Panel B depicts the optimal parameter estimates that are the results of our conditional simulated methods of moments estimation. As it makes intuitive sense, the estimated cash-flow volatility shows a pronounced increase when the company moves from the low-risk regime into the high-risk regime: The volatility increases from roughly 20% to more than 53%. Consistent with our assumption that risk-shifting is costly, the physical drift decreases from 13.1% to -6.6%. Hence, companies in the low-risk regime are both riskier and grow less. As a next step, the bankruptcy and the risk-shifting thresholds, which are resulting from the estimated parameters ζ_D and ζ_{RS}, are

[29] To avoid the detection of a local minimum, a pattern search algorithm is used.

[30] The underlying reason why the empirical and simulated time-series mean of the equity returns do not match in the period τ_D to τ_{RS} is that our estimated value of the risk-shifting threshold is very far away from the bankruptcy boundary. As a result, most firms alter their risk profile prior to the start of the simulation and hence the empirical moment calculation is only based on a small sub-sample of those firms that do engage in risk-shifting between τ_D and $\tau_D - 7$.

analyzed. First, the comparison between the optimal, model-determined and hence endogenous, bankruptcy boundary to the estimated one highlights a pronounced difference: The value of the estimated bankruptcy boundary is 0.96 and this value is well above the optimal one which is 0.37.[31] Therefore companies, whose outstanding bonds have at least one covenant associated, default at an earlier point in time than what an equity maximizing manager would optimally choose. This could occur for example if bankruptcy is not chosen endogenously but rather declared due to some exogenous reasons, e.g. covenant violations. In fact, in the model the coupon is set to 1.0 and hence the estimated bankruptcy threshold is very close to what a cash-flow based covenant would imply. Second, examining the risk-shifting threshold, one can observe that the parameter estimate is both very large ($X_{RS} = 23.96$) and considerably above the model implied optimal risk-shifting threshold ($X^*_{RS} = 9.19$).[32] This actually implies that a large number of companies are already in the high-risk regime seven years prior to bankruptcy. Therefore, these companies do not alter their risk profile (again). One interpretation may be that covenants hinder risky firms from engaging in further risk-shifting activities prior to default.

B. Firms without covenants

Next, the sub-sample of companies whose bonds do not have any covenant is analyzed. Table 7 depicts the moment comparisons on the top and the parameter estimates on the bottom. Similarly to the covenant sample, one can conclude that the empirical and simulated moments match again well.

As can be seen in Panel B, the parameter estimate of the companies' cash-flow volatility increases very sharply upon risk-shifting. While σ_L is estimated to be 37%, σ_H raises to 86%. Hence, these companies rapidly alter their risk-profile. Moreover, this effect is more pronounced than in the above described covenant sub-sample, indicating that restrictive bond covenants may hinder firms from even more excessive risk-taking. Interestingly however, the move from the low-risk to the high-risk regime also causes the measure $\mathbb{P}$ drift of the cash-flow process to rise, indicating that the investments into risky projects may lead to some firm growth. In general however it is well-known that growth rate of a Brownian motion is difficult to estimate in any SMM estimation. Nevertheless, this finding is broadly consistent with the above described summary statistics, where the investment grew three years prior to default for firms without bond covenants, whereas it fell for companies with covenants. The resulting investment could thus give rise to a temporary higher growth rate. Examining the risk-shifting

[31] $X_D = X_D^* + \zeta_D\ (\bar{X}_D - X_D^*)$ and thus $0.957 = 0.366 + 0.3915 * (1.8745 - 0.366)$.

[32] $X_{RS} = X_D + \zeta_{RS}\ (\bar{X}_{RS} - X_D)$ and hence $23.958 = 0.957 + 0.983 * (24.356 - 0.957)$.

threshold X_{RS} in more detail, one can observe that the decision to alter the company's risk profile actually occurs much closer to bankruptcy compared to the no-covenants firm sample: The bankruptcy boundary is estimated to be 0.104 and the risk-shifting threshold is 0.349. Additionally, the comparison between the estimated and the optimal threshold reveals that in absence of covenants, risk-shifting more likely to occur. The endogenous and model determined boundary X^*_{RS} is 0.204, which is not too far off the estimated value. Last, looking at the bankruptcy boundary, a similar comparison reveals that the estimated threshold of 0.196 is relatively close to the endogenously determined one. Hence equity maximizing managers choose the timing of bankruptcy that is close to the one which maximizes the equity value. Moreover, the bankruptcy occurs at a lower threshold and thus at a later point in time than in the case when protective covenants are in place. Therefore, these findings highlight that companies that do not have bond-covenants are engaging in risk-sifting and are thus suffering from agency conflicts.

In order to analyze whether firms without bond-covenants have chosen their debt contract optimally, we conduct a counterfactual exercise: What would be the hypothetical valuation consequences for the average firm in the no-covenant sample if it had instead issued bonds which had included cashflow covenants? Figure 2 summarizes the results. The blue line depicts the original relationship between the equity, debt, and firm value for the average firm in the no-covenant sample. The dashed green line highlights the values of the same securities for the same firm but this time its debt has a cashflow covenant attached that deters the firm from risk shifting attached to it. This covenant prescribes technical default if the operating income X reaches the threshold $X_D(cov)$. The lowest panel shows that the firm value is always smaller if the firm issues debt with cashflow covenants attached. This is in accordance with our theoretical prediction in section 3.1 were we showed that the inefficiency losses resulting from the restrictions imposed by the cashflow covenant exceeds the agency costs from asset substitution if risk-shifting is relatively costly. This is indeed the case for the firms belonging to the no-covenant sample. Risk shifting reduces the growth rate of operating income by 2.5 percentage points which compares to a reduction of 0.22 percentage points for firms in the covenant sample. Thus, for this type of firm restricting its behavior via the covenant actually destroys more value than what is lost via the asset substitution problem. Hence, we find that this type of firm has chosen its debt contract optimally.

C. Further discussion

Examining in more detail companies whose outstanding bonds have one or more protective covenant associated, the above described findings highlight that both the estimated as well as the endogenous risk-shifting thresholds are far away from the respective bankruptcy boundaries. These companies do not appear to alter their risk profile just briefly prior to bankruptcy. Therefore, a remaining question is whether companies with debt covenants ever alter their risk profile. Stated differently, does an alternative theoretical model which does not include a risk-shifting option match the data equally well or even better? To analyze this, we again use our conditional simulated methods of moments technique to estimate such an alternative model. Subsequently the fit of the two competing models is compared. Preliminary results indicate that the model with risk-shifting outperforms the one without risk-shifting. Hence, while risk-shifting does seem to occur at some point, bond covenants are helpful in mitigating the expropriation of bond-holders in the last years prior to default.

7 Conclusion

While the general concept of the asset substitution or risk-shifting problem is well rooted in the theoretical literature, empirical studies have traditionally had a more difficult time both documenting its economic relevancy in the first place and assessing the capability of different covenants to mitigate such detrimental behavior. The underlying reasons are that a number of key variables are typically unobservable to outside researchers and additionally that the risk-shifting decision and the usage of bond covenants is often a joint decision of the company.

This paper makes two important contributions: First, a novel empirical estimation technique is developed which enables the analysis of conditional samples without introducing a selection bias. We analyze the firm behavior for a sample of defaulted companies where we use the basic intuition that risk-shifting is most likely to occur in times of financial distress. In combination with a simple structural model of a firm, our estimation method is subsequently used to identify and to analyze risk-shifting. This means that with the help of our conditional simulated methods of moments estimation technique, we are able to link a firm's unobservable risk-shifting decision to its observable equity prices. We thus estimate various unobservable parameters, such as the threshold upon which firms decide to alter their risk-profile. In a second step, this paper highlights that bond covenants are helpful in mitigating the companies' risk shifting incentives. We separately analyze two samples of companies: On the one side firms whose outstanding bonds have covenants associated and on the contrary a sample of firms without any bond covenant. We find that companies without covenants both increase their cash-flow risk more and also default later in comparison to companies with covenants. Moreover, protective covenants can hinder risk-shifting in the years prior to default. Nevertheless, the firms belonging to the no-covenant sample have chosen their debt contracts optimally as bond covenants would have generated inefficiency costs that exceed the agency costs from asset substitution.

To conclude, this paper highlights that bond covenants can be helpful in mitigating the well-known asset substitution problem but come at a cost.

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Appendix A: $P(X_{t_k}, \tau_D = t_0 + s \mid X_{t_{k-1}}, \tau_{RS} > t_{k-1})$

$$P(X_{t_k}, \tau_D = t_0 + s \mid X_{t_{k-1}}, \tau_{RS} > t_{k-1}) =$$

$$= \; P(\tau_D = t_0 + s \mid X_{t_k}, \tau_{RS} > t_k)\; P(X_{t_k}, \tau_{RS} > t_k \mid X_{t_{k-1}}, \tau_{RS} > t_{k-1})$$

$$+ \; P(\tau_D = t_0 + s \mid X_{t_k}, \tau_{RS} \le t_k)\; P(X_{t_k}, \tau_{RS} \le t_k \mid X_{t_{k-1}}, \tau_{RS} > t_{k-1})$$

$$P(\tau_D = t_0 + s \mid X_{t_k}, \tau_{RS} > t_k)\; P(X_{t_k}, \tau_{RS} > t_k \mid X_{t_{k-1}}, \tau_{RS} > t_{k-1}) =$$

$$= \int_0^{\Delta k} P(\tau_{RS} = t_{k-1} + z \mid X_{t_{k-1}}, \tau_{RS} > t_{k-1})\; dz$$

$$* \; \frac{X_{t_k} - X_{RS}}{\sigma_1\sqrt{2\pi}}\; e^{-\frac{(X_{t_k}-\mu_1)^2}{2\sigma_1^2}} \frac{1}{z\sigma_H\sqrt{2\pi}\sqrt{\Delta t + z}}\; e^{-\frac{(X_{RS}-\mu(\Delta t+z)-X_{t_{k-1}})^2}{2\sigma^2(\Delta t+z)}}$$

$$P(\tau_D = t_0 + s \mid X_{t_k}, \tau_{RS} \le t_k)\; P(X_{t_k}, \tau_{RS} \le t_k \mid X_{t_{k-1}}, \tau_{RS} > t_{k-1}) =$$

$$= \int_0^{s-(t_{k-1}-t_0)} P(\tau_D = t_0 + z \mid \tau_{RS} = t_k + z)\; dz$$

$$* \; \left\{ \frac{X_{t_k} - X_{RS}}{\sigma_1\sqrt{2\pi}}\; e^{-\frac{(X_{t_k}-\mu_1)^2}{2\sigma_1^2}} \frac{1}{z\sigma_H\sqrt{2\pi}\sqrt{\Delta t + z}}\; e^{-\frac{2\mu(X_{t_{k-1}}-X_{RS})}{\sigma_L^2}}\; e^{-\frac{(X_{RS}-\bar{\mu}-\mu(\Delta t+z))^2}{2\sigma^2(\Delta t+z)}} \right.$$

$$\left. - \; \frac{X_{t_k} - X_{RS}}{\sigma_1\sqrt{2\pi}}\; e^{-\frac{(X_{t_k}-\mu_1)^2}{2\sigma_1^2}} \frac{1}{z\sigma_H\sqrt{2\pi}\sqrt{\Delta t + z}}\; e^{-\frac{(X_{RS}-\mu(\Delta t+z)-X_{t_{k-1}})^2}{2\sigma^2(\Delta t+z)}} \right\}$$

where $\sigma_1^2 = \frac{\sigma_H^2 z\Delta t}{z+\Delta t}$, $\mu_1 = \frac{X_D\Delta t + X_{t_{k-1}} z}{\Delta t+z}$ and $\bar{x} = 2X_{RS} - X_{t_{k-1}}$.

Appendix B: Tables and Graphs

Table 1: Sensitivity analysis: Cash-flow covenant vs. no covenant

This table depicts the sensitivity analysis for the theoretical model which includes or which does not include a cash-flow covenant. The cost of risk-shifting is calculated as the ratio of the firm value if the firm is able to alter its risk profile and the firm value if risk is fixed at the low level ($\mu_L = \mu_H$ and $\sigma_L = \sigma_H$). The strength of risk-shifting is calculated as the ratio of the optimal risk-shifting threshold X^*_{RS} to the optimal bankruptcy threshold X^*_D. In Panel A, the following parameter values are used for the calibration: the risk-neutral drift and volatility are set to $\mu_i \in \{0.04, 0.038\}$ and $\sigma_i \in \{0.1, 0.2\}$, the risk-free rate r is 0.05, taxes τ_c and τ_d are 0.25 and bankruptcy costs are 0.25. Panel B depicts the sensitivity analysis with regards to these parameters. $\mu_H > 0$ is assumed.

Panel A	*Cost of risk-shifting*	*Strength of risk-shifting*
No covenant	0.968	1.635
Cash-flow covenant	1.000	*n.a.*

Panel B	σ_L	σ_H	μ_H	μ_L	r	τ_e
1) Risk-shifting magnitude: no covenant						
Cost of risk-shifting	+	−	−	+	+	−
Strength of risk-shifting	−	+	+	−	−	*n.a.*
2) Endogenous thresholds						
No Covenant						
Risk-shifting threshold (X^*_{RS})	−	+	+	−	+	+
Bankruptcy threshold (X^*_D)	+	−	−	+	+	+
Coupon (C^*)	+	−	−	+	+	+
Cash-flow covenant						
Risk-shifting threshold (X^*_{RS})	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*
Bankruptcy threshold = coupon ($X_D = C^*$)	−	−	+	+	+	+

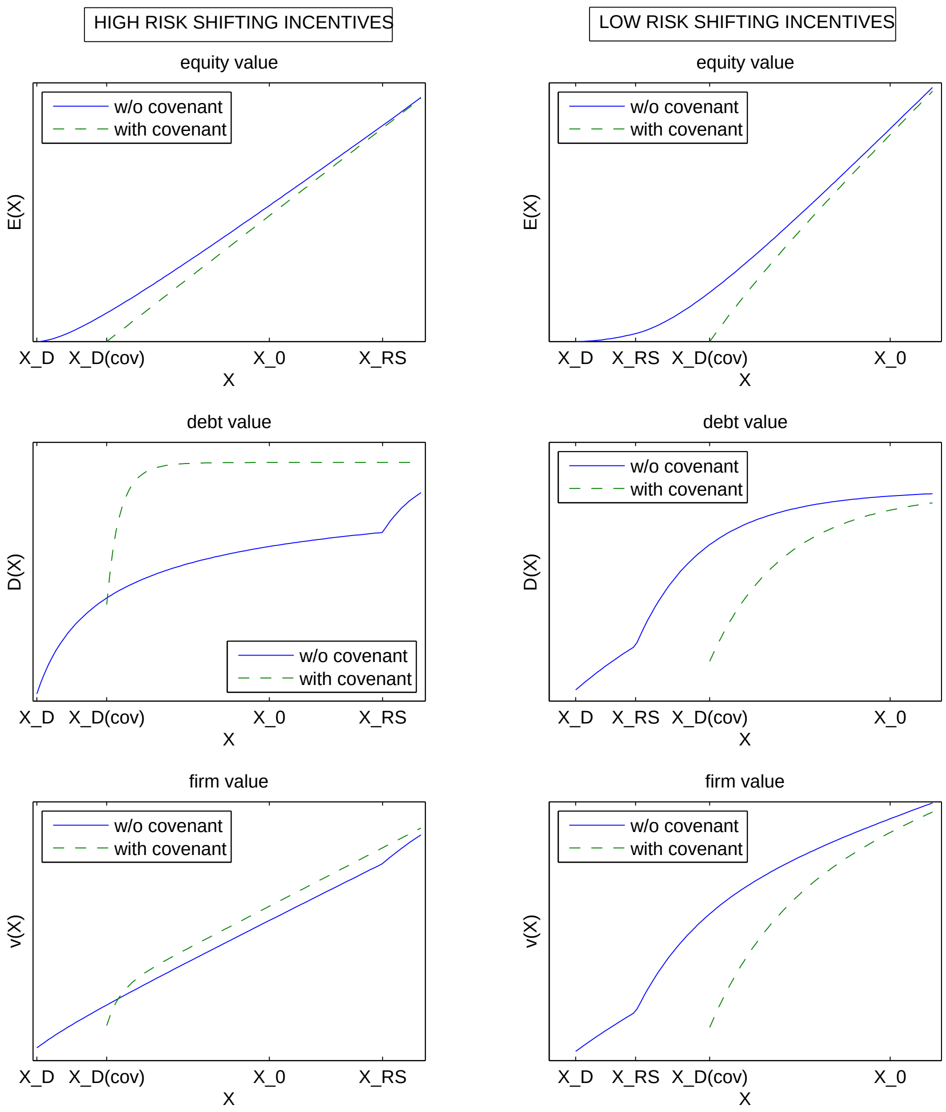

Figure 1: When should a firm use covenants to prevent risk shifting?
The left column depicts the equity, debt, and firm value as a function of the state variable (operating income, X) when the firm has high risk shifting incentives. Such a situation arises when risk shifting is relatively cheap. The blue line depicts the security values if the debt contract has no covenant attached and the dashed green line shows the values if a cash-flow covenant that destroys equityholders' risk-shifting incentives is in place. The right column depicts the same information for a firm that finds risk-shifting relatively expensive (larger decrease in the drift rate).

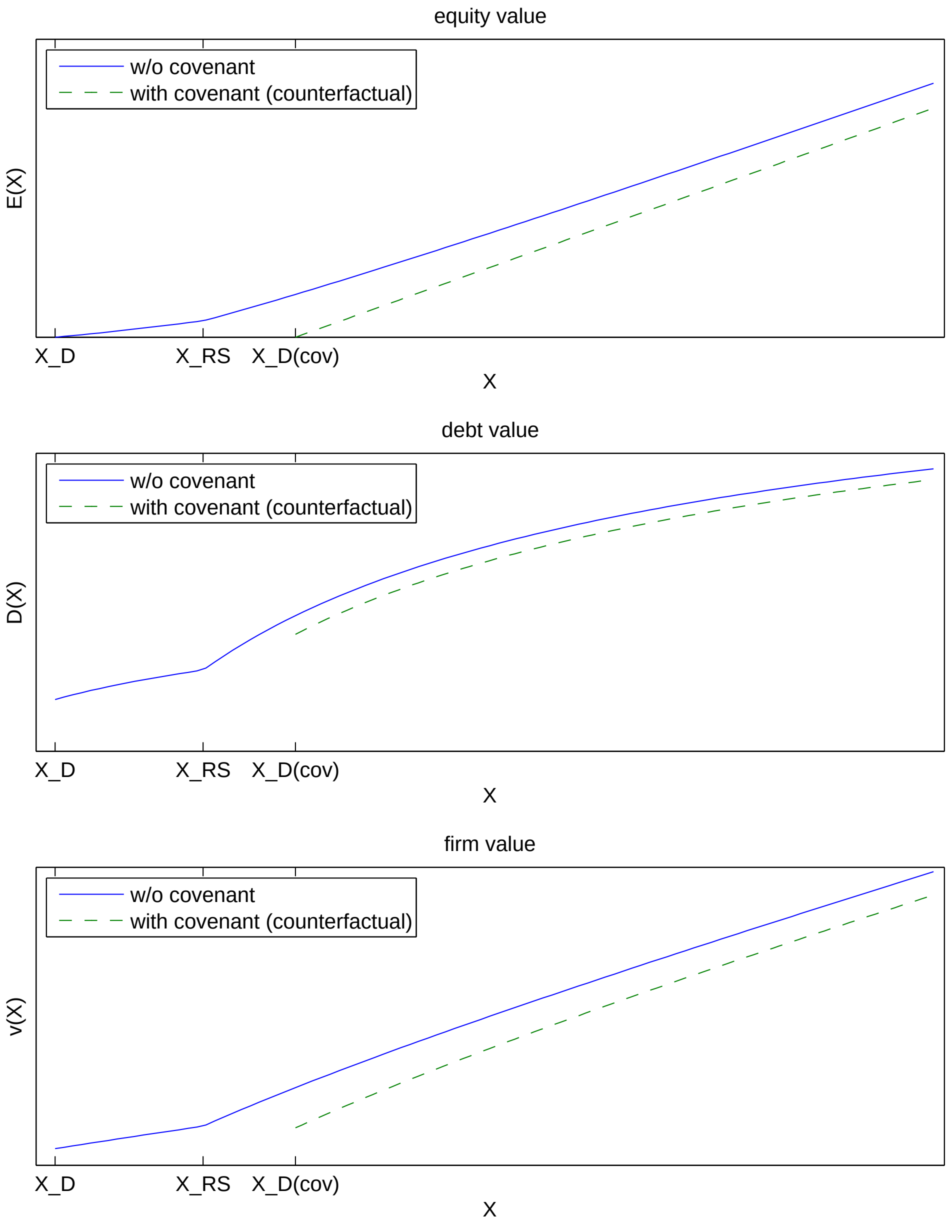

Figure 2: Why certain firms don't use covenants.
This figure depicts the equity, debt, and firm value as a function of the state variable (operating income, X) for the average firm belonging to the no-covenant sample. Examining the actual situation that debt has no covenants associated, the blue line highlights the reaction of the security values to changes in operating income. The dashed green line depicts the hypothetical counterfactual, that is a situation in which a cash-flow covenant that destroys the equityholders' risk-shifting incentives were in place.

Table 2: Description of the main parameters and variables

This table depicts the description of the main parameters of the theoretical model, the parameters describing the stationary distribution, the variable definition of equity and the coupon as well as the values of the exogenously set parameters.

Symbol	Value	Interpretation
Stationary distribution parameters (estimated via a SMM)		
k		Shape parameter of the Gamma distribution
θ		Scale parameter of the Gamma distribution
Model parameters (estimated via our conditional SMM)		
σ_L		Cash-flow volatility prior to risk shifting
σ_H		Cash-flow volatility subsequent to risk shifting
δ_L		$\delta_L = r - \mu_L$ where μ_L is the risk neutral drift prior to risk-shifting
δ_H		$\delta_H = r - \mu_H$ where μ_H is the risk neutral drift subsequent to risk-shifting
α_L		Drift under the physical measure $\mathbb{P}$ prior to risk shifting
α_H		Drift under the physical measure $\mathbb{P}$ subsequent to risk shifting
ζ_D		Parameter describing the bankruptcy boundary X_D
ζ_{RS}		Parameter describing the risk-shifting boundary X_{RS}
Definition of variables		
E		Market capitalization (shares outstanding * share price)
C		Coupon payments (interest expense)
Exogenous parameters		
r	0.05	Interest rate
τ_c	0.35	Corporate tax rate
τ_d	0.35	Personal tax rate
α	0.35	Bankruptcy costs

Table 3: Classification of bond covenants

This table describes the classification of bond covenants. For each bond outstanding, the FISD database reports up to 54 different covenants. We use the Smith & Warner (1979) framework as described in Table 2 of Chava et al. (2010) to classify these covenants into four distinct groups: investment restrictions, subsequent financing restrictions, event-related restrictions and dividend restrictions.

1) Investment restrictions:		
	Direct investment restrictions	
	Indirect investment restrictions:	
		Restrictions on transactions with affiliates
		Restrictions on re-designating subsidiaries
		Fixed charge coverage of parent and subsidiaries
		Maintenance of minimum net worth
		After acquired property clause
	Asset disposition restrictions:	
		Asset sale clause
		Sale and transfer of assets to unrestricted subsidiaries
	Merger and consolidation restrictions	
	Stock sale restrictions	
	Bond is secured	
2) Subsequent financing restrictions:		
	Common and preferred issuance restrictions of parent and subsidiaries	
	Debt priority restrictions of parent and subsidiaries	
	Restrictions on sale and lease obligations	
	Restrictions on subordinate debt issuances:	
		Leverage test of parent and subsidiaries
		Subsidiary borrowings and guarantees
		Net earnings test
		Negative pledge covenant
	Direct investment restrictions:	
		Indebtedness
		Funded and senior debt issuances
		Liens
3) Event related restrictions:		
	Default-related event covenants:	
		Cross default
		Cross acceleration
		Rating decline trigger
		Declining net worth covenant
	Change in control poison put	
4) Dividend and other payment restrictions		

Table 4: Descriptive statistics in the years prior to bankruptcy

This table depicts the mean descriptive statistics of the main variables of interest for the different years prior to bankruptcy. The standard deviation is depicted in parentheses. All data is retrieved from the database called Capital IQ and regulated and financial firms are removed. The market capitalization are the number of shares outstanding times the share price; following Nikolov & Schmid (2012), investments are calculated as (capital expenditure - sale of property plant and equipment)/total gross property plant and equipment; the market-to-book ratio is the market value of equity market divided by the book value of equity. We follow Morellec et al. (2012) in calculating the leverage of the firm: (total liabilities + preferred stock - deferred taxes)/(total assets - book equity + market equity). The remaining variables are normalized by total assets and total assets themselves are in billions of USD.

	1	2	3	4	5	6	7
Panel A: Firms with at least one bond-covenant							
Market capitalization	0.214	0.391	0.380	0.499	0.515	0.552	0.584
	(0.188)	(0.392)	(0.362)	(0.408)	(0.456)	(0.728)	(0.775)
Market-to-book	1.279	1.095	1.555	2.534	2.973	2.279	1.576
	(2.348)	(5.427)	(2.404)	(5.191)	(6.809)	(3.398)	(1.382)
Leverage	0.841	0.725	0.721	0.641	0.653	0.661	0.643
	(0.120)	(0.179)	(0.184)	(0.179)	(0.177)	(0.234)	(0.255)
Operating cash-flow	-0.008	0.041	0.014	0.031	0.015	0.008	0.039
	(0.104)	(0.124)	(0.211)	(0.054)	(0.058)	(0.071)	(0.102)
Investments	0.016	0.025	0.020	0.023	0.028	0.033	0.029
	(0.028)	(0.029)	(0.018)	(0.021)	(0.035)	(0.054)	(0.056)
Cash	0.046	0.037	0.036	0.039	0.040	0.037	0.054
	(0.065)	(0.058)	(0.049)	(0.050)	(0.057)	(0.053)	(0.061)
Total assets	1.311	1.641	2.031	2.312	1.979	1.692	1.222
	(1.801)	(2.975)	(4.789)	(4.772)	(3.327)	(2.921)	(1.595)
Panel B: Firms without bond covenants							
Market capitalization	0.393	0.364	0.966	0.717	1.235	0.699	1.100
	(0.415)	(0.204)	(1.282)	(0.611)	(1.243)	(0.711)	(1.054)
Market-to-book	0.608	0.468	1.512	2.142	2.784	1.558	1.836
	(0.885)	(1.480)	(2.834)	(2.826)	(2.549)	(0.805)	(1.345)
Leverage	0.697	0.666	0.496	0.505	0.463	0.539	0.369
	(0.210)	(0.181)	(0.257)	(0.281)	(0.289)	(0.230)	(0.231)
Operating cash-flow	0.054	-0.148	-0.124	-0.012	0.040	0.055	0.047
	(0.222)	(0.489)	(0.328)	(0.321)	(0.270)	(0.394)	(0.248)
Investments	0.023	0.034	0.059	0.037	0.077	0.031	0.064
	(0.045)	(0.026)	(0.073)	(0.032)	(0.079)	(0.055)	(0.076)
Cash	0.069	0.072	0.165	0.109	0.141	0.048	0.110
	(0.091)	(0.083)	(0.208)	(0.148)	(0.219)	(0.038)	(0.111)
Total assets	0.400	0.473	0.510	0.573	0.544	0.643	0.425
	(0.362)	(0.311)	(0.380)	(0.405)	(0.439)	(0.459)	(0.425)

Table 5: Descriptive statistics for bonds outstanding

This table depicts the descriptive statistics of all bonds outstanding as well as their respective covenants for the sample of defaulted companies. All data is retrieved via the FISD database. Companies which are part of the regulated or financial industry are disregarded and convertible bonds are also not part of the analysis. The offering yield is the yield to maturity at the time of issuance and the treasury spread reported in FISD and is calculated as the the difference between the yield of the benchmark treasury issue and the issue's offering yield. The security level corresponds to the following classification: subordinate (1), junior subordinate (2), senior subordinate (3), senior (4), senior secured (5). The classification of the different covenants in Panel C follows Chava et al. (2010) and the details are depicted in Table 1.

	mean	p25	median	p75
Panel A: Bonds outstanding				
Number of bonds per firm	12.24	3	6	18
Offering amount (mil)	233.40	100	160	300
Offering yield (%)	9.61	8	10	11
Treasury spread (b.p.)	240.17	0	138	425
Maturity (in months)	126.97	84	118	121
Issuance time before default (in months)	108.63	47	82	151
Security level	3.81	3	4	4
Panel B: Bonds with vs. without covenants				
B1: Bonds with covenants (59%)				
Offering amount (mil)	256.05	100	175	300
Offering yield (%)	9.50	8	9	11
Treasury spread (b.p.)	137.84	0	81	222
Maturity (in months)	128.74	84	117	121
Issuance time before default (in months)	100.64	45	84	147
Security level	3.77	3	4	4
B2: Bonds without covenants (41%)				
Offering amount (mil)	200.63	90	150	275
Offering yield (%)	9.70	8	10	11
Treasury spread (b.p.)	345.55	0	388	556
Maturity (in months)	124.40	84	120	121
Issuance time before default (in months)	120.21	52	81	162
Security level	3.88	3	4	4
Panel C: Classification of covenants				
Subsequent financing restrictions	89%			
Event-related restrictions	86%			
Investment restrictions	83%			
Dividend or other payment restrictions	66%			

Table 6: Moments estimation: Companies with bond covenants

Using our conditional conditional simulated methods of moments estimation approach, this table compares the model-generated moments with the those using our sample of defaulted firms between 2000 and 2013. The values of the cash-flow at $\tau_D - 7$ are scaled by the companies' interest payments. All data is retrieved via the FISD or Capital IQ database. Only companies whose bonds have at least one covenant associated are used.

A) Moments

	Empirical moments	Simulated moments
Moments connected to the stationary distribution parameters		
Cross-sectional mean of cash-flow at τ_{D-7}	4.4956	5.0945
Cross-sectional variance of cash-flow at τ_{D-7}	15.1358	18.1478
Cross-sectional skewness of cash-flow at τ_{D-7}	1.6062	2.1812
Moments connected to the model parameters		
Time-series mean of equity returns	0.0385	-0.0215
Time-series variance of equity returns	0.8344	1.0956
Cross-sectional variance of equity returns	0.8251	0.6247
Serial correlation of equity	0.0564	0.0892
Time-series mean of cash-flow returns	-0.0112	-0.0120
Time-series variance of cash-flow returns	0.2208	0.3852
Cross-sectional variance of cash-flow returns	0.2414	0.2353
Serial correlation of cash-flow	0.0181	0.0233
Time-series mean of cash-flow returns ($\tau_D - \tau_{RS}$)	0.4429	-0.4172
Time-series mean of cash-flow returns ($\tau_{RS} - 7$)	-0.1360	-0.1439
Time-series variance of cash-flow returns ($\tau_D - \tau_{RS}$)	0.0387	0.0369
Time-series variance of cash-flow returns ($\tau_{RS} - 7$)	0.2226	0.2853

B) Parameter estimates

k	θ
0.9266	3.9644

δ_L	δ_H	σ_L	σ_H	α_L	α_H	ζ_{RS}	ζ_D
0.1000	0.1022	0.1988	0.5358	0.1309	-0.0658	0.9830	0.3915

Table 7: Moments estimation: Companies without bond covenants

Using our conditional conditional simulated methods of moments estimation approach, this table compares the model-generated moments with the those using our sample of defaulted firms between 2000 and 2013. The values of the cash-flow at $\tau_D - 7$ are scaled by the companies' interest payments. All data is retrieved via the FISD or Capital IQ database. Only companies whose bonds do not have any covenant associated are used.

A) Moments

	Empirical moments	Simulated moments
Moments connected to the stationary distribution parameters		
Cross-sectional mean of cash-flow at τ_{D-7}	2.8505	3.2391
Cross-sectional variance of cash-flow at τ_{D-7}	4.6813	5.8376
Cross-sectional skewness of cash-flow at τ_{D-7}	1.0499	1.7282
Moments connected to the model parameters		
Time-series mean of equity returns	0.0361	-0.0452
Time-series variance of equity returns	0.8009	0.8059
Cross-sectional variance of equity returns	0.9315	1.1009
Serial correlation of equity	0.0608	0.0652
Time-series mean of cash-flow returns	-0.0240	-0.0237
Time-series variance of cash-flow returns	0.4895	0.1853
Cross-sectional variance of cash-flow returns	0.2846	0.3978
Serial correlation of cash-flow	0.0434	0.0153
Time-series mean of cash-flow returns ($\tau_D - \tau_{RS}$)	-0.2017	-0.3044
Time-series mean of cash-flow returns ($\tau_{RS} - 7$)	-0.6489	-0.6586
Time-series variance of cash-flow returns ($\tau_D - \tau_{RS}$)	0.5308	0.1372
Time-series variance of cash-flow returns ($\tau_{RS} - 7$)	0.4385	0.3863

B) Parameter estimates

k	θ
1.5567	1.7761

δ_L	δ_H	σ_L	σ_H	α_L	α_H	ζ_{RS}	ζ_D
0.0222	0.0478	0.3719	0.8551	-0.1484	0.0928	0.4000	0.9938