Two Tales of Debt*

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Abstract

We analyze the heterogeneous nature of firms' debt contracts, some of which focus on liquidation values of discrete assets whereas others focus on going-concern values of the business. Using hand-collected data, we show that firms on average have limited liquidation values. Companies with lower liquidation values have more debt backed by going-concern values and more intensive performance monitoring. They pay higher interest rates only for debt against discrete assets. We present a model that matches our findings, explains the use of debt against different aspects of the firm, and demonstrates how creditor monitoring and covenants facilitate borrowing beyond liquidation values.

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1 Introduction

Debt is one of the most widely used contracts for financing companies around the world. The nature and the enforcement of debt contracts have long been key questions in economics research. Broadly speaking, debt enforcement can be characterized by two approaches (Djankov, Hart, McLiesh, and Shleifer, 2008; Diamond, Hu, and Rajan, 2020). In one approach, creditors lend against the liquidation value of discrete assets, namely separable and often tangible assets that can be evaluated and repossessed on a standalone basis. For this type of debt, lenders mainly focus on assessing the liquidation values of the assets pledged to them, which can be relied upon even if the firm no longer exists, and they set borrowing limits accordingly. In another approach, creditors lend against the value of the firm as an operating business (i.e., going-concern value)—this value may benefit from human capital, organizational structures, and business relations, and may not be captured by discrete or tangible assets. For this type of debt, lenders' payoffs are tied to the value created by the business, and the allocation of control rights (over business decisions) between firms and creditors can play an important role.

Firms' debt contracts in the US reflect these two approaches: some focus on the liquidation value of discrete assets while others focus on the going-concern value of the company as a whole.[1] In particular, debt contracts can be backed by *different aspects of the firm* and priority rules are *multidimensional*, as exemplified by bankruptcy resolution. For instance, in Chapter 11, a debt contract secured by a piece of equipment has the highest priority claim against the equipment value (i.e., it has a senior claim up to the transaction or liquidation value of the equipment), whereas a debt contract secured by a blanket lien on the firm has the highest priority claim against the firm's going-concern value (i.e., it has a senior claim up to the going-concern value of the firm, minus the liquidation value of any discrete assets pledged separately). These debt contracts also differ in the determinants of their quantities and pricing, and in creditor monitoring. The multiple forms of debt contracts and multifaceted priority rules paint a more intricate picture than classic benchmarks such as Townsend (1979), and echo the importance of understanding debt heterogeneity emphasized by Rauh and Sufi (2010).

Why do firms use these different types of debt? What determines the prevalence and characteristics of each type? What ultimately shapes firms' total debt capacity? We answer these questions by constructing a new hand-collected dataset on the liquidation values of discrete assets and going-concern values of firms across different industries.

[1] Commercial mortgages, equipment loans, and loans against working capital are standard examples of lending against discrete assets, while a substantial portion of business loans and most corporate bonds in the US are backed by the cash flow value of the firm as a whole (Lian and Ma, 2021).

We show that firms on average have limited liquidation values (well below their total liabilities). Nonetheless, companies with lower liquidation values rely more on debt backed by going-concern values with strong creditor monitoring. We also find that total leverage does not depend on liquidation values, at least for large firms or those with positive earnings. We then provide a model to demonstrate that having different types of debt with multifaceted priority rules, combined with contractual provisions such as covenants, strengthens creditors' incentives to monitor firm performance and helps firms borrow beyond liquidation values.

Measuring the liquidation values of various types of assets across industries is an essential but challenging task. We hand collect this information from one of the most systematic disclosure sources: liquidation analyses in Chapter 11 filings between 2000 and 2016. In particular, firms in Chapter 11 continue to operate, but they are required by law to report the liquidation values of all of their assets if they were liquidated.[2] We obtain the liquidation recovery rate (i.e., liquidation value as a fraction of book value) for each main asset category (fixed asset, inventory, receivable, etc.), and take the average in each two-digit SIC industry to reduce noise. We then estimate the liquidation values of Compustat firms using the liquidation recovery rate of each type of asset in their industry and the book value of assets they have. Additionally, we collect firms' going-concern values in restructuring from the Chapter 11 cases (over 90% of public firms' bankruptcy filings by value are Chapter 11). We use firm values after emergence if available and firm value estimates in Chapter 11 plans otherwise. We normalize going-concern values by total assets at filing, and take the average for each industry.

We perform extensive checks about the informativeness of the data. For liquidation values of different assets, we cross-check with auction data that covers equipment in aerospace manufacturing (Ramey and Shapiro, 2001) and construction, and with liquidation proceeds in Chapter 7. These checks verify that our data is consistent with market-based transactions. We also cross-check with liquidation value benchmarks creditors use in ex ante lending decisions for non-financial firms in general, and with proceeds from sales of fixed assets among Compustat firms. In a companion paper (Kermani and Ma, 2021), we further show that the liquidation recovery rates are well-explained by the physical attributes of assets used in different industries, measured independently based on industry-wide data from the Bureau of Economic Analysis (BEA). These checks verify

[2]These estimates commonly derive from appraisals by specialists in asset liquidations and valuations, who perform on-site field exams and simulate live liquidations. Later we also analyze default recovery rates of debt from Moody's; however, this variable does not directly measure liquidation values of firms' assets for several reasons. First, Moody's data mostly represent debt recoveries in restructurings not liquidations. Second, payments to non-debt liabilities (e.g., tax claims, trade creditors) are often omitted. Third, default recovery rates of a debt security also depend on its seniority and other contract terms.

that our data is relevant for non-financial firms more generally. For going-concern values in restructuring, we cross-check estimates in Chapter 11 plans and post-emergence market trading data, which are consistent with each other on average. Overall, we do not find evidence of systematic biases. Although the measures inevitably contain some noise that could attenuate our results, we show below that they have substantial explanatory power for the behavior of non-financial firms.

Among Compustat firms, we find that the estimated liquidation value of fixed assets (property, plant, and equipment, or PPE) plus working capital (inventory and receivable) is on average 25% of total book assets, and 41% if all cash holdings are included. This compares to total liabilities of around 60% for the average Compustat firm and 70% for the average non-investment grade firm. As we detail in Section 2.4, the majority of firms with positive leverage, and the vast majority of non-investment grade firms, have debt and total liabilities that exceed liquidation values. In other words, liquidation values are not enough to support firms' liabilities. Meanwhile, the average Chapter 11 going-concern value is 79%, with an inter-quartile range of 68% to 100%.

After documenting the properties of firms' assets, we investigate key features of firms' debt contracts, including debt composition, tightness of financial covenants, interest rates, and debt recovery rates in default. We demonstrate that all of these debt characteristics reflect the relevance of the two approaches of debt enforcement, which varies systematically as a function of firms' liquidation values, going-concern values, and borrowing amount. Overall, preserving going-concern values is important and doing so may require some creditors to monitor firm performance; meanwhile, another set of creditors focus on the liquidation value of liquid assets, which offers them protection regardless of firm performance. The two approaches entail different lender expertise, and the dichotomy can also enhance monitoring incentives as we discuss later.

For debt composition, we organize debt into three groups. We start with whether creditors have claims against discrete assets or against the business as a whole (commonly referred to as "asset-based debt" and "cash flow-based debt" by creditors, and we follow their terminology). In bankruptcy, payoffs of the former are primarily driven by the value of the particular assets pledged to them, while payoffs of the latter depend on the going-concern cash flow value of the firm as a whole (which we verify later). US bankruptcy laws impose an automatic stay, which prevents asset-based debt from threatening to seize assets in order to obtain more than what its claim is entitled to. In ex ante lending decisions, asset-based debt also stipulates borrowing limits determined by the liquidation value of the particular assets pledged. We then further decompose cash flow-based debt into debt with light monitoring such as bonds and debt with strong monitoring such as loans (which often impose stringent financial covenants and exercise

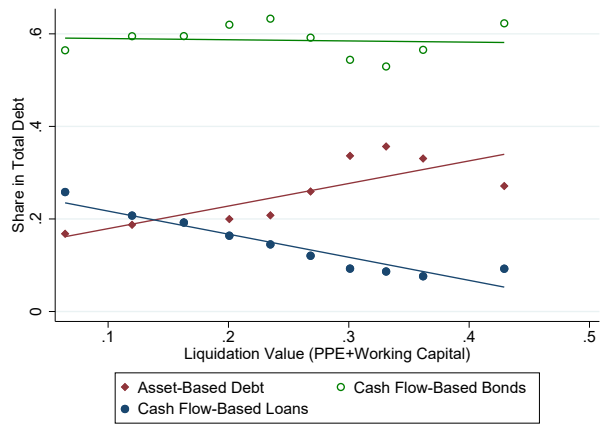
creditor control rights, as highlighted by Roberts and Sufi (2009) among others).[3]

Figure 1 provides an overview of how debt heterogeneity varies according to key firm attributes.[4] The prevalence of asset-based debt, where creditors have claims against discrete assets (e.g., equipment loans), increases with liquidation values and decreases with industry-average Chapter 11 going-concern values. On the other hand, the prevalence of cash flow-based bonds and loans, where creditors have claims against the firm as a whole, decreases with liquidation values and increases with going-concern values. In sum, corporate debt is far from homogeneous, and firms differ systematically in the extent to which their debt relies on liquidation values versus going-concern values.

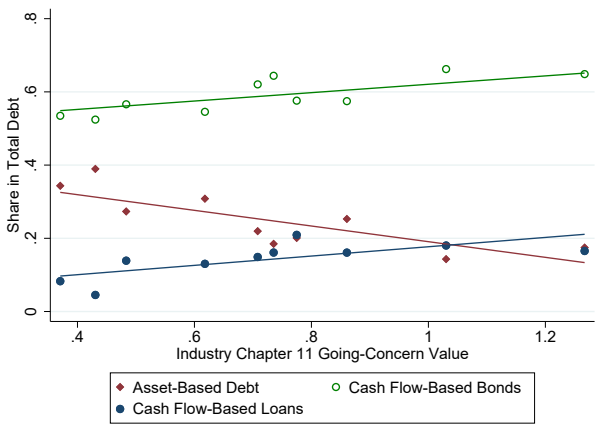
Figure 1: Debt Composition and Firm Attributes

This figure shows asset-based debt, cash flow-based bonds, and cash flow-based loans as a share of total debt, in 10 bins based on firm liquidation value from PPE and working capital (normalized by total firm assets) in Panel A and average Chapter 11 going-concern value (normalized by total assets at filing) in each firm's industry in Panel B. Sample is based on Compustat and CapitalIQ.

Panel A. By Liquidation Value



Panel B. By Chapter 11 Going-Concern Value



We also find that debt composition displays some pecking order. Firms rely more on asset-based debt against liquid and generic assets for the initial amount of borrowing (it can have a slight cost advantage, but many firms do not have a large amount of such assets). The share of this type of debt is high for the first 5% to 10% of book leverage, and falls substantially as firms take on more debt, especially for firms with low liquidation values. Firms then use more cash flow-based debt with weak control for medium levels of borrowing. Finally, firms have a greater prevalence of cash flow-based debt with strong control for high levels of leverage. Results are similar using liquidation values predicted by the physical attributes of assets in an industry as instruments and

[3]Throughout this paper, we use the terms "monitoring" and "control rights" to refer to monitoring of firms' operating performance and control over business decisions.

[4]This illustration follows Rauh and Sufi (2010) to use rated firms, which have similar capital market access. Our subsequent tests use all Compustat firms, which produce very similar results.

using industry-average liquidation values (instead of firm-level liquidation values).

Moreover, our framework sheds new light on the classic issue of secured debt. As mentioned previously, secured debt is not necessarily about discrete or tangible assets (in contrast to the conventional notion in the economics literature). In the US, having security (or "collateral") allows creditors to obtain priority: creditors can take priority against the value of discrete assets through secured asset-based debt, or against the going-concern value of the firm through secured cash flow-based debt (taking security against "substantially all assets" of the firm, often referred to as "blanket liens"). A key economic function of blanket liens is to implement strong control over the company, so they can be viewed as another representation of cash flow-based debt with strong control. In the data, we find that the prevalence of secured cash flow-based debt decreases with liquidation values, increases with industry-average Chapter 11 going-concern values, and increases with leverage. Indeed, these features are similar to cash flow-based loans discussed above, and are the *opposite* of asset-based debt.

We then examine covenant tightness as another indicator of the intensity of creditor monitoring. We measure covenant tightness following Murfin (2012), and estimate the probability of covenant violations based on covenant thresholds specified at loan issuance. We find that financial covenants in loans, especially performance covenants (generally specified as a function of firms' operating earnings), are tighter when liquidation values are lower and when leverage is higher. Financial covenants also tend to be tighter when the industry-level Chapter 11 going-concern values are higher.

Additionally, we analyze other debt characteristics to corroborate the nature of different types of debt and the focus of their lenders. We show that the interest rates of asset-based debt decrease with liquidation values, but this pattern does not hold for cash flow-based debt. We also study the determinants of debt recovery rates in default. We show that default recovery rates of asset-based debt have a significant positive dependence on liquidation values of discrete assets, but not on firms' Chapter 11 going-concern values; default recovery rates of cash flow-based debt display the opposite pattern. The evidence is in line with the payment determination and priority rules under US bankruptcy laws. In sum, these findings further demonstrate that different debt contracts are backed by different aspects of the firm; they also verify that cash flow-based debt does not depend implicitly on liquidation values.

Finally, we find that total borrowing does not increase with liquidation values for large firms and firms with positive earnings. Total borrowing does have a strong positive relationship with liquidation values for small firms and firms with negative earnings.

We provide a simple model of creditor monitoring that illuminates the empirical findings and closely follows US institutional settings. In the model, an entrepreneur

invests in a project that can result in success or failure (liquidation). The probability of success depends on costly effort by the entrepreneur, which is not contractible (moral hazard). However, there is an observable noisy signal of performance in an interim period, and the contract can allocate control rights to an informed lender as a function of the signal. This design can be thought of as a financial covenant. Upon a low realization of the signal, the informed lender can investigate and find out the true effort of the entrepreneur. If low effort is detected, the informed lender can threaten an intervention, which can be interpreted as Chapter 11 restructuring.

Our model offers several takeaways that are consistent with the data. First, it shows that monitoring and creditor control are more important when liquidation values are low and leverage is high. Second, monitoring is undertaken by a subset of cash flow-based debt. In particular, the model pinpoints that such debt should have high priority against the firm's business value in success and in restructuring, but not against the liquidation value. This ensures that the informed lender has both the skin in the game to pay monitoring costs and time-consistent incentives to intervene if low effort is detected. Third, as long as covenants can be enforced and monitoring is not too costly, liquidation values affect debt composition but not necessarily total debt capacity. Fourth, although only a small fraction of debt comes with strong monitoring, it can provide valuable services to other creditors and help the firm borrow beyond the liquidation value. In comparison, the way to obtain debt capacity beyond liquidation values in several classic models is to threaten a seizure of assets, which is not consistent with the automatic stay under US bankruptcy laws.

Our analysis can also inform models of firms' borrowing constraints. Our data provides guidance for the tightness of borrowing constraints if they are based on liquidation values, which is a common modeling specification in the literature (Kiyotaki and Moore, 1997). Our results then show that total debt capacity is not necessarily bound by liquidation values: many firms borrow more than their liquidation values, and total borrowing does not vary much with liquidation values, among large firms and firms with positive earnings. In addition, the empirical evidence and the model suggest that financial development requires not just secure property rights, but also institutions that preserve firms' going-concern values (e.g., restructuring-oriented bankruptcy systems, creditor monitoring, covenant enforcement). Property right institutions (e.g., those that enhance creditors' ability to seize tangible assets) can help lenders avoid paying monitoring costs. However, given the low liquidation values of firms in most industries, control right institutions (e.g., those that enhance creditors' ability to monitor firm performance) are ultimately essential for firms' access to debt financing.

1.1 Literature Review

First, our analysis is related to, and in large part motivated by, prior studies on different perspectives of debt enforcement. One branch of work focuses on pledging physical assets that creditors can seize (Hart and Moore, 1994, 1998; Kiyotaki and Moore, 1997; Rampini and Viswanathan, 2010, 2013; Demarzo, 2019), which has influenced empirical analyses of both firms and households (Benmelech, Garmaise, and Moskowitz, 2005; Almeida and Campello, 2007; Benmelech and Bergman, 2009; Mian and Sufi, 2011; Chaney, Sraer, and Thesmar, 2012).[5] Another branch of work points to the importance of creditor monitoring and control rights (Diamond, 1984; Aghion and Bolton, 1992; Dewatripont and Tirole, 1994; Holmstrom and Tirole, 1997; Kaplan and Strömberg, 2003; Diamond, Hu, and Rajan, 2021), and documents the role of financial covenants for implementing creditor control rights (Smith and Warner, 1979; Chava and Roberts, 2008; Roberts and Sufi, 2009; Nini, Smith, and Sufi, 2012; Matvos, 2013; Becker and Ivashina, 2016; Green, 2018; Chodorow-Reich and Falato, 2020; Berlin, Nini, and Yu, 2020). We contribute to the literature by providing new data on firms' liquidation values and going-concern values, and by demonstrating how they shape the relevance of different approaches of debt enforcement, both empirically and in a parsimonious model.

Second, our work relates to research on debt structure, which has covered several issues, including loans versus bonds (Denis and Mihov, 2003; De Fiore and Uhlig, 2011, 2015; Crouzet, 2018), interactions among creditors (Bolton and Scharfstein, 1996; Repullo and Suarez, 1998; Park, 2000), secured debt (Donaldson, Gromb, and Piacentino, 2020a; Benmelech, Kumar, and Rajan, 2020a), interest rates (Luck and Santos, 2020; Benmelech, Kumar, and Rajan, 2020b), and implications of asset-based and cash flow-based debt (Lian and Ma, 2021; Ivashina, Laeven, and Moral-Benito, 2020; Cloyne, Ferreira, Froemel, and Surico, 2020). In addition, some early work documents how liquidation costs affect the debt choices of firms emerging from bankruptcy (Alderson and Betker, 1995). We utilize information from bankruptcy filings to extract industry-level features and show the explanatory power for debt contracts of firms in general. Our empirical and theoretical analyses also provide an integrated framework for a number of debt characteristics (e.g., debt composition, financial covenants, interest rates, and default recovery rates) that are often analyzed one at a time.

Third, our work connects to the law and finance literature on the importance of legal institutions for debt enforcement (Gertner and Scharfstein, 1991; La Porta, Lopez-de

[5]The properties of asset-based debt in our data are in line with classic studies of such debt, which often focus on industries including commercial real estate and airlines (where liquidation values are high and asset-based debt is prominent). Nonetheless, most non-financial firms do not have high liquidation values and rely more on borrowing against firm value.

Silanes, Shleifer, and Vishny, 1998; Smith and Strömberg, 2004; Acemoglu and Johnson, 2005; Beck and Levine, 2005; Haselmann, Pistor, and Vig, 2010; Becker and Josephson, 2016) and real outcomes (Strömberg, 2000; Ponticelli and Alencar, 2016; Iverson, 2018; Bernstein, Colonnelli, and Iverson, 2019; Corbae and D'Erasmo, 2020; Iverson, Madsen, Wang, and Xu, 2020). Liquidation values of physical assets can be especially important for debt contracts in earlier stages of financial development, where restructuring-based bankruptcy systems are underdeveloped and financial performance has limited verifiability (Gan, 2007; Benmelech, 2009). Our results suggest that further advancement of financial development requires improving institutions that facilitate creditor monitoring and orderly restructuring to preserve firms' going-concern values.[6]

The rest of the paper proceeds as follows. Section 2 describes the data and presents the basic statistics. Section 3 shows our main empirical results about how debt characteristics vary with firms' liquidation values, going-concern values, and the amount of borrowing. Section 4 presents the model. Section 5 concludes.

2 Data and Definition

In this section, we describe the data collection and the definition of main variables. We focus on non-financial firms (SIC codes outside of 6000 to 6999 and less than 9000).

2.1 Liquidation Values and Chapter 11 Going-Concern Values

We hand collect data on liquidation values of major asset categories (i.e., PPE, inventory, receivable, etc.) and going-concern firm values in restructuring, from Chapter 11 filings between 2000 and 2016. Below, we detail our data collection process and perform extensive checks to verify the informativeness of the data.

2.1.1 Data Collection

We begin with Chapter 11 filings by public US non-financial firms based on New Generation Research's BankruptcyData database. We then retrieve disclosure statements of these cases from Public Access to Court Electronic Records (PACER) and BankruptcyData. The disclosure statements provide a comprehensive set of information, including estimates of the liquidation value of different assets and the going-concern value of the business. When a case has multiple disclosure statements, we use the earliest version. If the information we need is not available, we then use the latest version.

[6]Our result can also provide a rationale for the limitations of laws and bankruptcy reforms that focus on creditors' rights to access and seize hard assets (Acharya, Amihud, and Litov, 2011; Vig, 2013).

Liquidation Values

In US Chapter 11, firms continue to operate, but they are also required to perform a liquidation analysis and report the liquidation value of their assets if they were liquidated in Chapter 7. The liquidation analysis considers a scenario where a firm would cease operations and a trustee would sell off its assets (on a largely piecemeal basis over a roughly one year horizon). US bankruptcy laws stipulate that claim holders should receive at least as much in Chapter 11 restructuring as they would in liquidation. To our knowledge, the liquidation analyses in Chapter 11 cases provide the most comprehensive reporting of liquidation values covering all types of assets across different industries (whereas secondary market trading data is sparse for many types of real assets, and it is also difficult to know the asset composition across industries to aggregate values of individual items at the firm level).[7] As we explain in Sections 2.2 and 3.3, liquidation values of firms' assets cannot be directly inferred from default recovery rates of debt (because Moody's data mostly reflects debt recovery in restructuring not liquidation, and omits payments to non-debt liabilities).

The liquidation analysis typically presents a summary table with the net book value, liquidation value, and liquidation recovery rate (liquidation value as a fraction of net book value), for each type of asset (PPE, inventory, receivable, etc.) as well as for the firm overall.[8] It also includes additional explanations about the sources and assumptions of the estimates. The estimates commonly derive from appraisals performed by asset liquidation and valuation specialists, who have extensive knowledge about the liquidation process (e.g., how much can be sold to primary, secondary, and tertiary buyers). They assess various assets' liquidation values by conducting field exams and simulating live liquidations. They are also responsible for assessing liquidation values for lenders, and some liquidation analyses directly use estimates by lenders. By definition, the liquidation value captures the value of reallocating separable assets on a standalone basis, not combined with human capital or organizational capital.[9]

Figure 2 shows two examples of liquidation analysis summary tables from a chemical company, Lyondell, and a communication products company, Sorenson Communications. As shown in these cases, the liquidation analysis often includes several estimates

[7] The liquidation analysis is performed for both in-court and prepackaged Chapter 11 cases.

[8] Because the liquidation recovery rates are normalized by net book values, we also check that the depreciation rates firms use for book assets are reasonable. For each firm in Compustat, we calculate its PPE depreciation rate, as well as the fixed asset depreciation rate in its industry according to the BEA's fixed asset tables. We find that depreciation rates used by firms are very similar to those used by the BEA; the correlation is over 0.5 and the average difference is about one percentage point.

[9] Whether different discrete assets are likely to be sold together or separately relies on the analyses and simulations by appraisal specialists. As shown in Figure 2, firms often provide high, midpoint, and low estimates of the liquidation value, which in part reflect these issues. For PPE liquidation recovery rates, the high estimate is on average two percentage points higher than the midpoint estimate.

(low, midpoint, high). We use the midpoint estimate in our baseline analysis (or the average of the low and high estimates when the midpoint estimate is not available). Section IA2 in the Internet Appendix presents notes from Lyondell's liquidation analysis, which show that the liquidation value of PPE comes from plant-level appraisals by American Appraisal Associates and the liquidation value of working capital (inventory and receivable) is based on lenders' assessments for credit facilities against working capital assets. Both firms continue to operate after Chapter 11, but these court documents provide unique disclosures of the liquidation value assessments of their assets.

The liquidation analysis data has several advantages. First, it covers *all of the assets* owned by a firm, instead of only the assets that have active secondary markets, have been selected to be sold, or have been pledged to lenders (Berger, Ofek, and Swary, 1996; Murfin and Pratt, 2019; Franks, Seth, Sussman, and Vig, 2021). For instance, specialized, illiquid assets may not trade in secondary markets or be pledged to lenders; firms' asset sales could have strategic considerations (Maksimovic and Phillips, 2001). Second, the liquidation analysis data provides not only the liquidation value in dollars but also the liquidation recovery rate (i.e., the liquidation value as a fraction of book value), whereas most other data sources do not have information about book values or recovery rates. Liquidation recovery rates are important for comparisons across different types of assets, and for constructing firm-level liquidation value estimates among a broader set of firms. Finally, relative to indirect proxies of asset specificity (Rauch, 1999; Benmelech, 2009; Kim and Kung, 2017), our data allows for assessment of magnitudes, such as comparing liquidation values with going-concern values or debt values.

In the main analyses, we use the average liquidation recovery rates for each type of asset in a given industry (two-digit SIC). With the assumption that owned assets are similar in a given industry, we construct the liquidation value estimate of a Compustat firm k in industry i and year t as:

$$LiqVal_t^k = \sum_j \lambda_i^j NBV_t^{kj}, \tag{1}$$

where λ_i^j is the average liquidation recovery rate of asset type j in industry i, and NBV_t^{kj} is the net book value of asset type j of firm k in year t. In Kermani and Ma (2021), we verify that liquidation recovery rates are largely an industry feature, and are closely tied to the physical attributes of assets used in each industry. For PPE, for instance, we find that physical attributes (such as mobility, durability, and standardization) measured using BEA data can account for roughly 40% of the cross-industry variation in PPE liquidation recovery rates. Additionally, we analyze variations of liquidation recov-

ery rates due to time-varying macroeconomic conditions or industry conditions (Shleifer and Vishny, 1992). We find that the impact of macro and industry conditions on liquidation recovery rates is weak on average, but stronger for relatively standardized assets that are used economy-wide or industry-wide (not customized for a particular firm). Overall, time-varying economic conditions appear unlikely to offset major differences across industries due to physical attributes.[10]

Our data covers assets owned by firms. Some assets that firms use may be under operating leases, instead of being owned (Benmelech and Bergman, 2008; Eisfeldt and Rampini, 2009).[11] In Internet Appendix Section IA4, we perform robustness checks of our main results, assuming operating lease liabilities are akin to asset-based debt and leased assets contribute to the liquidation value of discrete assets (as lessors can repossess the leased assets when leases end). In addition, to gauge the prevalence of operating leases, we check data from the new accounting rule adopted in 2019 (Accounting Standards Update 842), which requires firms to report leased assets and corresponding operating lease liabilities. We find that the median ratio of leased assets to owned assets is about 3.5% among Compustat firms (inter-quartile range 1.6% to 8.1%), which is reasonably small.[12] Moreover, the prevalence of operating leases is largely an industry feature, and industry fixed effects (e.g., two-digit SIC) have an R^2 of 40% for the ratio of leased to owned assets.[13] This is in line with our observation above that the features of firms' assets have general similarities within an industry.

Going-Concern Values in Restructuring

We also hand collect data on firms' going-concern values in Chapter 11. Specifically, we collect data on estimated firm going-concern values from the valuation analysis in Chapter 11. We also collect data on post-emergence market values (market value of equity plus book value of debt, within one year of Chapter 11 confirmation) for firms that emerged as public companies, and enterprise values in acquisition for firms that

[10]For instance, to bring PPE liquidation recovery rates from the highest industries (e.g., transportation at around 69%) to the median (e.g., a typical manufacturing industry at around 35%), macro or industry conditions need to change by more than two standard deviations.

[11]For capital leases (instead of operating leases), it is typically viewed that the lessee is likely to have ultimate ownership of the leased asset (e.g., buy the asset at the end of the lease). In this case, the leased asset always shows up on the asset side of the lessee's balance sheet, and the lease shows up on the liability side and is included in asset-based debt in our classification.

[12]Another way to estimate the prevalence of operating leases is to use BEA data to calculate assets owned by the two lessor sectors, which are 5310 (Real Estate, which includes REITs that lease real estate properties to others) and 5320 (Rental and Leasing Services and Lessors of Intangible Assets). The total (non-residential) assets owned by these two sectors are also less than 5% of total assets owned by non-financial corporate businesses in the Flow of Funds. Since the lessor sectors also include some lessors to households (e.g., car rentals), this estimate could be upward biased.

[13]The ratio of leased to owned assets is high for retail (average above 20% for apparel stores, department stores, restaurants, and furniture stores), modest for airlines and cinemas (average around 10%), and low (average below 10%) for most other industries.

were acquired. We normalize the going-concern value by total assets at the time of the filing, which provides the going-concern recovery rate. Since Chapter 11 represents over 90% of public firms' bankruptcy filings by value, it is reasonable to use this data for going-concern values in restructuring among Compustat firms (even though we do not observe going-concern values in the minority of Chapter 7 cases).

In the baseline analysis, we use post-emergence market value or acquisition value if available and supplement with estimates in the Chapter 11 valuation analysis otherwise. On average, the valuation analysis estimate is similar to the post-emergence market value when both types of data are available (the average difference is close to zero), consistent with observations in Gilson, Hotchkiss, and Ruback (2000). In Internet Appendix Section IA2, we show that these two values also have similar distributions, indicating that going-concern value estimates from the Chapter 11 valuation analysis are reasonably reliable. Finally, we take the average of going-concern recovery rates in each industry. Chapter 11 going-concern values also vary across industries because firms in some industries can perform well in Chapter 11, while firms in other industries may experience more operational disruptions or are more difficult to restructure (the extreme being financial intermediaries as Ma and Scheinkman (2020) discuss).

At the industry level, there is no strong correlation between Chapter 11 going-concern values and liquidation recovery rates of discrete assets. The correlation between the industry-average Chapter 11 going-concern value and the industry-average liquidation recovery rate of PPE, inventory, and receivable is 0.05 (p-value 0.76), -0.21 (p-value 0.17), and 0.08 (p-value 0.61), respectively.

Data Coverage

We are able to find liquidation values of non-cash assets for 387 cases in 48 two-digit SIC industries, and going-concern values for 328 cases in 49 two-digit SIC industries. Table IA1 shows the number of cases for each industry. For some small industries such as fishing (less than one firm in Compustat per year in our sample period), building materials (5 to 15 firms in Compustat per year), and special construction (10 to 20 firms in Compustat per year), we have few observations. For large industries such as business services (500 to 1,000 firms in Compustat per year), chemicals (600 to 700 firms in Compustat per year), mining (200 to 300 firms in Compustat per year), communications (100 to 300 firms in Compustat per year), etc., we have many observations.

2.1.2 Cross-Checks

We perform a number of checks for our data on liquidation values. There are three types of possible concerns. The first type of concern is firms in Chapter 11 may have

incentives to understate their assets' liquidation values in order to justify restructuring. We note that for the median Chapter 11 firm in our data, the going-concern value is twice as much as the total liquidation value, so the manipulation incentive may not be very strong. The second type of concern is firms in Chapter 11 are special because Chapter 11 may occur when a firm, its industry, or the economy experiences unfavorable conditions, which may contribute to lower liquidation values. The third type of concern is reported liquidation values can be noisy or arbitrary, and therefore uninformative.

We perform four categories of checks below to address these concerns. First, we verify that our data is consistent with market-based outcomes (in settings where such data is available), including auction results and liquidation proceeds in Chapter 7. Second, the data is also consistent with liquidation value benchmarks that creditors use in ex ante lending decisions to non-financial firms in general, and the data for PPE is broadly in line with proceeds from PPE sales among Compustat firms. Third, we find that the physical characteristics of assets used in different industries (measured from all firms in the industry) are key determinants of liquidation recovery rates. In Section 3, we also present robustness checks of our main results using liquidation values predicted by the physical characteristics of assets in an industry as instruments. Firm-specific conditions and industry conditions can have some impact (e.g., they can change liquidation recovery rates by five percentage points), but do not seem to make a qualitative difference. About 12% of our data comes from NBER recessions and 33% from industry recessions (i.e., industry revenue growth in the bottom quartile), so the data does not overwhelmingly represent conditions in economic downturns. Finally, while the data inevitably contains some noise, in this paper and in Kermani and Ma (2021), we find that it has substantial explanatory power for the behavior of non-financial firms in general. Overall, the data does not seem to display systematic biases; it is well-explained by asset attributes in different industries and informative about non-financial firms' decisions.

Comparison with Chapter 7 Liquidation Proceeds. We cross-check the estimated liquidation values in our data with proceeds obtained in Chapter 7 liquidations, and the results are reported in Table IA2. We cannot use Chapter 7 cases for our main analyses because they primarily report total liquidation proceeds realized by the trustee, so we cannot obtain liquidation recovery rates for each type of asset. Instead, we can only analyze whether the *total* liquidation proceeds in Chapter 7 cases are in line with the estimated *total* liquidation values in the Chapter 11 liquidation analyses we use. A further complication is that in Chapter 7 the trustee may "abandon" certain assets, whose values are then not included in the reported liquidation receipts (Bris, Welch, and Zhu, 2006). This can happen if an asset has little value, or is fully encumbered (i.e., the estimated liquidation value is less than the amount of debt against the asset) so the

trustee returns it to creditors for foreclosures.[14] Accordingly, we make the following assumptions. In the "basic" scenario, we only use total liquidation receipts from the trustee report. In the "medium" scenario, we add 50% of either asset-based debt or secured debt. This assumes that 50% of such debt claims are associated with abandoned assets and that they recover at par. In the "high" scenario, we add 100% of either asset-based debt or secured debt. This assumes that all of these debt claims are associated with abandoned assets and that they recover at par, which is an aggressive assumption that likely over-estimates the total liquidation value.

In Table IA2, we compare the estimated total liquidation values in Chapter 11 liquidation analyses with the total liquidation proceeds in Chapter 7, controlling for industry and time fixed effects. We normalize total liquidation values by total assets at filing. This table shows that the Chapter 7 liquidation proceeds are less than the Chapter 11 liquidation analysis estimates in the "basic" scenario and comparable in the "high" scenario. Overall, our Chapter 11 liquidation analysis data is in line with total liquidation proceeds in Chapter 7.

Comparison with Auction Results. Ramey and Shapiro (2001) collect detailed data from liquidation auctions of aerospace manufacturing equipment, and estimate a liquidation recovery rate of 28%. In our data, based on the same SIC (372), the equipment liquidation recovery rate is 32%, which is very similar. In addition, in Kermani and Ma (2021) we analyze a large dataset of construction equipment auctions and find an average liquidation recovery rate of 55%, which is the same as what is implied by our liquidation analysis data (the liquidation analysis data is at the industry level, so we use the asset composition by industry from the BEA's fixed asset table to calculate the implied liquidation recovery rate for a particular type of equipment).

Comparison with Lenders' Benchmarks. Our data is also consistent with the advance rate that creditors use for lending against discrete assets (i.e., the maximum debt allowed as a fraction of book value), which reflects lenders' liquidation value assessments for non-financial firms in general. These assessments also come from field examinations and liquidation simulations of specialist appraisers. According to a large bank, the advance rate for lending against industrial PPE is on average 20% to 30% of book value. In our data, the average industry-level PPE liquidation recovery rate is 35%. The advance rate for lending against eligible inventory is on average 50% to 60% of book value (see also OCC *Comptroller's Handbook on Asset-Based Lending*, or the variable *BorrowerBasePercentage* in DealScan when the variable *BorrowerBaseType* is "Eligible

[14] If the liquidation value of an asset is greater than the debt against it, then there is excess value that belongs to the bankruptcy estate, which other claimants should be entitled to. Such assets would be sold by the trustee, and the excess value would be used to pay other claim holders.

Inventory"),[15] where about 80% of inventory is eligible (e.g., work-in-progress inventory often ineligible), which implies a total inventory liquidation recovery rate of 40% to 48%. In our data, the average industry-level inventory liquidation recovery is 44%. The advance rate for lending against eligible receivables is on average 80% of book value (see also the OCC handbook, or the variable *BorrowerBasePercentage* in DealScan when the variable *BorrowerBaseType* is "Eligible Accounts Receivable"), where about 80% of receivables are eligible (e.g., government receivable and foreign receivable are typically not eligible), which implies a total receivable liquidation recovery rate of 64%. In our data, the average industry-level receivable liquidation recovery rate is 63%.

Comparison with PPE Sale Recovery Rates of Compustat Firms. In Kermani and Ma (2021), we compute industry-level recovery rates implied by PPE sales among all Compustat firms (i.e., sale proceeds relative to estimated book value of PPE sold). We find that these values are similar to the PPE liquidation recovery rates in our data, with a significant positive correlation between the two measures across industries.

Determinants of Liquidation Recovery Rates. In Kermani and Ma (2021), we also analyze determinants of liquidation recovery rates in detail. We find that they are shaped by the physical attributes of assets across different industries, measured independently among all firms in each industry using BEA data. Indeed, if there were no reallocation frictions—i.e., if PPE was costless to transport, fully durable, and not customized—then the data suggests that the liquidation recovery rate would be over 100%. In addition, we find that macroeconomic and industry conditions have a weak impact on liquidation recovery rates on average, and stronger when assets are not custom designed (assets highly customized to a given firm do not seem to have much liquidation value in any case). It would take substantial changes in macro or industry conditions (over one standard deviation) to shift PPE liquidation recovery rates by 10 percentage points (even if assets are not customized). Similarly, firm-specific conditions may affect liquidation values, but in normal circumstances they do not seem to make a qualitative difference. In particular, the liquidation value captures the value in *alternative* use, rather than the performance of the current business (e.g., real estate of an unprofitable bookstore may have high liquidation values, while customized equipment of a profitable pharmaceutical company may have limited liquidation values). In sum, while economic conditions can affect liquidation recovery rates, they do not seem to offset the impact of physical attributes: they do not easily erase differences across industries or lead to drastically different overall liquidation recovery rates.

[15] Asset-based debt (i.e., debt against discrete assets) typically has a borrowing base requirement that specifies the maximum amount of debt allowed for borrowing against particular assets. In DealScan, the variable *BorrowerBaseType* specifies the assets pledged, and the variable *BorrowerBasePercentage* specifies the advanced rate against those assets.

Taken together, we do not find that our data systematically understates liquidation recovery rates, relative to Chapter 7 proceeds, auction results, or lenders' estimates (although it is difficult to rule out idiosyncratic issues in a particular case). Given that the liquidation recovery rate data is most comprehensive for Chapter 11 firms, we investigate extensively whether it is reflective of non-financial firms more generally. The checks above and our empirical analyses in the rest of the paper suggest that it provides relevant information for firms in general in a given industry.

2.2 Debt Characteristics

Debt Composition

We collect data on the composition of non-financial firms' outstanding debt from CapitalIQ. CapitalIQ's debt detail dataset provides comprehensive debt-level information for all types of debt, including the amount outstanding and key contract features. This data covers most Compustat firms since 2003, and the total debt amount at the firm level matches well with Compustat. Internet Appendix IA3 summarizes the main steps of our classification procedure. Because the debt characteristics we focus on are only relevant for firms with debt, and correspondingly firms with no debt are largely absent in our datasets (both the CapitalIQ debt composition data and the interest rate data discussed later), we restrict our sample to firms with positive leverage in this paper.

Asset-Based Debt and Cash Flow-Based Debt. First, we classify debt into asset-based debt and cash flow-based debt as in Lian and Ma (2021), according to the economic determinants of creditors' claims in the US. Asset-based debt refers to debt against discrete assets, which includes commercial mortgages against commercial real estate as well as asset-based loans against PPE, inventory, receivable, oil and gas reserves, etc. Asset-based debt establishes exclusive claims against the value of a particular asset by explicitly taking security interests in the asset, and can be identified accordingly. Lenders also commonly limit the size of asset-based debt by the estimated liquidation value of the particular assets pledged to them (hence the name), where the liquidation value is assessed in ways similar to our data as discussed in Section 2.1. Cash flow-based debt refers to debt against the firm as a whole, which includes both loans (e.g., many syndicated loans) and the vast majority of bonds. It can be either secured by the firm as a whole ("substantially all assets" in contractual parlance and often referred to as "blanket liens," excluding particular assets pledged to asset-based debt), or unsecured. Debt capacity in this case is not related to liquidation values of discrete assets, but commonly tied to cash flows generated by the business in the form of operating

earnings (hence the name) as a reflection of the firm's going-concern values.[16] In Section 3, our analyses of debt amount, interest rates, and default recovery rates also verify that cash flow-based debt does not have implicit dependence on liquidation values.

Overall, the terms "asset-based debt" and "cash flow-based debt" follow creditors' usage, and can be thought of as shorthand references to debt based on the liquidation value of discrete assets and the going-concern value of the firm. One could use alternative terms such as "liquidation value-based debt" and "going concern value-based debt," but in this paper we follow lenders' terminology. We also analyze in detail the difference between this categorization and secured versus unsecured debt in Section 3.1.

The going-concern value of a firm and the liquidation value of discrete assets can differ significantly due to the role of human capital, organizational capital, and business models, as well as the high degree of asset specificity shown above. Section 2.1 also documents that liquidation recovery rates of discrete assets are not very correlated with firms' going-concern values. The distinction of different types of debt, with priority over different aspects of the firm, is especially relevant when firms have multiple sets of creditors (if there is only one creditor, then payoffs in default are driven by the firm's going-concern value if the firm is restructured and liquidation value if the firm is liquidated, regardless of whether the debt is explicitly tied to discrete assets). The average firm in our data has six debt contracts outstanding (three asset-based and three cash flow-based), and the number of claimants is larger if trade creditors and other non-debt liabilities are also taken into account. In practice, different lenders specialize in different lending approaches: some have expertise in evaluating the liquidation value of discrete assets (Gopal, 2019), while others have expertise in analyzing and monitoring firms' operations (Berger, Minnis, and Sutherland, 2017).

Cash Flow-Based Debt with Strong and Weak Control. Second, among cash flow-based debt, we create two further categories: debt with strong control and debt with weak control. In the baseline analysis, we use loans as a proxy for strong control and bonds as a proxy for weak control, as loans have concentrated ownership and stronger monitoring than bonds (Diamond, 1984, 1991; Berlin and Loeys, 1988; Holmstrom and Tirole, 1997). In additional analyses in Section 3, we also use high priority (i.e., secured by blanket liens on the firm as a whole) as a proxy for strong control: since it is difficult for borrowers to raise additional financing without the permission or support of lenders with blanket liens, such lenders can have strong power.

[16]The classification procedures and default resolutions are also discussed in detail in Lian and Ma (2021). In Chapter 11, which is most relevant for major non-financial firms, payoffs of asset-based debt are primarily driven by the value of discrete assets pledged to them, while payoffs of cash flow-based debt are primarily driven by the going-concern value of the firm, which we verify in Section 3.3.

Covenant Tightness

We collect data on financial covenants in commercial loans from DealScan. We focus on loan covenants because they are more stringent and active than bond covenants. In particular, financial covenants in loans generally require compliance every quarter (whereas financial covenants in bonds typically require compliance only if the borrower takes certain actions). DealScan provides information about the threshold of compliance, which allows us to estimate covenant tightness following Murfin (2012). Covenant information in DealScan has been widely available since 1996.

Interest Rates and Default Recovery Rates of Debt

We collect data on interest rates for all outstanding debt from CapitalIQ, and for loan issuance from DealScan. In addition, we collect data on default recovery rates for different debt instruments from Moody's Default and Recovery Database. The default recovery rates of debt are different from the liquidation recovery rates of firms' assets we discussed in Section 2.1. In particular, liquidation recovery rates capture the properties of firms' assets, and we use them to calculate firms' liquidation values on the asset side. Default recovery rates of debt, on the other hand, depend not only on firms' asset features but also on capital structures, payments to non-debt claims (e.g., tax claims, trade creditors), and the form of default resolution (restructuring versus liquidation). For instance, the default recovery rate of an individual debt instrument is a function of its seniority and other contract features. Furthermore, the debt default recovery rates cannot directly separate firms' liquidation values and going-concern values. In Section 3.3, we show that default recovery rates of asset-based debt are primarily sensitive to liquidation values of discrete assets, whereas default recovery rates of cash flow-based debt are primarily sensitive to firms' going-concern values, in line with the payment determination rules in bankruptcy in the US.

2.3 Summary Statistics

Table 1, Panel A, shows summary statistics of industry-level liquidation recovery rates. For PPE, the average is 35%; the inter-quartile range is 24% to 44% (the top quartile includes industries such as transportation, wholesale, and hotels, while the bottom quartile includes personal services and education). For inventory, the average 44%; the inter-quartile range is 34% to 56% (the top quartile includes industries such as auto dealers, apparel stores, and supermarkets, while the bottom quartile includes restaurants, construction, and IT). For receivables, the average is 63%; the inter-quartile range is 55% to 71% (the top quartile includes industries such as utilities, medical devices, and

mining, while the bottom quartile includes education and airlines).[17]

Table 1, Panel A, also shows summary statistics of the firm-level liquidation value (normalized by book assets) estimated for Compustat firms. We calculate this value by combining the industry-level liquidation recovery rate with the book value of each type of asset a firm has, as in Equation (1). We include PPE and working capital (inventory and receivable) in the baseline variable. The mean and median of the baseline liquidation value variable are both 25%; the inter-quartile range is 15% to 34%. When all of cash holdings are included, the mean and median are around 41% and 39%; the inter-quartile range is 29% to 50%. We can also include book intangibles to account for potential liquidation values from those intangible assets that are well-defined and separable (such as licenses, patents, software, and data).[18] The average firm-level liquidation value from book intangibles is about 2.7%, and all results are similar when they are included. Figure 3, Panel A, shows a breakdown of liquidation values contributed by different types of assets for the average firm. Liquidation values from PPE are on average 9.6% of book assets, while liquidation values of inventory and receivable combined are about 15%.

The last row of Table 1, Panel A, shows summary statistics of Chapter 11 going-concern values. We calculate the average Chapter 11 going-concern value (normalized by total book assets at filing) by industry as discussed in Section 2.1.1, and apply it to firms more generally based on their industries. Since over 90% of public firms' bankruptcies by value are Chapter 11, it is reasonable to use going-concern values from observed Chapter 11 cases. The mean and median of the Chapter 11 going-concern value are about 78%; the inter-quartile range is 68% to 100%. Figure 3, Panel B, plots the distribution of the Chapter 11 going-concern value (dashed blue line) compared to the distribution of the liquidation value (solid red line for not including cash, and dotted green line for including cash), and the former tends to be much higher than the latter.

Finally, Table 1, Panel B, shows summary statistics for total book leverage and debt composition among non-financial firms in our sample.

2.4 Borrowing Relative to Liquidation Values

Figure 4 demonstrates the distribution of firms' liabilities relative to liquidation values. Panel A plots the cumulative distribution function (CDF) of total debt relative to

[17] Receivables may not have full liquidation recovery rates because of past due receivables, as well as foreign receivables, government receivables, and receivables from concentrated large customers, which are difficult to collect. Some receivables may also be offset by payables to the same counterparties.

[18] According to accounting rules, intangible assets appear on firms' balance sheets (book intangibles) if they are acquired from outside. Many such intangible assets are separable and can generate liquidation values on a standalone basis. On the other hand, other forms of intangibles, such as organizational capital, are not separable from the firm and do not generate liquidation values.

the liquidation value of fixed assets and working capital. It shows that total debt exceeds the liquidation value of fixed assets and working capital for many firms, such as around 52% of firms with positive leverage and 80% of non-investment grade firms. Furthermore, liquidations in practice incur overhead costs that are 5% to 10% of liquidation values, which we have not subtracted from the liquidation value estimates; the liquidation values we use represent "gross liquidation values" which refer to proceeds from asset sales, instead of "net liquidation values" which account for overhead costs.

Panel B plots the CDF of total liabilities relative to cash plus the liquidation value of fixed assets and working capital (solid red line). Total liabilities include non-debt liabilities, which are also important claims against the firm (e.g., trade credit, employee compensation, and taxes), and they share the pie with debt holders.[19] The liquidation value including cash could be generous given that cash holdings often serve liquidity purposes (Alfaro, Bloom, and Lin, 2019), and discretionary cash holdings may fluctuate. We find that 71% of firms with positive leverage and 94% of non-investment grade firms have more liabilities than the liquidation value of PPE and working capital plus cash. These fractions are also sizable. In comparison, the dashed blue line in Panel B shows the CDF of total liabilities relative to industry-average Chapter 11 going-concern values. In this case, about 33% of firms have liabilities greater than the industry-average Chapter 11 going-concern value, and even fewer firms (7%) have total debt above this level.

Overall, the results suggest that firms' liquidation values are limited, and not necessarily sufficient to support their debt and liabilities in general.

3 Liquidation Values, Chapter 11 Values, and Debt Characteristics

In this section, we present the main results of how debt characteristics vary based on liquidation values, Chapter 11 going-concern values, and the amount of borrowing. The analyses demonstrate how the two approaches of debt enforcement shape a number of debt features, including debt composition, financial covenants, interest rates, and debt recovery rates in default. The results demonstrate that different debt contracts are backed by different aspects of the firm. We then investigate firms' total borrowing.

[19] Some non-debt liabilities such as taxes can be more senior than debt claims (and employees and critical vendors are also often paid during bankruptcy before debt holders are paid). Regular trade creditors are typically treated as general unsecured creditors in bankruptcy.

3.1 Debt Composition

As explained in Section 2.2, we organize debt into three categories: 1) asset-based debt (debt against discrete assets such as PPE and working capital), 2) cash flow-based debt with weak control (debt against the firm as a whole with light creditor intervention, such as bonds), and 3) cash flow-based debt with strong control (debt against the firm as a whole with more intensive creditor involvement, such as loans). For liquidation values, we use firm-level liquidation values of PPE and working capital in the main analyses. We control for cash holdings but do not include them directly in liquidation values, since cash holdings can be fairly discretionary. We also perform robustness checks using the average liquidation value in an industry to further reduce the impact of firms' discretionary choices. For Chapter 11 going-concern values, we use the average amount (normalized by total assets at filing) in a firm's industry (two-digit SIC). For leverage, we use the ratio of total debt to book assets. In Internet Appendix Section IA4, we also show the main results are similar if we add operating leases as another form of asset-based debt and another contributor to the liquidation value of discrete assets.

A. Asset-Based Debt

Figure 5, Panel A, shows a binscatter plot of the share of asset-based debt in total debt, for firms with low liquidation values (in blue circles) and high liquidation values (in red diamonds). The 20 bins are formed by book leverage, and the low versus high liquidation value groups represent firms in the bottom and top terciles of liquidation values in each year. The figure shows that the share of asset-based debt in total debt is relatively high when firms borrow a small amount (book leverage below 5% or 10%), and decreases when firms borrow more, especially for firms with low liquidation values. Correspondingly, a similar binscatter plot in Figure IA1, Panel A, shows that asset-based debt relative to total assets increases roughly linearly with leverage for firms with high liquidation values, but plateaus as leverage increases for firms with low liquidation values. The results echo Figure 1 that asset-based debt is more prevalent among firms with high liquidation values. They also suggest some degree of pecking order: asset-based debt against generic and liquid assets can be less costly, so it is more common when firms need a small amount of debt. However, when firms borrow more, they do not necessarily have many such assets, and the prevalence of asset-based debt declines.[20]

Table 2 reports the results in regressions, where we control for other firm charac-

[20] In the data, we do not find that firms use up all the liquidation value of discrete assets for asset-based debt before taking on cash flow-based debt. One important reason is that many discrete assets can be specialized and illiquid, which are not easy to pledge directly. Another reason is some asset-based debt may involve fixed costs. For instance, to receive an asset-based revolver, a firm needs to set up a system to record and report the amount of receivable and inventory to lenders on a regular basis, and to have lenders conduct field exams of their assets, which can be cumbersome.

teristics that may affect debt choices. Column (1) shows that the share of asset-based debt increases with liquidation values. Column (2) shows that the share decreases with leverage, especially when liquidation values are low. Columns (3) and (4) show the amount of asset-based debt increases with total indebtedness, especially for firms with high liquidation values. In addition, the prevalence of asset-based debt decreases with going-concern values (industry-level Chapter 11 values and current firm market values).

B. Cash Flow-Based Debt with Weak Control

Figure 5, Panel B, shows a binscatter plot of the share of cash flow-based bonds in total debt, for firms with low liquidation values (in blue circles) and high liquidation values (in red diamonds). The share of this type of debt is hump-shaped, and is highest for medium ranges of leverage. As we explain next, this hump-shaped pattern is driven by the fact that firms with high leverage rely more on debt with strong monitoring. Figure IA1, Panel B, shows a corresponding binscatter plot for cash flow-based bonds relative to total assets. These plots show that the prevalence of this type of debt is also higher for firms with low liquidation values (consistent with Figure 1), and the impact of liquidation values is stronger as leverage increases. Table 3 presents these results in regressions. It also shows that the prevalence of cash flow-based bonds increases with firms' going-concern values (the industry-level Chapter 11 value, as well as the firm's current market value).

C. Cash Flow-Based Debt with Strong Control

Figure 5, Panel C, shows a binscatter plot of the share of cash flow-based loans in total debt, for firms with low liquidation values (in blue circles) and high liquidation values (in red diamonds). We see that firms with low liquidation values rely more on cash flow-based debt with strong control, especially when leverage is high. Figure IA1, Panel C, shows a corresponding binscatter plot for cash flow-based loans relative to total assets. Interestingly, for firms in the bottom tercile of liquidation values, the reliance on cash flow-based loans increases substantially after book leverage exceeds 20%. This is close to the average firm-level liquidation value in this group. For firms in the top tercile of liquidation values, on the other hand, an increased reliance on cash flow-based loans occurs at book leverage above around 35%. Again, this threshold is close to the average firm-level liquidation value in this group. Table 4 presents results in regressions. It also shows that the prevalence of this type of debt decreases with liquidation values and increases with going-concern values (the industry-level Chapter 11 value, as well as the firm's current market value). As we discuss in Section 4, despite being less than 25% of total debt even for firms with high leverage, cash flow-based loans can play an important monitoring role for high leverage firms, which benefits cash flow-based debt

in general (including bond holders).[21]

D. Essence of Secured Debt

Our analyses also shed new light on the nature of secured debt, a classic issue in economics research (Berger and Udell, 1990; Donaldson, Gromb, and Piacentino, 2020a; Benmelech, Kumar, and Rajan, 2020a; Rampini and Viswanathan, 2020). Although the academic literature typically associates secured debt with debt against separable or tangible assets (i.e., asset-based debt in our categorization), this is not necessarily the case in the US. Under US law, creditors obtain priority by taking security (Baird and Jackson, 1984). They can do so with respect to different aspects of the firm: creditors can take priority over the standalone value of discrete assets (secured asset-based debt), or over the going-concern value of the firm (secured cash flow-based debt).[22]

Asset-based debt is typically explicitly secured by discrete assets, to establish clear priority over the value of such assets. In bankruptcy, asset-based debt would have a high priority claim (i.e., secured claim) up to the standalone value of the assets pledged to it, and a low priority (i.e., unsecured deficiency claim) for the remaining face value (if any). Meanwhile, cash flow-based debt can take security in the form of "substantially all assets" (other than assets pledged to asset-based debt), sometimes referred to as "blanket liens" ("all assets" in this context include business synergies and organizational capital, not just tangible assets, and effectively refer to the company as a whole). Such a claim has priority over the going-concern value of the firm. In Chapter 11, its collateral value is given by the going-concern value of the firm as a whole (minus the liquidation value of discrete assets pledged to asset-based debt).[23] Secured cash flow-based debt is often

[21]Recently, there has been an increase in the issuance of covenant light ("cov-lite") loans, which may raise questions about whether creditor controls are weakening. Cov-lite generally refers to loans with covenants that require compliance when borrowers take certain actions (e.g., raising new debt), instead of traditional loan covenants that require compliance every quarter. In some cases, cov-lite reflects the delegation of control rights to a subset of lenders: the tranches of a loan held by banks have standard financial covenants, while those sold to institutional investors are cov-lite (Berlin, Nini, and Yu, 2020). In other words, cov-lite does not necessarily mean no covenants, and some lenders may retain regular financial covenants. Furthermore, as we show below, our main results hold using secured cash flow-based debt—which typically has blanket liens over the firm as a whole—as another proxy for debt with strong control. These tests have the advantage of avoiding the complications of classifying cov-lite loans. The prevalence of blanket liens has remained steady, so this mechanism of creditor control through blanket liens has not been affected by the recent rise of cov-lite loans.

[22]Unsecured or subordinated debt, on the other hand, represents low-priority debt claims that are marginal claimants to the pool of value. In Chapter 11 restructuring, the marginal value is given by the firm's going-concern value; in Chapter 7 liquidation, the marginal value is given by the liquidation value.

[23]This priority rule is also recognized by ratings agencies. For example, Fitch writes in its report: "Fitch recognizes that an ABL is entitled to priority over other first lien cash flow-based debt to the extent of the value of specific collateral securing the ABL. Therefore, in allocating the adjusted EV to the two classes of senior secured claims, Fitch first allocates the portion attributable to the liquidation value of the specific assets securing the ABL (referred to as the "collateral component"); and the enterprise value for the other first lien debt is net of the amount allocated to the ABL collateral component" (Dabas, Simonton, and Oline, 2013). "ABL" and "EV" stand for "asset-based lending" and "enterprise value."

used to implement strong creditor control over a firm, given that much of firm value is pledged to these creditors, and it is difficult to raise new debt without their consent.

Table 5 and Figure IA2 show that secured cash flow-based debt displays very different properties than those observed for asset-based debt in Table 2 and Panel A of Figures 5 and IA1. First, secured cash flow-based debt is more prevalent among low liquidation value firms, whereas asset-based debt is more prevalent among high liquidation value firms. Second, the share of secured cash flow-based debt in total debt increases with leverage, while that of asset-based debt decreases. Third, secured cash flow-based debt increases with Chapter 11 going-concern values, similar to cash flow-based loans and bonds. In contrast, asset-based debt decreases with Chapter 11 going-concern values. Overall, the results show that secured debt has different components with different economic properties, consistent with observations in Ivashina, Laeven, and Moral-Benito (2020) and Lian and Ma (2021), and should not be uniformly viewed as borrowing against the liquidation value of separable or tangible assets.

Finally, several studies find that the share of secured debt in total debt is higher for firms with lower ratings (Rauh and Sufi, 2010; Benmelech, Kumar, and Rajan, 2020a). In our data, the average share of secured debt among investment grade and non-investment grade firms is 19% and 46% respectively, consistent with this observation. The average share of asset-based debt changes from 19% to 29%, primarily driven by lower firm value and higher volatility of low-rated firms. Meanwhile, the average share of secured cash flow-based debt changes from 1% to 19%, and accounts for a substantial part of the increase in secured debt among low rated firms.

E. Liquidation Values Predicted by Physical Attributes and Industry-Level Variations

To further demonstrate the robustness of our data and address concerns about possible biases in liquidation recovery rates measured through Chapter 11 firms, we perform analyses using liquidation recovery rates predicted by the physical attributes of assets in different industries. As mentioned in Section 2.1.2, in Kermani and Ma (2021) we measure physical attributes using data from the BEA, which covers all firms in an industry. For fixed assets, we find that both the level and the variation of liquidation recovery rates are well-explained by mobility (transportation costs), durability (depreciation rates), and customization (design costs in production). For inventory, we also find that shelf life, mobility, and customization, measured for each industry using BEA and Compustat data, account for liquidation recovery rates. For receivable, we find that the prevalence of doubtful receivables and foreign sales in an industry decreases liquidation recovery rates. Accordingly, in Panel A of Table IA3, we apply liquidation recovery rates predicted by these fundamental attributes of assets in an industry to construct liquida-

tion value estimates for Compustat firms in our sample, use them to instrument firms' liquidation values, and check the robustness of our main regressions.[24]

In addition, one possible concern is that the firm-level liquidation value can be affected by a given firm's choices regarding asset composition. Although choices with respect to the combination of asset composition and debt composition can reflect the connections between asset attributes and debt structures in our framework, one might worry about other factors that affect both sides. Accordingly, in Panel B of Table IA3 we present additional results using industry-level liquidation values (i.e., the average firm-level liquidation value from PPE and working capital over total assets in an industry), which are not affected by the asset choices of a given firm.

Overall, the results in Table IA3 are similar to the main results in Tables 2 to 4. Asset-based debt is more prevalent when liquidation values are higher, and the sensitivity of asset-based debt to liquidation values is higher when leverage is higher. Cash flow-based loans and bonds are more prevalent when liquidation values are lower, and the sensitivity to liquidation value is also more pronounced when leverage is higher. Finally, cash flow-based loans and bonds are increasing in the industry's Chapter 11 going-concern value, while asset-based debt is not.

F. Within-Firm Variations

In the above analyses, we exploit cross-sectional variations in firms' liquidation values, which are largely driven by industry features. In comparison, within-firm variations in the liquidation value are more likely to be affected by firm-specific decisions to acquire or finance certain assets. Nonetheless, it is reasonable to ask whether the "pecking order" of debt composition we show also holds within a firm (i.e., how debt composition depends on the level of borrowing). We present this result in Table IA4, where we add firm fixed effects to focus on within-firm variations and examine how debt composition changes with leverage. We also allow this relationship to depend on liquidation values by interacting leverage with industry-level liquidation values (we use industry-level liquidation values here so that the interaction coefficient is driven only by within-firm changes in leverage, not by within-firm changes in liquidation values). We confirm that the pecking order results are very similar in this within-firm analysis. The share of asset-based debt declines as book leverage increases, especially for firms with low liquidation values. Meanwhile, the share of cash flow-based debt rises, and the shift to cash flow-based loans is especially pronounced for firms with low liquidation values.

[24] In other words, we construct $\widehat{LiqValt}^k = \sum_j \widehat{\lambda}_i^j NBV_t^{kj}$ for each firm k in year t to instrument the liquidation value in Equation (1), where $\widehat{\lambda}_i^j$ is the liquidation recovery rate of asset type j predicted by physical attributes of assets in firm k's industry i.

G. Liquidation Values by Type of Asset

In the above, we combine all asset-based debt into one group for parsimony. Below, we also investigate the relationship between different subsets of asset-based debt and different components of the liquidation value. Table IA5 shows how the amount of asset-based debt backed by working capital and PPE relates to the liquidation values of working capital versus PPE. We find that the liquidation value of working capital is mainly predictive of the amount of asset-based debt backed by working capital, and not the amount of asset-based debt backed by PPE. The reverse holds for the liquidation value of PPE, which is predictive of the amount of asset-based debt backed by PPE (not working capital). In sum, each type of asset-based debt is backed by the liquidation value of a particular type of asset, consistent with the design of asset-based debt.

3.2 Covenant Tightness

To further investigate the role of creditor monitoring, we also examine the tightness of financial covenants as a function of firm attributes. We measure covenant tightness following Murfin (2012). The measure captures the probability of violating a financial covenant given the firm's current financial conditions and the thresholds of financial covenants. We match covenant thresholds at loan issuance from DealScan with the borrower's financial conditions from Compustat. Specifically, following Murfin (2012), we represent the thresholds of financial ratios set by the covenants as $\underline{\mathbf{r}}$, which is a $K \times 1$ vector and K is the number of covenants the firm has. The corresponding actual financial ratios of the firm are denoted by $\mathbf{r}$ and evolve as follows:

$$\mathbf{r}' = \mathbf{r} + \epsilon \sim N_K(\mathbf{0}, \Sigma), \tag{2}$$

where Σ is the covariance matrix of financial ratios, estimated as in Murfin (2012). Covenant strictness is then the probability of violating at least one covenant, namely there exists k such that $r_k < \underline{r_k}$:

$$p = 1 - F_K(\mathbf{r} - \underline{\mathbf{r}}), \tag{3}$$

where F_K is the multivariate normal CDF with mean 0 and variance Σ. Internet Appendix Section IA5 explains the details of the estimation.

We assign financial covenants into two groups. The first group consists of performance covenants, which are tied to firms' operating performance, commonly measured using operating earnings (earnings before interest, taxes, depreciation and amortization, or EBITDA). Examples include restrictions on maximum debt-to-earnings ratios

and minimum interest coverage ratios (or equivalently maximum ratios of debt payments to earnings). Performance covenants are often viewed as trip wires that facilitate the contingent allocation of control rights, allowing lenders to intervene in managerial actions if firms have poor performance (Christensen and Nikolaev, 2012).[25] The second group consists of other financial covenants, including covenants on book leverage (e.g., maximum debt-to-asset or debt-to-equity ratios) and liquidity metrics (e.g., minimum current assets to current liabilities), which aim to ensure that firms have sufficient capital or liquidity. They have become much less common in recent decades and are less effective for monitoring performance (Demerjian, 2011; Griffin, Nini, and Smith, 2020).

Figure 6 and Table 6 show the variation of covenant tightness. Covenants are tighter when leverage is higher, consistent with prior studies of the agency theory of covenants (Bradley and Roberts, 2015). In addition, the tightness of performance covenants is higher, and increases more with leverage, for firms with lower liquidation values. This is in line with the results on cash flow-based debt with strong control in Table 4 and Table 5, which also point to more intensive creditor monitoring in these settings. Furthermore, covenant tightness increases with the industry-level Chapter 11 value. As we discuss further in Section 4, enforcing covenants requires effective threat (i.e., if borrowers do not comply with creditors' requests, creditors can accelerate the loan, which will likely result in bankruptcy filings). The credibility of the threat can depend on the Chapter 11 value (i.e., how well firms in a given industry can function in Chapter 11 restructuring), which shapes creditors' payoffs if they were to accelerate the loan and send the firm to restructuring in Chapter 11. More generally, as we also see in Tables 4 and 5, the strength of creditor control rights tends to increase with Chapter 11 values.

3.3 Additional Results

We analyze several additional debt characteristics, including interest rates and default recovery rates, to further corroborate the focus of different types of debt. We also perform additional checks to examine whether asset-based debt plays a role in monitoring firms' operational performance.

A. Interest Rates

Figure 7, Panel A, shows a binscatter plot of interest rates on asset-based debt and

[25] It is not necessary to have moral hazard to justify the existence of financial covenants, such as restrictions on the ratio of debt to earnings. Restrictions on maximum debt-to-earnings ratios can arise if multiples of earnings approximate how much lenders can receive in default (e.g., Chapter 11), as explained in Lian and Ma (2021) (just as restrictions on maximum debt to liquidation values can arise if lenders are paid based on liquidation values in default Kiyotaki and Moore (1997). However, with moral hazard, earnings-based covenants can have additional functions for ameliorating moral hazard, as we illustrate in Section 4.

book leverage for firms in the top and bottom terciles of liquidation values (controlling for year fixed effects and firm size). Figure 7, Panel B, investigates the same relationship, but for cash flow-based debt. These plots show several interesting patterns. First, firms with low liquidation values pay significantly higher interest rates when they borrow through asset-based debt. This relationship, however, does not exist for cash flow-based debt. Second, interest rates on cash flow-based debt are more sensitive to firm leverage than interest rates on asset-based debt. Both of these patterns are consistent with the observation that asset-based debt relies mainly on the liquidation value of discrete assets, whereas cash flow-based debt relies on the going-concern value of the firm. While these patterns provide useful information, one might be worried that they can be affected by endogenous sorting of firms into different types of debt. For example, perhaps firms that have low liquidation values yet choose to borrow asset-based debt could be riskier than firms that have high liquidation values and borrow through asset-based debt, leading to higher observed interest rates.

In Table 8, we address such concerns by exploiting variations in the interest rates on different types of debt within the same firm and the same year, or even within the same loan package, similar to the empirical strategy of Benmelech, Kumar, and Rajan (2020b). In columns (1) to (4), we use interest rate information on outstanding debt from CapitalIQ, and control for firm-year fixed effects to absorb any time-varying firm characteristics. We use interest rates on loans and bonds in column (1) and focus on loans in column (2). The results suggest that higher liquidation values are associated with significantly lower interest rates on asset-based debt relative to cash flow-based debt. In columns (3) and (4), we repeat the same analysis for firms above and below median leverage; the differential impact of liquidation values on the interest rates of asset-based loans is slightly larger for firms with higher leverage. Finally, in column (5), we compare interest rates on different types of loans issued in the same loan package using data from DealScan. Again we find that higher liquidation values are associated with significantly lower interest rates for asset-based loans.

Overall, the results on interest rates show that higher liquidation values from discrete assets can make asset-based debt relatively cheap. Correspondingly, higher liquidation values are associated with a higher prevalence of asset-based debt. However, interest rates on cash flow-based debt do not depend on liquidation values.

B. Debt Recovery Rates in Default

In addition to the interest rate results that show the *ex ante* pricing of different types of debt, we examine debt recovery rates in bankruptcy, which provide direct evidence on the *ex post* importance of liquidation values and going-concern values for the payoffs

of different debt claims in default resolutions.

In Table 9, we use debt recovery rates from Moody's Default & Recovery Database (DRD) to investigate this issue. Not all firms in this data are public; therefore, we perform our analysis both for the entire sample (odd columns) and for the sample of public firms for which we can find their Chapter 11 liquidation analyses as well as pre-filing financial information (even columns). Accordingly, in the odd columns, the independent variables include industry-average liquidation values and going-concern values; in the even columns, the independent variables include firm-level liquidation values, going-concern values, and pre-filing firm financials. In columns (5) and (6), we replace Chapter 11 going-concern values with the bottom quartile of Q (i.e., market value of assets over book value of assets) in the industry, which can also be informative about the going-concern values of firms in restructuring.

The results of Table 9 show that the default recovery rate of asset-based debt is mainly affected by the liquidation value of discrete assets; it does not depend much on the going-concern value of the firm. In contrast, the default recovery rate of cash flow-based debt is driven by the going-concern value of the firm, not the liquidation value. These results are consistent with the interest rate results shown earlier, as well as with US bankruptcy laws. Overall, they verify that asset-based lenders would focus on the liquidation value of discrete assets pledged to them, whereas cash flow-based lenders would focus on the going-concern value of the firm. This dichotomy is in line with the definition of these two types of debt and our observation that they are backed by *different aspects of the firm*.

C. Comparison with Book Values of "Tangible Assets"

In Table IA6, we also compare our liquidation value measure with the book value of "tangible assets" often used in prior work (Rajan and Zingales, 1995; Almeida and Campello, 2007; Rampini and Viswanathan, 2013). Conceptually, measuring the liquidation value of discrete assets is important for several reasons. First, in ex ante lending decisions of asset-based debt, creditors specify borrowing limits according to the estimated liquidation value of the discrete assets pledged. Second, in ex post default resolutions, payoffs of asset-based debt are primarily determined by the liquidation value of the discrete assets pledged.

In the data, we examine how different measures explain both the quantity and the interest rates of asset-based debt. We show comparisons with two common measures of tangible assets, namely the book value of PPE in Panel A and the book value of PPE plus inventory in Panel B. For the amount of asset-based debt analyzed in columns (1) and (2), our measure provides information beyond the traditional book values. For interest

rates analyzed in columns (3) and (4), we find that asset-based debt has lower interest rates when firms have higher liquidation values. On the other hand, interest rates on asset-based debt are weakly increasing in the traditional book value measures. One possible explanation for this result is that book values may also reflect credit demand, whereas our measure of liquidation value is better at capturing the credit supply for asset-based debt (i.e., lenders' willingness to lend against discrete assets).

D. Asset-Based Debt and Monitoring

So far we have assumed that asset-based debt is not much involved in monitoring firm performance. As shown above, its recovery rates in default depend primarily on the liquidation value of discrete assets, rather than the value of the firm as an operating business; it also sets interest rates with a focus on the former.

One may wonder if lenders of some asset-based debt, such as asset-based revolvers, may also be involved in monitoring firms' operating performance. Asset-based revolvers are revolving lines of credit mainly backed by working capital, which allow firms to borrow up to the liquidation value of working capital (the borrowing base). There are two reasons why lenders of these revolvers might be involved in monitoring. First, the revolvers can be part of a loan package that also includes cash flow-based term loans. The lead lenders of the asset-based revolver and the cash flow-based term loan may overlap. In these cases, one might think that the revolver could be used to strengthen the term loan's bargaining power in enforcing monitoring. Second, if the firm borrows more from the revolver than what is allowed by the borrowing base, the firm has to either reduce its borrowing or post more collateral. Otherwise, the firm violates the borrowing base requirement and incurs a technical default (just like violations of financial covenants), which could give the lender control rights. We investigate both of these possibilities in Internet Appendix Figures IA3 and IA4.

In Figure IA3, we use DealScan data to plot the frequency of having the same lead lender for both an asset-based loan and a cash flow-based loan in a loan package, as a function of firm leverage (Panel A) and firm size (Panel B), for firms with low versus high liquidation values. The main takeaway is that the frequency of having overlaps in lead lenders is significantly higher for firms with low liquidation values. This seems consistent with our main observation that firms with low liquidation values rely more on lending relations with more intensive monitoring.

To evaluate the relevance of the second channel, ideally we would want to measure the frequency of violating the borrowing base requirement. Unfortunately, DealScan only has data at loan issuance and CapitalIQ does not have data on the borrowing base requirement. Accordingly, we approximate the maximum borrowing base using the

liquidation value of working capital. We construct a dummy variable that is equal to one if the firm borrows more through asset-based revolvers than its working capital liquidation value. Figure IA4 shows that such occurrences are rare for most levels of leverage. They are slightly more likely for firms with lower liquidation values. Overall, the incidence of asset-based lenders being able to exercise control rights appears infrequent. Correspondingly, the incidence of asset-based lenders having to worry about the firm value, beyond the liquidation value of the particular assets pledged them, is also low. Furthermore, even if some asset-based loans do get involved in monitoring firm performance, this seems more likely for firms with lower liquidation values.

3.4 Total Leverage

Finally, an important question is the extent to which liquidation values affect total borrowing. In Figure 8, we find that total leverage has a strong positive relationship with liquidation values among small firms and firms with negative earnings, in line with the view of Rampini and Viswanathan (2013). Meanwhile, total leverage does not increase with liquidation values among large firms and firms with positive earnings. Table 7 presents the results in regressions, which show similar findings.[26]

The evidence is consistent with observations in Lian and Ma (2021), who document that cash flow-based debt dominates among large firms, whereas asset-based debt is more important among small firms. Our measures of liquidation values allow us to directly demonstrate determinants of total debt capacity. Overall, large firms, which generally have positive earnings (for more than 90% firm-years in terms of EBITDA) and a low probability of liquidation, have easy access to cash flow-based debt. We find that their total debt capacity does not depend on liquidation values. On the other hand, small public firms, which have negative earnings more than half of the time and are more likely to be liquidated, rely on asset-based debt and cannot access cash flow-based debt as easily. We find that their total debt capacity depends significantly on liquidation values. Figure IA5 also uses heat maps to show that while many large firms in Compustat have more debt than liquidation values, few small firms do. Outside Compustat, Jang (2020) documents that small firms backed by private equity (PE) have high earnings and behave like large Compustat firms: they primarily borrow cash flow-based debt and their total leverage is not dependent on liquidation values. Our model in Section 4 illustrates that when it is feasible to enforce control rights based on verifiable

[26] Given our focus on debt characteristics and correspondingly firms with positive leverage as discussed in Section 2.2, these results demonstrate the intensive margin. For the extensive margin of firms with no debt, we find that zero leverage is more likely when firms are small, have low liquidation values, and have negative earnings.

signals and firm going-concern values, liquidation values can affect debt composition but may not drive total debt capacity.

4 Model

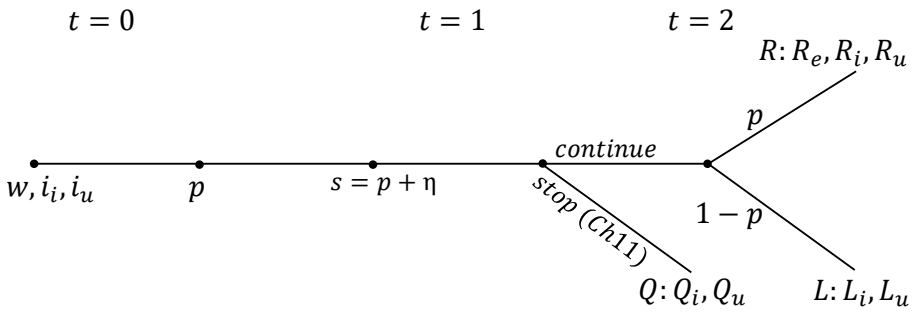
We now present a model that analyzes the connections between firm attributes and debt characteristics. It shows that monitoring would be more intensive when liquidation values are low and leverage is high. The model also delivers multidimensional priority rules under the optimal arrangement. It demonstrates that monitoring would be undertaken by creditors who have high priority against the firm's business value in success and in restructuring, but not against the liquidation value. In addition, the model shows that debt with strict monitoring provides broader benefits and helps firms borrow beyond liquidation values. Finally and importantly, the model aims to follow, as closely as possible, the features of US bankruptcy laws and debt contracts in practice.

4.1 Setup

We consider a model with three agents: an entrepreneur, an informed investor, and an uninformed investor. The entrepreneur has an investment opportunity that requires one unit of funding. The entrepreneur's total wealth is $w < 1$, and the remainder needs to be financed using external funds from uninformed and informed investors. The investment outcome can be high (R) or low (L). The good outcome represents successful operations. The bad outcome represents business failure and liquidation. The probability of success (p) is determined by the entrepreneur's effort, at cost $\frac{1}{2}\gamma p^2$ to the entrepreneur. All agents also have access to a storage technology with return 1. The entrepreneur's effort p is privately known and not contractible, but the firm's performance is a noisy signal of p and is contractible. The informed investor can access a technology that enables her to investigate and find out about p, but this technology costs c per incidence of monitoring. Accordingly, we separate the investors into informed and uninformed to examine the mechanisms and functions of creditor monitoring.

The model has three periods. The sequence of events is also illustrated in the diagram below. At $t = 0$, the entrepreneur offers take-it or leave-it contracts to the investors. If accepted, the investment decisions are made. It is also assumed that the informed investor pays the expected cost of monitoring in advance (i.e., at $t = 0$) and the entrepreneur chooses effort (or the probability of success p) after observing whether the informed investor has paid the expected monitoring cost.[27]

[27] There are several ways to think about this assumption that monitoring costs are paid in advance. For



Timing of the Model

At $t = 1$, investors observe a noisy public signal of effort $s = p + \eta$, where $\eta \sim N(0, \sigma)$. The signal can be thought of as the firm's financial performance (such as earnings). It is verifiable and contractible. The contract specifies a threshold s^*, below which the informed investor has the control right to decide whether the project should continue or stop. This contractual provision can be thought of as a financial covenant based on observable firm performance. Upon a low realization of the signal (i.e., $s < s^*$), the informed investor can observe the true value of p through the costly monitoring technology, and she then decides whether to continue or stop the project. If the project is stopped, the return will be Q ($L < Q < 1$). We interpret this intervention as a restructuring, e.g., through Chapter 11, and Q can represent the going-concern value in Chapter 11 restructuring. On the other hand, if the project continues, at $t = 2$ the final outcome is realized, which is R (success) with probability p and L (failure) with probability $1 - p$. If the signal is high (i.e., $s \geq s^*$), then the project continues automatically.

The contract $\mathbb{C}$ specifies the investment of the informed and uninformed investors (i_i, i_u) as well as the allocation of payments among them when the project continues and the outcome is high (R_i, R_u), when the outcome is low (L_i, L_u), and when the project is stopped (Q_i, Q_u). The contract also specifies the threshold s^* below which the informed investor has control rights. Given the resource constraint, payments to the entrepreneur in different states are $R_e = R - R_i - R_u$, $L_e = L - L_i - L_u$, and $Q_e = Q - Q_i - Q_u$.

Assumption 1. $L < Q < 1 < \frac{(R-L)^2}{2\gamma} + L$.

This assumption ensures that the project has positive net present value for some level of effort. In addition, the value of the project with restructuring is higher than the liquidation value, but less than the initial investment.

instance, the teams and employees of informed lenders need to be formed in advance. Legal, diligence, and contractual work also need to be performed in advance.

4.2 First Best

Before characterizing the optimal financial contract, we study the first best. The first best maximizes the total surplus:

$$\max_p pR + (1-p)L - \frac{1}{2}\gamma p^2,$$

which gives us

$$p^{FB} = \frac{R-L}{\gamma}.$$

Therefore, the optimal level of effort is increasing in the difference between the high outcome and the low outcome $(R-L)$, and decreasing in the cost of effort γ.

4.3 Optimal Financial Contract

We now consider the optimal financial contract when the firm is financed without the informed investor, as well as the case when the informed investor is required.

Assumption 2. *Contracts are restricted to those with* $L_i \leq Q_i \leq p^{FB}R_i + (1-p^{FB})L_i$ *and* $L_u \leq Q_u \leq p^{FB}R_u + (1-p^{FB})L_u$.

This ensures that the contract is consistent with US bankruptcy laws where investors in Chapter 11 (restructuring) should receive no less than what they would receive in Chapter 7 (liquidation). In addition, investors cannot use bankruptcy for rent extraction.

4.3.1 Without Informed Investor

We first consider the case without the informed investor. Here the entrepreneur's problem is to maximize profits given the uninformed investor's participation constraint:

$$\max_{p,R_u,L_u} \; p(R-R_u) + (1-p)(L-L_u) - \frac{1}{2}\gamma p^2,$$
$$\text{s.t. } pR_u + (1-p)L_u \geq i_u.$$

Proposition 1. *For* $w \in [1-L, 1]$, *the first best can be achieved without an informed investor and* $R_u = L_u = i_u = 1-w$.

This is simply because as long as $R_u = L_u$, the marginal incentive of the entrepreneur is not affected by the presence of an outside investor. However, if $w < 1-L$ (or $i_u > L$), the first best cannot be achieved without an informed investor. This is because if $i_u > L$, the participation constraint of the uninformed investor requires $R_u > L$, and therefore the entrepreneur's effort $\hat{p} = (R-R_u)/\gamma$ will be less than p^{FB}.

4.3.2 With Informed Investor

We now consider the case when $w < 1 - L$ and therefore the first best cannot be achieved without the informed investor. We investigate how the presence of the informed investor can alleviate the moral hazard problem.

We define p^* as the threshold effort level of the entrepreneur, below which the informed investor will stop the project if she has control rights. Then the optimal contract consists of the optimal choices of s^* and p^*, as well as investors' contributions (i_i, i_u) and payoffs $\{(R_i, R_u), (Q_i, Q_u), (L_i, L_u)\}$, which maximize the total output net of monitoring costs and the entrepreneur's effort costs, subject to incentive compatibility and participation constraints of all agents. Since we only consider the cases where the entrepreneur borrows more than L, it is straightforward that $L_e = 0$ in the optimal contract.

Therefore, the optimal contract can be characterized as:

$$\max_{p^*, \mathbb{C}} \; p^*R + (1-p^*)L - \frac{1}{2}\gamma p^{*2} - \mathbb{P}[s < s^*|p^*]c, \quad s.t.$$

$$\forall p < p^* : \; pR_i + (1-p)L_i < Q_i, \tag{4}$$

$$\forall p \geq p^* : \; pR_i + (1-p)L_i \geq Q_i, \tag{5}$$

$$\forall p < p^* : \; \mathbb{P}[s < s^*|p]Q_e + \mathbb{P}[s \geq s^*|p]pR_e - \frac{1}{2}\gamma p^2 \leq p^*R_e - \frac{1}{2}\gamma p^{*2}, \tag{6}$$

$$\mathbb{P}[s < s^*|\tilde{p}]Q_i + \mathbb{P}[s \geq s^*|\tilde{p}]\,[\tilde{p}R_i + (1-\tilde{p})L_i] \leq i_i, \tag{7}$$

$$p^*R_i + (1-p^*)L_i - \mathbb{P}[s < s^*|p^*]c \geq i_i, \tag{8}$$

$$p^*R_u + (1-p^*)L_u \geq i_u. \tag{9}$$

Equations (4) and (5) ensure that the informed investor stops the project whenever she observes effort below p^* and allows the project to continue otherwise. The only choice of (R_i, L_i, Q_i) that satisfies both conditions is:

$$p^*R_i + (1-p^*)L_i = Q_i. \tag{10}$$

Accordingly, the informed investor does not experience any loss in the event of restructuring. One can think of this condition as the informed lender having priority with respect to the enterprise value in restructuring. Indeed, it is exactly this seniority that ensures monitoring is enforceable and stopping the project at $t = 1$ when the effort is below p^* is incentive compatible for the informed investor.

Equation (6) makes sure that when the informed investor monitors and enforces the threat point p^*, the entrepreneur does not benefit from shirking and therefore chooses effort p^*. In particular, given Equation (10), the informed investor stops the project

when she has control rights (i.e., $s < s^*$) and finds effort below p^*. The entrepreneur then receives Q_e. Otherwise, the project continues and is successful with probability p.

Equation (7) guarantees that the informed investor has the skin in the game to pay the expected monitoring cost at $t = 0$. In particular, if the informed investor does not pay the monitoring cost, the entrepreneur will choose effort below p^*. Given Equation (10), this means that the informed investor's best response is to stop the project whenever she has control rights (i.e., $s < s^*$).The entrepreneur's effort in that case $\tilde{p}$ is given by:

$$\tilde{p} = \arg\max_{p} \ \mathbb{P}[s < s^*|p]Q_e + \mathbb{P}[s \geq s^*|p]pR_e - \frac{1}{2}\gamma p^2.$$

As a result, given Equation (7), not paying the expected monitoring cost at $t = 0$ generates a negative net return for the informed investor. Equations (8) and (9) satisfy the participation constraint of the informed and uninformed investors.

Note that based on the definition of $\tilde{p}$, the optimality of s^* requires that:

$$\mathbb{P}[s < s^*|\tilde{p}]Q_e + \mathbb{P}[s \geq s^*|\tilde{p}]pR_e - \frac{1}{2}\gamma\tilde{p}^2 = p^*R_e - \frac{1}{2}\gamma p^{*2}.$$

Otherwise, total monitoring costs $\mathbb{P}[s < s^*|p^*]c$ can be reduced without violating any of our constraints.

Finally, among all possible contracts, we choose the one that requires the minimum amount of investment by the informed investor (i_i). This can be rationalized by assuming that the informed investor has slightly higher cost of capital than the uninformed investor. See Internet Appendix Section IA6 for the full characterization of the optimal contract with an informed investor.

Proposition 2. *For any level of entrepreneur wealth $w \in [\underline{w}, 1 - L]$, the optimal contract with minimum investment by the informed investor requires priority of the informed investor with respect to the project value in restructuring (i.e., $Q_i = i_i + \mathbb{P}[s < s^*|p^*]c$), and priority of the uninformed investor with respect to the liquidation value (i.e., $L_u = L$).*[28]

The priority of the informed investor in restructuring is follows directly from her incentive compatibility at $t = 1$ (i.e., Equation (10)) and her participation constraint (i.e., Equation (8)). This ensures that the decision to stop the project for low levels of effort (i.e., $p < p^*$) is time-consistent. Otherwise, the informed lender may have incentives to let the project continue to avoid ex post losses. The optimal financial contract with the minimum level of investment by the informed investor also requires $L_i = 0$ and $L_u = L$,

[28] $\underline{w}$ is the minimum level of wealth for which the project net of effort cost and monitoring cost has positive NPV. That is, $\underline{w}$ is the minimum value of w which satisfies $p^*(w)R + [1 - p^*(w)]\,L - \frac{1}{2}\gamma p^*(w)^2 - \mathbb{P}[s < s^*(w)|p^*(w)]c - 1 \geq 0$.

since the ex ante incentive of the informed investor to pay the expected monitoring cost at $t = 0$ is a function of $R_i - L_i$. Intuitively, this is because if the informed investor shirks on monitoring then the entrepreneur chooses effort $\tilde{p}$, which is less than the optimal level p^*. Therefore, it is the difference between R_i and L_i that incentivizes the informed lender to pay the monitoring cost. Accordingly, any increase in L_i should be associated with a similar increase in R_i and consequently in i_i.

Finally, Figure 9 shows covenant tightness ($\mathbb{P}[s < s^*|p^*]$) in Panel A and investment of the informed investor (i_i) in Panel B, as a function of the entrepreneur's wealth. The solid blue line represents a case with low liquidation values, and the dashed red line represents a case with high liquidation values.[29] In the limit of $w \to 1 - L$, the solution to the above equations converges to $\mathbb{P}[s < s^*|p^*] = 0$ and $i_i = 0$, which confirms the smooth transition between situations with and without the informed investor. In the optimal solution, investment by the informed investor and covenant tightness both increase as leverage rises. The increase in covenant tightness ensures that despite less skin in the game, the entrepreneur has incentives to exert the optimal level of effort. The increase in the informed investor's investment also ensures that she has incentives to pay the monitoring cost. Moreover, for the same level of leverage, lower liquidation values are associated with a higher reliance on the informed investor and tighter covenants.

So far we have considered the optimal contract with the minimum level of investment by the informed investor. We now ask whether there is any level of leverage for which the optimal contract cannot be achieved without an uninformed investor.

Proposition 3. *For any level of entrepreneur's wealth $w \in [\underline{w}, 1 - Q + \mathbb{P}[s < s^*|p^*]c)$, the optimal contract requires the existence of both the informed investor and the uninformed investor.*

This proposition can be proved by noting that enforcing the threat requires satisfiying Equation (10). Also, combining Equations (8) and (10), we have $i_i = Q_i - \mathbb{P}[s < s^*|p^*]c$. Therefore, the maximum investment that satisfies the incentive compatibility of the informed investor is $Q - \mathbb{P}[s < s^*|p^*]c$. This means that any additional amount of borrowing has to take the form of low priority debt from the uninformed investor.

This result shows the complementarity between the informed investor and the uninformed investor for high levels of leverage. Basically, the informed investor's incentive compatibility condition requires full recovery in the event of restructuring. As a result, the total value of the project in the event of restructuring limits the total amount of borrowing from the informed investor.

[29] The choice of parameters for the low liquidation value case is: $R = 2$, $L = 0.25$, $c = 0.1$ and $\gamma = 1.9$, and that for the high liquidation value case is: $R = 1.75$, $L = 0.5$, $c = 0.1$ and $\gamma = 1.35$. This set of parameters ensures the net present values of the two projects are almost the same. In both cases, we have $\sigma = 2$ and $Q = 0.8$.

4.4 Discussion

Despite its relative simplicity, our model sheds light on several key features of the data. First, consistent with Panel C in Figure 5 and Figure IA1, firms rely significantly more on loans with monitoring for levels of leverage above their liquidation values. Relatedly, consistent with results in Table 6 and Figure 6, the tightness of covenants increases with leverage and decreases with liquidation values. Second, the model highlights that monitoring debt is backed by the firm's business value in success and in Chapter 11 restructuring, not by the liquidation value of discrete assets. Third, in the model as long as covenants can be enforced and monitoring costs are reasonably small, liquidation values do not necessarily determine the total borrowing capacity of the firm, but only the composition of its debt. This is consistent with the finding in Section 3.4 that total leverage does not depend on liquidation values among large firms.

The model is also useful for thinking about the design of firms' capital structure and debt structure. To begin, the entrepreneur has the least senior claim to the project, which we can think of as equity. As in Gale and Hellwig (1985), an equity contract minimizes entrepreneur moral hazard. More importantly, despite being a small fraction of the capital structure, loans with strong control can provide a monitoring service that other investors benefit from. Nonetheless, the enforcement of monitoring requires both high priority (full recovery) of the informed investor in the case of restructuring and the sensitivity of the informed investor to the entrepreneur's effort. For high levels of leverage, the model shows these two conditions cannot be satisfied without the existence of the uninformed investor. Therefore, the interaction between different types of lenders is key for addressing the time consistency problem of the informed investor; it ensures that the informed investor does not have incentives to continue projects with low net present values.[30] Finally, consistent with empirical evidence in Schwert (2020), the model predicts that the interest rate on debt from informed investors is higher than the interest rate on debt from uninformed investors. The higher interest rate on debt from informed lenders is not necessarily a sign of market power, but instead a compensation to informed lenders for the monitoring costs.

Overall, the model points to the role of control right institutions and property right institutions in determining firms' borrowing capacity. Better property right institutions

[30]The prediction that seniority of the informed lender makes the monitoring threat credible is similar to the theoretical results in Park (2000) and Repullo and Suarez (1998). However, these models abstract from the multifaceted priority rules observed in the data. Our model shows that it is the seniority with respect to the going-concern value of the firm (not the liquidation value) that helps the informed lender enforce monitoring. Bolton and Scharfstein (1996) study the holdup problem as another mechanism that can connect liquidation values with debt structures, which predicts that the number of creditors may increase with liquidation values.

may help lenders avoid paying monitoring costs. However, given the low level of liquidation values for firms in most industries, the development and effectiveness of control right institutions that facilitate creditor monitoring of firm performance can be important for firms' ultimate debt capacity. Covenants help allocate control rights and enforce monitoring, consistent with empirical results in previous research (Chava and Roberts, 2008; Roberts and Sufi, 2009; Nini, Smith, and Sufi, 2012).

We note several caveats in interpreting this model. First, the model focuses in particular on monitoring debt to illustrate the role of creditor control, and for simplicity it does not distinguish between asset-based debt and cash flow-based debt with weak control. We can further decompose uninformed debt into a part that is secured by the liquidation value of discrete assets, which has priority against this value, and a remaining part. That is, one can think of $i_u = i_{ABL} + i_B$ (where i_{ABL} denotes asset-based debt and i_B denotes bonds), and $i_{ABL} = R_{ABL} = Q_{ABL} = L_{ABL} \leq L_u = L$. With this additional division, asset-based debt (i_{ABL}) and cash flow-based bonds (i_B) would have the empirical properties documented in Section 3.1. In practice, asset-based debt provides lenders with strong protection through the liquidation value of standardized and separable assets, which is a primary way to reduce the need to analyze and monitor a firm's business operations. It can enjoy slightly lower interest rates (Luck and Santos, 2020; Benmelech, Kumar, and Rajan, 2020a) and its prevalence is higher among firms with more liquid and generic assets. It is also possible that asset-based debt can address dynamic commitment problems that we are not considering here (Donaldson, Gromb, and Piacentino, 2020b; Demarzo, 2019). Additionally, cash flows are verifiable in our model; if they were not, asset-based debt would also play a primary role.

Second, in the current model, restructuring is only an outside option that makes the threat to enforce high effort credible; it does not occur in equilibrium. In practice, restructuring does happen and firm value in restructuring is an important determinant of the default recovery rate of cash flow-based debt. This feature can be captured by adding a luck component in the probability of success, which is beyond the firm's control (i.e., $p = e + \nu$, where e is the entrepreneur's effort and ν is luck). In this case, restructuring can be optimal for low realizations of ν and will happen with some probability.

Third, the current model does not allow for renegotiation of payments to investors (e.g., promised payments to the informed investor might change following covenant violation). Accordingly, while we are concerned with the incentive compatibility of the informed investor both ex ante and ex post, we do not require the contract to be renegotiation-proof.

5 Conclusion

In this paper, we collect new data to study the nature of debt enforcement among US non-financial firms. We first show that the liquidation value of fixed assets and working capital on average accounts for only 23% of total book assets. We then demonstrate key features of firms' debt contracts (including debt composition, interest rates, default recovery rates, and covenants) as a function of their liquidation values, going-concern values, and indebtedness, which reflect that different debt contracts are backed by different aspects of the firm. Companies with lower liquidation values have more cash flow-based debt and more intensive creditor monitoring of firm performance. They pay higher interest rates only when they borrow through asset-based debt. Overall, total leverage does not necessarily depend on the liquidation value of discrete assets, except among small public firms and firms with negative earnings. We provide a simple model that rationalizes the empirical results and demonstrates the role of creditor control rights in debt enforcement.

Our findings have several additional implications. First, our data sheds further light on the long-standing question of firms' borrowing constraints. Our liquidation value data provides estimates of the maximum debt capacity if borrowing constraints are determined by the liquidation value of discrete assets. Given that non-financial firms' assets tend to be highly specific, such borrowing constraints are rather restrictive. Indeed, many firms in the data borrow beyond the liquidation value of discrete assets, and total leverage does not depend on the liquidation value when covenants on firm performance are not very costly to enforce and the corporate restructuring system is well-developed. Second, our evidence suggests that only having institutions to enforce property rights (e.g., seize and liquidate hard assets) may be insufficient. In light of the limited liquidation values of many firms, financial development benefits from institutions that help creditors monitor firm performance and preserve going-concern values. Relatedly, the development of different industries in a country can depend on the institutional environment: industries with lower liquidation values may find it difficult to thrive in countries without well-developed control right institutions.

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Main Figures and Tables

Figure 2: Examples of Summary Tables in Liquidation Analyses

This figure shows two examples of liquidation analysis summary tables. Panel A shows the example of a chemical company, Lyondell (case number 09-10023). Panel B shows the example of a communications product company, Sorenson Communications (case number 14-10454).

Panel A. Lyondell

Obligor Debtors
Liquidation Analysis

Exhibi

(MILLIONS)	NBV	Low	High	Midpoint
Cash & Equivalents & Short Term Investments	$238.1	$238.1	$238.1	$238.1
Trade Accounts Receivable	1,248.1	748.9	873.7	811.3
Other Receivables	268.1	8.4	57.0	32.7
Intercompany Receivables	30,474.1	0.0	0.0	0.0
Inventory	1,872.5	1,295.9	1,511.0	1,403.5
Prepaids and Other Current Assets	305.4	0.0	0.0	0.0
Property, Plant & Equipment, net	9,366.5	1,577.4	1,577.4	1,577.4
Investments and Long-Term Receivables	27.5	0.2	1.8	1.0
Intercompany Investments	43,823.1	336.1	373.1	354.6
Intangible Assets, net	1,254.1	427.6	427.6	427.6
Insurance Proceeds	0.0	0.0	229.6	114.8
Other Long-Term Assets	72.2	61.6	63.6	62.6
Gross Proceeds	$88,949.4	$4,694.2	$5,352.9	$5,023.5
Costs Associated with Liquidation:				
Payroll/Overhead		(93.9)	(107.1)	(100.5)
Liquidation Costs of PP&E		(157.7)	(157.7)	(157.7)
Chapter 7 Trustee Fees		(140.8)	(160.6)	(150.7)
Chapter 7 Professional Fees		(70.4)	(80.3)	(75.4)
Net Estimated Proceeds before EAI Assets		$4,231.3	$4,847.2	$4,539.2

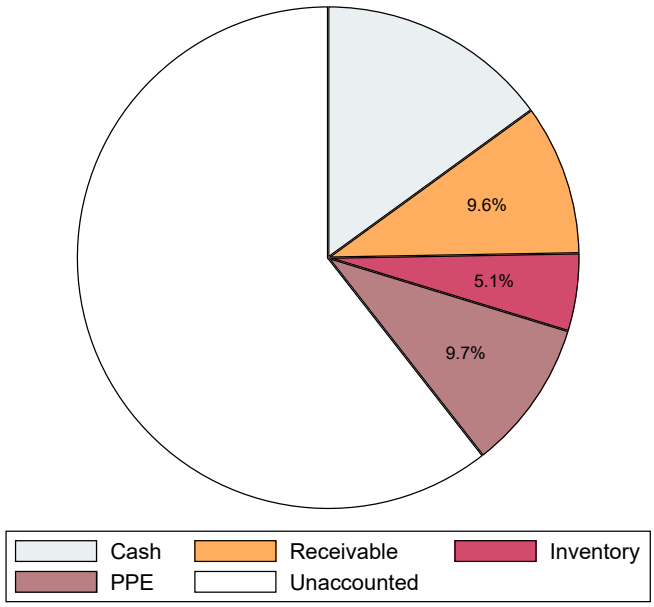
Panel B. Sorenson Communications

Gross Assets Available for Distribution		**Unaudited Balances**	**Estimated Asset Recovery %**		**Estimated Recovery $**	
($ in 000's)	**Notes**	**Jan. 31, 2014**	**Low**	**High**	**Low**	**High**
Cash & Cash Equivalents	A	$ 94,596	100%	100%	$ 94,596	$ 94,596
Accounts Receivable	B	138,727	75%	100%	104,046	138,727
Prepaid and Other Current Assets	C	8,351	5%	10%	418	835
Property, Plant and Equipment, net	D	72,584	6%	12%	4,389	8,779
Goodwill, net	E	214,900	0%	0%	-	-
Intangible Assets	F	98,765	17%	50%	16,348	49,043
Other Assets, Miscellaneous	G	16,901	0%	3%	-	550
Income from Wind-Down Operations	H	-			-	30,276
Total Assets and Gross Proceeds		**$ 644,824**	**34%**	**50%**	**$ 219,796**	**$ 322,805**

Figure 3: Liquidation Values and Chapter 11 Going-Concern Values

The pie chart in Panel A shows the composition of liquidation values for the average non-financial firm in Compustat. It includes the value of cash, as well as the liquidation value of working capital (receivable and inventory) and property, plant, and equipment (PPE). The total size of the pie is total book assets. The figure in Panel B shows the distributions of non-financial firms' liquidation values (normalized by total book assets), both excluding and including cash, along with the distribution of industry-average Chapter 11 going-concern values based on the two-digit SIC of each firm. Sample is Compustat firms between 1996 and 2016.

Panel A. Average Composition of Liquidation Values



Panel B. Liquidation Values and Chapter 11 Going-Concern Values

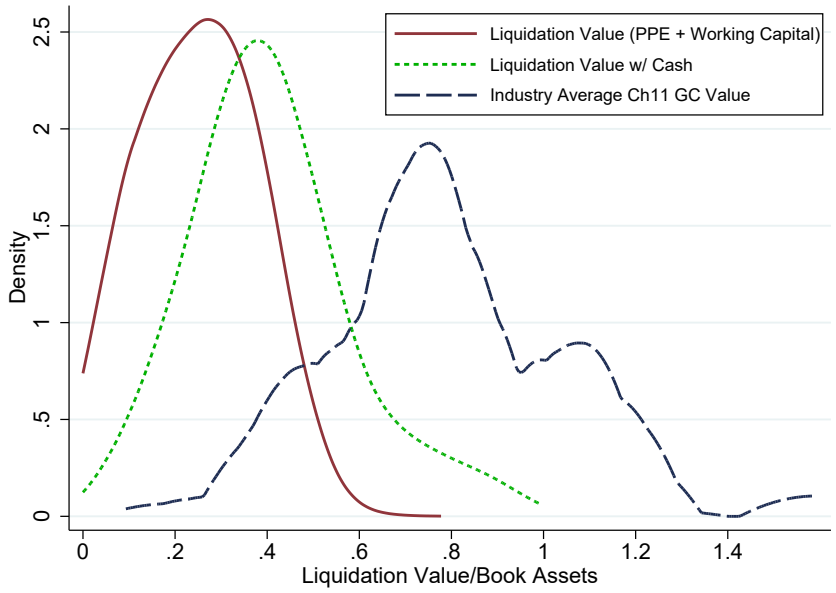
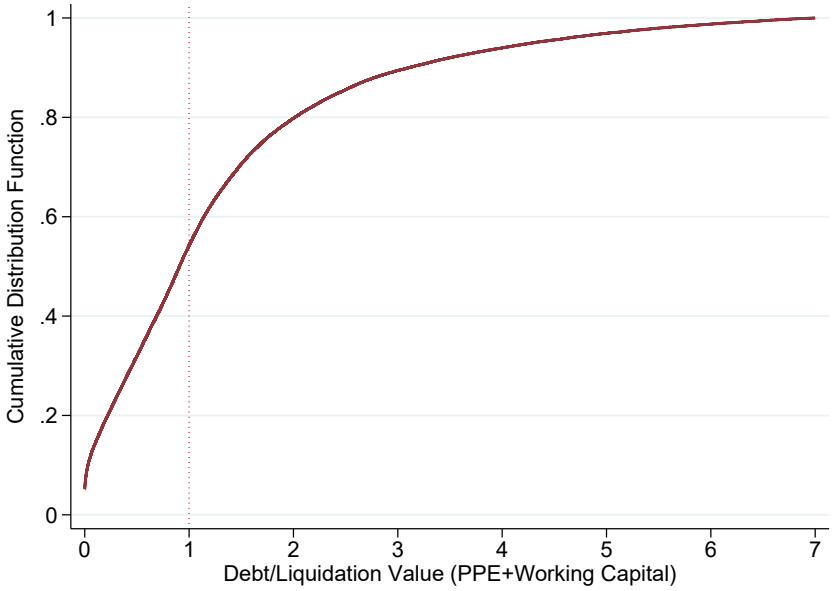


Figure 4: Borrowing Relative to Liquidation Values

Panel A shows the cumulative density function (CDF) of the ratio of total debt relative to the liquidation value of fixed assets and working capital. Panel B shows the CDF of the ratio of total liabilities relative to the cash plus the liquidation value of fixed assets and working capital (solid red curve), and the ratio of total liabilities relative to the industry-average Chapter 11 going-concern value (dashed blue curve). Sample is based on Compustat and CapitalIQ, and sample period is 2003 and 2016. We restrict to firms with book leverage between zero and one, and truncate the ratios in the plots at 7.

Panel A. Total Debt/Liquidation Value



Panel B. Total Liabilities/Liquidation Value (with Cash)

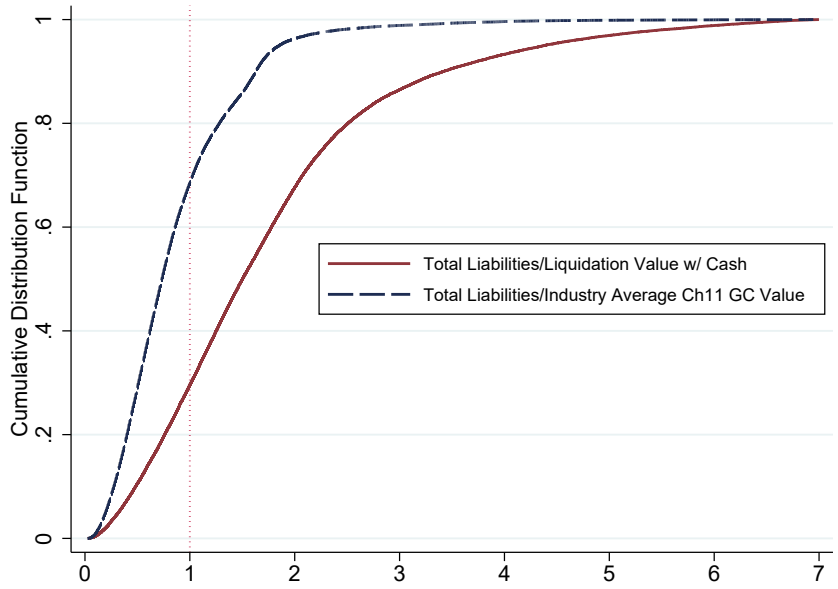
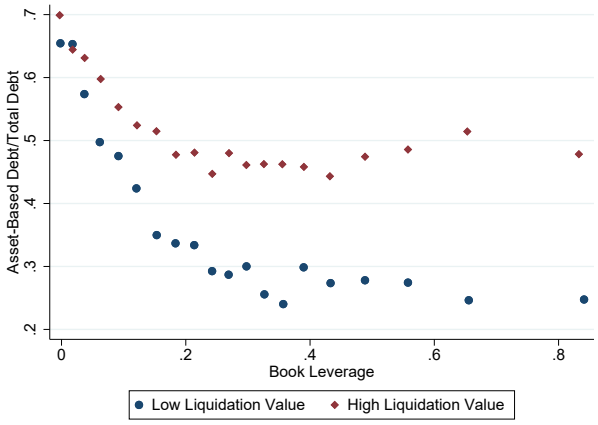


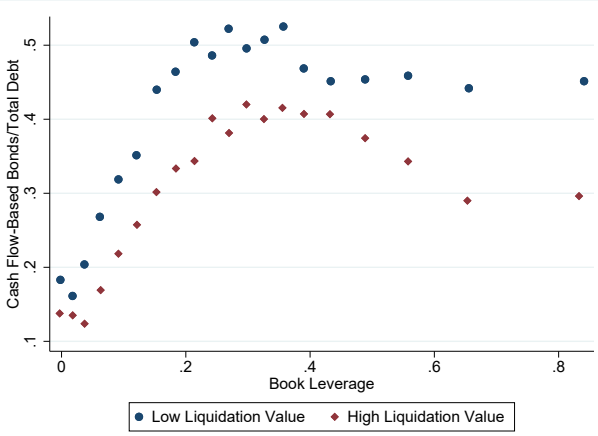
Figure 5: Debt Composition

The figure in Panel A provides a binned scatterplot of asset-based debt as a share of total debt against book leverage in 20 equal-sized bins, for firms with high and low liquidation value. The figures in Panels B and C provide similar plots of cash flow-based bonds and cash flow-based loans respectively. The high (low) liquidation value group includes firms in the top (bottom) tercile of liquidation value each year. Year fixed effects are included. Sample is based on Compustat and CapitalIQ, and sample period is 2003 (beginning of CapitalIQ data for constructing debt composition) to 2016. We restrict to firms with book leverage between zero and one.

Panel A. Asset-Based Debt



Panel B. Cash Flow-Based Debt with Weak Control (Bonds)



Panel C. Cash Flow-Based Debt with Strong Control (Loans)

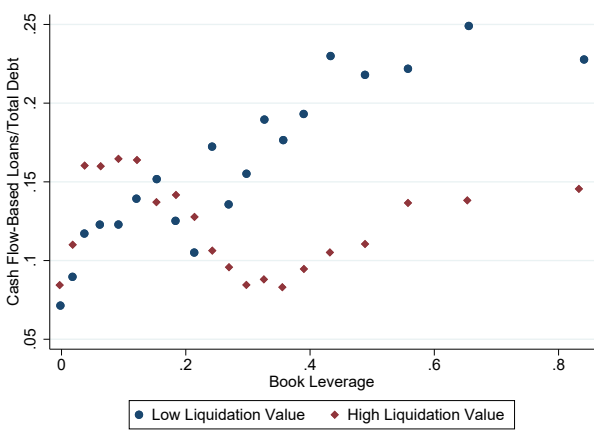


Figure 6: Tightness of Performance Covenants

The figure provides a binned scatterplot of the tightness of performance covenants (probability of violating at least one covenant, in %) against book leverage in 20 equal-sized bins, for firms with high and low liquidation value. The loan covenant tightness measure is constructed using loan covenant thresholds data from DealScan and firm balance sheet data from Compustat, following the procedure of Murfin (2012). Performance covenants include financial covenants on EBITDA, debt to EBITDA, senior debt to EBITDA, interest coverage, fixed charge coverage, cash interest coverage, and debt service coverage. Firms in the top tercile of liquidation values in Compustat each year are categorized within the high liquidation value group, and firms in the bottom tercile are categorized within the low liquidation value group. Year fixed effects and loan size controls are included. Sample period is 1996 to 2016. We restrict to firms with book leverage between zero and one.

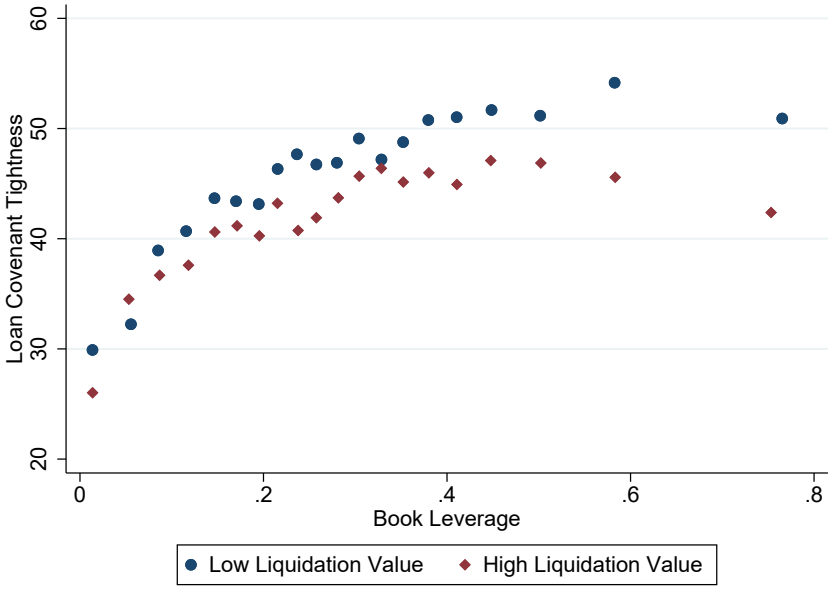
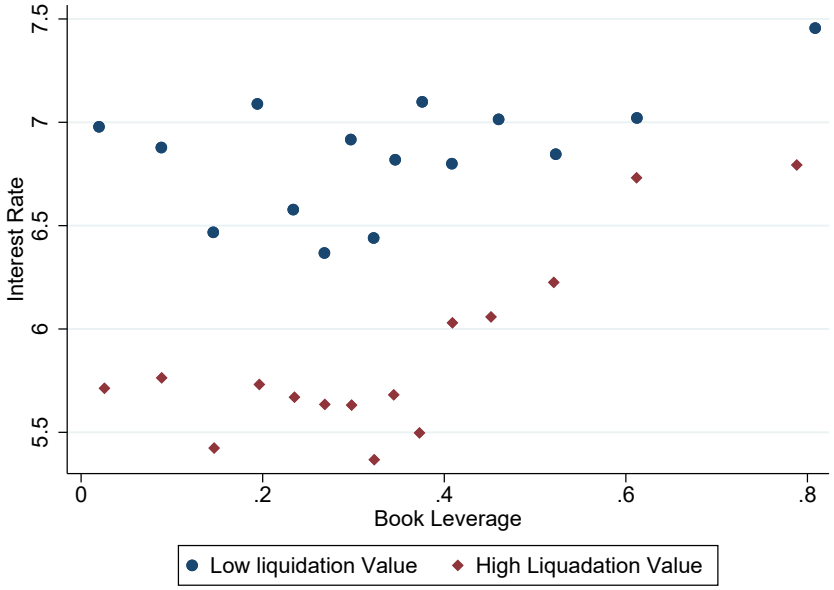


Figure 7: Interest Rates

The figure provides a binned scatterplot of interest rates against book leverage in 20 equal-sized bins for firms with high and low liquidation values. Interest rate data comes from CapitalIQ. Firms in the top tercile of liquidation values in Compustat each year are categorized within the high liquidation value group, and firms in the bottom tercile are categorized within the low liquidation value group. Year-quarter fixed effects are included. Sample period is 2003 (beginning of CapitalIQ data) to 2016. We restrict to firms with book leverage between zero and one.

Panel A. Asset-Based Debt



Panel B. Cash Flow-Based Debt

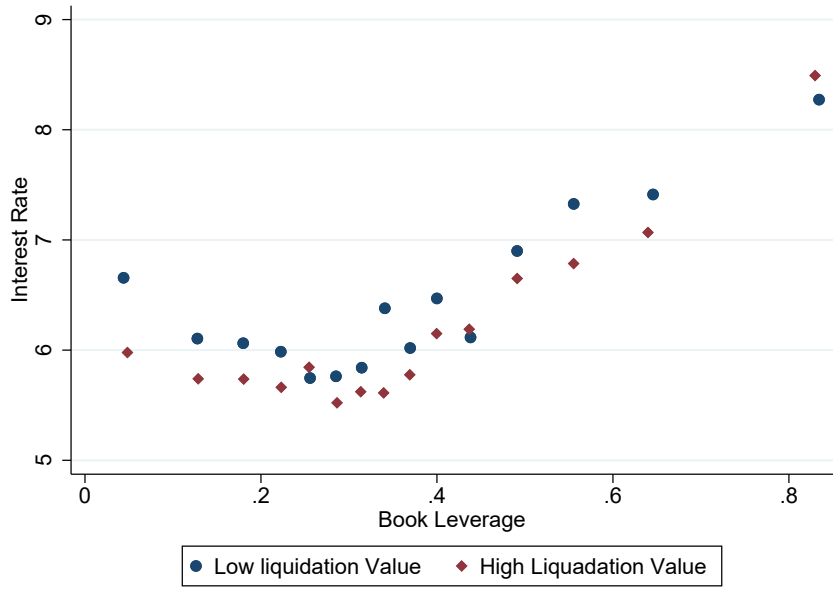
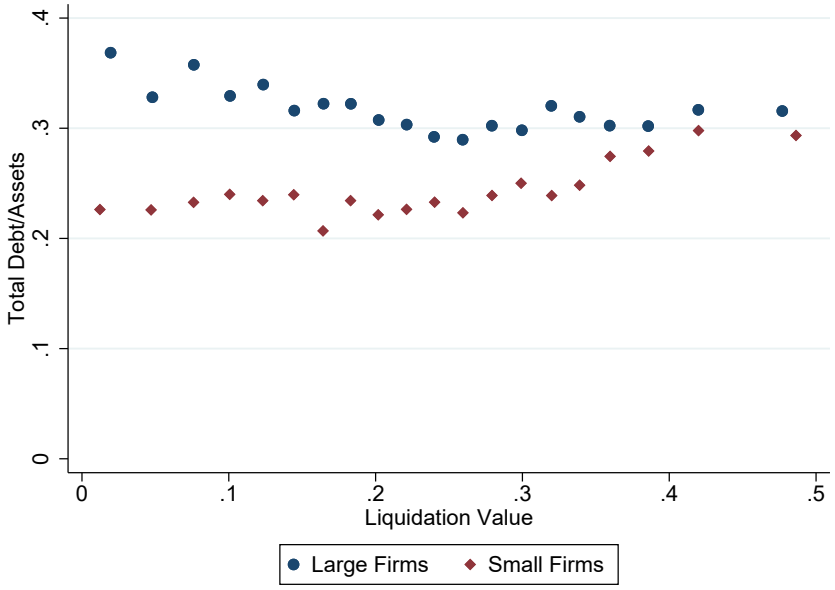


Figure 8: Liquidation Values and Total Borrowing

Panels A and B provide binned scatterplots of book leverage (total debt/total book assets) against liquidation values in 20 equal-sized bins, for firms with high and low total assets and positive and negative EBITDA. Large (small) refers to firms with assets above (below) Compustat median in each year. Year fixed effects are included. Sample is based on Compustat and CapitalIQ, and sample period is 2003 to 2016. We restrict to firms with book leverage between zero and one.

Panel A. Large versus Small Firms



Panel B. Firms with Positive versus Negative Earnings

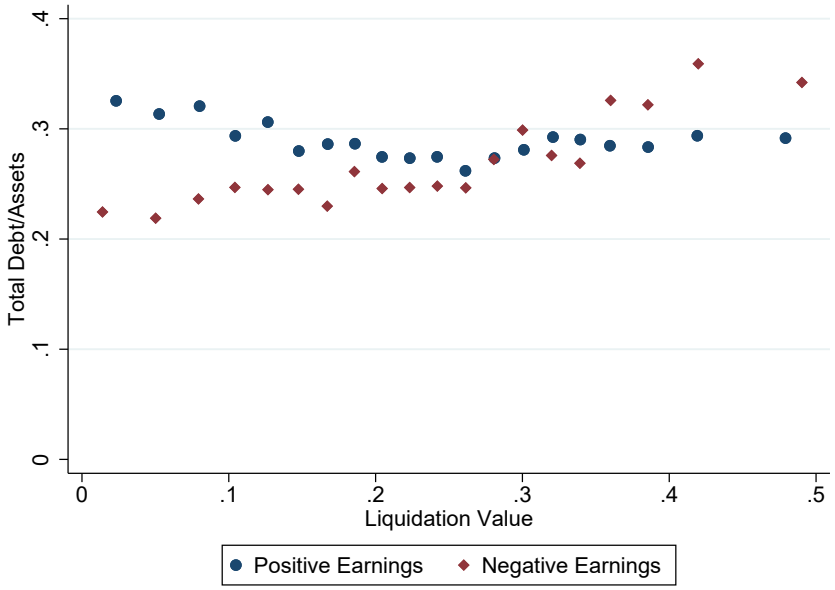
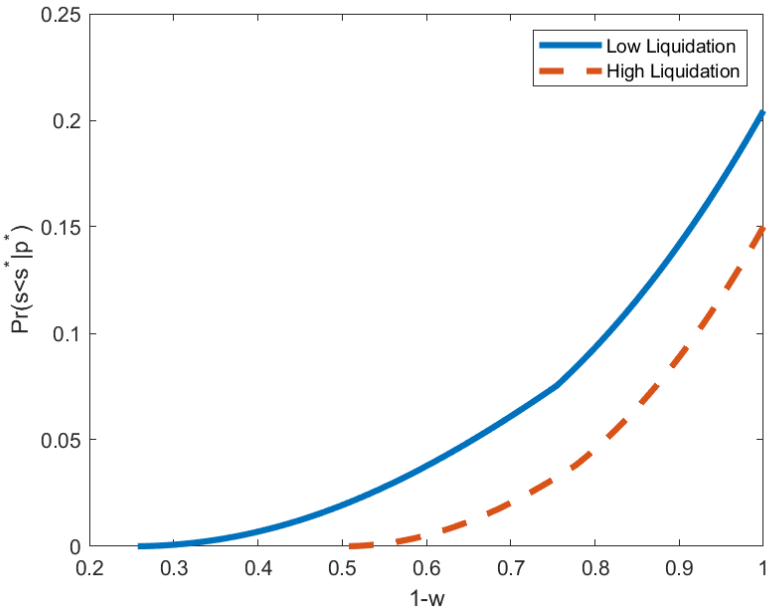


Figure 9: Model Solutions

Panel A plots covenant tightness (probability of violation) as a function of book leverage (one minus the entrepreneur's wealth) for firms with low liquidation value (solid line) and high liquidation value (dashed line). Panel B shows investment of the informed investor as a function of book leverage for firms with low liquidation value (solid line) and high liquidation value (dashed line).

Panel A. Covenant Tightness $\mathbb{P}[s < s^* | p*]$



Panel B. Investment by Informed Investor i_i

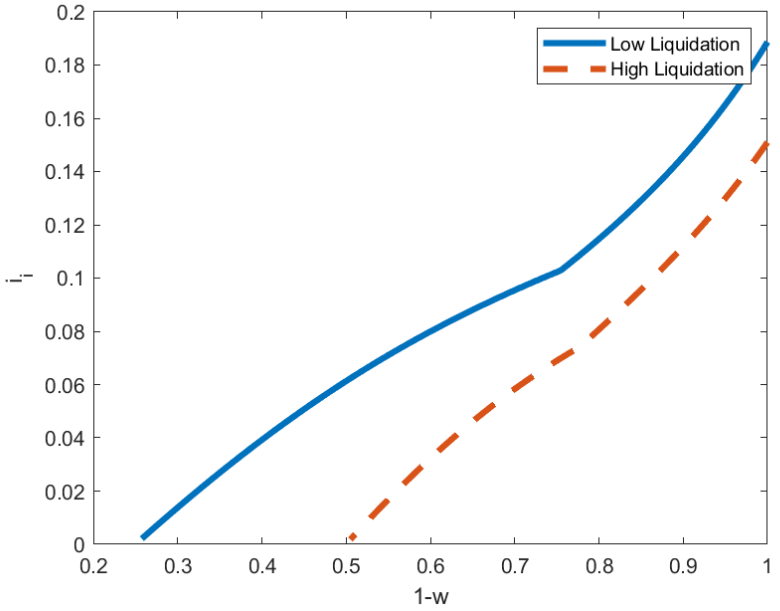


Table 1: Summary Statistics

This table presents summary statistics including mean, standard deviation, and quartiles. Panel A shows statistics for industry-level liquidation recovery rates of PPE, inventory, and receivable, and for firm-level estimated liquidation values in Compustat. The baseline firm-level liquidation value includes PPE and working capital (inventory and receivable), and is normalized by total book assets. It is calculated by combining the industry-average liquidation recovery rate and the book value of each type of asset. The value with cash adds all cash holdings. Chapter 11 going-concern value is the industry-average Chapter 11 value (normalized by total assets at the time of the filing) matched to the firm according to its industry. Panel B shows statistics of total debt and debt composition. The baseline sample period for firm-level Compustat data is 1996 to 2016, except for CapitalIQ debt composition data, which has been available since 2003 (so the debt statistics in Panel B cover 2003 to 2016). We restrict to firms with book leverage between zero and one.

Panel A. Asset Attributes

Industry-level	mean	sd	p25	p50	p75
PPE liquidation recovery rate	35.34	16.69	23.54	32.82	44.49
Inventory liquidation recovery rate	44.26	15.66	33.70	43.92	56.30
Receivable liquidation recovery rate	61.60	13.64	55.07	63.03	70.76
Firm-level (Compustat)	**mean**	**sd**	**p25**	**p50**	**p75**
Liquidation value (PPE, working capital)	24.79	12.84	14.85	24.96	34.47
Liquidation value with cash	40.57	17.87	28.83	38.85	49.94
Ch11 going-concern value	79.18	25.72	67.76	77.63	100.06

Panel B. Debt Composition

	mean	sd	p25	p50	p75
Total debt / Assets	0.27	0.22	0.08	0.24	0.40
Asset-based debt / Total debt	0.45	0.43	0.00	0.32	0.99
Cash flow-based debt / Total debt	0.49	0.43	0.00	0.52	0.97
Cash flow-based bonds / Total debt	0.35	0.40	0.00	0.09	0.77
Cash flow-based loans / Total debt	0.14	0.29	0.00	0.00	0.09
Secured cash flow-based debt / Total debt	0.10	0.25	0.00	0.00	0.00
Unsecured cash flow-based debt / Total debt	0.39	0.42	0.00	0.19	0.88

Table 2: Asset-Based Debt

This table reports firm-level annual regressions where the outcome variable is asset-based debt as a share of total debt in columns (1) and (2), and asset-based debt in total assets in columns (3) and (4). Liquidation value includes PPE and working capital, and is normalized by the firm's total book assets. In columns (2) and (4), both liquidation value and book leverage are demeaned using sample means. Ch11 GC value is the average Chapter 11 going-concern values (normalized by total book assets at the time of Chapter 11 filings) in the firm's industry (two-digit SIC). Market value of assets is book value of assets minus book value of equity plus market value of equity. EBITDA is normalized by lagged total assets, and cash holdings are normalized by total assets. Year fixed effects are included. Standard errors are double-clustered by firm and year and reported in parentheses, and asterisks denote significance levels (***=1%, **=5%, *=10%). Sample is based on Compustat and CapitalIQ, and sample period is 2003 to 2016. We restrict to firms with book leverage between zero and one.

	Share of Total Debt		Share of Total Asset	
	(1)	(2)	(3)	(4)
Liquidation value	0.315***	0.448***	0.136***	0.220***
	(0.050)	(0.060)	(0.020)	(0.029)
Book leverage	-0.277***	-0.286***	0.358***	0.352***
	(0.025)	(0.024)	(0.015)	(0.014)
Liquidation value × Book leverage		1.301***		0.819***
		(0.184)		(0.097)
Ch11 GC value	-0.098***	-0.089***	-0.034***	-0.028***
	(0.020)	(0.020)	(0.007)	(0.007)
Market/book value of assets	-0.026***	-0.024***	-0.007***	-0.006***
	(0.004)	(0.004)	(0.001)	(0.001)
EBITDA	0.049***	0.059***	-0.000	0.006
	(0.016)	(0.016)	(0.005)	(0.005)
Past 12m equity return vol	-0.010	-0.015	-0.001	-0.004
	(0.010)	(0.011)	(0.004)	(0.005)
Cash	0.028	0.002	-0.054***	-0.070***
	(0.031)	(0.030)	(0.011)	(0.010)
Log(assets)	-0.092***	-0.094***	-0.023***	-0.024***
	(0.003)	(0.003)	(0.001)	(0.001)
Observations	29458	29458	29566	29566
Within R^2	.231	.236	.271	.286
Time fixed effects	Yes	Yes	Yes	Yes

Table 3: Cash Flow-Based Debt with Weak Control (Bonds)

This table reports firm-level annual regressions where the outcome variable is cash flow-based bonds as a share of total debt in columns (1) and (2), and cash flow-based bonds in total assets in columns (3) and (4). The independent variables are the same as those in Table 2. Year fixed effects are included. Standard errors are double-clustered by firm and year and reported in parentheses, and asterisks denote significance levels (***=1%, **=5%, *=10%). Sample is based on Compustat and CapitalIQ, and sample period is 2003 to 2016. We restrict to firms with book leverage between zero and one.

	Share of Total Debt		Share of Total Asset	
	(1)	(2)	(3)	(4)
Liquidation value	-0.042	-0.107	0.005	-0.043
	(0.056)	(0.070)	(0.021)	(0.034)
Book leverage	0.248***	0.252***	0.423***	0.427***
	(0.036)	(0.037)	(0.023)	(0.023)
Liquidation value × Book leverage		-0.635***		-0.471***
		(0.211)		(0.123)
Ch11 GC value	0.054**	0.050**	0.015**	0.011*
	(0.020)	(0.020)	(0.006)	(0.006)
Market/book value of assets	0.012***	0.011***	0.005***	0.005***
	(0.004)	(0.004)	(0.001)	(0.001)
EBITDA	-0.100***	-0.105***	-0.022***	-0.025***
	(0.016)	(0.016)	(0.005)	(0.005)
Past 12m equity return vol	0.034**	0.036**	0.002	0.003
	(0.014)	(0.015)	(0.006)	(0.006)
Cash	0.207***	0.220***	0.108***	0.118***
	(0.031)	(0.030)	(0.011)	(0.011)
Log(assets)	0.109***	0.109***	0.027***	0.027***
	(0.004)	(0.004)	(0.002)	(0.002)
Observations	29441	29441	29556	29556
Within R^2	.275	.276	.425	.43
Time fixed effects	Yes	Yes	Yes	Yes

Table 4: Cash Flow-Based Debt with Strong Control (Loans)

This table reports firm-level annual regressions where the outcome variable is cash flow-based loans as a share of total debt in columns (1) and (2), and cash flow-based loans in total assets in columns (3) and (4). The independent variables are the same as those in Table 2. Year fixed effects are included. Standard errors are double-clustered by firm and year and reported in parentheses, and asterisks denote significance levels (***=1%, **=5%, *=10%). Sample is based on Compustat and CapitalIQ, and sample period is 2003 to 2016. We restrict to firms with book leverage between zero and one.

	Share of Total Debt		Share of Total Asset	
	(1)	(2)	(3)	(4)
Liquidation value	-0.279***	-0.350***	-0.110***	-0.133***
	(0.041)	(0.046)	(0.015)	(0.020)
Book leverage	0.087***	0.091***	0.128***	0.130***
	(0.021)	(0.021)	(0.016)	(0.016)
Liquidation value × Book leverage		-0.701***		-0.217***
		(0.143)		(0.062)
Ch11 GC value	0.049***	0.044**	0.015***	0.014**
	(0.015)	(0.015)	(0.005)	(0.005)
Market/book value of assets	0.009**	0.008**	0.001	0.001
	(0.003)	(0.003)	(0.001)	(0.001)
EBITDA	0.064***	0.058***	0.016***	0.015***
	(0.009)	(0.009)	(0.003)	(0.003)
Past 12m equity return vol	-0.038**	-0.036**	-0.008**	-0.007**
	(0.013)	(0.013)	(0.003)	(0.003)
Cash	-0.207***	-0.192***	-0.070***	-0.066***
	(0.026)	(0.025)	(0.007)	(0.006)
Log(assets)	-0.012***	-0.012***	-0.003***	-0.003***
	(0.002)	(0.002)	(0.001)	(0.001)
Observations	29458	29458	29231	29231
Within R^2	.029	.032	.107	.11
Time fixed effects	Yes	Yes	Yes	Yes

Table 5: Secured Cash Flow-Based Debt

This table reports firm-level annual regressions where the outcome variable is secured cash flow-based debt as a share of total debt in columns (1) and (2), and secured cash flow-based debt in total assets in columns (3) and (4). The independent variables are the same as those in Table 2. Year fixed effects are included. Standard errors are double-clustered by firm and year and reported in parentheses, and asterisks denote significance levels (***=1%, **=5%, *=10%). Sample is based on Compustat and CapitalIQ, and sample period is 2003 to 2016. We restrict to firms with book leverage between zero and one.

	Share of Total Debt		Share of Total Asset	
	(1)	(2)	(3)	(4)
Liquidation value	-0.305***	-0.366***	-0.120***	-0.149***
	(0.039)	(0.044)	(0.016)	(0.021)
Book leverage	0.256***	0.259***	0.164***	0.166***
	(0.022)	(0.022)	(0.018)	(0.018)
Liquidation value × Book leverage		-0.603***		-0.272***
		(0.113)		(0.066)
Ch11 GC value	0.027**	0.022*	0.015**	0.013**
	(0.011)	(0.011)	(0.005)	(0.005)
Market/book value of assets	-0.004	-0.005*	-0.002*	-0.002*
	(0.003)	(0.003)	(0.001)	(0.001)
EBITDA	0.007	0.002	0.007**	0.005*
	(0.008)	(0.007)	(0.003)	(0.002)
Past 12m equity return vol	0.029***	0.031***	0.010**	0.011**
	(0.008)	(0.008)	(0.004)	(0.004)
Cash	-0.126***	-0.114***	-0.049***	-0.043***
	(0.018)	(0.018)	(0.006)	(0.006)
Log(assets)	-0.012***	-0.012***	-0.004***	-0.004***
	(0.002)	(0.002)	(0.001)	(0.001)
Observations	29348	29348	29361	29361
Within R^2	.074	.078	.143	.148
Time fixed effects	Yes	Yes	Yes	Yes

Table 6: Loan Covenant Tightness

This table reports regressions of the tightness of loan covenants at issuance. Loan covenant tightness is measured using loan covenant thresholds data from DealScan and firm balance sheet data from Compustat following the procedure of Murfin (2012). It captures the probability (in %) of violating at least one covenant. Performance covenants in columns (1) and (2) include EBITDA, debt to EBITDA, senior debt to EBITDA, interest coverage, fixed charge coverage, cash interest coverage, and debt service coverage covenants. Other financial covenants in columns (3) and (4) include debt to equity, debt to net worth, debt to tangible net worth, current ratio, quick ratio, and capital expenditure covenants. In columns (2) and (4), both liquidation value and book leverage are demeaned using sample means. Control variables are the same as those in Tables 2 to 4, plus log loan size. Year fixed effects are included. Standard errors are double-clustered by firm and year and reported in parentheses, and asterisks denote significance levels (***=1%, **=5%, *=10%). Sample period is 1996 to 2016. We restrict to firms with book leverage between zero and one.

	Performance Covenant		Other Covenant	
	(1)	(2)	(3)	(4)
Liquidation value	-14.566***	-15.687***	5.358	5.361
	(2.366)	(2.362)	(3.391)	(3.423)
Book leverage	24.460***	24.293***	9.851***	9.851***
	(1.415)	(1.397)	(2.646)	(2.644)
Liquidation value × Book leverage		-16.296		0.036
		(9.849)		(18.192)
Ch11 GC value	1.424*	1.393*	1.827	1.827
	(0.783)	(0.779)	(1.393)	(1.392)
Market/book value of assets	-1.054**	-1.058**	-1.170**	-1.170**
	(0.374)	(0.379)	(0.420)	(0.425)
EBITDA	-14.273***	-14.359***	-1.845	-1.845
	(3.362)	(3.403)	(2.769)	(2.769)
Past 12m equity return vol	-1.449	-1.412	4.917***	4.917***
	(1.245)	(1.239)	(1.389)	(1.392)
Cash	-9.438***	-9.049***	-11.907**	-11.908**
	(2.030)	(2.037)	(4.624)	(4.680)
Log(assets)	-1.857***	-1.843***	-2.649***	-2.649***
	(0.219)	(0.220)	(0.525)	(0.525)
Log(loan amount)	1.610***	1.602***	0.607	0.607
	(0.223)	(0.223)	(0.385)	(0.384)
Observations	6392	6392	3583	3583
Within R^2	.208	.209	.071	.071
Time fixed effects	Yes	Yes	Yes	Yes

Table 7: Liquidation Values and Total Borrowing

This table reports firm-level annual regressions on the relationship between liquidation value and total leverage (total debt/total book assets). Small firms are firms with total assets below Compustat median in each year. Industry-average liquidation value is the average firm-level liquidation value (including PPE and working capital) in the firm's industry (two-digit SIC) during the sample period. Standard errors are double-clustered by firm and time and are reported in parentheses, and asterisks denote significance levels (***=1%, **=5%, *=10%). Sample is based on Compustat and CapitalIQ, and sample period is 2003 to 2016. We restrict to firms with book leverage between zero and one.

	Book Leverage					
	(1)	(2)	(3)	(4)	(5)	(6)
Liquidation value	-0.086**	-0.039	-0.088**			
	(0.030)	(0.027)	(0.031)			
Ind-avg liquidation val				-0.064	0.058	-0.070
				(0.044)	(0.040)	(0.045)
Small firm × Liquidation val	0.226***		0.208***			
	(0.037)		(0.043)			
Negative EBITDA × Liquidation val		0.290***	0.137***			
		(0.034)	(0.039)			
Small firm × Ind-avg liquidation val				0.249***		0.230***
				(0.060)		(0.071)
Negative EBITDA × Ind-avg liquidation val					0.235***	0.117
					(0.068)	(0.073)
Small firm	-0.123***		-0.132***	-0.126***		-0.134***
	(0.010)		(0.012)	(0.015)		(0.017)
Negative EBITDA		-0.086***	-0.000		-0.074***	-0.002
		(0.010)	(0.012)		(0.017)	(0.018)
Observations	44179	41758	41758	46546	43959	43959
Within R^2	.031	.01	.037	.027	.006	.032
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Table 8: Interest Rates

This table shows the relationship between liquidation values and interest rates. The sample for columns (1) to (4) is debt records in CapitalIQ, which include all types of debt firms have. We use the initial observation (i.e., observation around issuance) for each debt. The sample for column (5) is DealScan loan issuance. Liquidation value is the liquidation value of PPE and working capital of the issuer firm. Low leverage and high leverage refer to firms with book leverage below and above the sample median. We include firm-year fixed effects and interest rate type-year fixed effects (interest rate types include fixed rate and floating rate with different benchmarks). Standard errors are double-clustered by firm and time and reported in parentheses, and asterisks denote significance levels (***=1%, **=5%, *=10%). Sample period is 2003 to 2016 for CapitalIQ, and 1996 to 2016 for DealScan. We restrict to firms with book leverage between zero and one.

	CapitalIQ				DealScan
	Loans & Bonds	Loans			Loans
		All	Low Leverage	High Leverage	
	(1)	(2)	(3)	(4)	(5)
Asset-based debt=1 × Liquidation value	-1.507**	-1.427**	-1.136**	-1.949*	-0.925***
	(0.522)	(0.581)	(0.507)	(1.071)	(0.299)
Asset-based debt=1	0.050	0.480***	0.590***	0.376**	-0.400***
	(0.072)	(0.088)	(0.083)	(0.132)	(0.038)
Bond=1	0.790***				
	(0.099)				
Note=1	0.288**				
	(0.131)				
Observations	46566	23028	12524	10504	12195
Within R^2	.02	.018	.024	.013	.042
Interest rate type-year fixed effects	Yes	Yes	Yes	Yes	Yes
Firm-year fixed effects	Yes	Yes	Yes	Yes	Yes

Table 9: Creditor Recovery Rates in Default

This table shows the relationship between firm characteristics and default recovery rates for different types of debt. Each observation is a debt instrument in default from Moody's Default & Recovery Database. Columns (1), (3), and (5) use industry-level variables and controls. Columns (2), (4), and (6) use firm-level variables and controls for the subsample of observations in Moody's default recovery rate data that we can match with Compustat firms. Firm-level liquidation value is the liquidation value of the firm (from PPE and working capital) prior to default. Industry-level liquidation value is the average firm-level liquidation value in Compustat in each industry (two-digit SIC). Ch11 GC value is the firm's Chapter 11 going-concern value (normalized by book assets at filing) if we can match it with a case in our bankruptcy dataset, and otherwise the industry-average Chapter 11 going-concern value. Market value of assets is calculated as the book value of assets minus the book value of equity plus the market value of equity. Log (debt amount) is log of the debt claim's face value. Firm-level controls in columns (2), (4), and (6) include EBITDA (normalized by lagged assets), market value/book value of assets, past 12 months stock returns, and cash holdings (normalized by assets), prior to default. Default year fixed effects are included. Standard errors are double-clustered by industry and time and reported in parentheses, and asterisks denote significance levels (***=1%, **=5%, *=10%). Sample period is 1996 to 2016.

	Asset-Based Debt				Cash Flow-Based Debt			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Industry-level liquidation value	39.468**		49.929**		-0.251		17.696	
	(16.522)		(17.957)		(20.881)		(22.332)	
Liquidation value		34.360**		33.495**		5.115		0.301
		(12.705)		(12.735)		(23.780)		(24.815)
Industry-level Ch11 GC value	-12.814*				-7.531			
	(7.119)				(7.638)			
Ch11 GC value		3.560				25.132***		
		(8.653)				(8.364)		
25% market/book value of assets in industry			5.853	7.265			36.357**	33.025**
			(10.195)	(18.273)			(16.283)	(13.731)
% of debt claims more senior	-65.587***	-49.524***	-68.135***	-49.322***	-41.739***	-42.064***	-43.107***	-38.299***
	(10.508)	(15.415)	(10.376)	(16.119)	(5.722)	(3.302)	(5.611)	(5.179)
Bond=1	-26.962***	-24.356***	-26.291***	-24.595***	-16.237***	-16.354***	-15.361***	-19.273***
	(8.279)	(6.998)	(8.396)	(7.371)	(5.415)	(4.831)	(5.341)	(4.925)
Log(debt amount)	2.042	3.247*	2.086	3.342*	-2.706	-5.600***	-2.471	-5.375***
	(1.710)	(1.857)	(1.736)	(1.851)	(2.037)	(0.854)	(2.009)	(1.109)
Pre-filing log(assets)		-1.398		-1.480		6.723***		5.944**
		(1.528)		(1.485)		(1.734)		(2.124)
Pre-filing EBITDA		8.785		8.281		6.904		2.307
		(13.371)		(12.150)		(6.529)		(7.422)
Pre-filing market/book value of assets		-2.751		-2.547		-5.664*		-4.967
		(2.644)		(2.733)		(3.026)		(3.236)
Pre-filing past 12m equity return vol		2.617		2.542		1.665		2.515
		(6.040)		(5.852)		(6.866)		(7.236)
Pre-filing cash		8.469		9.551		-5.565		-10.332
		(23.718)		(23.152)		(19.622)		(25.338)
Observations	955	387	952	392	2237	1023	2224	1033
Within R^2	.321	.407	.314	.405	.209	.277	.222	.242
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

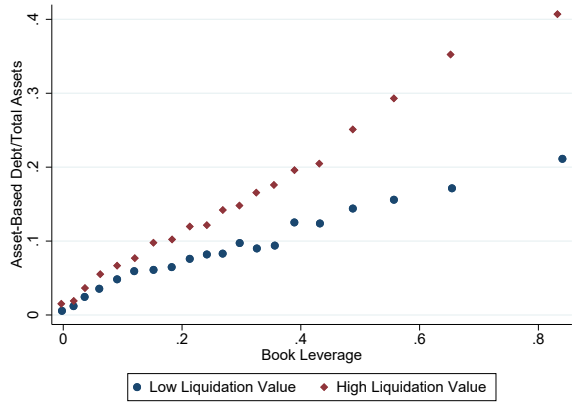
Internet Appendix

IA1 Additional Figures and Tables

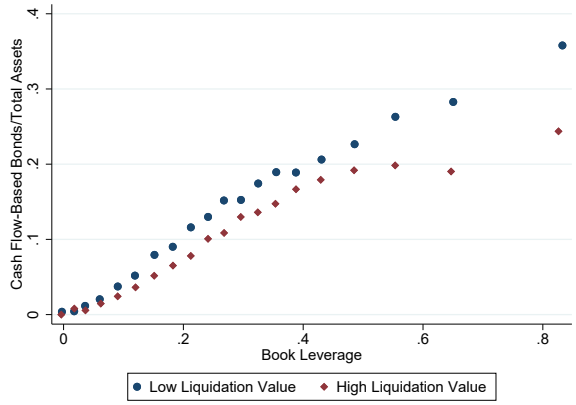
Figure IA1: Debt Composition Relative to Total Assets

The figure in Panel A provides a binned scatterplot of asset-based debt as a share of total assets against book leverage in 20 equal-sized bins, for firms with high and low liquidation value. The figures in Panels B and C provide similar plots of cash flow-based bonds and cash flow-based loans respectively. The high (low) liquidation value group includes firms in the top (bottom) tercile of liquidation value each year. Year fixed effects are included. Sample is based on Compustat and CapitalIQ, and sample period is 2003 (beginning of CapitalIQ data for constructing debt composition) to 2016. We restrict to firms with book leverage between zero and one.

Panel A. Asset-Based Debt



Panel B. Cash Flow-Based Debt with Weak Control (Bonds)



Panel C. Cash Flow-Based Debt with Strong Control (Loans)

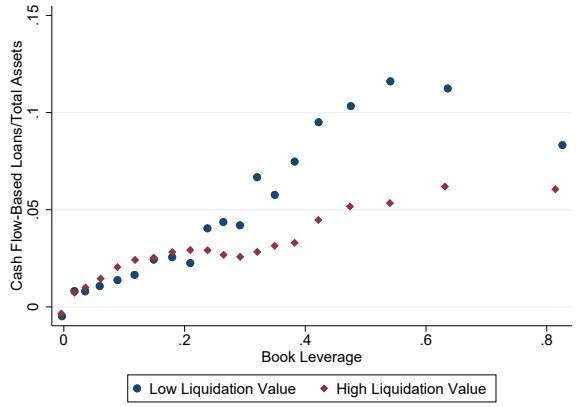
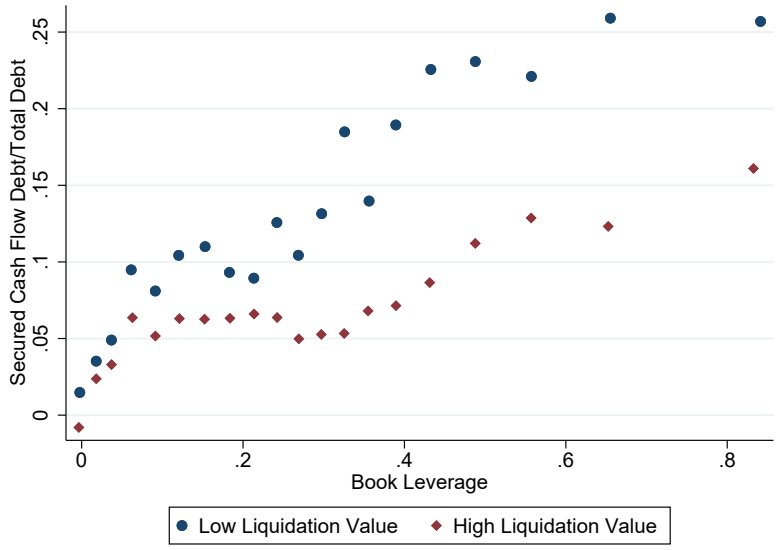


Figure IA2: Secured Cash Flow-Based Debt

The figure in Panel A provides a binned scatterplot of secured cash flow-based debt as a share of total debt against book leverage in 20 equal-sized bins, for firms with high and low liquidation values. The figure in Panel B provides a similar plot of secured cash flow-based debt as a share of total assets. The high (low) liquidation value group includes firms in the top (bottom) tercile of liquidation value each year. Year fixed effects are included. Sample is based on Compustat and CapitalIQ, and sample period is 2003 (beginning of CapitalIQ data for constructing debt composition) to 2016. We restrict to firms with book leverage between zero and one.

Panel A. Share in Total Debt



Panel B. Divide by Total Assets

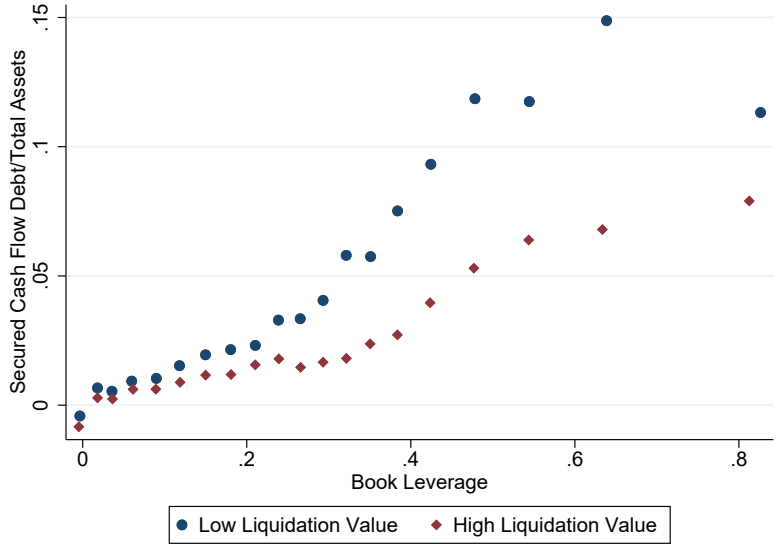
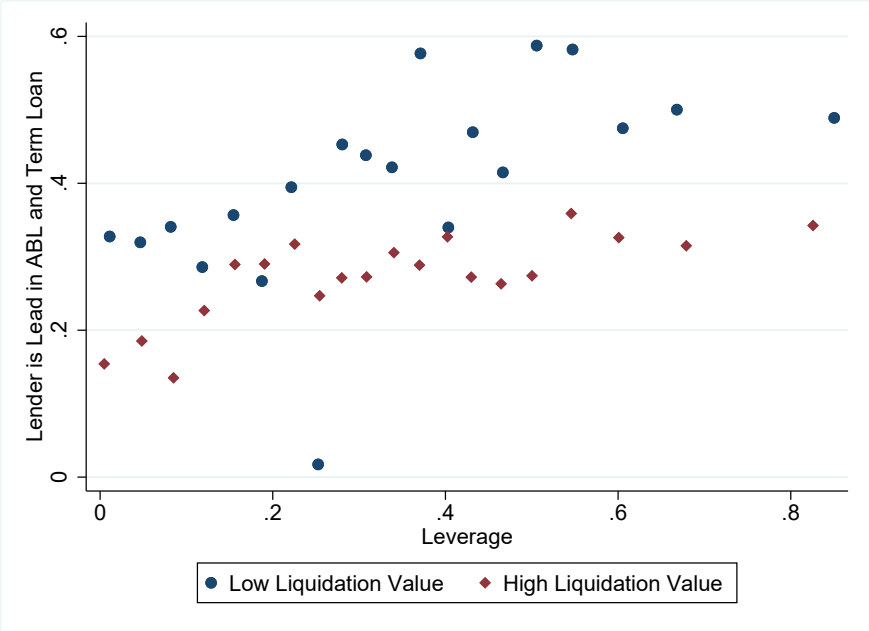


Figure IA3: Frequency of Having the Same Lead Lenders in Asset-Based Loans and Cash Flow-Based Loans

The figure provides a binned scatterplot of the share of DealScan loan packages where the same lender is a lead lender for an asset-based revolver and a cash flow-based term loan, against book leverage in Panel A and firm size (log total assets) in Panel B, in 20 equal-sized bins for firms with high and low liquidation values. Loan lender data comes from DealScan. Firms in the top tercile of liquidation values in Compustat each year are categorized within the high liquidation value group, and firms in the bottom tercile are categorized within the low liquidation value group. Year fixed effects are included. Sample period is 1996 to 2016. We restrict to firms with book leverage between zero and one.

Panel A. By Book Leverage



Panel B. By Firm Size

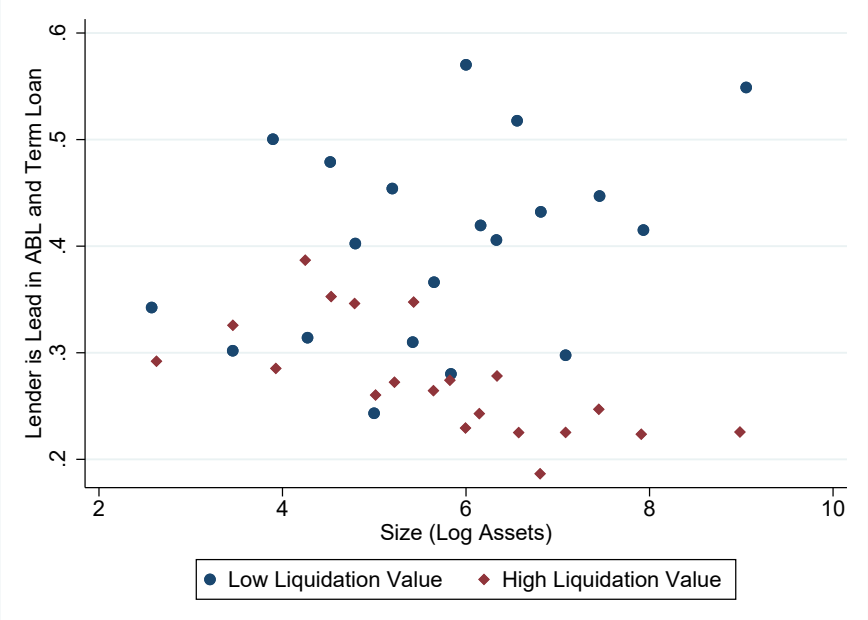


Figure IA4: Probability of Borrowing Base Violations

The figure provides a binned scatterplot of the share of firms where asset-based debt against working capital is greater than the estimated liquidation values of working capital assets, as a function of book leverage in 20 equal-sized bins, for firms with high and low liquidation values. The amount of debt against working capital is constructed using debt-level data from CapitalIQ. Firms in the top tercile of liquidation values in Compustat each year are categorized within the high liquidation value group, and firms in the bottom tercile are categorized within the low liquidation value group. Year fixed effects are included. Sample period is 2003 (beginning of CapitalIQ data) to 2016. We restrict to firms with book leverage between zero and one.

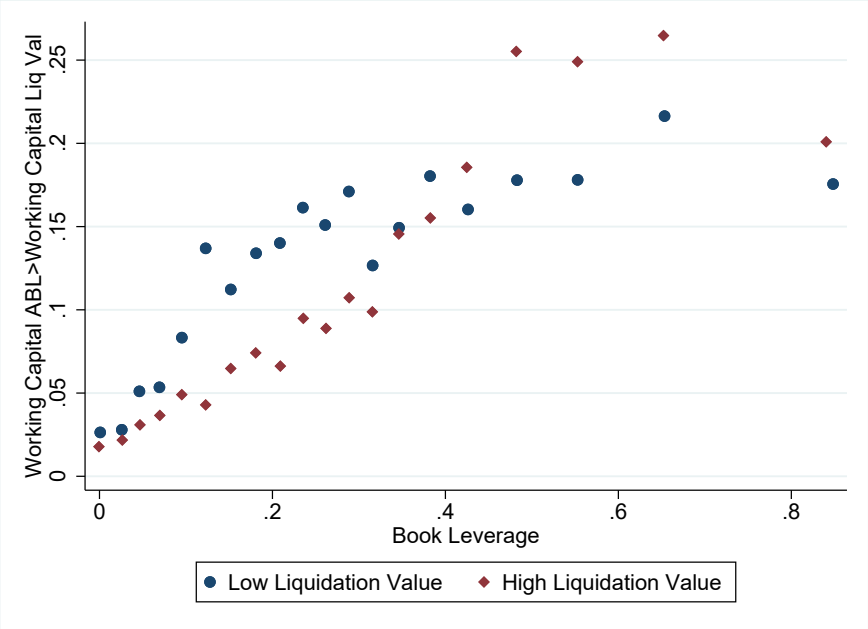
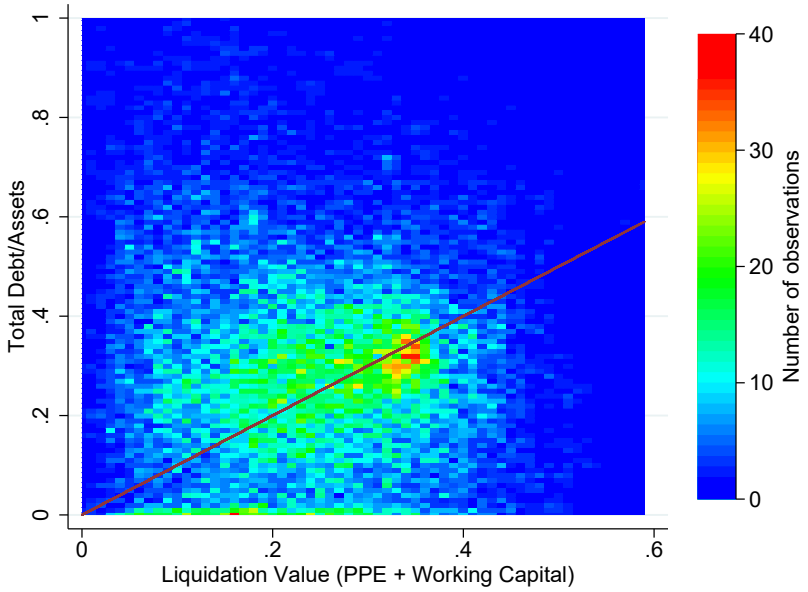


Figure IA5: Liquidation Values and Total Borrowing: Large and Small Firms

This figure shows heat maps of total leverage (y-axis) against liquidation value of fixed asset and working capital (x-axis) among large firms in Panel A and small firms in Panel B. The 45-degree line is also plotted. Large (small) firms are those with assets above (below) Compustat median in a given year. Sample is based on Compustat and CapitalIQ, and sample period is 2003 to 2016. We restrict to firms with book leverage between zero and one.

Panel A. Large Firms



Panel B. Small Firms

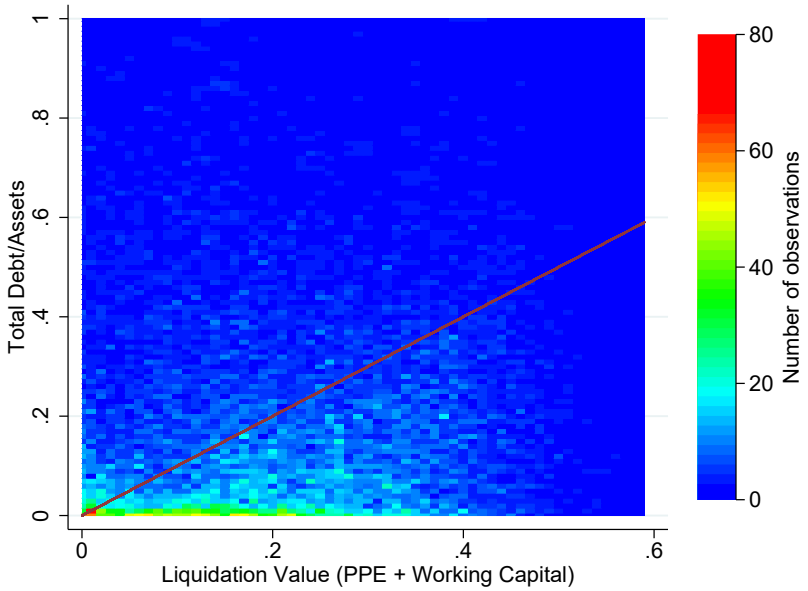


Table IA1: Industry List

The table shows the number of cases in each two-digit SIC industry for which we can find liquidation recovery rates of receivable, inventory, or PPE. The cases are from the list of public Chapter 11 filings between 2000 and 2016 from BankruptcyData.com. We exclude financial firms (SIC between 6000 and 6999) and public administration (SIC greater than 9000).

2-digit SIC	Industry	N
9	Fishing/Hunting/Trapping	1
10	Metal Mining	5
12	Bituminous Coal and Lignite Mining	6
13	Oil/Gas Extraction	48
14	Mining/Quarrying-Nonmetals	2
15	Building Constr. Gen. Contractors/Op. Builders	3
17	Constr. Special Trade Contractors	1
20	Food/Kindred Products	9
22	Textile Mill Products	4
23	Apparel & Similar Materials	4
24	Lumber/wood Products	2
25	Furniture & Fixtures	3
26	Paper & Allied Products	11
27	Printing, Publishing & Allied Industries	19
28	Chemicals & Allied Products	24
30	Rubber & Miscellaneous Plastics Products	11
32	Stone, Clay, Glass, & Concrete Products	3
33	Primary Metal Industries	10
34	Fabricated Metal Products	7
35	Industrial & Commercial Machinery & Computer Equip	7
36	Electronic Equip, except Computer Equip	21
37	Transportation Equip	19
38	Measuring/Analyzing/Controlling Instruments	4
39	Misc. Manufacturing Industries	6
41	Local/Suburban Transit & Interurban Highway Transportation	2
42	Motor Freight Transportation & Warehousing	2
44	Water Transportation	8
45	Transportation by Air	9
47	Transportation Services	3
48	Communications	26
49	Electric, Gas & Sanitary Services	7
50	Wholesale Trade-Durable Goods	2
51	Wholesale Trade-Nondurable Goods	5
52	Building Materials, Hardware, Garden Supply, & Mobile Home Dealers	1
53	General Merchandise Stores	3
54	Food Stores	3
55	Automotive Dealers & Gas Service Stations	2
56	Apparel & Accessory Stores	6
57	Home Furniture, Furnishings, & Equip Stores	3
58	Eating/Drinking Places	9
59	Misc. Retail	7
70	Hotels, Rooming Houses, Camps, & other Lodging	7
72	Personal Services	2
73	Business Services	29
78	Motion Pictures	8
79	Amusement & Recreation Services	5
80	Health Services	7
82	Educational Services	1
Total		387

Table IA2: Cross-Checks with Chapter 7 Liquidation Proceeds

This table compares the estimated total liquidation values in the liquidation analysis of Chapter 11 cases with total liquidation proceeds in Chapter 7 cases. Panel A reports the average total liquidation value, normalized by total assets at the time of filing. Column (1) uses total liquidation receipts from the Chapter 7 trustee report. Columns (2) and (3) use total liquidation receipts from the trustee report plus 50% of asset-based debt and secured debt, respectively. Columns (4) and (5) use total liquidation receipts from the trustee report plus 100% of asset-based debt and secured debt, respectively. Panel B reports regression coefficients of the total liquidation value of each case (normalized by total assets at filing) on a Chapter 7 dummy. Year and industry fixed effects are included. Standard errors clustered by year are reported in parentheses, and asterisks denote significance levels (***=1%, **=5%, *=10%).

Panel A. Raw Statistics

	Total Liquidation Value/Total Assets				
Assumptions	Basic	Medium v1	Medium v2	High v1	High v2
	(1)	(2)	(3)	(4)	(5)
Chapter 7 average	0.12	0.33	0.32	0.48	0.49
Chapter 11 estimated average	0.31				

Panel B. Regression Comparisons

	Total Liquidation Value/Total Assets				
	Basic	Medium v1	Medium v2	High v1	High v2
	(1)	(2)	(3)	(4)	(5)
Chapter 7=1	-0.170***	-0.077*	-0.084**	-0.018	-0.023
	(0.024)	(0.033)	(0.028)	(0.043)	(0.036)
Time fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes

Table IA3: Liquidation Values Based on Physical Attributes and Industry-Level Variations

This table reports firm-level annual regressions where the outcome is asset-based debt in columns (1) and (4), cash flow-based bonds in columns (2) and (5), and cash flow-based loans in columns (3) to (6). Columns (1) and (3) use shares in total debt, and columns (4) to (6) use shares in total asset. In Panel A, we calculate the liquidation value using liquidation recovery rates predicted by industry-level physical attributes of PPE, inventory, and receivable, and use it as an instrument for the firm-level liquidation value. In Panel B, we use industry-average liquidation value (instead of firm-level liquidation value), calculate for each industry (two-digit SIC) during the sample period. Liquidation value variables and book leverage are demeaned. The firm-level control variables are the same as those in Tables 2 to 4. Year fixed effects are included. Standard errors are double-clustered by firm and year and reported in parentheses, and asterisks denote significance levels (***=1%, **=5%, *=10%). Sample is based on Compustat and CapitalIQ, and sample period is 2003 to 2016. We restrict to firms with book leverage between zero and one.

Panel A. Liquidation Values Predicted by Asset Physical Attributes

	Share of Total Debt			Share of Total Asset		
	Asset-Based (1)	CF Bonds (2)	CF Loans (3)	Asset-Based (4)	CF Bonds (5)	CF Loans (6)
Liquidation value	0.487***	-0.161*	-0.339***	0.242***	-0.077**	-0.128***
	(0.064)	(0.076)	(0.050)	(0.029)	(0.034)	(0.020)
Liquidation value × Book leverage	1.487***	-0.773***	-0.735***	0.910***	-0.584***	-0.206***
	(0.187)	(0.212)	(0.153)	(0.097)	(0.124)	(0.062)
Book leverage	-0.284***	0.248***	0.093***	0.353***	0.427***	0.130***
	(0.024)	(0.037)	(0.022)	(0.014)	(0.023)	(0.017)
Ch11 GC value	-0.085***	0.044**	0.045**	-0.026***	0.008	0.014**
	(0.019)	(0.020)	(0.015)	(0.007)	(0.006)	(0.005)
Observations	29458	29441	29458	29566	29556	29231
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Industry-Level Liquidation Values

	Share of Total Debt			Share of Total Asset		
	Asset-Based (1)	CF Bonds (2)	CF Loans (3)	Asset-Based (4)	CF Bonds (5)	CF Loans (6)
Ind-avg liq val	0.178**	0.162	-0.361***	0.141***	0.060	-0.126***
	(0.078)	(0.093)	(0.057)	(0.039)	(0.044)	(0.027)
Ind-avg liq val × Book leverage	1.765***	-0.720**	-1.029***	0.793***	-0.203	-0.277**
	(0.294)	(0.327)	(0.224)	(0.146)	(0.181)	(0.101)
Book leverage	-0.271***	0.242***	0.084***	0.366***	0.420***	0.128***
	(0.024)	(0.035)	(0.022)	(0.014)	(0.021)	(0.016)
Ch11 GC value	-0.114***	0.079***	0.037**	-0.036***	0.024***	0.012**
	(0.020)	(0.021)	(0.016)	(0.008)	(0.007)	(0.005)
Observations	30870	30853	30870	30981	30971	30625
Within R^2	0.230	0.278	0.026	0.275	0.423	0.098
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Table IA4: Within-Firm Variations in Debt Composition

This table reports firm-level annual regressions where the outcome variable is asset-based debt (as a share of total debt) in columns (1) and (2), cash flow-based bonds in columns (3) and (4), and cash flow-based loans in columns (5) and (6). Book leverage and industry-average liquidation value are demeaned. The firm-level control variables are the same as those in Tables 2 to 4. Firm and year fixed effects are included. Standard errors are double-clustered by firm and year and reported in parentheses, and asterisks denote significance levels (***=1%, **=5%, *=10%). Sample is based on Compustat and CapitalIQ, and sample period is 2003 to 2016. We restrict to firms with book leverage between zero and one.

	Asset-Based Debt		CF-Based Bonds		CF-Based Loans	
	(1)	(2)	(3)	(4)	(5)	(6)
Book leverage	-0.366***	-0.359***	0.334***	0.333***	0.086***	0.084***
	(0.032)	(0.034)	(0.032)	(0.032)	(0.021)	(0.021)
Industry-avg liq value × Book leverage		1.063***		-0.370		-0.540**
		(0.339)		(0.320)		(0.243)
Market/book value of assets	-0.005	-0.006	-0.005	-0.005	0.006**	0.006**
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
EBITDA	0.019	0.025	-0.032*	-0.036**	0.015*	0.014
	(0.018)	(0.019)	(0.016)	(0.017)	(0.008)	(0.008)
Past 12m equity return vol	-0.000	-0.000	-0.008	-0.008	-0.000	0.001
	(0.008)	(0.008)	(0.007)	(0.007)	(0.005)	(0.005)
Cash	-0.108***	-0.118***	0.232***	0.236***	-0.122***	-0.115***
	(0.033)	(0.034)	(0.033)	(0.034)	(0.026)	(0.027)
Log(assets)	-0.078***	-0.081***	0.063***	0.066***	0.022***	0.023***
	(0.007)	(0.007)	(0.008)	(0.008)	(0.006)	(0.006)
Observations	32398	30693	32380	30676	32398	30693
Within R^2	.036	.039	.039	.041	.007	.008
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Table IA5: Asset-Based Debt and Liquidation Values by Type of Asset

This table reports firm-level annual regressions where the outcome variable is asset-based debt against working capital (inventory and receivable) or PPE, normalized by total asset-based debt in columns (1) and (2), and normalized by total assets in columns (3) and (4). All regressions include liquidation values of working capital and of PPE. All the firm-level control variables are the same as those in Tables 2 to 4. Year fixed effects are included. Standard errors are double-clustered by firm and year and reported in parentheses, and asterisks denote significance levels (***=1%, **=5%, *=10%). Sample is based on Compustat and CapitalIQ, and sample period is 2003 to 2016. We restrict to firms with book leverage between zero and one.

	Share of Asset-Based Debt		Share of Total Asset	
	Working Capital	PPE	Working Capital	PPE
	(1)	(2)	(3)	(4)
Working capital liquidation value	0.597***	-0.043	0.145***	-0.002
	(0.061)	(0.038)	(0.015)	(0.005)
PPE liquidation value	-0.082	0.351***	0.041*	0.061***
	(0.097)	(0.049)	(0.021)	(0.008)
Ch11 GC value	0.060**	-0.048**	-0.011**	-0.010***
	(0.023)	(0.018)	(0.005)	(0.002)
Market/book value of assets	-0.007	-0.011***	-0.003***	-0.001***
	(0.005)	(0.003)	(0.001)	(0.000)
EBITDA	0.029	-0.029*	0.006**	-0.006***
	(0.018)	(0.014)	(0.002)	(0.001)
Past 12m equity return vol	-0.006	-0.028*	0.001	-0.005***
	(0.014)	(0.013)	(0.003)	(0.001)
Cash	-0.557***	0.116***	-0.065***	0.001
	(0.033)	(0.026)	(0.006)	(0.002)
Log(assets)	-0.024***	0.003	-0.011***	-0.001
	(0.004)	(0.003)	(0.001)	(0.000)
Book leverage	0.058	-0.064***	0.105***	0.010***
	(0.036)	(0.018)	(0.008)	(0.002)
Observations	23257	23156	30931	30842
Within R^2	.108	.027	.134	.056
Time fixed effects	Yes	Yes	Yes	Yes

Table IA6: Comparison with Book Value of "Tangible Assets"

This table reports firm-level annual regressions in columns (1) and (2) where the outcome variables are asset-based debt normalized by total assets in column (1) and asset-based debt as a share in total debt in column (2), and debt-level regressions in columns (3) and (4) where the outcome variable is the interest rate. The regressions compare our liquidation value measure with the book value of tangible assets using PPE in Panel A and PPE plus inventory in Panel B. Column (3) uses interest rates (from CapitalIQ) on asset-based debt, and column (4) uses interest rates on all debt. The other independent variables are the same as those in Tables 2 to 4 (the firm-level variables drop out in column (4) with firm-year fixed effects), and columns (3) and (4) also control for bond and loan indicators and log debt amount. Standard errors are double-clustered by firm and year and reported in parentheses, and asterisks denote significance levels (***=1%, **=5%, *=10%). Sample is based on Compustat and CapitalIQ and sample period is 2003 to 2016. We restrict to firms with book leverage between zero and one.

Panel A. PPE as Tangible Assets

	Asset-Based Debt as Share of		Interest Rates on	
	Asset	Debt	Asset-Based	All
	(1)	(2)	(3)	(4)
Liquidation value	0.118***	0.253***	-2.292***	
	(0.021)	(0.054)	(0.339)	
PPE	0.025**	0.087***	0.618***	
	(0.011)	(0.027)	(0.190)	
Asset-based debt=1 × Liquidation value				-1.782***
				(0.524)
Asset-based debt=1 × PPE				0.306
				(0.271)
Asset-based debt=1				0.375*
				(0.179)
Book leverage	0.352***	-0.298***		
	(0.014)	(0.025)		
Observations	29566	29458	21943	46573
Within R^2	.271	.232	.094	.02
Controls	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Firm-year fixed effects	No	No	No	Yes

Panel B. PPE and Inventory as Tangible Assets

	Asset-Based Debt as Share of		Interest Rates on	
	Asset	Debt	Asset-Based	All
	(1)	(2)	(3)	(4)
Liquidation value	0.104***	0.201***	-2.400***	
	(0.024)	(0.061)	(0.387)	
PPE plus inventory	0.026**	0.094***	0.389*	
	(0.011)	(0.030)	(0.220)	
Asset-based debt=1 × Liquidation value				-1.541**
				(0.670)
Asset-based debt=1 × PPE plus inventory				0.026
				(0.444)
Asset-based debt=1				0.422**
				(0.191)
Book leverage	0.353***	-0.292***		
	(0.015)	(0.025)		
Observations	29566	29458	21943	46573
Within R^2	.271	.232	.092	.02
Controls	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Firm-year fixed effects	No	No	No	Yes

IA2 Data on Liquidation Values and Chapter 11 Going-Concern Values

IA2.1 Additional Explanations of Liquidation Value Assessments

Below we show excerpts of detailed discussions for the summary liquidation value estimates shown in the Lyondell Chemical example in Figure 2. They explain the procedures for the liquidation value estimates of different types of assets.

Figure IA6: Lyondell Chemical Example: Plant-Level Information for All PPE

This figure shows an excerpt of discussions about PPE liquidation value estimates in the liquidation analysis of Lyondell (Panel A), and an excerpt of plant-level estimates in the accompanying appendix of Lyondell's filings (Panel B).

Panel A. PPE Discussion in Liquidation Analysis

Property, Plant, and Equipment ("PP&E")

- PP&E includes all owned land, land improvements and buildings, battery limit process units, off sites, support assets and construction in progress.
- Appendix I is a report prepared by American Appraisal Associates, Inc. that includes projected liquidation values of PP&E as of April 1, 2010 that were used for this Liquidation Analysis.

Panel B. Plant-Level Estimate in Liquidation Analysis Appendix

PLANT CODE	PLANT NAME	LOCATION	SEGMENT	GRAND TOTAL
CHEMICALS SEGMENT				
4102	BASELL MEXICO	POLYOLEFINAS MEXICO	CHEMICALS	973,000
4100	BASELL MEXICO	BASELL MEXICO	CHEMICALS	21,000
BCO	BAYPORT EO	PASADENA, TX	CHEMICALS	23,875,000
BLO	BAYPORT PO @ 17.4% OWNERSHIP	PASADENA, TX	CHEMICALS	12,388,000
	BERRE	BERRE, FRANCE	CHEMICALS	24,442,000
RBO	BOTLEK	BOTLEK, NETHERLANDS	CHEMICALS	138,328,000
CIO	BRUNSWICK	BRUNSWICK, GA	CHEMICALS	4,415,000
CHO	CHANNELVIEW - NORTH	CHANNELVIEW, TX	CHEMICALS	155,927,000
CXO	CHANNELVIEW - SOUTH	CHANNELVIEW, TX	CHEMICALS	18,801,000
CXO	CHANNELVIEW SOUTH- PO/SM 2	CHANNELVIEW, TX	CHEMICALS	26,252,000
CVOX	CHANNELVIEW SOUTH- PO/SM 1 @ 17.4% OWNERSHIP	CHANNELVIEW, TX	CHEMICALS	3,721,000
CXO	CHANNELVIEW SOUTH- BDO	CHANNELVIEW, TX	CHEMICALS	9,211,000
CLO	CLINTON	CLINTON, IA	CHEMICALS	41,805,000
FLO	FOS-SUR-MER	FOS-SUR-MER, FRANCE	CHEMICALS	45,974,000
CCO	CORPUS CHRISTI	CORPUS CHRISTI, TX	CHEMICALS	88,349,000
0	VERENNES	VERENNES	CLOSED	0
JAX	JACKSONVILLE	JACKSONVILLE, FL	CHEMICALS	9,067,000
LPO	LA PORTE	LA PORTE, TX	CHEMICALS	64,340,000
LAO	LA PORTE ACETYLS	LA PORTE, TX	CHEMICALS	31,798,000
RMO	MAASVLATKTE @ 50% OWNERSHIP	MAASVLATKTE, NETHERLANDS	CHEMICALS	32,486,000
MIO	MORRIS	MORRIS, IL	CHEMICALS	24,638,000
1001	MUENCHSMUENSTER	MUENCHSMUENSTER, GERMANY	CHEMICALS	46,524,000
NEO	NEWARK	NEWARK, NJ	CHEMICALS	336,000
CBP	PIPELINE	MARKHAM-MONT BELVIEU, TX	CHEMICALS	98,163,000
TCO	TUSCOLA	TUSCOLA, IL	CHEMICALS	5,296,000
1001	WESSELING	KNAPSACK, GERMANY	CHEMICALS	409,707,000
TOTAL CHEMICALS SEGMENT				**1,316,837,000**

Figure IA6: Lyondell Chemical Example: Plant-Level Information for All PPE (Cont.)

PLANT CODE	PLANT NAME	LOCATION	SEGMENT	GRAND TOTAL
POLYMERS SEGMENT				
	BASELL POLYOLEFINS KOREA	SEOUL, ROK	POLYMERS	0
BYO	BAYPORT POLYMER	PASADENA, TX	POLYMERS	36,765,000
1000	BAYREUTH	BAYREUTH, GERMANY	POLYMERS	16,938,000
	BERRE	BERRE, FRANCE	POLYMERS	110,074,000
1301	BRINDISI	BRINDISI, ITALY	POLYMERS	76,841,000
1201	CARRINGTON	CARRINGTON, UK	POLYMERS	10,848,000
CBO	CHOCOLATE BAYOU POLYMERS	ALVIN, TX	POLYMERS	28,853,000
CLO	CLINTON	CLINTON, IA	POLYMERS	96,414,000
4005	EDISON	EDISON, NJ	POLYMERS	8,717,000
FPO	FAIRPORT	FAIRPORT, OH	POLYMERS	1,714,000
1300	FERRARA	FERRARA, ITALY	POLYMERS	30,654,000
1001	FRANKFURT	FRANKFURT, GERMANY	POLYMERS	16,278,000
4005	JACKSON	JACKSON, TN	POLYMERS	6,398,000
1001	KNAPSACK	KNAPSACK, GERMANY	POLYMERS	44,376,000
LPO	LA PORTE	LA PORTE, TX	POLYMERS	44,115,000
LKO	LAKE CHARLES POLYMER	LAKE CHARLES, LA	POLYMERS	43,770,000
2100	CLYDE PP	CLYDE, AUSTRALIA	POLYMERS	8,102,000
3110	GEELONG LABORATORY	GEELONG, AUSTRALIA	POLYMERS	22,000
3100	GEELONG PP	GEELONG, AUSTRALIA	POLYMERS	19,186,000
3000	MELBOURNE OFFICE	MELBOURNE, AUSTRALIA	POLYMERS	282,000
5000	PETROKEN	ENSENADA, ARGENTINA	POLYMERS	13,923,000
5100	PINDA	PINDA, BRAZIL	POLYMERS	343,000
4014	MANSFIELD	MANSFIELD, TX	POLYMERS	9,443,000
MTO	MATAGORDA	MATAGORDA, TX	POLYMERS	86,656,000
1201	MILTON KEYNES	MILTON KEYNES, UK	POLYMERS	8,532,000
1400	MOERDIJK	MOERDIJK, NETHERLANDS	POLYMERS	38,669,000
MIO	MORRIS	MORRIS, IL	POLYMERS	74,834,000
1001	MUENCHSMUENSTER	MUENCHSMUENSTER, GERMANY	POLYMERS	112,442,000
1601	TARRAGONA	TARRAGONA, SPAIN	POLYMERS	27,076,000
1300	TERNI	TERNI, ITALY	POLYMERS	37,679,000
VTO	VICTORIA	VICTORIA, TX	POLYMERS	24,349,000
8505	BAP GUANGZHOU	GUANGZHOU, PRC	POLYMERS	3,027,000
8503	BAP SUZHOU	SUZHOU, PRC	POLYMERS	2,876,000
8000	BAP THAILAND	BANGKOK, THAILAND	POLYMERS	3,777,000
8500	BASELL ASIA PACIFIC	HONG KONG, PRC	POLYMERS	13,000
LJI	LYONDELL JAPAN	TOKYO, JAPAN	POLYMERS	3,000
SIN	LYONDELL SOUTH ASIA	SINGAPORE	POLYMERS	1,000
TOTAL POLYMERS SEGMENT				**1,043,990,000**

Figure IA7: Lyondell Chemical Example: Other Assets

This figure shows an excerpt of discussions about the liquidation value estimates for inventory, receivable, and cash in the liquidation analysis of Lyondell.

Panel A. Inventory Discussion in Liquidation Analysis

Inventory

- The Debtors' inventories are comprised of raw materials, work-in-process ("WIP") and finished goods, as well as supplies and materials.
- Types of inventory products include polymers (polyethylene and polypropylene), chemicals (ethylene and propylene), and refining products (such as gasoline, diesel, and jet fuel).
- The recovery analysis was performed by reviewing the external field examination and bank appraisal by entity for the period ending September 30, 2009, which was in effect at the end of 2009.
- The September 30, 2009 gross recovery advance rates for raw materials, WIP and finished goods were discounted by approximately 7% for ineligibles to reflect the recovery ranges for each entity whose inventory secures bank financing.
- The "supplies and materials" component of inventory is assumed to have a recovery range of 50% to 75% for all entities.
- The recovery ranges vary by entity and type of inventory, as presented in the table below.
- The products produced in EAI are primarily polymers and chemicals, and the inventory liquidation assumptions for EAI approximate those of Basell USA Inc.

	Lyondell Chemical Company	Basell USA Inc.	Equistar Chemicals, LP	Houston Refining LP	Millennium Petrochemicals, Inc. (Virginia)
Raw Materials	68.7% - 78.7%	60.9% - 70.9%	69.9% - 79.9%	71.6% - 81.6%	57.3% - 67.3%
Work-In-Process	54.5% - 64.5%	68.7% - 78.7%	64.7% - 74.7%	67.6% - 77.6%	57.3% - 67.3%
Finished Goods	67.3% - 77.3%	68.7% - 78.7%	79.6% - 89.6%	67.6% - 77.6%	73.2% - 83.2%

Panel B. Cash and Receivable Discussion in Liquidation Analysis

Cash and Cash Equivalents and Short-Term Investments

- The Liquidation Analysis assumes that operations during the liquidation period would not generate additional cash available for distribution except for net proceeds from the disposition of non-cash assets.
- The liquidation value for all entities is estimated to be approximately 100% of the net book value as of December 31, 2009.

Trade Accounts Receivable

- The analysis of accounts receivable assumes that a chapter 7 trustee would retain certain existing staff of the Debtors to handle an aggressive collection effort for outstanding trade accounts receivable for the entities undergoing an orderly liquidation.
- Collectible accounts receivable are assumed to include all third-party trade accounts receivable.
- A range of discount factors based on the January 1, 2010 U.S. asset backed facilities effective advance rates were applied to receivables to estimate liquidation values.
- Collections during a liquidation of the Debtors may be further compromised by likely claims for damages for breaches of (or the likely rejection of) customer contracts, and attempts by customers to set off outstanding amounts owed to the Debtors against such claims.
- The liquidation values of trade accounts receivable were estimated at 60.0% to 70.0% of the net book value as of December 31, 2009 for purposes of this Liquidation Analysis.

IA2.2 Chapter 11 Going-Concern Values: Market-Based and Plan-Based

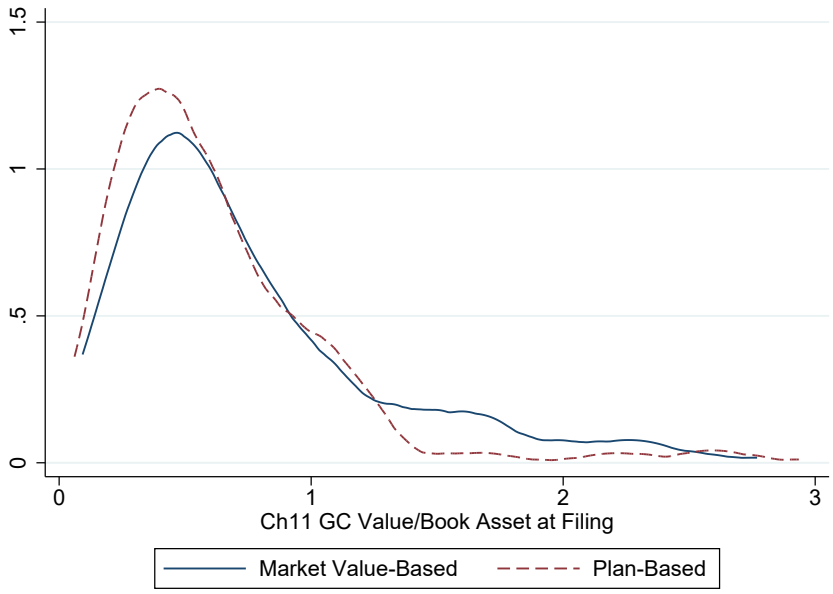
As explained in Section 2.1, for Chapter 11 going-concern values, we use firm value estimates from post-emergence market trading information as well as the valuation analysis in Chapter 11 plans. In particular, we use market value-based estimates when they are available (market value of equity plus book value of debt if the firm emerged as a public company, or acquisition value if the firm is acquired), and plan-based estimates otherwise. We normalize the going-concern value by total book assets at the time of the filing. Figure IA8, Panel A, shows the distribution of the market-value based estimates and the distribution of the plan-based estimates, which look similar.

For cases where both estimates are available, we also find that they are similar on average, consistent with prior findings of Gilson, Hotchkiss, and Ruback (2000). The median difference of market value-based estimate minus plan-based estimate is about 0.08 (inter-quartile range -0.08 to 0.26). The median ratio of these two values is about 1.14 (inter-quartile range 0.86 to 1.6). Figure IA8, Panel B, shows the distribution of the difference between the two estimates, which has most of its mass around zero. Overall, the data suggests that the Chapter 11 going-concern values are reasonably reliable.

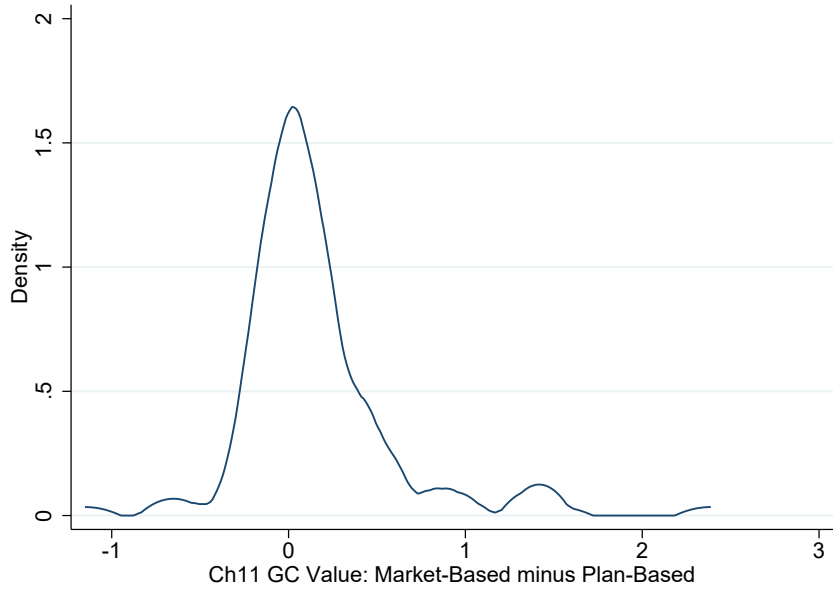
Figure IA8: Distributions of Chapter 11 Going-Concern Values

Panel A shows the distribution of Chapter 11 going-concern values using post-emergence market values (market value of equity plus book value of debt, or acquisition value) in the solid blue line, and the distribution of Chapter 11 going-concern values using plan estimates in the dashed red line. Both values are normalized by total book assets at filing. Panel B shows the distribution of market value estimates minus plan estimates. Each observation is a Chapter 11 case.

Panel A. Market and Plan Values



Panel B. Differences between Market and Plan Values



IA3 Classification Procedure of Asset-Based Debt and Cash Flow-Based Debt

Below we explain the categorization of asset-based and cash flow-based debt using debt-level data for non-financial firms in CapitalIQ. For each debt, CapitalIQ records the amount outstanding and provides detailed descriptions of the contract. We assign firms' debt into the following groups: 1) asset-based debt, 2) cash flow-based debt, 3) personal loans, 4) miscellaneous and unclassified borrowing. We proceed in several steps:

1. We classify a debt as an asset-based debt if
   - the debt descriptions contain the following key words (and their variants): asset-based, ABL, borrowing base, mortgage, real estate/building, equipment, machine, fixed asset, inventory, receivable, working capital, automobile/vehicle, aircraft, capital lease, SBA/small business, oil/drill/rig, reserve-based, factoring, industrial revenue bond, finance company, capital lease, construction, project finance;
   - it is a secured revolver (since asset-based revolvers are more common than cash flow-based revolvers with blanket liens).
2. We classify a debt as a personal loan if
   - the lender is an individual (Mr./Ms., etc);
   - it is from directors/executives/founders/shareholders/related parties.
3. We assign a debt to the miscellaneous/unclassified group if it is
   - borrowing from governments or a pollution control bond;
   - insurance-related borrowing, or borrowing from vendor/seller/supplier/landlord;
   - borrowing from affiliated companies.
4. We classify a debt as a cash flow-based debt if it **does not belong to any of the categories above** and
   - it explicitly says "cash flow-based"/"cash flow loan";
   - it is unsecured, is a "debenture", or is secured by "substantially all assets";
   - it contains the following key words and their variants, which are representative of cash flow-based loans: first lien/second lien/third lien, term facility/term loan facility/term loan a, b, c..., syndicated, tranche, acquisition line, bridge loan;
   - it is a bond or it contains standard key words for bonds, such as senior subordinated, senior notes, x% notes due, private placement, medium term notes;
   - it is a convertible bond.
5. We assign all remaining secured debt to asset-based debt to be conservative.

Among cash flow-based debt, we classify a contract as a loan if its descriptions contain the following key words (and their variants):

- bank loan, revolv, credit line, bank line, term loan/term facility, first lien/second lien/third lien, syndicate, various financial institutions.

IA4 Additional Results Incorporating Operating Leases

One may also view operating leases as akin to asset-based debt, in the sense that the lessor can repossess the asset under an operating lease when the lease terminates (Eisfeldt and Rampini, 2009). In this section, we perform robustness checks which include estimates of the value of operating leases as asset-based debt. In this case, the estimated present value of future rental payments would be both the operating lease liability and the operating lease asset. We assume a liquidation recovery rate of 100% if the lessor were to repossess the asset.[31]

We estimate the value of operating leases using two methods. The first method follows Rampini and Viswanathan (2013) and multiplies firms' annual rental expenses by ten. The second method utilizes the value of operating leases provided by firms, which became available in 2019 after changes in accounting rules, as discussed in Section 2.1.1. We obtain firms' estimates of operating leases in 2019 from Compustat Snapshot and CapitalIQ. For each firm, we calculate the ratio of operating leases relative to owned assets. We take the average ratio in each two-digit SIC industry, and use this ratio to estimate the value of operating leases for pre-2019 firm-years in our sample (i.e., we multiply owned assets by this ratio to estimate operating leases in prior years).

We add operating leases to asset-based debt, total debt, and total assets. We then compute total leverage including operating leases, as well as debt composition (relative to total debt and total assets). We also add operating leases to liquidation values (and normalize the liquidation value using the new total assets). Indeed, since operating leases by design are directly included in both the liquidation value and the amount of asset-based debt, this can contribute to a mechanical positive association between asset-based debt (including operating leases) and liquidation values (including operating leases).

The results are presented in Table IA7 below. The regression specifications follow those in columns (3) and (4) of Tables 2 to 4, and the left hand side is different types of debt normalized by assets. The only difference here is we include capitalized operating leases in liquidation values, total assets, total leverage, and asset-based debt. The results are similar to those in Tables 2 to 4, if not stronger (by design) as explained above. Asset-based debt increases strongly with liquidation values, while cash flow-based bonds and loans decrease with liquidation values.

[31] The results are robust to assuming an alternative liquidation recovery rate of 70%.

Table IA7: Results Including Operating Leases

In this table, we include the capitalized value of operating leases in liquidation values, asset-based debt, total leverage, and total assets. We use two methods to estimate the value of operating leases as described above. The dependent variables are asset-based debt in columns (1) and (2), cash flow-based bonds in columns (3) and (4), and cash flow-based loans in columns (5) and (6), all normalized by total assets (including operating leases). The firm-level control variables are the same as those in Tables 2 to 4. Year fixed effects are included. Standard errors are double-clustered by firm and year and reported in parentheses, and asterisks denote significance levels (***=1%, **=5%, *=10%). Sample is based on Compustat and CapitalIQ, and sample period is 2003 to 2016.

Panel A. Method 1

	Asset-Based Debt		CF-Based Bonds		CF-Based Loans	
	(1)	(2)	(3)	(4)	(5)	(6)
Liquidation value	0.517***	0.495***	-0.314***	-0.297***	-0.141***	-0.139***
	(0.016)	(0.016)	(0.022)	(0.021)	(0.015)	(0.014)
Book leverage	0.471***	0.464***	0.333***	0.339***	0.120***	0.121***
	(0.012)	(0.013)	(0.019)	(0.021)	(0.016)	(0.015)
Liquidation value × Leverage w/ lease		0.907***		-0.699***		-0.136***
		(0.038)		(0.041)		(0.027)
Ch11 GC value	-0.011	-0.007	-0.004	-0.007	0.014***	0.013***
	(0.007)	(0.006)	(0.006)	(0.006)	(0.004)	(0.004)
Observations	29566	29566	29556	29556	29231	29231
Within R^2	.59	.616	.38	.409	.111	.114
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Method 2

	Asset-Based Debt		CF-Based Bonds		CF-Based Loans	
	(1)	(2)	(3)	(4)	(5)	(6)
Liquidation value	0.265***	0.362***	-0.108***	-0.177***	-0.116***	-0.133***
	(0.020)	(0.028)	(0.023)	(0.032)	(0.015)	(0.019)
Book leverage	0.400***	0.389***	0.387***	0.397***	0.124***	0.127***
	(0.014)	(0.014)	(0.022)	(0.023)	(0.016)	(0.016)
Liquidation value × Leverage w/ lease		1.146***		-0.825***		-0.191***
		(0.101)		(0.123)		(0.059)
Ch11 GC value	-0.036***	-0.025***	0.016**	0.009	0.015***	0.014***
	(0.007)	(0.007)	(0.007)	(0.006)	(0.004)	(0.004)
Observations	29566	29566	29556	29556	29231	29231
Within R^2	.323	.349	.395	.411	.105	.107
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

IA5 Estimating Financial Covenant Tightness

We construct covenant tightness measures following Murfin (2012).[32] The main idea is to compare covenant threshold values from DealScan with firms' financial ratios around the time of loan issuance, to calculate the slack of the loan covenant (i.e., distance between the covenant threshold and the actual financial ratio at issuance). Using these slack values along with an industry-year-specific covariance matrix of changes in log firm financial ratios, we can calculate the probability of covenant violations, which we use as the measure of covenant tightness.

First, we construct a firm-quarter dataset which calculates the logs of the relevant financial ratios using Compustat data.[33] For the tightness of performance covenants, we include cash interest coverage, debt to EBITDA, debt service coverage, EBITDA, fixed charge coverage, interest coverage, and senior debt to EBITDA covenants. For the tightness of other financial covenants, we include debt to equity, debt to tangible net worth, net worth, current ratio, quick ratio, and capital expenditure covenants. We take the log of the actual financial ratios, and calculate changes in firms' log financial ratios. We then create a positive-definite covariance matrix of changes in the log of financial ratios. Following Murfin (2012), we calculate the covariance matrices for each one-digit SIC industry and backwards-rolling ten-year period combination. In addition, prior to creating each covariance matrix, observations with missing values for the changes in log financial ratios are dropped. Finally, the changes in log of financial ratios are winsorized at the 1% level.

We merge loan covenant thresholds from DealScan with firms' financial ratios one quarter prior to the start date of each loan. For covenants with maximum thresholds, we calculate the slack between the log of the covenant threshold and the log of the financial ratio. For covenants with minimum thresholds, we calculate the slack between the log of the covenant threshold's inverse and the log of the financial ratio's inverse.

The final step is to calculate the multivariate normal probability of covenant violations. First, we remove loan observations that do not have covenants relevant for the measure of covenant tightness, or those that violate covenants prior to the start date (i.e., have a negative slack value). Using the covariance matrices of changes in financial ratios, we calculate each loan's multivariate normal probability of the relevant slack variable being greater than or equal to zero, for each one-digit SIC industry-year combination. The covenant tightness measure, which captures the probability of violating at least one covenant, is one minus the calculated multivariate normal probability.

[32] We thank Justin Murfin for sharing his code.

[33] For the thresholds that require a minimum ratio, such as minimum EBIDTA, we take the inverse of the financial value, which allows the slack between the covenant threshold and the financial ratio to be positive.

IA6 Solution to the Model

The optimal contract can be characterized as the solution to:

$$\max_{p^*,\mathbb{C}} \; p^*R + (1-p^*)L - \frac{1}{2}\gamma p^{*2} - \mathbb{P}[s < s^*|p^*]c, \;\; s.t.$$

$$pR_i + (1-p)L_i = Q_i, \tag{IA1}$$

$$\mathbb{P}[s < s^*|\tilde{p}]Q_e + \mathbb{P}[s \geq s^*|\tilde{p}]\tilde{p}R_e - \frac{1}{2}\gamma\tilde{p}^2 = p^*R_e - \frac{1}{2}\gamma p^{*2}, \tag{IA2}$$

$$\mathbb{P}[s < s^*|\tilde{p}]Q_i + \mathbb{P}[s \geq s^*|\tilde{p}]\left[\tilde{p}R_i + (1-\tilde{p})L_i\right] = i_i, \tag{IA3}$$

$$p^*R_i + (1-p^*)L_i - \mathbb{P}[s < s^*|p^*]c = i_i, \tag{IA4}$$

$$p^*R_u + (1-p^*)L_u = i_u, \tag{IA5}$$

and

$$\tilde{p} = \arg\max_{p} \; \mathbb{P}[s < s^*|p]Q_e + \mathbb{P}[s \geq s^*|p]pR_e - \frac{1}{2}\gamma p^2.$$

Combining Equations (IA1), (IA3), and (IA4), we have:

$$R_i - L_i = \frac{\mathbb{P}[s < s^*|p^*]}{\mathbb{P}[s \geq s^*|\tilde{p}]}\frac{c}{p^* - \tilde{p}}.$$

Also, taking the first order condition of the above system of equations, $(p^*, \tilde{p}, s^*, R_e, Q_e)$ is the solution to this system of equations:

$$p^* = \frac{R-L}{\gamma} - \frac{c}{\gamma}\frac{\partial}{\partial p^*}\mathbb{P}[s < s^*|p^*],$$

$$\mathbb{P}[s \geq s^*|\tilde{p}]\tilde{p}R_e + \mathbb{P}[s < s^*|\tilde{p}]Q_e - \frac{1}{2}\gamma\tilde{p}^2 = p^*R_e - \frac{1}{2}\gamma p^{*2},$$

$$p^*(R - R_e) + (1-p^*)L = (1-w) + \mathbb{P}[s < s^*|p^*]c,$$

$$\gamma\tilde{p} = \frac{\partial}{\partial\tilde{p}}\left[\mathbb{P}[s \geq s^*|\tilde{p}]\tilde{p}R_e + \mathbb{P}[s < s^*|\tilde{p}]Q_e\right],$$

$$Q_e = \max\left(0, Q - (1-w) - \mathbb{P}[s < s^*|p^*]c\right).$$

And the rest of the parameters of the contract can be written as a function of $(p^*, \tilde{p}, s^*, R_e, Q_e)$.

For the contract with minimum investment from the informed investor, we have: $L_i = 0$, $R_i = \frac{\mathbb{P}[s<s^*|p^*]}{\mathbb{P}[s\geq s^*|\tilde{p}]}\frac{c}{p^*-\tilde{p}}$, $Q_i = p^*R_i$, and $i_i = p^*R_i - \mathbb{P}[s < s^*|p^*]c$. Finally, for the uninformed investor we have: $i_u = 1 - w - i_i$, $L_u = L$, $R_u = (i_u - L)/p^* + L$, and $Q_u = Q - Q_e - Q_i$.