Debt Capacity of Real Estate Collateral

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Abstract

We study whether real estate assets have a greater positive influence on firm leverage than other tangible assets. Using a large sample of COMPUSTAT firms, we find a significant positive relation between tangibility and leverage in general, and the relation is strongest for real estate collateral. Furthermore, we find that the relation holds only for credit constrained firms, i.e., those likely to highly value the additional borrowing capacity of real estate. Our results imply that knowing the composition of a firm's tangible assets is important in understanding its leverage. Our findings could help explain why REITs are relatively highly leveraged, even though debt offers them no tax benefit.

Key words: real estate, leverage, credit constraints
JEL classification: G32

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1. Introduction

Many capital structure studies find that firms' leverage ratios are positively related to the proportion of their assets that are tangible. They conclude that lenders are willing to lend more against tangible assets than intangible assets. But those studies use an aggregate measure of tangible assets, which implicitly assumes that all types of tangible assets provide equally attractive collateral. The studies may use an aggregate tangibility measure because most firms stopped reporting the components of their tangible assets in 1997.

Our paper tests whether "more tangible" assets (such as real estate) can support more debt than other types of tangible assets (mostly machinery and equipment). We accomplish our task after identifying a time period (1984 to 1996) when firms were required to report components of their tangible assets and COMPUSTAT gathered that data.

A broad implication of our study is that real estate is a relatively valuable asset because it provides greater debt capacity and financial flexibility. Indeed, our results show that real estate is most potent in supporting credit constrained firms' borrowing. This is consistent with Graham and Harvey's (2001) survey that finds that U.S. CFOs' top debt policy goal is to maintain financial flexibility. Acharya, Almeida, and Campello (2007) show that firms build spare debt capacity to more flexibly finance future investments. Firms that tilt their balance sheets toward more real estate could do so as a way to build that debt capacity.

Williamson (1988), Shleifer and Vishny (1992), Brown, Ciochetti, and Riddiough (2006), Giambona, Harding, and Sirmans (2008), and Liu, Liu, and Zhang (2010) argue convincingly that an asset's debt capacity depends on its redeployability, and that real estate is more redeployable because it is less firm-specific than other assets. Similarly, Hart and Moore (1994) suggest that an asset's debt capacity depends on creditors' costs to repossess and redeploy it under financial distress. More easily contractible assets (e.g., real estate) should possess higher debt capacities. Finally, Rajan and Winton (1995) have shown that creditors may lend more on slowly depreciating assets (e.g., land and buildings) because the assets' values are more certain, durable, and require less monitoring.

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2 Brown, Ciochetti, and Riddiough (2006) further provide empirical evidence that, for distressed loans, foreclosure is less likely when assets are less redeployable, which supports the idea that the borrower’s decision to default is endogenous.
Our main empirical prediction is that real estate has a stronger positive effect on leverage than other types of tangible assets, such as machinery & equipment, but only for credit constrained firms. We depart from previous empirical capital structure studies in that we split the tangibility ratio into real estate collateral (land & building tangibility), and machinery, equipment & other tangibility. In this way, we can test whether real estate has a larger debt capacity than other types of tangible assets. Indeed, we find that real estate has about twice the impact on firm leverage as other types of tangible assets. Furthermore, we find no significant relation between leverage and asset tangibility for credit unconstrained firms.

Firms’ leverage and asset investment decisions are endogenous by nature, which can cause econometric difficulties for our tests. Indeed, our ordinary least squares (OLS) and industry fixed-effects leverage regressions show weak support for our predictions. But OLS and industry fixed-effects fail to capture the full extent of the relation between tangibility and leverage because they do not account for firm-specific differences. Using a firm fixed-effects panel regression approach improves our model specification and produces stronger support for our hypotheses.

But even the fixed-effects model can fail to capture unobserved firm characteristics that are related to leverage and change within each firm. Such endogenous firm changes lead to biased fixed-effects regression estimates. To control for this possibility, we combine firm fixed-effects with a two-stage instrumental variables (IV) approach. We find that the IV coefficient estimate for land & building in the leverage regression becomes much larger relative to OLS and fixed-effects specifications because endogeneity is more thoroughly addressed. Conversely, the estimates on machinery, equipment & other become smaller. In addition, we show that the positive relation between leverage and asset tangibility still holds only for the subsamples of credit constrained firms.

We find that the economic effect of real estate on leverage is about twice as large as the economic effect of machinery, equipment & other. For example, a one standard deviation increase in real estate increases leverage by about 25% from its mean compared to only about 12% for a one standard deviation increase in machinery, equipment & other.

Clearly, the composition of tangible assets is an important driver of overall firm debt capacity, with real estate being the most important. This could help to explain why REITs have much larger leverage ratios than most other firms. The average market leverage for REITs is around 46% (SNL database) compared to 20% for COMPUSTAT firms (our Table 1). This is surprising because REITs do not pay corporate taxes and, therefore, do not benefit from debt tax shields. We suggest that REITs have relatively high leverage ratios because their real estate assets are “more tangible,” and can support more corporate borrowing. This implies that knowing the composition of a firm’s tangible assets is important in explaining its leverage, and
that the traditional tax shield explanation could be less important than many believe.

Nevertheless, we exclude REITs from our sample for several reasons. Capital structure studies of REIT-only samples usually do not include tangibility in their leverage regression models (see, Giambona, Harding, and Sirmans, 2008; Ooi, Ong, and Li, 2009; Hardin and Wu, 2009) because of limited variation in the tangibility ratio across REITs. An exception is Harrison, Pasanian, and Seiler (2011), who include tangibility in their REIT leverage regression and find a relatively small but significant positive relation. The small effect compared to what we find for a large sample of COMPUSTAT firms is likely due to the limited range in tangibility for REITs, and the fact that REITs hold only real estate. For example, the sample of REITs in the SNL Data Source database have tangibility of 0.917, 0.946, 0.965, and 0.993, at the 25th, 50th, 75th, and 100th percentiles of tangibility, respectively. Our COMPUSTAT sample firms have tangibility of 0.242, 0.342, 0.444, and 0.995 at the 25th, 50th, 75th, and 100th percentiles of tangibility, respectively.

The remainder of this paper is structured as follows. The next section provides a setting for our study and discusses our main empirical hypothesis. Section 3 describes the data and summary statistics. The empirical analysis discussed in Section 4. Section 5 is a conclusion.
2. The Economic Setting

In the frictionless world of Modigliani-Miller, collateral does not matter. It can affect the risk level of debt, but it does not create additional corporate value. In the presence of real world financial frictions, however, such as risk-shifting, moral hazard (Jensen and Meckling, 1976, Galai and Masulis, 1976), underinvestment (Myers, 1977), or adverse selection (asymmetric information), collateral can enhance firm value. In these cases, collateralizable assets can be pledged to debt holders to reduce the costs of financial frictions.

It is reasonable to believe that lenders will lend more to a firm that pledges relatively liquid and redeployable collateral. Indeed, Benmelech and Bergman (2011b) show that a decrease in the liquidity and value of collateral can increase the cost and reduce the availability of debt financing across firms in an industry. Credit constrained firms are likely to be especially hurt by declines in the value of their collateral because they are at or close to their borrowing capacity.

Owning relatively more liquid and redeployable assets should be particularly valuable to credit constrained firms because those assets give them more financial flexibility and potential borrowing capacity. Like Faulkender and Petersen (2006), we distinguish between financial constraints and credit constraints. Firms are credit constrained when they cannot issue their desired level of relatively cheap debt to fully fund their investments, and must instead issue costly equity. Credit constrained firms understand that lenders prefer “hard tangibles” to back their loans, hence, constrained firms are willing to deviate from their unconstrained optimal investment plan by “overinvesting” in real estate in order to secure more debt financing. The value of additional low-cost debt financing offsets their loss from overinvesting in real estate (compared to how much they would have invested in real estate if they were unconstrained). Conversely, credit unconstrained firms can entirely finance their investments by issuing debt, and need not deviate from their optimal investment plan to secure their desired level of debt. They make their investment and leverage decisions separately; for them, there should be no significant relation between asset tangibility and debt. The appendix presents a simple model to support this notion.

Our empirical prediction is that real estate is more liquid and redeployable than other types of assets like machinery that are more firm-specific. We suggest that other assets such as machinery & equipment are often less attractive to debt holders as collateral because they are more costly to resell. Our empirical models in section 4 start with regressions of leverage for the full sample of firms on two categories

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of tangible assets; real estate collateral, and machinery, equipment & other, along with control variables. We then estimate the same regression model for sub-samples of credit constrained and unconstrained firms. We expect a relatively stronger positive relation between real estate collateral and leverage compared to the same relation for machinery, equipment & other, but the differential relation should only appear in the sample of credit constrained firms.
3. Data and Descriptive Statistics

Our sample selection starts with all active and inactive firms in COMPUSTAT with their main operations in the U.S. From that set, we exclude firms in the following industries: financial, lease, REIT or real estate firms. We also exclude governmental and non-profit organizations. Our data sample starts in 1984 and ends in 1996 because COMPUSTAT reports net values for the components of property, plant and equipment during this period. Starting in January 1997, firms were not required to report components of property, plant and equipment, hence, COMPUSTAT no longer collects that data.

The capital structure literature measures tangibility as the ratio of property, plant and equipment net of accumulated depreciation to the book value of total assets. We conjecture that some tangible assets, such as land & building, are "more tangible", i.e., can offer creditors more attractive collateral than firm-specific assets such as machinery & equipment. COMPUSTAT provides a breakdown of property, plant and equipment (PPE) into four components: land & building, machinery & equipment, construction of plant & equipment in progress, and other types of tangible assets. This breakdown is crucial to our study because it allows us to compare land & building, which we call Real Estate Collateral, with other types of tangible assets.

On average, land & building makes up 33 percent of total tangible assets, machinery & equipment makes up 51 percent, and the other two components combined make up only 16 percent. Therefore, we combine machinery & equipment with the last two components to form the category Machinery, Equipment & Other. This allows us to compare the separate effects of real estate collateral on firm leverage ratios with the effects of all other assets on leverage.

Leverage is the ratio of total debt to market value of total assets. Total debt is defined as the sum of long-term debt (COMPUSTAT data item 9) and current liabilities (COMPUSTAT data item 34). Market value of total assets is the sum of book value of total assets (COMPUSTAT data item 6) minus book value of equity (COMPUSTAT data item 60) plus market value of equity, which is the product between the share price (COMPUSTAT data item 199) and total number of shares outstanding (COMPUSTAT data item 54). Real estate collateral, is the ratio of the sum of net book value of land and building (COMPUSTAT data items 158+155) to the book value of total assets. Machinery, Equipment & Other, is the ratio of the net book values of machinery & equipment, plant & equipment in progress, and the sum of capital leases and other tangible assets (COMPUSTAT data items 156+73+159+250) to book value of total assets. Tangibility is the sum of real estate collateral and machinery, equipment & other. Tangibility is the proxy for tangible assets used in the extant capital structure literature.
Market-to-Book Ratio is the ratio of the market value of total assets to book value of total assets. Firm size is the market value of total assets (measured in millions of 1996 dollars\(^4\)). We use the natural logarithm of firm size in our regression models. Profitability is the ratio of earnings before interest, taxes, depreciation and amortization (COMPUSTAT data item 13) to book value of total assets. Volatility is the ratio of the standard deviation of earnings before interest, taxes, depreciation and amortization using at least four years of consecutive observations, to the average book value of total assets over the same time horizon. Earnings Growth is the ratio of the change in income before extraordinary items (COMPUSTAT data item 20) from t to t+1 to the market value of equity.

Investment Tax Credit Dummy is a dummy variable equal to 1 if investment tax credit (COMPUSTAT data item 51) is positive, and zero otherwise. Net Operating Loss Carryforward Dummy is a dummy variable equal to 1 if operating loss carryforward (COMPUSTAT data item 52) is positive, and zero otherwise. Bond Market Access is a dummy variable that takes the value of 1 if the firm has either a bond rating (COMPUSTAT data item 280) or a commercial paper rating (COMPUSTAT data item 283), and zero otherwise. This definition is used by Faulkender and Petersen (2006) to proxy for access to public bond markets. Firm Age is the number of years since the firm first appeared in COMPUSTAT. We use the natural logarithm of firm age in our regressions.

We exclude those firm-year observations for which the value of total assets or net sales is less than $1 million. To control for the presence of outliers, we delete observations if property, plant and equipment (PPE) is more than 100% of total assets, the market-to-book ratio is larger than 10, or earnings growth or profitability are larger than 300% in absolute value. Our results remain qualitatively similar if we winsorize the remaining continuous variables. This entails replacing values below (above) the 1st (99th) percentile with the 1st (99th) percentile.

We also exclude firm-year observations that have large changes in business fundamentals, including increases in size or sales of more than 100% compared to the previous year. Similarly, we exclude firms involved in major restructuring, bankruptcy or merger activities.

Our final sample includes 2,250 firms with complete data to run our regression models during the sample period 1984 to 1996. The resulting unbalanced panel includes 9,609 firm-year observations, meaning that each firm appears in our sample on average 5.3 years with a range from 2 to 12 years.

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\(^4\) We use the Producer Price Index (PPI) published by the U.S. Department of Labor as the deflator.
Table 1 presents summary statistics for our dataset. Our sample is comparable to those of other capital structure studies (e.g., Faulkender and Petersen, 2006) in terms of leverage ratio, tangibility and other regression variables. About 35% of total assets are tangible assets, of which Real Estate Collateral and Machinery, Equipment & Other account for about 33% and 67%, respectively.

[Table 1 here]
4. Results

In this section, we present a series of regressions that model the relation between leverage and tangibility. We start with the traditional leverage models used in earlier studies, where asset tangibility is measured by a single variable, and later compare those model results with our real-estate-conditioned leverage models, where tangible assets are split into Real Estate Collateral, and Machinery, Equipment & Other. Both the traditional and real-estate-conditioned models are estimated using four regression methods; OLS, Industry Fixed-Effects (FE), Firm FE, and Two-Stage Least Squares Instrumental Variables (2SLS-IV).

OLS regressions require tangibility to be determined exogenously; if not, OLS estimates could be biased. The relation between leverage and tangibility, however, could be endogenous. Lenders could lend more to high-tangible-asset firms, but firms facing credit constraints might endogenously choose more tangible assets in order to increase their ability to borrow.

We address the potential endogeneity bias in the OLS regression estimates in several ways. One is to use fixed-effects (FE) panel regression methods to control for industry-specific effects on leverage. This method controls for industry effects but not firm-specific effects. A second method is to use firm fixed effects panel regression to control for unobserved characteristics that are fixed for each firm, but vary across firms (see Verbeek and Nijman, 1992a, 1992b, Vella, 1998, and Lemmon, Roberts and Zender, 2008). Finally, even the firm fixed-effect regressions could be biased if there remain some unobserved characteristics related to leverage that change within each firm across time. To control for this possibility, we combine fixed-effects with 2SLS-IV.

4.1. Traditional Model Results

The results for the traditional models using the four methods are presented in the first four columns of Table 2. They illustrate the importance of accounting for endogeneity, and the value of using IV estimates as opposed to OLS estimates. Starting with the estimates in the first row, the estimate on Tangibility is positive and significant, confirming previous studies’ findings of a positive relation between tangibility and leverage. Note that the estimate in the Firm-FE model is larger than the OLS and Industry-FE model estimates, and the estimate in the IV model is larger still. Some of the other estimates on control variables change as well. As we explain in more detail below, this is likely due to the endogeneity of leverage and
tangibility, which is better accounted for in the Firm-FE and IV models.

Besides measuring the effects of Tangibility, the models include control variables used in earlier studies of leverage from the traditional capital structure literature. These controls include market-to-book ratio, firm size, profitability, volatility of earnings, earnings growth, investment tax credit, net operating loss carryforward, bond access, and firm age. Focusing on the IV regression estimates in column 4, the signs of the statistically significant estimates agree with earlier studies' findings. For example, the estimate on the market-to-book ratio is negative and significant, consistent with Myers’ (1977) and Hart’s (1993) predictions that firms with significant growth opportunities will use less leverage to avoid the under-investment problem. The estimate on profitability is also negative and significant, consistent with Myers’ (1984) pecking order theory where highly profitable firms use less leverage (more internal equity).

Ross (1977) predicts that firms expecting positive earnings growth can increase their leverage as a signal that they will have the cash flows to handle more debt without defaulting. Consistent with this prediction, the estimate on earnings growth is positive and significant. Firms with alternative tax shields to debt tax shields may use less leverage, hence, the negative and significant estimate on the investment tax credit dummy. The estimate on the net operating loss carryforward dummy is positive and significant. Barclay, Marx and Smith (2003) and Johnson (2003) find the same results. Johnson (2003) suggests that net operating loss carryforwards can be positively related to leverage because carryforwards imply that the firm has incurred some equity losses, which will cause the denominator of the leverage ratio to decrease and the ratio itself to increase, all else equal.

Consistent with the argument and the results of Faulkender and Petersen (2006), we find a positive estimate on the bond market access dummy. Firms with access to the public debt market are less opaque and can borrow more. Better access to the bond market can lower debt costs, and provide firms with incentives to use more debt. We also find a positive estimate on firm age, consistent with the notion that creditors view older firms as less risky and thus are willing to lend more to them.

4.2. Real-Estate-Conditioned Models and Endogeneity

The potential for endogeneity bias is the most important econometric issue in our study. The endogeneity bias effects are particularly apparent in the real-estate-conditioned models in columns five through eight of Table 2, where tangibility is split into Real Estate Collateral, and Machinery, Equipment & Other. The estimates on these two tangibility variables are positive and significant as expected, however, the OLS estimate on Real Estate Collateral is biased down, and the estimate on Machinery, Equipment &
Other is biased up. The estimate on Real Estate Collateral increases from 0.218 in the OLS model, to 0.445 in the IV model. Conversely, the estimate on Machinery, Equipment & Other declines from 0.205 in the OLS model, to 0.166 in the IV model. These biases are masked somewhat in the traditional models because they offset one another when they are combined in one estimate on Tangibility.

Focusing on the IV model estimates, we find results that are highly consistent with the expectation that more easily redeployable assets, such as real estate, have a higher debt capacity. The estimate on Real Estate Collateral is more than twice as large as the estimate on Machinery, Equipment, and Other. The firm-FE model provides similar results. The industry fixed-effects model does not account for unobserved firm characteristics and provides weaker results, suggesting that merely controlling for industry effects is insufficient to adequately account for endogeneity.

Table 3 presents results used to evaluate the first stage regressions of the IV method. For brevity, it reports only the estimates on each IV models' first stage instruments, and their associated diagnostic statistics. Estimates on the control variables that are included in both the first and second stage regressions, are available on request.

We considered instruments that are likely to affect a firm's decision to purchase real estate or equipment, but that are unlikely to have a direct impact on their leverage decision. We selected the instruments after interviewing executives at consulting companies on the role of commercial real estate for end-users, at rating companies on the role of corporate tangible assets for rating quality, and at corporate finance departments on the decision process for the amount and composition of different corporate tangible assets.

Two types of instruments came up rather consistently in our interviews. The first measures the development of a firm's headquarters local real estate market and the capital/labor intensity of the sector where the firm operates. The second measures the structural characteristics of a firm's industry.

We have a total of four instruments, two for Real Estate Collateral (number of REITs and industry average real estate collateral), and two for Machinery, Equipment & Other (industry capital-labor standards and industry average machinery, equipment & other). We assess the development of the firm's local real estate market using the number of local REITs. REITs were established with the Real Estate Act of 1960, specifically to help improve local commercial real estate markets. Chan, Erickson, and Wang (2003) find that REITs improve the supply of real estate in the local markets where they operate. Firms could hold relatively more or less real estate depending upon the potential availability of real estate for sale. More REITs in the local market implies more readily available real estate if the need arises.
We assess the capital/labor intensity of the firm’s industry using the industry capital-labor (K/L) ratio. Our conjecture is that the manufacturing structure (machinery and equipment) and labor configuration are related decisions (see MacKay and Phillips, 2005).

The second set of instrumental variables account for industry structural characteristics. Here we include industry-year averages for Real Estate Collateral and Machinery, Equipment & Other.

[Table 3 here]

The estimates on our instruments have the expected signs. For example, the estimates on our industry averages that measure industry characteristics are positive. Because many industries have unique production technologies, most firms in the industry will have tangible assets that are positively related to the industry averages.

The estimates on the number of REITs are negative. The negative relation makes intuitive sense. If firms consider REITs to be ready sellers of real estate, then they could hold less real estate on their own balance sheets to economize on assets. If a sudden need arises, they can approach REITs to fill the need.

The estimates on the K/L ratio are positive. This suggests that firms use more machinery & equipment in more capital intensive industries. For instance, manufacturing industries are relatively machinery intensive, while service industries are relatively labor intensive.

The diagnostic statistics for the first-stage regressions reported at the bottom of Table 3 indicate that we cannot reject the validity of the first-stage specifications. The low p-values for the Hansen J-tests of over-identifying restrictions indicate that we never reject the joint null hypothesis that our instruments are uncorrelated with the error term in the regressions, and that the models are well-specified. We note that the low p-value for the Hansen J-test allow us to conclude that the exclusion restrictions are met in the data and that the instruments are not directly related to leverage. Furthermore, the low p-values associated with the first stage F-test of excluded instruments confirm that our instruments are relevant in explaining the variation of our endogenous variables. And the R-squared and Shea’s partial R-squared indicate that our instruments have reasonable explanatory power.

Overall, our findings support our empirical prediction that more easily redeployable assets, such as real estate, create more debt capacity than other forms of tangible assets. However, we expect that this result should hold mainly for credit constrained firms. Moreover, one could be concerned that despite the fact that the nominal estimate on Real Estate Collateral is relatively large, the estimates measure marginal effects and not absolute economic effects, which are more important. We address these two issues in the next two sub-sections.
4.3. Tangibility and Leverage for Credit Constrained and Unconstrained Firms

We expect that tangible assets enhance the borrowing capacity of credit constrained firms but not unconstrained firms. Therefore, we re-estimate our regression models for different sub-sets of our sample firms that can be classified ex-ante as credit constrained.

We rely on the three credit constraint proxies widely used in the finance literature (see, for instance, Almeida, Campello and Weisbach, 2004; Almeida and Campello, 2007; Erickson and Whited, 2000). The first proxy is firm size. Erickson and Whited (2000) argue that smaller firms are usually younger and therefore, creditors face greater information asymmetry with small firms and are less likely to loan to them. Accordingly, in each sample year from 1984 to 1996 we rank firms according to their size (based on assets) and we classify as credit constrained (unconstrained) those firms in the bottom (top) three size deciles in each sample year.

The second credit constraint proxy is bond market access. Whited (1992) suggests that to obtain a bond rating, a firm undergoes “a great deal of public scrutiny”, which should lower its level of information asymmetry. We can therefore expect that firms without a bond rating face higher credit constraints from lenders. Again, in each sample year from 1984 to 1996 we classify firms as credit constrained (unconstrained) if they have no (a) bond rating.

The third credit constraint proxy is the dividend payout ratio. Fazzari, Hubbard and Petersen (1988) argue that firms decide to pay out dividends only after investment and financing decisions are made. If a firm decides to pay little or no dividends, then it likely faces credit constraints; otherwise, it could have borrowed to fund investments and have paid dividends. We define the dividend payout as the ratio of dividends plus stock repurchases to operating income. In each sample year from 1984 to 1996, we rank firms according to their dividend payout ratio and classify as credit constrained (unconstrained) those firms with a dividend payout ratio in the bottom (top) three deciles of the yearly dividend payout ratio distribution.

Table 4 reports IV regressions for sub-samples of constrained and unconstrained firms. Results closely fit our theoretical predictions. Real estate is a potent source of collateral for credit constrained firms. In particular, the coefficient estimate on Real Estate Collateral is positive and highly significant for each of the three credit-constrained sub-samples; results are robust to the proxy used to identify credit constrained firms. Furthermore, the estimates are larger than the estimates on Machinery, Equipment & Other.

[Table 4 here]

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5 Erickson and Whited (2000) suggest convincingly that firm size is a rather genuine classification scheme for credit constraints because it cannot be endogenously determined by the management in the short- to medium-term.
Moreover, Table 4 shows that neither of the tangibility measures is a significant driver of leverage for unconstrained firms, and this result is robust for all three credit constraint proxies. Overall, results reported in Table 4 strongly support our prediction that real estate is the most important source of collateral, but only for credit constrained firms. It could still be possible that the effect of Real Estate Collateral on leverage is economically smaller or similar in size to that of Machinery, Equipment & Other. We consider economic significance in the next sub-section.

4.4. Economic Significance

Table 5 compares the economic significance of the effects of each of the continuous variables in our IV leverage regression models. We show results for the full sample as well as for the three sub-samples of credit constrained firms. Economic significance is measured by the estimated percentage change in leverage from its mean, driven by a one standard deviation increase in a particular continuous variable, holding all other variables constant at their sample means.

[Table 5 here]

The most important result in Table 5 is that the economic effect of Real Estate Collateral is much larger than the economic effects of Machinery, Equipment & Other. This holds for each sub-sample of credit constrained firms. For example, for the "size" subsample, a one standard deviation increase in Real Estate Collateral increases firm leverage by about 32%. This is more than twice as large as the economic effect of a one standard deviation increase in Machinery, Equipment & Other.

Finally, note that Real Estate Collateral is the most important determinant of leverage. It economically dominates any other variable in the leverage regression, including traditional variables like market-to-book ratio, profitability, etc., which were the focus of earlier capital structure papers. But our results imply that real estate is a more important driver of leverage, even after controlling for the effects of these other variables.

4.5. Statistical Robustness

We check the robustness of our results in several ways. First, we re-estimate all of the 2SLS instrumental variables regressions using instrumental variables generalized method of moments (IV-GMM).

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6 Campello and Giambona (2012) focus on asset salability and find similar evidence.
The IV-GMM estimator provides an efficiency gain over the standard IV estimator by allowing for the form of heteroskedasticity to be unknown as well as for arbitrary intra-cluster correlation in the sample (see MacKay and Phillips, 2005; Baum, Schaffer, Stillman, 2002). All of our results hold using this alternative estimation technique.

Given the panel structure of our data, the regression residuals could be serially correlated across observations of a given firm. For this reason, all of our regressions account for clustering. Petersen (2009) provides simulation evidence showing that regressions that account for firm clustering produce standard errors corrected for this type of serial correlation.

An alternative method to handle the serial correlation, proposed by Kayhan and Titman (2007) and Wald and Long (2007), employs block-bootstrap sampling with replacement from the original sample. To preserve the dependence structure of the errors in the original sample, they propose sampling firm clusters rather than firm-year observations. We obtain 1,000 random draws each including T firm clusters from our original sample, and each time we estimate the regression coefficients. Replicating all of our analysis using this block-bootstrap procedure shows that most of our results are qualitatively similar to those reported in Table 4.

There is an ongoing debate in the finance literature about the choice between the book-value measure of leverage, advocated by Graham and Harvey (2001), Frank and Goyal (2003) and Shyam-Sunder and Myers (1999), and the market-value measure of leverage advocated by Welch (2004) and widely used in the empirical capital structure literature. Particularly relevant for our purposes is Welch’s (2004) point that, because the book value of equity decreases through accounting depreciation of firm assets, the relation between tangibility and leverage could arise mechanically. This is why we use market-valued leverage in our regressions. Nevertheless, we check the robustness of our results to the book-value measure of leverage and find no qualitative differences.

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5. Conclusions

Capital structure studies have consistently documented a positive relation between tangibility and leverage, including Rajan and Zingales (1995), MacKay and Phillips (2005), Faulkender and Petersen (2006) Wald and Long (2007), Kale and Shahrur (2007), Lemmon and Zender (2007), Bharath, Pasquariello and Wu (2009), and Harrison, Pasanian, and Seiler (2011). Most argue that this is because firms can pledge tangible assets as collateral to lenders, who in turn, are willing to lend more.

These earlier studies do not distinguish between possible differences in the degrees of asset tangibility across asset types. We study the effects of different degrees of asset tangibility on leverage, along with the effects of credit constraints, after disaggregating the tangibility ratio into two component parts (Real Estate Collateral and Machinery, Equipment & Other). We can test for a difference in the effects of each component on leverage because we identified a sub-period (1984-1996) of the COMPUSTAT database when firms had to report the components and COMPUSTAT gathered the data.

Our results show that "more tangible" assets (such as real estate) can support proportionately more debt than other types of tangible assets. We show that Real Estate Collateral has a stronger positive effect on leverage than Machinery, Equipment & Other. Furthermore, the positive relation between tangibility and leverage, and the relatively strong relation for Real Estate Collateral hold only for credit constrained firms. For credit unconstrained firms, we find no significant relation between tangibility and leverage. One implication of these findings is that the composition of tangible assets can be important in determining a firm's debt capacity.

Many who believe that the tax benefits of debt largely drive leverage ratios have been puzzled by the fact that REITs' average leverage is more than twice that of other firms (46% versus 20%). This is true even though REITs pay no taxes at the corporate level, and therefore, enjoy no debt tax benefits. Although we exclude REITs from our sample because they hold only real estate, our paper suggests that REITs' substantial holdings of real estate collateral facilitate their substantial borrowing. Future research could consider additional implications of real estate collateral for financing and investment activities. It should do so by recognizing that there are limits to debt capacity and high leverage for growth. These limits have become apparent during the recent financial crises.
6. References


Table 1 - Summary Statistics of Firm Characteristics

The table provides descriptive statistics for the main variables used in this paper. Our data are from the COMPUSTAT industrial database. Each variable is defined in detail in the text. The sample includes all firms with the exception of financial firms, lease, real estate, governmental and non-profit organizations. Our sample period ranges from 1984 through 1996.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>St. Dev.</th>
<th>25th Pct</th>
<th>75th Pct</th>
<th>Obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leverage</td>
<td>0.201</td>
<td>0.163</td>
<td>0.175</td>
<td>0.056</td>
<td>0.307</td>
<td>9,642</td>
</tr>
<tr>
<td>Tangibility</td>
<td>0.352</td>
<td>0.324</td>
<td>0.173</td>
<td>0.242</td>
<td>0.444</td>
<td>9,618</td>
</tr>
<tr>
<td>Real Estate Collateral</td>
<td>0.120</td>
<td>0.104</td>
<td>0.114</td>
<td>0.035</td>
<td>0.165</td>
<td>9,642</td>
</tr>
<tr>
<td>Machinery, Equipment &amp; Other</td>
<td>0.232</td>
<td>0.202</td>
<td>0.148</td>
<td>0.130</td>
<td>0.300</td>
<td>9,618</td>
</tr>
<tr>
<td>Market-to-Book Ratio</td>
<td>1.632</td>
<td>1.303</td>
<td>1.064</td>
<td>1.029</td>
<td>1.824</td>
<td>9,642</td>
</tr>
<tr>
<td>Firm Size</td>
<td>1.272</td>
<td>0.124</td>
<td>6.732</td>
<td>0.036</td>
<td>0.483</td>
<td>9,642</td>
</tr>
<tr>
<td>Profitability</td>
<td>0.107</td>
<td>0.134</td>
<td>0.171</td>
<td>0.069</td>
<td>0.188</td>
<td>9,642</td>
</tr>
<tr>
<td>Volatility</td>
<td>0.091</td>
<td>0.067</td>
<td>0.090</td>
<td>0.042</td>
<td>0.111</td>
<td>9,631</td>
</tr>
<tr>
<td>Earnings Growth</td>
<td>0.020</td>
<td>0.007</td>
<td>0.297</td>
<td>-0.034</td>
<td>0.040</td>
<td>9,642</td>
</tr>
<tr>
<td>Investment Tax Credit</td>
<td>0.246</td>
<td>0.000</td>
<td>0.430</td>
<td>0.000</td>
<td>0.000</td>
<td>9,642</td>
</tr>
<tr>
<td>Net Operating Loss Carryforward</td>
<td>0.253</td>
<td>0.000</td>
<td>0.435</td>
<td>0.000</td>
<td>1.000</td>
<td>9,642</td>
</tr>
<tr>
<td>Bond Market Access</td>
<td>0.159</td>
<td>0.000</td>
<td>0.365</td>
<td>0.000</td>
<td>0.000</td>
<td>9,642</td>
</tr>
<tr>
<td>Firm Age</td>
<td>25.449</td>
<td>23.000</td>
<td>10.515</td>
<td>19.000</td>
<td>35.000</td>
<td>9,642</td>
</tr>
</tbody>
</table>
Table 2 – Regression Estimates for the Relations between Leverage, Tangibility, and Real Estate Collateral

The dependent variable is the ratio of book value of total debt to the market value of total assets. Tangibility is the ratio of the sum of net book value of Property, Plant, and Equipment to book value of total assets. Real Estate Collateral is the ratio of net book value of land and buildings to book value of total assets. Machinery, Equipment & Other is the ratio of machinery and equipment, plant and equipment in progress, and other tangible assets to total assets. Both the “Traditional-Tangibility Leverage Model” and the “Real-Estate Leverage Model” are estimated using OLS, Industry Fixed Effects (FE) and Firm FE regressions, as well as Fixed-Effects Two Stage Least Squares Instrumental Variable (IV) regressions. All regressions include year dummies. White heteroskedastic consistent standard errors adjusted for clustering across observations of a given firm are reported in parentheses (Rogers, 1993, and White, 1980). *** (**, *) indicate respectively that the regression coefficient is statistically different from zero at the 1% (5%; 10%) level. The reported R²’s do not include the effect of fixed-effects.

<table>
<thead>
<tr>
<th></th>
<th>Traditional-Tangibility Leverage Model</th>
<th>Real-Estate Leverage Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OLS</td>
<td>Industry-FE</td>
</tr>
<tr>
<td>Tangibility</td>
<td>0.209***</td>
<td>0.184***</td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
<td>(0.032)</td>
</tr>
<tr>
<td>Real Estate Collateral</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machinery, Equipment &amp; Other</td>
<td>0.007***</td>
<td>-0.010***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Market-to-Book Ratio</td>
<td>-0.060***</td>
<td>-0.053***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>Log of Firm Size</td>
<td>-0.124***</td>
<td>-0.122***</td>
</tr>
<tr>
<td></td>
<td>(0.018)</td>
<td>(0.020)</td>
</tr>
<tr>
<td>Profitability</td>
<td>-0.163***</td>
<td>-0.101***</td>
</tr>
<tr>
<td></td>
<td>(0.038)</td>
<td>(0.039)</td>
</tr>
<tr>
<td>Earnings Growth</td>
<td>0.018**</td>
<td>0.021**</td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>Investment Tax Credit</td>
<td>-0.027***</td>
<td>-0.019***</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Net Operating Loss Carryforward</td>
<td>0.059***</td>
<td>0.058***</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>Bond Market Access</td>
<td>0.063***</td>
<td>0.062***</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Log of Firm Age</td>
<td>-0.009</td>
<td>-0.011</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Obs.</td>
<td>9,609</td>
<td>9,609</td>
</tr>
<tr>
<td>R²</td>
<td>0.262</td>
<td>0.229</td>
</tr>
</tbody>
</table>
Table 3 - First Stage IV Regression Estimates for the Relations between Tangible Assets and the Instrumental Variables

This table reports first stage instrumental variable regressions for Tangibility and Real Estate Models. We only tabulate coefficient estimates on excluded instruments in the interest of space. To control for firm fixed-effects, each variable is demeaned by the firm-specific means. All models also include year dummies. White heteroskedastic consistent standard errors adjusted for clustering across observations of a given firm are reported in parentheses (Rogers, 1993, and White, 1980). *** (**, *) indicate respectively that the regression coefficient estimates is statistically different from zero at the 1% (5%; 10%) level. The reported $R^2$’s do not include the effect of firm fixed-effects.

<table>
<thead>
<tr>
<th></th>
<th>First-Stage: Tangibility Model</th>
<th>First-Stage: Real-Estate Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tangibility</td>
<td>Real Estate Collateral</td>
</tr>
<tr>
<td>Industry Avg. – Real Estate Collateral</td>
<td>0.516***</td>
<td>0.473***</td>
</tr>
<tr>
<td></td>
<td>(0.061)</td>
<td>(0.060)</td>
</tr>
<tr>
<td>Industry Avg. – Machinery, Equipment &amp; Other</td>
<td>0.485***</td>
<td>-0.005</td>
</tr>
<tr>
<td></td>
<td>(0.050)</td>
<td>(0.026)</td>
</tr>
<tr>
<td>Log of Number of REITs</td>
<td>-0.013**</td>
<td>-0.006*</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Industry K/L Standards</td>
<td>0.422*</td>
<td>0.130</td>
</tr>
<tr>
<td></td>
<td>(0.226)</td>
<td>(0.166)</td>
</tr>
<tr>
<td>Obs.</td>
<td>9,040</td>
<td>9,040</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.104</td>
<td>0.092</td>
</tr>
<tr>
<td>Shea’s Partial $R^2$</td>
<td>0.083</td>
<td>0.067</td>
</tr>
<tr>
<td>F-test Excluded Instruments</td>
<td>41.04***</td>
<td>20.30***</td>
</tr>
<tr>
<td>Hansen’s J-test (p-value)</td>
<td>0.270</td>
<td>0.890</td>
</tr>
</tbody>
</table>
This table reports the second stage of the instrumental variable (IV) regression models for leverage for different sub-groups of financially constrained firms (e.g., firms in the bottom 3 size deciles, firms without bond market access and firms in the bottom 3 payout deciles) and for financially unconstrained firms (e.g., firms in the top 3 size deciles, firms with bond market access and firms in the top 3 payout deciles) as described in the text. The dependent variable is the ratio of book value of total debt to the market value of total assets. Real Estate Collateral and Machinery, Equipment & Other are the predicted values from the corresponding first stage regressions estimated for each sub-sample of financially constrained and financially unconstrained firms. To control for firm fixed-effects, each variable is demeaned by the firm-specific means. All regressions also include year dummies. White heteroskedastic consistent standard errors adjusted for clustering across observations of a given firm are reported in parentheses (Rogers, 1993, and White, 1980). *** (**; *) indicate respectively that the regression coefficient estimate is statistically different from zero at the 1% (5%; 10%) level. The reported $R^2$’s do not include the effect of firm fixed-effects.

<table>
<thead>
<tr>
<th></th>
<th>Btm. 3 Deciles of Size</th>
<th>Top 3 Deciles of Size</th>
<th>Bond Market Access: Not</th>
<th>Bond Market Access: Yes</th>
<th>Btm. 3 Deciles of Payout</th>
<th>Top 3 Deciles of Payout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real Estate Collateral</td>
<td>0.518*** (0.149)</td>
<td>0.150 (0.382)</td>
<td>0.533*** (0.118)</td>
<td>-0.402 (0.492)</td>
<td>0.385*** (0.147)</td>
<td>-0.219 (0.392)</td>
</tr>
<tr>
<td>Machinery, Equipment &amp;</td>
<td>0.199 (0.148)</td>
<td>-0.100 (0.133)</td>
<td>0.220** (0.089)</td>
<td>-0.347 (0.241)</td>
<td>0.215* (0.112)</td>
<td>0.003 (0.170)</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market-to-Book Ratio</td>
<td>-0.038*** (0.006)</td>
<td>-0.023*** (0.007)</td>
<td>-0.040*** (0.004)</td>
<td>-0.044*** (0.012)</td>
<td>-0.044*** (0.005)</td>
<td>-0.035*** (0.007)</td>
</tr>
<tr>
<td>Log of Firm Size</td>
<td>-0.018 (0.012)</td>
<td>-0.007 (0.013)</td>
<td>0.002 (0.006)</td>
<td>-0.026 (0.019)</td>
<td>-0.001 (0.008)</td>
<td>0.019 (0.014)</td>
</tr>
<tr>
<td>Profitability</td>
<td>-0.061*** (0.022)</td>
<td>-0.329*** (0.068)</td>
<td>-0.102*** (0.020)</td>
<td>-0.459*** (0.098)</td>
<td>-0.061*** (0.022)</td>
<td>-0.367*** (0.055)</td>
</tr>
<tr>
<td>Volatility</td>
<td>-0.080 (0.058)</td>
<td>-0.032 (0.124)</td>
<td>-0.014 (0.063)</td>
<td>-0.077 (0.174)</td>
<td>-0.023 (0.079)</td>
<td>-0.077 (0.088)</td>
</tr>
<tr>
<td>Earnings Growth</td>
<td>0.032*** (0.008)</td>
<td>-0.006 (0.017)</td>
<td>0.021*** (0.006)</td>
<td>-0.016 (0.017)</td>
<td>0.021*** (0.007)</td>
<td>0.015 (0.019)</td>
</tr>
<tr>
<td>Investment Tax Credit</td>
<td>-0.020** (0.010)</td>
<td>-0.012** (0.006)</td>
<td>-0.018*** (0.005)</td>
<td>-0.013* (0.008)</td>
<td>-0.026*** (0.008)</td>
<td>-0.011* (0.006)</td>
</tr>
<tr>
<td>Net Operating Loss</td>
<td>0.041*** (0.010)</td>
<td>0.006 (0.010)</td>
<td>0.039*** (0.006)</td>
<td>0.013 (0.010)</td>
<td>0.030*** (0.008)</td>
<td>0.022** (0.010)</td>
</tr>
<tr>
<td>Carryforward</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bond Market Access</td>
<td></td>
<td></td>
<td>0.039*** (0.009)</td>
<td></td>
<td>0.038* (0.021)</td>
<td>0.014 (0.010)</td>
</tr>
<tr>
<td>Log of Firm Age</td>
<td>0.082 (0.058)</td>
<td>-0.138*** (0.042)</td>
<td>0.063** (0.029)</td>
<td>0.047 (0.064)</td>
<td>0.087** (0.036)</td>
<td>0.028 (0.060)</td>
</tr>
<tr>
<td>Obs.</td>
<td>2,529</td>
<td>2,660</td>
<td>7,415</td>
<td>1,448</td>
<td>3,616</td>
<td>2,543</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.253</td>
<td>0.212</td>
<td>0.220</td>
<td>0.223</td>
<td>0.242</td>
<td>0.182</td>
</tr>
</tbody>
</table>
Table 5 - Economic Significance of the Determinants of Leverage for the Full Sample and the Sub-Samples of Credit Constrained Firms

This table reports the percentage changes in leverage (second stage of instrumental variable regression) relative to its sample mean as each continuous regressor increases by 1 standard deviation, while all other regressors are kept at their sample means for the full sample and the three sub-samples of credit constrained firms. The dependent variable is the ratio of book value of total debt to the market value of total assets. To control for firm fixed-effects, each variable is demeaned by the firm-specific means. All regressions also include year dummies. *** (**; *) indicate respectively that the regression coefficient is statistically different from zero at the 1% (5%; 10%) level based on White heteroskedastic consistent standard errors adjusted for clustering across observations of a given firm (Rogers, 1993, and White, 1980).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full Sample</th>
<th>Sub-Samples of Credit Constrained Firms</th>
<th>Bond Market Access: Not</th>
<th>Bottom 3 Deciles of Payout</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(%)</td>
<td>(%)</td>
<td>(%)</td>
<td>(%)</td>
</tr>
<tr>
<td>Real Estate Collateral</td>
<td>25.08***</td>
<td>32.50***</td>
<td>30.30***</td>
<td>23.47***</td>
</tr>
<tr>
<td>Machinery, Equipment &amp; Other</td>
<td>12.17**</td>
<td>15.26</td>
<td>16.74**</td>
<td>17.38*</td>
</tr>
<tr>
<td>Market-to-Book Ratio</td>
<td>-21.14***</td>
<td>-16.69***</td>
<td>-22.06***</td>
<td>-25.06***</td>
</tr>
<tr>
<td>Log of Firm Size</td>
<td>5.72</td>
<td>-3.51</td>
<td>1.53</td>
<td>0.00</td>
</tr>
<tr>
<td>Profitability</td>
<td>-10.20***</td>
<td>-7.13***</td>
<td>-9.08***</td>
<td>-6.70***</td>
</tr>
<tr>
<td>Volatility</td>
<td>-0.89</td>
<td>-5.10</td>
<td>-0.47</td>
<td>-1.15</td>
</tr>
<tr>
<td>Earnings Growth</td>
<td>2.80***</td>
<td>6.47***</td>
<td>3.26***</td>
<td>4.20***</td>
</tr>
<tr>
<td>Investment Tax Credit</td>
<td>-2.14***</td>
<td>-3.64**</td>
<td>-2.12***</td>
<td>-3.80***</td>
</tr>
<tr>
<td>Net Operating Loss Carryforward</td>
<td>7.99***</td>
<td>9.99***</td>
<td>8.64***</td>
<td>7.33***</td>
</tr>
<tr>
<td>Bond Market Access</td>
<td>7.80***</td>
<td></td>
<td></td>
<td>4.18*</td>
</tr>
<tr>
<td>Log of Firm Age</td>
<td>11.32*</td>
<td>20.27</td>
<td>16.17**</td>
<td>22.26**</td>
</tr>
<tr>
<td>Obs.</td>
<td>9,040</td>
<td>2,529</td>
<td>7,415</td>
<td>3,616</td>
</tr>
</tbody>
</table>
This appendix develops a simple repudiation-theory model in the spirit of Hart and Moore (1994), and follows a modeling strategy similar to Almeida and Campello (2007) and Benmelech and Bergman (2011a). We establish a positive link between tangibility and leverage, and show that it only exists for credit constrained firms.

Our model extends the theoretical framework of Almeida and Campello (2007) and Benmelech and Bergman (2011a) to study the equilibrium relation between asset tangibility and the leverage ratio. The model relies on the inalienability of human capital and managerial repudiation, presented in Hart and Moore (1994).

Consider a firm with an investment opportunity that produces cash flows $f(I)$ from realized investment $I > 0$ after one period. $f(I)$ is a strictly increasing and concave function of investment. The firm needs outside financing to undertake the investment project.

$D > 0$ is the amount of debt that the firm raises to help fund the project. All parties (creditors and the firm) are assumed to be risk neutral and the risk-free rate is normalized to zero. The creditors’ outside option is to invest the amount $D$ in the money market at the risk-free rate. There is a large pool of creditors competing for investment opportunities so that the firm only needs to compensate a lender for their outside option. Suppose further that the firm has additional pledgeable risk-free assets $W$. These can be cash that the firm uses to partially finance the investment, as in Almeida and Campello (2007), but we characterize them as risk-free pledgeable assets for convenience.

We depart from earlier studies by assuming that the firm also has access to equity financing to partly fund its investment, which we denote by $E \geq 0$. The amount $E$ corresponds to the additional amount of equity capital raised to fund the investment opportunity, not the total equity value of the firm. However, equity financing involves proportional issuance costs $\varepsilon > 0$; $\varepsilon E$ goes to the underwriter while the firm gets the net proceeds, $(1 - \varepsilon)E$. These issuance costs drive firms to strictly prefer debt over equity. Although we assume that debt is costless to issue, it only needs to be less costly to issue than equity. Alternatively, one could introduce a debt tax shield to ensure that firms strictly prefer debt over equity, all else equal. This would complicate the model by introducing corporate taxes, hence, we instead choose issuance costs as the wedge between debt and equity. This is in keeping with the tax environment of REITs.
The parameter $\theta$, $0 \leq \theta \leq 1$, denotes the fraction of investment $I$ that is tangible, and can be recovered by the creditors in case of liquidation (in addition to $W$). We assume that $\theta$ is exogenous, and thus independent from the investment. Following the approach of Hart and Moore (1994), we assume that the firm’s managers’ technical skills are necessary for the investment to run profitably. Managers could repudiate contracts by withdrawing their critical human capital right after the money has been invested (and potentially triggering liquidation). This leaves lenders with no bargaining power if they try to renegotiate their debt contracts with managers, hence, creditors will only obtain the firm’s liquidation value, i.e., $(W + \theta I)$. As a result, creditors will never lend the firm more than the liquidation value of the firm; i.e.,

$$D \leq (W + \theta I).$$  

(1)

In equilibrium, renegotiation never occurs because creditors limit the amount of the loan according to condition (1). All else equal, firms with larger $\theta$ have a larger debt capacity because creditors know they will recapture a greater fraction of the investment cost if they must liquidate the firm.

The firm’s program to maximize the value of its investment is:

$$\max_I f(I) - I - \epsilon E(I),$$

(2)

s.t. $I = D + (1 - \epsilon) E(I),$

and $D \leq (W + \theta I)$.

$E$ is a function of $I$ because the larger the investment, the more likely that the firm will need to raise equity, assuming that $W$ is fixed and $\theta < 1$. We also have that $D > 0$ and $E(I) \geq 0$.

The solution from (2) is the firm’s optimal investment $I^*$. If the firm has a large amount of pledgeable assets such that $I^* < (W + \theta I)$, then the firm will fully fund its investment with debt, so $I^* = D$ and $E(I^*) = 0$. In this case, the firm has enough collateral to convince creditors to lend it the full cost of its investment. The firm avoids having to raise equity and bear issuance costs. Here, the firm attains the first-best level of investment, $I^* = I_{fb}$, and it also captures the full net present value of its investment, $NPV = f(I^*)$.

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8 In the empirical analysis, we control for the possibility that $\theta$ is endogenously determined.
The firm's leverage ratio, $L_{fb}$, is:

$$L_{fb} = \frac{I_{fb}}{W + f(I_{fb})}.$$  

(3)

The tangibility of the firm's assets, $\theta$, does not enter (3), hence, because the firm is not credit constrained in the first-best case, there is no relation between the tangibility and leverage. The intuition is that if the firm's pledgeable assets exceed its investment costs, additional tangibility of its assets does not affect the amount of debt it will raise, nor does it affect the value of the firm. So when firms are not credit constrained, they make capital structure decisions independent from investment decisions.

The more interesting case arises when the firm is credit constrained. In this case, the firm will have to issue equity and bear issuance costs, hence, the optimal solution to (2) is no longer the first-best. The second constraint in (2) is now binding so that,

$$D = (W + \theta I),$$  

(4)

and the firm issues equity and receives the net proceeds $(1 - \varepsilon)E(I)$, so that equity issued is

$$E(I) = [(1 - \theta)I - W] / (1 - \varepsilon).$$  

(5)

$E(I)$ is simply the difference between the investment cost and the firm's pledgeable assets in (4), grossed up by $(1 - \varepsilon)$ to cover the issuance costs.

With the credit constraint and equity issuance, the first-order condition from (2) becomes:

$$f'(I) - 1 - \varepsilon \frac{(1-\theta)}{(1-\varepsilon)} = 0.$$  

(6)

The constrained solution from (2) is a second-best solution. Now the firm's optimal investment is smaller than before$^{10}$, $I' = I_{ab} < I_{fb}$, and it must issue both debt ($D < I'$) and equity ($E(I') > 0$). With a lower level of

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$^9$ Derivation: $D = I_{fb}; E = 0; V = D + E + E^{old} = I_{fb} + 0 + W + NPV = W + f(I_{fb}).$ $V$ is total firm value, which is the sum of debt and equity (new and old), i.e., the value of existing assets plus the present value of new investments.

$^{10}$ In the first-best, the first-order condition is $f(I) - 1 = 0.$ In (6), the additional term is strictly positive, leading to a lower level of investment as a result of a concave cash flow function $f(I)$.  

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investment, and after absorbing equity issuance costs, the net present value of the second-best investment falls below that of the first-best investment. Consequently, the firm’s value is smaller under the second best investment, and it’s leverage ratio changes to, $L_{sb}$:  

$$L_{sb} = \frac{W + \theta I^*}{W + f(I^*) - \varepsilon E(I^*)}. \quad (7)$$

Leverage is now a function of the firm’s asset tangibility, $\theta$. Taking the derivative of (7) with respect to $\theta$ yields:

$$\frac{\partial L}{\partial \theta} = \frac{(I^* + \theta \frac{\partial I^*}{\partial \theta})(W + f(I^*) - \varepsilon E(I^*)) - (W + \theta I^*)(\frac{\partial f(I)}{\partial I} + \varepsilon \frac{\partial E(I^*)}{\partial \theta})}{(W + f(I^*) - \varepsilon E(I^*))^2}. \quad (8)$$

The derivative is positive if the numerator of (8) is positive. Therefore, to consider the conditions for a positive relation we have,

$$\left(I^* + \theta \frac{\partial I^*}{\partial \theta}\right)(W + f(I^*) - \varepsilon E(I^*)) > (W + \theta I^*)(\frac{\partial f(I)}{\partial I} + \varepsilon \frac{\partial E(I^*)}{\partial \theta}) \cdot (9)$$

Rearranging produces,

$$L_{sb} = \frac{W + \theta I^*}{W + f(I^*) - \varepsilon E(I^*)} < \left(\frac{I^* + \theta \frac{\partial I^*}{\partial \theta}}{\frac{\partial f(I)}{\partial I} + \varepsilon \frac{\partial E(I^*)}{\partial \theta}}\right). \quad (10)$$

From the first order condition (6), we know that,

$$\frac{\partial f(I)}{\partial I} = 1 + \varepsilon \frac{(1-\theta)}{(1-\varepsilon)}, \quad (11)$$

and from (5) we obtain,

$$\frac{\partial E(I)}{\partial I} = \frac{(1-\theta)}{(1-\varepsilon)}. \quad (12)$$

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11 Derivation: $D = W + \theta I^*$ from (4); $E = I^* - D = (1 - \theta) I^* - W$; $E^{old} = W + NPV$; $V = D + E + E^{old} = W + f(I^*)$. 

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Substituting (11) and (12) into (10) and rearranging produces,

\[ L_{sb} < \theta + \frac{I^*}{\theta} . \] (13)

Condition (13) shows that the relation between tangibility and leverage is positive for credit constrained firms, as long as the leverage ratio is less than the tangibility ratio, plus a second positive term of unknown size. In our data sample, the average leverage ratio is 0.201 and the average tangibility ratio is 0.352, hence, this condition is likely to be satisfied for many firms without considering the positive influence of the second term.

The second term could be quite large for several reasons. First, if the equity issuance cost (\( \varepsilon \)) is small (it is commonly around five percent), then \( I^* = I_{fb} \), and the second term is large because the sensitivity of investment to any variable at its global maximum is small. Certainly, the change in the optimal investment with respect to a small change in tangibility is unlikely to exceed the initial level of optimal investment, hence, the second term is likely to be greater than one.

If we had chosen equity issuance costs to be a fixed cost, \( S \), then it is easy to see that the relation between tangibility and leverage is always positive. In that case, the third term in the denominator of the leverage ratio in (7) would be replaced by \( S \), hence, the tangibility ratio only appears in the numerator and with a positive sign. Although a proportional issuance cost is more realistic, investment bankers often charge a larger proportion for smaller equity issues reflecting their attempt to recover their fixed costs. To the extent that \( \varepsilon \) increases to offset decreases in \( E(I^*) \), issuance cost will be approximately fixed, yielding a strictly positive relation between tangibility and leverage.

Proposition 1 summarizes the empirical implications of our model for leverage.

**Proposition 1:** The relation between leverage and asset tangibility is, (i) positive for low levels of tangibility \( \{ \theta < (I_{fb} - W)/I_{fb} \} \) where the firm is credit constrained, (ii) but for higher levels of tangibility where the firm is no longer credit constrained, there is no relation.

This proposition states that there is a positive relation between tangibility and leverage when the firm is credit constrained. In this case, the firm must raise equity of \( [(1 - \theta)I - W]/(1 - \varepsilon) \) and commit to invest in assets with a sufficient collateral capacity to convince its creditors to loan it the amount \( W + \theta I \).
We operationalize this prediction by drawing on differences in tangibility across different types of corporate assets. Firms’ production technologies partly determine the mix of investment assets that they can select, hence, all firms cannot simply select the more tangible assets.
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