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## Journal of Financial Economics

journal homepage: [www.elsevier.com/locate/jfec](http://www.elsevier.com/locate/jfec)Collateral and capital structure<sup>☆</sup>

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## ARTICLE INFO

## Article history:

Received 13 February 2012

Received in revised form

15 January 2013

Accepted 16 January 2013

## JEL classification:

D24

D92

E22

G31

G32

G35

## Keywords:

Collateral

Capital structure

Risk management

Leasing

Tangible assets

## ABSTRACT

We develop a dynamic model of investment, capital structure, leasing, and risk management based on firms' need to collateralize promises to pay with tangible assets. Both financing and risk management involve promises to pay subject to collateral constraints. Leasing is strongly collateralized costly financing and permits greater leverage. More constrained firms hedge less and lease more, both cross-sectionally and dynamically. Mature firms suffering adverse cash flow shocks may cut risk management and sell and lease back assets. Persistence of productivity reduces the benefits to hedging low cash flows and can lead firms not to hedge at all.

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## 1. Introduction

We argue that collateral determines the capital structure and develop a dynamic agency-based model of firm

financing based on the need to collateralize promises to pay with tangible assets. We maintain that the enforcement of payments is a critical determinant of both firm financing and whether asset ownership resides with the user or the financier, i.e., whether firms purchase or lease assets. We study a dynamic neoclassical model of the firm in which financing is subject to collateral constraints derived from limited enforcement and firms choose between purchasing and renting assets. Our theory of optimal investment, capital structure, leasing, and risk management enables the first dynamic analysis of the financing vs. risk management trade-off and of firm financing when firms can rent capital.

In the frictionless neoclassical model, asset ownership is indeterminate and firms are assumed to rent all capital. The recent dynamic agency models of firm financing ignore the possibility that firms rent capital. Of course, a frictionless rental market for capital would obviate financial constraints. We explicitly consider firms' dynamic

<sup>☆</sup> We thank Michael Brennan, Francesca Cornelli, Andrea Eisfeldt, Michael Fishman, Piero Gottardi, Dmitry Livdan, Ellen McGrattan, Lukas Schmid, Ilya Strebulaev, Tan Wang, Stan Zin, an anonymous referee, and seminar participants at Duke University, the Federal Reserve Bank of New York, the Toulouse School of Economics, the University of Texas at Austin, New York University, Boston University, MIT, Virginia, UCLA, Michigan, Washington University, McGill, Indiana, Koc, Lausanne, Yale, Amsterdam, Emory, the 2009 Finance Summit, the 2009 NBER Corporate Finance Program Meeting, the 2009 SED Annual Meeting, the 2009 CEPR European Summer Symposium in Financial Markets, the 2010 AEA Annual Meeting, the 2010 UBC Winter Finance Conference, the IDC Caesarea Center Conference, the 2010 FIRS Conference, the 2010 Econometric Society World Congress, and the 2011 AFA Annual Meeting for helpful comments and Sophia Zhengzi Li for research assistance.

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lease vs. buy decision, modeling leasing as highly collateralized albeit costly financing. When capital is leased, the financier retains ownership which facilitates repossession and strengthens the collateralization of the financier's claim. Leasing is costly since the lessor incurs monitoring costs to avoid agency problems due to the separation of ownership and control.

We provide a definition of the user cost of capital in our model of investment with financial constraints that is similar in spirit to Jorgenson's (1963) definition in the frictionless neoclassical model. Our user cost of capital is the sum of Jorgenson's user cost and a term which captures the additional cost due to the scarcity of internal funds. In our model, firms require both tangible and intangible capital, but the enforcement constraints imply that only tangible capital can be pledged as collateral and borrowed against, resulting in a premium on internal funds; tangibility restricts external financing and hence leverage.

There is a fundamental connection between the optimal financing and risk management policy that has not been previously recognized. Both financing and risk management involve promises to pay by the firm, leading to a trade-off when such promises are limited by collateral constraints. Indeed, firms with sufficiently low net worth do not engage in risk management at all because the need to finance investment overrides the hedging concerns. This result is in contrast to the extant theory, such as Froot, Scharfstein, and Stein (1993), and is consistent with the evidence that more constrained firms hedge less provided by Rampini, Sufi, and Viswanathan (2012), and the literature cited therein, and with the strong positive relation between hedging and firm size in the data.

With constant investment opportunities, risk management depends only on firms' net worth and incomplete hedging is optimal, i.e., firms do not hedge to the point where the marginal value of net worth is equated across all states. In fact, firms abstain from risk management with positive probability under the stationary distribution. Thus, even mature firms that suffer a sequence of adverse cash flow shocks may see their net worth decline to the point where they find it optimal to discontinue risk management. We moreover characterize the comparative statics of firms' investment, financing, risk management, and dividend policy with respect to other key parameters of the model. Firms subject to higher risk can choose to hedge more and reduce investment due to the financing needs for risk management. Firms with more collateralizable or tangible assets can lever more and increase investment, while at the same time raising corporate risk management to counterbalance the increase in the volatility of net worth that higher leverage would otherwise imply. Firms with more curvature in their production function operate at smaller scale and may hence hedge less, not more as one might expect. Thus, our model has interesting empirical implications for firm financing and risk management both in the cross section and the time series.

With stochastic investment opportunities, risk management depends not only on firms' net worth but also on their productivity. If productivity is persistent, the overall

level of risk management is reduced, because cash flows and investment opportunities are positively correlated due to the positive correlation between current productivity and future expected productivity. There is less benefit to hedging low cash flow states. Moreover, risk management is lower when current productivity is high, as higher expected productivity implies higher investment and raises the opportunity cost of risk management. With sufficient but empirically plausible levels of persistence, the firm abstains from risk management altogether, providing an additional reason why risk management is so limited in practice. Furthermore, when the persistence of productivity is strong, firms hedge investment opportunities, i.e., states with high productivity, as the financing needs for increased investment rise more than cash flows.

Leasing tangible assets requires less net worth per unit of capital and hence allows firms to borrow more. Financially constrained firms, i.e., firms with low net worth, lease capital because they value the higher debt capacity; indeed, severely constrained firms lease all their tangible capital. Over time, as firms accumulate net worth, they grow in size and start to buy capital. Thus, the model predicts that small firms and young firms lease capital. We show that the ability to lease capital enables firms to grow faster. Dynamically, mature firms that are hit by a sequence of low cash flows may sell assets and lease them back, i.e., sale-leaseback transactions may occur under the stationary distribution. Moreover, leasing has interesting implications for risk management: leasing enables high implicit leverage; this may lead firms to engage in risk management to reduce the volatility of net worth that such high leverage would otherwise imply.

In the data, we show that tangible assets are a key determinant of firm leverage. Leverage varies by a factor 3 from the lowest to the highest tangibility quartile for Compustat firms. Moreover, tangible assets are an important explanation for the "low leverage puzzle" in the sense that firms with low leverage are largely firms with few tangible assets. We also take firms' ability to deploy tangible assets by renting or leasing such assets into account. We show that accounting for leased assets in the measurement of leverage and tangibility reduces the fraction of low leverage firms drastically and that firms with low lease adjusted leverage are firms with low lease adjusted tangible assets. Finally, we show that accounting for leased capital has a striking effect on the relation between leverage and size in the cross section of Compustat firms. This relation is essentially flat when leased capital is taken into account. In contrast, when leased capital is ignored, as is done in the literature, leverage increases in size, i.e., small firms seem less levered than large firms. Thus, basic stylized facts about the capital structure need to be revisited. Importantly, the lease adjustments to the capital structure we propose based on our theory are common in practice, and accounting rule changes are currently being considered by the US and international accounting boards that would result in the implementation of lease adjustments similar to ours throughout financial accounting. Our model and empirical evidence together suggest a collateral view of the capital structure.

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