Financing Investment: The Choice between Public and Private Debt*

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Abstract

We study the choice between public and private debt in a firm's marginal financing decision and its effects on corporate investment. To do so, we build a dynamic model of investment and financing decisions in which firms can choose not only the amount but also the type of debt to issue to finance investment. The paper shows how various firm and industry characteristics, such as liquidation costs, renegotiation frictions, cash flow volatility, product market competition, or credit supply, affect the costs and benefits of each debt source and the mix of debt ownership that borrowers demand. It also demonstrates that, by changing the cost of financing, these characteristics affect corporate investment. We test the predictions of the model using a large sample of U.S. firms for the period 1986-2007 and present new evidence on firms' debt choices and investment decisions, which is strongly supportive of our theory.

Keywords: Debt structure; capital structure; investment; credit supply; competition.

JEL Classification Numbers: D83; G12; G32; G33.

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In the frictionless financial markets of Modigliani and Miller (1958), capital structure is irrelevant and all value enhancing projects can be financed. The insight that market frictions make financing decisions relevant has spawned a large body of theoretical and empirical research, most of which focuses on the choice between equity and debt. In this paper, we examine a related but much less studied topic, namely the choice between public and private debt and its relation to corporate investment. To this end, we build a model of investment and financing decisions in which firms can choose not only the amount but also the type of debt to issue. We then examine whether the predictions of the model are supported by the data on firms' debt choices and investment decisions.

We base our analysis on a simple real options model in the spirit of Morellec and Schürhoff (2010) or Hackbarth and Mauer (2012), in which investment and financing decisions are endogenously and jointly determined. Specifically, we consider a firm with assets in place and a growth option to expand operations. The firm is initially financed with common equity and has the possibility to exercise its growth option at any time. To finance the cost of investment, the firm can issue a mixture of equity and debt. While real options models generally assume that firms have access to a single class of debt, we consider instead that they can finance investment using any combination of common stock, private debt, and public debt. Our paper addresses a set of key questions in corporate finance. First, how do debt structure and capital structure (i.e. the firm's leverage ratio) interact and what are the factors that drive these interactions? Second, how do debt structure and capital structure affect investment policy? Third, how do they depend on firm characteristics?

In the model, corporate income is subject to taxation, leading to a role for debt financing. The benefits and costs of each debt source affect not only the mix of debt ownership that borrowers demand but also corporate investment. As in Rajan (1992), our theory assumes that private debt is renegotiable so that borrowing from informed private lenders makes inefficient liquidations less likely and, therefore, reduces the cost of capital. However, the supply of private lenders with the required expertise is limited, leading to financing risk and to rent extraction by private lenders at the time of issuance. Based on these assumptions, the model characterizes the value-maximizing investment and financing policies for a firm acting in the best interests of incumbent shareholders and generates a rich set of testable predictions about the choice between public and private debt and corporate investment.

We highlight the main empirical implications. First, our theory predicts that firms with valuable investment opportunities are more likely to finance investment with a mixture of equity and public debt. Indeed, we show that for such firms the hold up (or rent extraction) problem associated with borrowing from a private lender is particularly acute and, therefore, the relative cost of private debt particularly high. Second, because private debt is renegotiable, our model predicts that firms with a greater likelihood of financial distress or lower bargaining power of shareholders in default have a preference for private debt. Indeed, default risk increases the likelihood of inefficient liquidations and makes private debt relatively less costly. Likewise, smaller deviations from absolute priority in default make renegotiable debt relatively less expensive and, hence, private debt more attractive.

We also incorporate in our analysis several realistic factors that affect the choice between private and public debt. The first such factor is the supply of capital in credit markets. We show that credit supply has two effects on the public-private debt choice in our framework. First, it determines the likelihood of finding informed private lenders. Second, it determines their bargaining power at the time of financing and, therefore, the cost of private debt. In particular, greater competition among financiers reduces the share of the investment surplus captured by private lenders. Therefore, a stronger supply of capital in credit markets tends to push the choice of debt instrument towards private debt.

The second factor is competition in the firm's product markets (or obsolescence risk). Specifically, we consider that competitors can implement projects that will make the firm's growth option worthless (or obsolete). We show that this obsolescence risk affects both the timing of investment and the choice of debt structure. In particular, as product market competition (or obsolescence risk) increases, the financing risk associated with private debt financing becomes higher and firms tend to favor public debt issues. Thus, while the effect of credit supply on debt structure is straightforward, the effect of obsolescence risk is not.

We also explore with our model how corporate investment depends on the firm and industry characteristics that determine the choice between public and private debt. We find that, by changing the firm's debt structure and its cost of capital, these characteristics affect the attractiveness of growth options and lead firms to speed up or delay investment (i.e. to over- or under-invest in the growth options). Notably, we demonstrate that the profitability of growth options, product market competition, and credit supply speed up investment, while the bargaining power of shareholders in default, liquidation costs, and cash flow volatility delay investment.

To test the predictions of the model, we form a large sample of U.S. firms for the period 1986-2007. Our sample consists of firms in the Compustat's annual database that have issued at least one bond or loan during our sample period. For this sample, we identify all bond issues and bank loan agreements and estimate logit models predicting the likelihood that a firm chooses public debt over private debt. In our estimations, we relate the issuance of private and public debt to all the demand- and supply-side factors featured in the model. In particular, we relate debt choices to the profitability of investment opportunities, the bargaining power of shareholders in default, cash flow volatility, liquidation costs, product market competition, and credit supply.

Our estimations reveal that debt choices are related to these explanatory variables in ways consistent with our theory. Notably, we find that firms with substantial growth opportunities (as measured by the firm's market-to-book ratio) are more likely to issue public debt. We also find that the bargaining power of shareholders in default and the intensity of product market competition increase the likelihood of issuing public debt. By contrast, firms facing a stronger credit supply and having volatile cash flows are more likely to issue private debt. Importantly, the variables that proxy for these factors in our estimations display statistically significant coefficients and imply large economic effects.

In addition to our results on debt choices, we consider the possibility that the factors that affect the source of debt also affect corporate investment. To conduct this analysis, we follow Whited (2006) and identify the effects of our explanatory variables on firms' investment rates. Specifically, we estimate a proportional hazard model in which we investigate which factors increase or decrease a firm's investment hazard. Our estimations show that growth options, credit supply, and competition shift investment hazard rates up, while liquidation costs, bargaining power in default, and cash flow volatility shift hazard rates down. We also perform several robustness tests using alternative proxies and hazard models to check the validity of our results. Overall, the evidence is strongly supportive of the model's predictions.

The present paper continues a line of research that uses dynamic structural models to analyze corporate policy choices. While early studies in this literature focused either on investment or on financing decisions,[1] a number of recent papers have examined the relation between a firm's investment opportunity set and its capital structure, emphasizing the role of the agency costs of debt in shaping the debt-equity choice.[2] Among these, our work is most closely related to a set of papers that study the effects of security provisions (see Morellec, 2001), priority structure (see Sundaresan and Wang, 2007, and Hackbarth and Mauer, 2012), or maturity structure (see Childs, Mauer, and Ott, 2005) on the interaction between investment and financing decisions. To the best of our knowledge, however, our paper is the first that models both endogenous investment and capital structure together with the choice between public and private debt. This allows us to generate important additional insights and empirical predictions. Notably, we are the first to characterize the effects of competition, credit supply, or bargaining power of shareholders in default on the choice between public or private debt.

Second, our paper relates to the empirical literature investigating the choice between public and private debt (see e.g. Blackwell and Kidwell, 1988, Houston and James, 1996, Johnson, 1997, Krishnaswami, Spindt, and Subramaniam, 1999, Colla, Ippolito, and Li, 2012, or Gomes and Phillips, 2012). Our paper extends this literature in several ways. First, we use an incremental approach that analyzes the determinants of new debt issues instead of focusing on the composition of a firm's debt financing at one point in time (see also Denis and Mihov, 2003, or Gomes and Phillips, 2012). This allows us to relate financing choices to explanatory variables measured just before the financing decision. Second, we provide direct

[1] See McDonald and Siegel (1985) and Leland (1994) for early contributions and Strebulaev and Whited (2012) for a review of this literature. With the exception of Hackbarth, Hennessy, and Leland (2007), that abstracts from investment decisions, financing frictions, and product market competition, these papers do not analyze the choice between public and private debt financing, which is the focus of our analysis.

[2] Mello and Parsons (1992) and Mauer and Triantis (1994) are the first to examine the interactions of investment and financing decisions in dynamic settings. Hennessy (2004) uses Q-theory to show that these interactions matter empirically. Sundaresan and Wang (2007) and Tserlukevich (2008) propose models in which firms can issue debt to exercise a sequence of growth options. Leland (1998) studies the relation between agency costs, risk management, and dynamic capital structure choice. Chen, Miao, and Wang (2010) derive utility-maximizing investment and financing policies for risk-averse entrepreneurs. Chen and Manso (2010) examine the effects of macroeconomic fluctuations on the agency costs of debt. Hackbarth and Mauer (2012) study the relation between the priority structure of corporate debt and investment decisions. Morellec and Schürhoff (2010, 2011) examine the effects of personal taxation and asymmetric information on the timing of investment and the choice between debt and equity financing.

evidence on the role of growth options, the bargaining power of shareholders in default, cash flow volatility, credit supply, and product market competition in the choice of debt source. Third, we show that the determinants of the choice of debt source also affect corporate investment by examining firms' investment rates using a multivariate duration analysis.

Finally, our paper relates to the study of Rajan (1992), which is the first to emphasize that while private debt can avoid inefficient liquidations, it can also lead to rent extraction. The model in Rajan is static and focuses on the choice between public and private debt. By contrast, our analysis is dynamic, incorporates additional determinants of debt choices, and relates debt structure to capital structure and corporate investment. This allows us to generate a rich set of empirical predictions that we test on a large sample of U.S. firms.

The remainder of the paper is organized as follows. Section 1 presents the model. Section 2 characterizes the value-maximizing investment and financing policies and their implications for debt structure and corporate investment. Sections 3 tests the predictions of the model. Section 4 concludes. Technical developments are gathered in the Appendix.

1. Model and assumptions

Throughout the paper, assets are continuously traded in complete and arbitrage-free markets. The default-free term structure is flat with an after-tax risk-free rate r, at which investors may lend and borrow freely. Corporate taxes are paid at a constant rate τ on operating cash flows and full offsets of corporate losses are allowed.

We consider an infinitely-lived firm with assets in place and a growth option to expand operations. Assets in place generate a continuous flow of operating income X_t as long as the firm is in operation, where $(X_t)_{t\geq 0}$ is governed by the process:

$$dX_t = \mu X_t dt + \sigma X_t dW_t, \qquad X_0 = x > 0.$$

under the risk neutral probability measure $\mathcal{Q}$. In this equation, $\mu < r$ and $\sigma > 0$ are constant parameters and $W = (W_t)_{t\geq 0}$ is a standard $\mathcal{Q}-$Brownian motion. The firm can exercise its growth option by paying the constant investment cost I. Immediately upon exercise, operating income increases from X to πX, where $\pi > 1$ is a constant factor that determines the growth potential of the firm. The firm has flexibility in the timing of investment but it can be preempted by potential competitors if it does not invest promptly. Specifically, we assume that over each time interval $[t, t + dt]$ before investment there is a probability λdt that the firm loses its growth option so that the growth option has an expected life of $\frac{1}{\lambda}$ years (as in Morellec and Schürhoff, 2011, or Hackbarth, Mathews, and Robinson, 2012).

The firm is initially financed with common equity (the set-up can be extended to incorporate a mix of debt and equity). To fund the investment project, it can issue a mixture of debt and equity at the investment date.[3] We consider that the firm has access to two classes of perpetual debt contracts: private debt contracts with coupon payment b and public debt contracts with coupon payment c.

Because the firm cash flows fluctuate stochastically, each type of debt contract is subject to default risk. In default, private debt contracts can be renegotiated to avoid inefficient liquidations. We assume however that private lenders with the required expertise are scarce and that, conditional on searching, the probability of getting financing from informed private creditors over each time interval $[t, t + dt]$ is δdt.[4] We also assume that firms incur a constant flow cost $\phi > 0$ when searching for informed private creditors and that, because of their scarcity, these creditors can capture part of the investment surplus at the time of financing.

As in Rajan (1992), our theory therefore assumes that intermediaries reorganize more efficiently than public (arm's length) investors. As in Rajan, this superior ability of private investors allows them to extract rents from borrowing firms. In our model, the source of these rents can be traced to the scarcity of informed lenders, which gives them bargaining power at the time of debt issuance. Specifically, we consider that once management and informed debt investors meet, they bargain to determine the proceeds from the debt issue or, equivalently, the allocation of the investment surplus between shareholders and private lenders. Given a non-negative surplus, we assume that the allocation of this surplus results

[3]The present paper considers that management makes only one financing decision at the time of investment to emphasize the tradeoffs between public and private debt. Hugonnier, Malamud, and Morellec (2012) consider instead a dynamic capital structure model with search frictions but ignore investment, competition, and assume that the firm can issue a single class of debt contracts. Hackbarth and Mauer (2012) show in a model similar to ours that separating investment and financing decisions is generally suboptimal.

[4]One potentially aggravating factor is that the firm may not be able to find informed private creditors with deep pockets and, thus, may have to rely on a group of private debt investors as in He and Xiong (2011). The firm will then issue private debt once it has found sufficiently many informed private debt investors.

from Nash bargaining. Denoting the bargaining power of shareholders by $\theta = \frac{\delta}{\rho+\delta}$, where $\rho \geq 0$, and the total investment surplus by $S(X; b, c)$, the amount ω^* that informed private lenders can extract at the time of financing satisfies

$$\omega^* = \underset{\omega \geq 0}{\operatorname{argmax}}\, \omega^{1-\theta} \left[S(X; b, c) - \omega\right]^{\theta} = (1-\theta)\, S(X; b, c).$$

When $\rho = 0$, we have $\theta = 1$ and shareholders capture all the investment surplus. When $\rho > 0$, the fraction of the surplus captured by shareholders increases with δ (i.e. competition among informed lenders reduces their ability to appropriate surplus).

Our assumptions imply that private credit supply has two effects on debt structure. First, it affects the likelihood of finding informed private lenders. Second, it affects their bargaining power at the time of issuance, and therefore, the cost of private debt. The paper does not attach any particular interpretation to the uncertainty in the supply of informed lenders. It may be related to shocks to banks health (as in Gan, 2007), to regulatory changes (as in Leary, 2009, Lemmon and Roberts, 2010, or Haselman, Pistor, and Vig, 2010), to the limited ability of financial intermediaries to verify the viability of projects (as in Faulkender and Petersen, 2006), or to variations in monetary policy (as in Kashyap, Stein and Wilcox, 1993, or Kashyap, Lamont, and Stein, 1994).

Instead of issuing private debt, the firm can choose to issue public debt. We consider as in Bulow and Shoven (1979) and Gertner and Scharfstein (1991) that public debt contracts are not renegotiable. Therefore, public debt does not require any specific expertise and, hence, is not subject to search frictions.[5] We assume however that public debt is subject to proportional issuance costs ι.[6] (Alternatively, one may assume that there exists a fixed *known* delay d in raising public debt, leading to an equivalent cost of issuance ι.)

After debt has been issued, the firm has the option to default on its debt obligations. If the firm has issued public debt at the time of investment, then default leads to liquidation. At the time of liquidation, the firm loses its interest tax shields and a fraction $\alpha \in (0, 1]$

[5]The model could allow public debtholders to extract part of the surplus at the time of investment and to make their bargaining power to depend on the supply of private credit. This would not affect any of our results since the value-matching condition (4) satisfied by equity at the time of investment with public debt implies that there is no surplus at that time.

[6]Blackwell and Kidwell (1988) and Krishnaswami, Spindt, and Subramaniam (1999) provide evidence that issuance costs are larger for public debt issues than for private issues.

its capital stock, leading to a drop in operating cash flows. That is, we consider that if the instant of liquidation is T, then $X_T = (1-\alpha)X_{T^-}$. If instead the firm has issued private debt, then default leads to renegotiation. We consider a Nash bargaining game in default that leads to a debt-equity swap, as in Fan and Sundaresan (2000). Denoting the bargaining power of shareholders in default by $\eta \in [0,1]$, the Nash bargaining solution implies that shareholders get a fraction $\eta\alpha$ of asset value in default. To account for renegotiation frictions, we also assume that renegotiations may fail with probability q, as in Davydenko and Strebulaev (2007) and Favara, Schroth, and Valta (2012).

Throughout the paper, management seeks to maximize shareholder wealth when making policy choices. For doing so, management selects (*i*) the firm's investment policy, (*ii*) the firm's financing structure – type of debt contract and leverage level – at the investment date, and (*iii*) the firm's default policy after debt has been issued. Because the decision to invest is irreversible, the firm's initial asset structure remains fixed until the firm cash flows rise to a sufficiently high level and the manager invests. Similarly, cash flows need to reach a sufficiently low level for the firm to default on its debt obligations after investment. We can thus see the manager's policy choices as determining the coupon payment and type of debt contract issued at the time of investment, the level of the cash flow shock at which it is optimal to invest, and the level of the cash flow shock at which it is optimal to default.

2. Model solution and empirical predictions

We solve the model backwards, starting with the values of equity, private debt, and public debt after investment. In a second stage, we derive the value-maximizing investment and financing policies that we use to produce our main empirical predictions.

2.1. Firm value after investment

We denote equity value before investment by $E_1(X)$ and the values of equity, bank debt, market debt, and the firm after investment by $E_2(X;b,c)$, $B(X;b)$, $D(X;c)$, and $V_2(X;b,c)$. In our setup, the value of equity before investment equals the sum of the present value of the cash flows accruing to shareholders until investment and the change in this present value at the time of investment. Since the firm can finance investment using equity and either private debt or public debt, we need to consider two cases. Suppose first that the firm issues private debt at the time of investment. In that case, shareholders get $E_2(X;b,0) - [I - B(X;b)] \equiv V_2(X;b,0) - I$ at the time of investment and the change in equity value is given by $V_2(X;b,0) - I - E_1(X)$. Similarly, when the firm issues public debt, the change in equity value at the time of investment is given by $V_2(X;0,c) - I - \iota D(X;c) - E_1(X)$ where $\iota D(X;c)$ represents registration costs. In the following, we therefore start by computing the value of the firm after investment net of registration costs, i.e. $V_2(X;b,c) - \iota D(X;c)$.

The value of the firm after investment is given by the sum of the cash flows accruing to claimholders until default, i.e. the after-tax operating cash flow plus the tax savings, and the present value of the cash flows accruing in default. Denote by $\underline{X}_i$ the default threshold selected by shareholders, for $i = B, D$ where $i = B$ (resp. $i = D$) when the firm issues private (resp. public) debt. Standard arguments imply that (see Appendix A):

$$V_2(X;b,c) = \pi\Lambda X + \frac{\tau\left(c1_{i=D} + \tau b1_{i=B}\right)}{r}\left[1 - \left(\frac{X}{\underline{X}_i}\right)^{\nu}\right] - \alpha\left(1_{i=D} + q1_{i=B}\right)\pi\Lambda\underline{X}_i\left(\frac{X}{\underline{X}_i}\right)^{\nu},$$

where $\nu < 0$ is the negative root of the quadratic equation $\frac{1}{2}\sigma^2 y(y-1) + \mu y - r = 0$ and the positive constant Λ is defined by

$$\Lambda = \frac{1-\tau}{r-\mu}.$$

This equation shows that the value of the levered firm is equal to the value of the unlevered firm (first term on the right hand side) plus the present value of the tax savings (second term) minus expected bankruptcy (third term). This last term shows that when the firm issues private debt from informed lenders, the probability of liquidation is reduced by a factor q, and firm value at the time of investment is increased.

The default threshold that maximizes equity value depends on whether the firm has issued public or private debt and is given by (see Appendix A):

$$\underline{X}_i^* = \frac{\nu}{\nu-1}\frac{r-\mu}{\pi r}\left(c1_{i=D} + \frac{b1_{i=B}}{1-(1-q)\eta\alpha}\right), \tag{1}$$

and the value-maximizing coupon payments for public and private debt respectively satisfy:

$$\begin{aligned} c^* &= X\Lambda\pi\frac{r(\nu-1)}{\nu(1-\tau)}\left[1 - \nu - \nu\left(\alpha + \iota(1-\alpha)\right)\frac{1-\tau}{\tau-\iota}\right]^{1/\nu}, \\ b^* &= X\Lambda\pi\frac{r(\nu-1)}{\nu(1-\tau)}\left[1-(1-q)\eta\alpha\right]\left[1 - \nu - \frac{\nu(1-\tau)\alpha q}{(1-(1-q)\eta\alpha)\tau}\right]^{1/\nu}. \end{aligned}$$

As shown by these expressions, the value-maximizing coupon payment at the time of issuance increases with the tax benefit of debt τ and decreases with bankruptcy and registration costs α and ι. Equation (1) also shows that when the firm issues private debt, shareholders can extract concessions from debtholders in default, leading to early default (i.e. $\underline{X}_B^* > \underline{X}_D^*$).

Plugging these expressions in the equation for firm value and taking into account the registration costs associated with public debt contracts, we finally get the value of the levered firm at optimal leverage net of registration costs as

$$\begin{aligned} V_2\left(X; b^*, 0\right) &= \pi\Lambda X\left\{1+\frac{\tau\left(\nu-1\right)}{\nu(1-\tau)}\left[1-\left(1-q\right)\eta\alpha\right]\left(\Theta-\Theta^{1-\nu}\right)-\alpha q\Theta^{1-\nu}\right\}, \\ V_2\left(X; 0, c^*\right)-\iota D(X; c^*) &= \pi\Lambda X\left\{1+\frac{\left(\tau-\iota\right)\left(\nu-1\right)}{\nu\left(1-\tau\right)}\left(\Gamma-\Gamma^{1-\nu}\right)-\left[\alpha+\iota\left(1-\alpha\right)\right]\Gamma^{1-\nu}\right\}, \end{aligned}$$

where

$$\Gamma=\left[1-\nu-\nu\left(\alpha+\iota\left(1-\alpha\right)\right)\frac{1-\tau}{\tau-\iota}\right]^{1/\nu} \text{ and } \Theta=\left[1-\nu-\frac{\nu\left(1-\tau\right)\alpha q}{\left(1-\left(1-q\right)\eta\alpha\right)\tau}\right]^{1/\nu}.$$

In our model, the benefits of private debt over public debt are that renegotiation in default lowers deadweight costs of financial distress and that there are no registration costs for private debt issues. The cost of private debt is that informed lenders are scarce and that the possibility to renegotiate the debt contract in default leads to early default. Consistent with this tradeoff, these equations show that when there are no successful renegotiations (i.e. $q=1$) and no registration costs (i.e. $\iota=0$), we have $V_2\left(X; b^*, 0\right)=V_2\left(X; 0, c^*\right)$. In addition, the value of the firm with private debt $V_2\left(X; b^*, 0\right)$ decreases with renegotiation frictions q while the value of the firm with public debt $V_2\left(X; 0, c^*\right)$ decreases with registration costs ι. Therefore, whenever $q<1$ or $\iota>0$, we have $V_2\left(X; 0, c^*\right)<V_2\left(X; b^*, 0\right)$.

2.2. Optimal investment and financing strategies

Prior to investment, management makes two types of decisions. First, it decides on the timing of investment. Second, it decides on the financing of the capital expenditure. Because the decision to invest is irreversible, it is natural to conjecture that the firm's asset structure remains fixed until the firm cash flows rise to a sufficiently high level and the manager invests. In addition, as shown by the above equations, the value of the firm after investment and the surplus from investment depend on the financing strategy of the firm at the time of investment. This implies that the selected investment trigger depends on the firm's financing strategy so that investment and financing decisions have to be jointly determined.

Denote by $\overline{X}_B^*$ the level of the cash flow shock above which it is optimal to search for private debt investors and invest in the project. (Note that in contrast to standard real options models, investment may not occur at $\overline{X}_B^*$ since the firm needs to find informed lenders.) In addition, denote by $\overline{X}_D^*$ the investment threshold when financing the capital expenditure with public debt. Since firm value at the time of investment is greater when financing the project with private debt, we have $\overline{X}_B^* < \overline{X}_D^*$. That is, the value-maximizing policy for shareholders is to refrain from investing for $X < \overline{X}_B^*$, to invest and issue private debt for $X \in [\overline{X}_B^*, \overline{X}_D^*)$ conditional on finding private debt investors, and to invest and issue public debt at $\overline{X}_D^*$ if no private debt investor has been found.

To derive equity value before investment, suppose first that the cash flow shock is in the region $[\overline{X}_B^*, \overline{X}_D^*)$ where it is optimal to issue private debt at the time of investment. The total investment surplus is then given by: $S(X, b^*, 0) \equiv V_2(X, b^*, 0) - I - E_1(X) = \Phi X - I - E_1(X)$ where

$$\Phi \equiv \pi\Lambda \left\{ 1 + \frac{\tau(\nu-1)}{\nu(1-\tau)} \left[1 - (1-q)\eta\alpha\right] \left(\Theta - \Theta^{1-\nu}\right) - \alpha q \Theta^{1-\nu} \right\} > 0.$$

Before investment, the firm delivers a cash flow stream $(1-\tau)X$. In addition to this cash flow stream, investors also get capital gains $\mathbb{E}[\mathrm{d}E_1]$ over each interval dt. Using Itô's lemma, we then have that equity value before investment satisfies (see Appendix B.1):

$$\begin{aligned} rE_1(X) &= \mu X E_1'(X) + \frac{\sigma^2}{2} X^2 E_1''(X) + (1-\tau)X \\ &\quad + \lambda\left[\Lambda X - E_1(X)\right] + \mathbf{1}_{X \in [\overline{X}_B^*, \overline{X}_D^*)} \left[\delta\theta\left(\Phi X - I - E_1(X)\right) - \phi\right], \end{aligned}$$

where $\mathbf{1}_{X \in [\overline{X}_B^*, \overline{X}_D^*)} = 1$ if $X \in [\overline{X}_B^*, \overline{X}_D^*)$.

The left hand side of this equation represents the required rate of return for investing in the firm's equity per unit of time. The right hand side is the sum of the cash flow generated by the firm's assets and the expected change in equity value. This right hand side is similar to those derived in standard contingent claims models (see Leland, 1994). However, it contains the additional terms $\lambda[\Lambda X - E_1(X)]$ and $\mathbf{1}_{X \in [\overline{X}_B^*, \overline{X}_D^*)} [\delta\theta(\Phi X - I - E_1(X)) - \phi]$ that reflect the effects of competition and credit supply uncertainty on equity value. The second of these terms is the product of the arrival rate of an informed lender δ and the surplus that shareholders extract from investment $(\theta(\Phi X - I - E_1(X)))$ net of search costs (ϕ), conditional on searching for informed lenders $(\mathbf{1}_{X\in[\overline{X}_B^*,\overline{X}_D^*)})$. Similarly, the first of these terms is the product of the change in equity value when a competitor invests $(\Lambda X - E_1(X))$ and the probability λ of such an event.

Equity value is solved subject to the following boundary conditions. First, since zero is an absorbing barrier for the cash flow shock, it must be that $E_1(0) = 0$. In that case, assets in place do not produce any cash flows and the option to expand is worthless. Also, since cash flows to claimholders are given by a (piecewise) continuous Borel-bounded function, the value function $E_1(\cdot)$ is piecewise $\mathcal{C}^2$ (see Theorem 4.9 pp. 271 in Karatzas and Shreve, 1991). Therefore, equity value satisfies the continuity and smoothness conditions:

$$\lim_{X\downarrow\overline{X}_B^*} E_1(X) = \lim_{X\uparrow\overline{X}_B^*} E_1(X), \text{ and } \lim_{X\downarrow\overline{X}_B^*} E_1'(X) = \lim_{X\uparrow\overline{X}_B^*} E_1'(X)$$

where derivatives are taken with respect to X.

In the model, the firm can finance the capital expenditure using equity and either private debt or public debt. The value-maximizing threshold for the investment region when issuing private debt satisfies the value-matching condition:[7]

$$E_1(\overline{X}_B^*) = \Phi\overline{X}_B^* - I.$$

As the cash flow shock increases it becomes more and more costly for the firm to wait for informed lenders. This gives us two additional boundary conditions. First, the value of equity at the time of investment when the firm finances the capital expenditure by issuing public debt satisfies the value-matching condition:

$$E_1(X)|_{X=\overline{X}_D^*} = V_2(\overline{X}_D^*; 0, c^*) - \iota D(X_{I,D}^*; c^*) - I = \Psi\overline{X}_D^* - I, \tag{4}$$

where

$$\Psi \equiv \pi\Lambda\left\{1 + \frac{(\nu-1)(\tau-\iota)}{\nu(1-\tau)}\left(\Gamma - \Gamma^{1-\nu}\right) - [\alpha + \iota(1-\alpha)]\Gamma^{1-\nu}\right\}.$$

Second, to ensure that investment with public debt financing occurs along the optimal path, the value of equity satisfies the smooth pasting condition:

$$\left.\frac{\partial E_1(X)}{\partial X}\right|_{X=\overline{X}_D^*} = \Psi.$$

[7]This condition follows from the value matching condition of shareholders at $\overline{X}_B^*$. Optimality is ensured by the continuity and smoothness conditions.

We then have the following result (see Appendix B.2):

Proposition 1 *The value of equity before investment is given by*

$$E_1(X) = \begin{cases} AX^{\xi} + \frac{1-\tau+\lambda\Lambda}{r+\lambda-\mu}X, & \text{for } X < \overline{X}_B^*, \\ CX^{\beta} + DX^{\zeta} + \frac{1-\tau+\lambda\Lambda+\delta\theta\Phi}{r+\lambda+\delta\theta-\mu}X - \frac{\delta\theta I+\phi}{r+\lambda+\delta\theta}, & \text{for } X \in [\overline{X}_B^*, \overline{X}_D^*), \end{cases}$$

where the value-maximizing investment thresholds with private and public debt financing $\overline{X}_B^*$ *and* $\overline{X}_D^*$ *respectively satisfy*

$$\overline{X}_B^* = z\,\overline{X}_D^*\,,$$

and

$$\overline{X}_D^* = \frac{\frac{\zeta[(r+\lambda)I-\phi]\left(1-z^{-\beta}\right)+\Xi(r+\lambda+\delta\theta)Iz^{-\beta}}{(\zeta-\beta)(r+\lambda+\delta\theta)}}{\frac{\zeta-1}{\zeta-\beta}\Psi + \frac{\zeta-1}{\zeta-\beta}\frac{1-\tau+\lambda\Lambda+\delta\theta\Phi}{r+\lambda+\delta\theta-\mu}\left(z^{1-\beta}-1\right) - \frac{\zeta-\xi}{\zeta-\beta}\Phi z^{1-\beta} - \frac{\xi-1}{\zeta-\beta}\frac{1-\tau+\lambda\Lambda}{r+\lambda-\mu}z^{1-\beta}}.$$

where $z < 1$ *is the solution to the non-linear equation*

$$\begin{aligned} &\frac{\zeta\left[(r+\lambda)I-\phi\right]\left(1-z^{-\beta}\right)+\xi\left(r+\lambda+\delta\theta\right)Iz^{-\beta}}{\beta\left[(r+\lambda)I-\phi\right]\left(z^{-\zeta}-1\right)-\xi\left(r+\lambda+\delta\theta\right)Iz^{-\zeta}} \\ = \; &\frac{(\zeta-1)\left[\Psi+\frac{1-\tau+\lambda\Lambda+\delta\theta\Phi}{r+\lambda+\delta\theta-\mu}\left(z^{1-\beta}-1\right)\right]-(\zeta-\xi)\,\Phi z^{1-\beta}-(\xi-1)\,\frac{1-\tau+\lambda\Lambda}{r+\lambda-\mu}z^{1-\beta}}{(1-\beta)\left[\Psi+\frac{1-\tau+\lambda\Lambda+\delta\theta\Phi}{r+\lambda+\delta\theta-\mu}\left(z^{1-\zeta}-1\right)\right]-(\xi-\beta)\,\Phi z^{1-\zeta}+(\xi-1)\,\frac{1-\tau+\lambda\Lambda}{r+\lambda-\mu}z^{1-\zeta}}. \end{aligned}$$

In these equations, the constants A*,* C*, and* D *satisfy*

$$\begin{aligned} A &= \left\{\left[\Phi - \frac{1-\tau+\lambda\Lambda}{r+\lambda-\mu}\right]\overline{X}_B^* - I\right\}(\overline{X}_B^*)^{-\xi}, \\ C &= \left\{\frac{\zeta-1}{\zeta-\beta}\left[\Psi - \frac{1-\tau+\lambda\Lambda+\delta\theta\Phi}{r+\lambda+\delta\theta-\mu}\right]\overline{X}_D^* - \frac{\zeta}{\zeta-\beta}\frac{(r+\lambda)I-\phi}{r+\lambda+\delta\theta}\right\}(\overline{X}_D^*)^{-\beta}, \\ D &= \left\{\frac{\beta-1}{\beta-\zeta}\left[\Psi - \frac{1-\tau+\lambda\Lambda+\delta\theta\Phi}{r+\lambda+\delta\theta-\mu}\right]\overline{X}_D^* - \frac{\beta}{\beta-\zeta}\frac{(r+\lambda)I-\phi}{r+\lambda+\delta\theta}\right\}(\overline{X}_D^*)^{-\zeta}, \end{aligned}$$

and the constant elasticities ξ*,* β*, and* ζ *are given by*

$$\begin{aligned} \xi &= (\sigma^2/2-\mu)/\sigma^2 + \sqrt{[((\sigma^2/2-\mu)/\sigma^2]^2 + 2\,(r+\lambda)\,/\sigma^2} > 1, \\ \beta &= (\sigma^2/2-\mu)/\sigma^2 - \sqrt{[(\sigma^2/2-\mu)/\sigma^2]^2 + 2(r+\lambda+\delta\theta)/\sigma^2} < 0, \\ \zeta &= (\sigma^2/2-\mu)/\sigma^2 + \sqrt{[(\sigma^2/2-\mu)/\sigma^2]^2 + 2(r+\lambda+\delta\theta)/\sigma^2} > 1. \end{aligned}$$

The expressions for the value of equity in Proposition 1 can be interpreted as follows. The first term on the right hand side of equity value in the no-investment region ($X < \overline{X}^*_B$) represents the option value of investing in the project and restructuring the firm's capital structure. The second term represents the value of a perpetual claim to the current flow of income. This second term captures the effects of obsolescence risk through the term $\frac{\lambda\Lambda}{r+\lambda-\mu}X$, that reflects both the increase in the discount rate due to competition and the value of the firm after a competitor has invested.

Similarly, the first two terms on the right hand side of equity value in the investment with private lending region ($\overline{X}^*_B \leq X < \overline{X}^*_D$) represent the change in the value of the firm if no private debt investor can be found before the cash flow shock returns to the no–investment region (first term) or reaches the investment threshold with public debt financing $\overline{X}^*_D$ (second term). The third term represents the sum of the present value of cash flows from assets in place and the increase in equity value due to investment with private debt financing. Since the firm meets informed private lenders at the rate δ, the value created by investment increases with δ. The fourth term represents the present value of investment and search costs.

When the expected delay associated with private debt financing (as measured by $1/\delta$) tends to zero, the value-maximizing investment threshold converges to the usual investment trigger with competition, defined by:

$$\lim_{\delta\uparrow\infty} \overline{X}^*_B(\delta) \equiv \overline{X}^*_\infty = \frac{\xi}{\xi-1}\frac{I}{\Phi-\Lambda}. \tag{6}$$

Equation (6) for $\overline{X}^*_\infty$ can also be written as:

$$\left\{(\pi-1) + \pi\left[\tau\frac{r\,(\nu-1)}{\nu(1-\tau)}\left[1-(1-q)\,\eta\alpha\right]\left(\Theta-\Theta^{1-\nu}\right) - \alpha q\Theta^{1-\nu}\right]\right\}\Lambda\overline{X}^*_\infty = \frac{\xi}{\xi-1}\,I\,.$$

The left-hand side of this equation represents the benefit from investment. At the time of investment, the firm (i) increases its operating cash flows (first term $\pi - 1$ in the square bracket) and (ii) rebalances its capital structure (second term in the square bracket). The right hand side of this equation is the adjusted cost of investment. This cost reflects the option value of waiting through the factor $\frac{\xi}{\xi-1}$. When this option has no value (which is the case as λ tends to infinity), shareholders follow the simple NPV rule, according to which one should invest as soon as the investment surplus is positive (i.e. as soon as $X > \frac{I}{\Phi-\Lambda}$).

2.3. Model predictions

The public-private debt choice. Since private debt is renegotiable – and therefore less costly – firms find it optimal to finance the capital expenditure by issuing private debt if the arrival rate of informed investors is high enough and the pricing of private debt is competitive enough. To better understand the economic determinants of firms' financing decisions, Figure 1 plots the ratio of the investment triggers $z \equiv \frac{\overline{X}_B^*}{\overline{X}_D^*}$ as a function of the arrival rate of informed lenders δ, the bargaining power of shareholders in default η, the size of the growth option π, cash flow volatility σ, liquidation costs α, and the arrival rate of competitors λ. In this Figure, a low value for the ratio z implies that the wedge between the investment thresholds $\overline{X}_B^*$ and $\overline{X}_D^*$ is larger so that firms have a greater likelihood of financing the capital expenditure with private debt (holding μ and σ constant).

Insert Figure 1 Here

In this Figure, we use parameter values that roughly reflect a typical S&P 500 firm. The risk free rate is set to $r = 5\%$. We set the risk-neutral growth rate and the volatility of the cash flow shock to $\mu = 0.67\%$ and $\sigma = 28.86\%$, in accordance with the recent estimates of Morellec, Nikolov, and Schürhoff (2012). The tax advantage of debt captures corporate and personal taxes and is set equal to $\tau = 15\%$. This corresponds to a tax environment in which the corporate tax rate is set at the highest possible marginal tax rate of 35% and the tax rates on dividends and interest income are set to 11.6% and 29.3%, consistent with Graham (1996). Liquidation costs are defined as the firm's going concern value minus its liquidation value, divided by its going concern value. We base the value of liquidation costs on the recent estimates of Glover (2012) and set $\alpha = 45\%$. The size of the growth option is set to $\pi = 1.25$ while the arrival rate of competitors is set to $\lambda = 1$. Several studies provide estimates for issuance costs as a function of the amount of debt being issued. We set $\iota = 2\%$, corresponding to the upper range of the values found in the empirical literature (see e.g. Altinkilic and Hansen, 2000, and Kim, Palia, and Saunders, 2007). Finally, we set $\delta = 3$, implying an expected financing delay with private debt of $\frac{1}{\delta} = 4$ months.

Figure 1 shows that as the arrival rate of private debt investors increases, the spread between the two thresholds becomes more important. Indeed, as δ increases, the present value of potential savings in default costs increases, the pricing of private debt improves, and it becomes relatively less interesting to finance the capital expenditure by issuing public debt. In addition, the Figure shows that an increase in the bargaining power of shareholders in default increases the cost of private debt and makes public debt more attractive (i.e. z increases). The Figure also shows that as the growth option becomes more valuable (i.e. as π increases) and as competition intensifies (i.e. as λ increases), the wedge between the two investment thresholds decreases, suggesting that firms become more likely to issue public debt. Finally, the Figure reveals that as default becomes more likely (i.e. as σ increases), private debt becomes relatively less costly and the wedge between the two investment thresholds increases. As a result, firms become more likely to issue private debt.

Remark: Since the renegotiation surplus in default increases with bankruptcy costs, one might be tempted to conclude that firms' incentives to issue private debt should increase with bankruptcy costs. In the model however, α has two opposite effects on the cost of private debt. First, it increases the renegotiation surplus. Second, it induces early default, leading to a combined effect that is difficult to sign (i.e. to a non-monotonic relation between α and z). By contrast, an increase in the bargaining power of shareholders in default leads to an increase in default risk and to an unambiguous increase in the cost of private debt. In the empirical analysis on simulated and real data below, we therefore focus on measuring the effects of this factor on the choice between public and private debt.

To examine in more detail the predictions of the model, we simulate a total of $N = 237,400$ artificial firms from our model and examine the effects of our explanatory variables on the choice between public and private debt by conducting an analysis similar to the ones used in recent empirical studies on the debt-equity choice (see, e.g., Leary and Roberts, 2010). In the model, the public-private debt choice is a nonlinear function of input parameter values. This relation can be linearized, yielding a binary choice equation like the one typically estimated in the empirical literature on financing decisions. The specification we estimate takes the form of a simple discrete choice logistic model for the financing vehicle.

Insert Table 1 Here

Table 1 summarizes our estimation results. As shown by the Table, our model predicts that public debt issuance is more prominent in firms with profitable investment opportunities, that operate in competitive environments, and when cash flow volatility is low. Table 1 also shows that public debt issuance is less likely when the supply of informed private debt investors is stronger. Finally, the results in the Table reveal that as the renegotiation power of shareholders in default increases, private debt becomes more costly, and public debt issuance more likely. In section 3, we conduct a similar analysis using real data to determine whether the predictions of the model are supported by the data on firms' debt choices.

Credit supply and investment. In the model, the timing of investment is endogenous and investment occurs the first time the cash flow process reaches the region $[\overline{X}_B^*, \overline{X}_D^*)$ and the firm can find private debt investors or reaches $\overline{X}_D^*$ before informed debt investors can be found. Figure 2 plots the investment triggers $\overline{X}_B^*$ (solid blue line) and $\overline{X}_D^*$ (dashed red line) as functions of the arrival rate of private creditors δ, the bargaining power of shareholders in default η, the size of the growth option π, cash flow volatility σ, liquidation costs α, and the arrival rate of competitors λ.

Insert Figure 2 Here

Consistent with economic intuition, Figure 2 shows that as the arrival rate of informed lenders increases, the opportunity cost of waiting to invest decreases (as the likelihood of finding investors increases), leading to an increase in the selected investment threshold $\overline{X}_B^*$. In other words, when the firm has to find informed investors to finance the project, it balances the opportunity cost of early investment (i.e. the option of waiting) with the opportunity cost of waiting (the risk of not finding informed lenders to finance the project).

A number of additional effects are illustrated by Figure 2. First, as bankruptcy costs α increase, the cost of debt financing raises. This in turn makes the investment opportunity less attractive, leading to an increase in the investment triggers. Second, as the risk of preemption λ increases, the value of waiting to invest decreases, leading to a decrease in the investment thresholds. Third, as in standard real options models, the value-maximizing investment triggers decrease with the size of the growth option (as measured by π) and increase with the volatility of the cash flow shock σ, i.e. with the level of uncertainty over the future project cash flows. Finally, as the bargaining power of shareholders in default η increases, the cost of private debt increases, making private (resp. public) debt financing less (resp. more) attractive.

To make the analysis complete, Table 2 examines the determinants of investment hazards, defined as the probability of undertaking the project as a function of time (as in Whited, 2006). To do so, we use the same panel of firms as in Table 1. Given the grouped data structure of our panel, we follow Whited (2006) and Leary and Roberts (2005) and estimate a mixed proportional hazard model, for which the hazard function at time t for firm i with covariates $x_i(t)$ is assumed to be

$$\gamma_i(t) = \omega_i \gamma_0(t) \exp(x_i(t)'\kappa). \tag{7}$$

In this model t is the time to investment (or equivalently the length of a spell), $\gamma_0(t)$ is the baseline hazard, which we model as a non-parametric step function, and $\exp(x_i(t)'\kappa)$ is the relative risk associated with the set of covariates $x_i(t)$, which allow the hazard to shift up or down depending on their values and on κ. Finally, ω_i is a random variable representing unobserved heterogeneity, which we assume to be independent of $x_i(t)$. The covariates we include in our analysis are the profitability of growth options, the bargaining power of shareholders in default, credit supply, competition, liquidation costs, and cash flow volatility. We estimate this model using maximum likelihood.

Insert Table 2 Here

Consistent with the above discussion, Table 2 shows that firms with more (or more valuable) growth options or a higher probability of being preempted invest more readily. Firms invest also more readily when the supply of informed lenders is stronger since the cost of capital decreases with credit supply. By contrast, cash flow volatility, liquidation costs, and the bargaining power of shareholders in default diminish investment propensities by making outside financing more costly and, hence, investment opportunities less attractive.

One important implication of our model is that negative shocks to the supply of bank debt may hamper investment even if firms have enough financial slack to fund profitable investment opportunities internally (due to the ability to issue equity costlessly as in standard real options models). Indeed, in our model, investment and financing decisions are jointly determined and the profitability of investment depends on the financing instrument chosen by the firm. As a result, a change in the supply or in the cost of one of the financing instruments can have major effects on the timing and probability of investment.

Our result on the relation between credit supply and corporate investment is consistent with the findings in Kashyap, Stein and Wilcox (1993) and Lemmon and Roberts (2010) that contractions in the supply of credit lead to declines in investment. It is also consistent with the survey of 1,050 chief financial officers by Campello, Graham, and Harvey (2010), in which more than half of the respondents said that the contraction in credit supply observed during the recent financial crisis led them to cancel or postpone their planned investments. Our theoretical framework provides a rationale for these effects, showing that credit supply may affect the real economy by changing the firm's cost of capital.

Summary of empirical predictions and comparison with the literature. Before turning to the empirical analysis, we summarize our main testable hypotheses:

HYPOTHESIS 1: DEBT STRUCTURE. *Firms (*i*) with more growth options, (*ii*) higher bargaining power in default, (*iii*) low cash flow volatility, (*iv*) operating in more competitive product markets, and (*v*) facing lower credit supply are more likely to issue public debt.*

HYPOTHESIS 2: CORPORATE INVESTMENT. *Firms with (*i*) high liquidation costs, and (*ii*) high bargaining power of shareholders in default delay investment, whereas firms (*iii*) operating in competitive product markets, (*iv*) facing a strong supply of lenders, or (*v*) having profitable growth options speed up investment.*

The empirical literature on debt structure has so far mostly focused on information based explanations of the public vs. private debt decision (see. e.g. Johnson, 1997, Krishnaswami, Spindt, and Subramaniam, 1999, Denis and Mihov, 2003, or Gomes and Phillips, 2012). Therefore, we view our predictions on the effects of investment opportunities, bargaining power, volatility, competition and credit supply on debt structure as being essentially novel. Another important difference between our paper and prior studies is that our model allows us to be very precise in the use and interpretation of explanatory variables. Our theoretical analysis shows for example that banks' superior ability in dealing with firms in financial distress does not imply that firms with large liquidation costs will have a preference for private debt issues. As argued above, such effects may be better captured by shareholders' bargaining power in default or by standard measures of default risk. Lastly, in contrast to most existing empirical studies, we use an incremental approach that analyzes the determinants of new debt issues instead of focusing on debt structure at one point in time.

While our predictions on debt choices are novel, some of our predictions on corporate investment are shared with a number of other studies. For example, Akdogu and MacKay (2008) test the prediction of Grenadier (2002) that competition lead firms to speed up investment and document a non-linear relation between investment hazards and measures of product market competition. Two recent studies by Almeida and Campello (AC, 2008) and Chaney, Sraer, and Thesmar (CST, 2012) find that the level of investment is positively related to asset tangibility. Our study complements that of Akdogu and MacKay by demonstrating the effects of competition on corporate investment using a number of new measures that have been shown to better capture product market competition. Similarly, while AC and CST focus on the relation between investment levels and tangibility, our analysis examines instead the effects of asset tangibility (or liquidation costs) on the timing of large investment projects (as in Whited, 2006). That is, in contrast to these studies that focus on smooth and incremental effects, our empirical approach allows us to capture the effects of our explanatory variables on infrequent and lumpy investment (see e.g. Doms and Dunne, 1998, or Cooper, Haltiwanger, and Power (1999) for evidence suggesting that investment decisions are lumpy). Finally, to the best of our knowledge, our predictions on the effects of bargaining power and credit supply on the timing of investment are not shared with any other study.

3. Empirical analysis

In this section we test the predictions of the model for the choice between public and private debt and for corporate investment using a large sample of U.S. firms for the period 1986-2007. We start by describing the data. We then examine the determinants of debt choices and investment hazards.

3.1. Data and sample description

Our empirical analysis is based on a sample of U.S. firms. We begin the sample construction by collecting data from Compustat's annual database for the period 1986-2007. Financial services firms (one-digit SIC equal to six) and regulated industries (two-digit SIC equal to 49) are excluded from the sample to avoid financing and investment choices determined by regulatory requirements (see e.g. Leary and Roberts, 2005, or Whited, 2006). We also drop firm-years with negative or zero total assets or sales, and firm-years for which the negative EBITDA is larger than total assets. Excluding these firms ensures that severely distressed firms do not have much impact on our results (see Bris, Koskinen, and Nilsson, 2009). Our results are robust to relaxing these constraints.

We then merge this data set with data from various other sources. First, following Erel, Julio, Kim, and Weisbach (2012), we obtain data on public debt issues from the Mergent Fixed Income Securities Database (FISD) and data on bank debt from Loan Pricing Corporation's Dealscan database. From FISD, we use all USD public debt issues made by domestic industrial firms with a valid issuer CUSIP, offering date, offering amount, and maturity. Similarly, from Dealscan we get all sole-lender and syndicated bank loans with a valid GVKEY, loan start date, loan amount, and maturity. We only keep firms that issue at least one bond or loan during our sample period, and we eliminate (*i*) loans that are explicitly used for refinancing purposes, and (*ii*) very small bonds and loans as they are unlikely to be used for investment purposes.[8] Second, we collect data on competition and industry structure from the Hoberg and Phillips data library.[9] Third, we retrieve institutional ownership data from Thomson Reuters' ownership database and executive stock ownership data from the ExecuComp database. Finally, we get data on credit conditions from the Senior Loan Officer Opinion Survey on Bank Lending Practices from the Federal Reserve, GDP growth rates from the U.S. Bureau of Economic Analysis (BEA), and recession/expansion dates from the National Bureau of Economic Research (NBER).

Using these data sources, we construct the following variables for our empirical analysis.

Growth options (π). In the model, private lenders may obtain an information monopoly that allows them to extract rents from the firm at the time of issuance. Hold up problems associated with borrowing from an informed private lender are likely to be particularly acute for firms with substantial growth opportunities. As a result, it is expected that these firms are less likely to rely on private debt. In the empirical analysis, we measure the importance

[8]We compute the bond and loan amount to asset ratios, respectively, and drop the lowest five percent of each distribution. Keeping these observations in the sample has no impact on our results.

[9]The data is available at http://www.rhsmith.umd.edu/industrydata/. We thank Gerard Hoberg and Gordon Phillips for making their data available.

of growth opportunities using the firm's market-to-book ratio (as in e.g. Barclay and Smith, 1995, or Houston and James, 1996). This ratio is defined as the sum of market equity (common shares outstanding (csho) times fiscal year-end share price (prcc_f)), book debt (debt in current liabilities (dlc) plus long-term debt (dltt)), and preferred stock (pstk) minus deferred taxes and investment tax credits (txditc), divided by total assets (at) at the end of the fiscal year. In a robustness test, we follow Whited (2006) and use sales growth as an alternative proxy for growth opportunities.

Shareholders' bargaining power in default (η). Because private debt is renegotiable, an increase in the bargaining power of shareholders leads to an increase in the cost of private debt and thus to an increase in the probability of issuing public debt. Following Davydenko and Strebulaev (2007), we measure shareholders' bargaining power in default by the fraction of total equity owned by institutional investors. More sophisticated and coordinated institutional investors are better at bargaining with creditors in potential renegotiations and eventually induce greater deviations from priority rules than individual investors.

In a robustness test, we also proxy for shareholders' bargaining power in default using the proportion of equity held by the top executives of the firm (Davydenko and Strebulaev, 2007). Indeed, managers generally stay in control after default (see Gilson, 1989) implying that managers with a larger stake in the firm have greater incentives to bargain fiercely in out-of-court or court-supervised (Chapter 11) renegotiations. Consistent with this view, Betker (1995) finds that deviations from the priority rule significantly increase in favor of shareholders when CEOs hold a greater stake in their firm.

Private credit supply (δ). Our model predicts that firms issue more private debt and invest more when credit supply is stronger since firms are more likely to find informed investors and the cost of private debt is lower. Our first proxy for the probability of finding informed investors (credit supply) is based on the "Senior Loan Officier Opinion Survey on Bank Lending Practices" from the Federal Reserve. The Federal Reserve conducts this survey by asking managers of approximately the sixty largest banks and twenty-four U.S. branches of foreign banks how their bank is changing their credit standards. In particular, we focus on the variable "Net percentage of banks tightening standards for commercial and industrial loans to large and middle-market firms."In actual tests, we lag this variable by one quarter and multiply it by minus one so that a higher value implies better credit supply.[10] The data is at the quarterly frequency and only available after the second quarter of 1990.

Several empirical studies have shown that the supply of capital in credit markets correlates positively with macroeconomic conditions (see e.g. Kashyap, Lamont, and Stein (1994) or Becker and Ivashina (2012)). In our empirical analysis, we therefore follow Erel, Julio, Kim, and Weisbach (2012) and use two additional proxies for credit supply. The first proxy is real GDP growth at the quarterly frequency. A higher GDP growth is likely to correlate positively with better access to credit. The second measure for credit supply is a dummy variable equal to one if the economy is in an expansion according to the NBER in a particular quarter and zero otherwise. For the investment hazard estimations in which we use annual data, we take annual averages of the credit supply proxies.

Competition (λ). We use several proxies for the intensity of product market conditions (or obsolescence risk). Our first proxy is the product market fluidity measure developed by Hoberg, Phillips, and Prabhala (2012), available in the Hoberg and Phillips data library. This proxy is based on business descriptions from firm 10-Ks and captures the structure and evolution of the product space occupied by firms. In particular, it captures competitive threats faced by firms in their product markets and the changes in rival firms' products relative to the firm. As such, it should well capture the risk of preemption that firms face in our model. This proxy is only available starting in year 1997.

Next, we use the Herfindahl-Hirschman Index (HHI) as proxy for the intensity of product market competition. A higher HHI implies weaker competition. The HHI is a widely used proxy for competition that is well grounded in industrial organization theory (see Tirole, 1988). We use two variants of the HHI in our estimations. The first is the HHI computed from Compustat data at the three-digit SIC industry level. We follow the literature and compute market shares based on firms' sales (see e.g. Hou and Robinson, 2006). The second HHI is based on the text-based network industry classification (TNIC) available in the Hoberg and Phillips data library. This new and dynamic industry classification is based on product descriptions from annual firm 10-K filings with the Securities and Exchange

[10] Several recent papers use this survey to capture credit supply conditions, e.g., Erel, Julio, Kim, and Weisbach (2012), or Murfin (2012).

Commission (SEC). Hoberg and Phillips (2011) use this new classification and show that it is better at explaining the cross-section of firm characteristics (see also Hoberg and Phillips, 2010). This proxy is available for the years 1996 to 2007. To facilitate the interpretation, we define both competition proxies as one minus HHI.

Liquidation costs (α). Following Davydenko and Strebulaev (2007), we use non-fixed assets (1-net PPE (ppent)) as our main liquidation cost proxy. In a robustness test, we use the intangibility of assets as an alternative proxy for liquidation costs. Specifically, we follow Berger, Ofek, and Swary (1996) and define asset tangibility as the sum of 0.715*receivables (rect), 0.547*inventories (invt), 0.535*net PPE (ppent), and cash (che), divided by total assets. This proxy of asset tangibility measures the expected value of assets in liquidation. Since liquidation costs decrease with asset tangibility, we define liquidation costs as one minus asset tangibility. In our estimations, we expect liquidation costs to decrease investment propensities.

Volatility (σ). An increase in cash flow volatility makes default more likely and renders public debt less attractive. In the empirical analysis, we measure volatility as the annual standard deviation of cash flows over the past five years, where we require at least three consecutive observations.[11] Following Whited (2006), cash flow is measured by income before extraordinary items (ib) plus depreciation and amortization (dp) divided by total assets. In a robustness test, we also compute a market-based probability of default (expected default frequency), following Bharath and Shumway (2008). This default risk proxy roughly corresponds to the number of standard deviations of asset growth by which a firm's market value exceeds the face value of debt.

Insert Table 3 Here

We include in our estimations several control variables that have been shown to affect debt structure (see e.g. Houston and James, 1996, Johnson, 1997, Krishnaswami, Spindt, and Subramaniam, 1999, or Colla, Ippolito, and Li, 2012). Size is the logarithm of net sales (sale). Market leverage is book debt over the market value of assets (market equity plus total assets minus total common equity (ceq)). Cash is cash and short term investments (che)

[11] We also computed cash flow volatility from quarterly data and obtained very similar results.

divided by total assets. A dummy variable, IG rating, takes the value of one when the firm has an investment grade rating and zero otherwise. In our analysis of investment hazards, we also need to measure firms' propensity to invest. Investment denotes capital expenditures (capx) during the fiscal year divided by total assets at the beginning of the fiscal year. Table 3 contains a detailed description of all the variables. We winsorize all firm-level variables at the 1% level in each tail to minimize the impact of outliers.

Panel A of Table 4 provides descriptive statistics of the firm characteristics. The full sample is an unbalanced panel with 49,063 firm-year observations.[12] The average market-to-book ratio is 1.53, average sales growth is 16%, and the average tangibility measures are 69% and 50%, respectively. The average proportion of common stock held by institutional investors (top executives) is 46% (4%), a value slightly lower than the one reported by Davydenko and Strebulaev (2007). Investment has a mean value of 7.6% of lagged total assets. The firms in our sample have average log sales of 5.86, which corresponds to total sales of 350 million. Moreover, the sample firms have an average market leverage of 20%, cash flow of 4.8% of assets, cash flow volatility of 7.7%, cash holdings of 12.8%, and a default probability of 18.9% (median of 0.4%). Finally, 18% of the firm-year observations have an investment grade credit rating. Overall, our sample is similar to those of related studies (see e.g. Erel, Julio, Kim, and Weisbach, 2012).

Insert Table 4 Here

Panel B provides descriptive statistics for the credit supply and competition variables. Over our sample period, the average net percentage of banks tightening credit standards is 6.3%. Average GDP growth is 5.5%, and most of the sample period is classified as an expansion according to the NBER (92.8%). Our main proxy for competition, product market fluidity, has an average value of 6.6, which is close to the value (6.9) reported by Hoberg, Phillips, and Prabhala (2012). The HHI(Compustat) and HHI(TNIC) have average values of 0.15 and 0.21, respectively.

[12]The number of observations is lower for the debt choice analysis. The reason for the difference is that in the debt choice analysis, we use the sample firms at the monthly frequency (as Erel, Julio, Kim, and Weisbach, 2012) and only keep the firm-months in which firms actually issue at least one bond or loan. By contrast, for the investment hazard analysis, we have the same set of firms in a more traditional firm-year panel data set. See the more detailed data descriptions at the beginning of each section.

3.2. *The choice between public and private debt*

In this section, we test the model's predictions regarding the public and private debt choice. To do so, we use the issue-level data from FISD and Dealscan. We collapse each firm's bond and bank loan issues at the month level and match the firm-months observations with accounting information from the most recent year-end reported in Compustat and with the quarterly and monthly macroeconomic variables. We only keep the firm-months in which firms issue a bond or loan. Next, we eliminate firm-months in which firms issue both bonds and bank loans (477 observations) and drop convertible bond issues (1,812 observations). We end up with a sample containing 3,836 firm-months with bond issues (4,968 bond issues) and 11,574 firm-months with bank loan issues (16,602 loan issues).

Table 5 shows descriptive statistics on how the bond and loan issues are distributed in time and how they vary by firm size. The number of bond issues gradually increases at the beginning of our sample period, reaching a maximum of 483 issues in the year 1998. After 1998, the number of bond issues remains at a lower level. The number of loan issues experiences significant growth with a maximum of 1,245 loan issues in 2004. While part of this growth can be attributed to the poor data coverage of Dealscan during the early sample period, this growth in the syndicated loan market is consistent with recent research on this topic (see e.g. Ivashina and Scharfstein, 2010). We also split each year the number of bond and loan issues by the median size of the issuer and report the number of issues for small and large firms. As expected, bonds are predominantly issued by large firms, while small firms have a preference for loans. Finally, we note that each year about 50% of our sample firms do not issue any bonds, while only about 5% of firms do not issue any loans.

Insert Table 5 Here

To be as close as possible to the model and to the simulations of the previous section, we estimate a series of logistic discrete choice models in which the dependent variable equals one if the firm issues public debt and zero if the firm issues private bank debt in a given month. In these logistic regressions, we are interested in measuring the effects of growth options, bargaining power in default, credit supply, competition, and volatility on the probability of issuing public or private debt. Following the literature, we include other potential determinants of the debt choice, including firm size, financial leverage, cash holdings, and credit rating (see e.g. Erel, Julio, Kim, and Weisbach, 2012, Johnson, 1997, Denis and Mihov, 2003, or Gomes and Phillips (2012)). The estimations include year fixed effects, and standard errors are adjusted for heteroskedasticity and within-firm clustering. Table 6 presents the main estimation results.

All four specifications of Table 6 examine the effects of growth options on the likelihood of issuing public debt, where we use the market-to-book ratio as a proxy for growth options. The coefficient is positive and statistically significant in all columns.[13] In column 1, for instance, the coefficient of market-to-book ratio has a value of 0.164, corresponding to a response probability 0.20 evaluated at the mean of all covariates. The coefficient implies that a one standard deviation increase in the market-to-book ratio (evaluated at the mean of all regressors) increases the response probability to 0.23, which is a relative increase of 15%. The significantly positive coefficient of the market-to-book ratio implies that project quality is an important determinant of the choice between public and private debt, consistent with the model's predictions.

Insert Table 6 Here

In column 2, we add shareholders' bargaining power measured by institutional ownership as an additional regressor. The coefficient has a value of 0.947 and is statistically significant. The response probability for this coefficient is 0.22. A one standard deviation increase in institutional ownership increases the response probability to 0.266 (evaluated at the mean of all covariates). The intuition is that as shareholders' bargaining power increases, shareholders are able to extract more rents at the expense of creditors in a potential renegotiation, and private debt becomes more costly. As a consequence, a public debt issue is more likely.

Next, we test in the third column whether supply of credit (based on the Federal Reserve survey) affects the probability of issuing a bond. We observe a negative and statistically significant coefficient with a value of -0.742 (response probability of 0.22), a result consistent with the model's predictions. Intuitively, when the supply of credit increases, search frictions decrease and firms are more likely to find informed bank financing.

[13] Prior studies find mixed evidence regarding the relation between the market-to-book ratio and debt choice. For instance, Denis and Mihov (2003) or Johnson (1997) do not find a significant relation between growth opportunities and public debt use, while Houston and James (1996) find a negative relation between the use of bank debt and growth opportunities for firms with single bank relationships.

Table 6 also reveals that product market competition (or obsolescence risk), measured by product market fluidity, has a positive effect on the probability of issuing public debt. In column 4, the coefficient of competition is positive and statistically significant, suggesting that a higher product market threat increases the likelihood of a bond issue. This result is again consistent with the model's prediction. In the model, firms operating in competitive product markets prefer issuing public debt instead of searching for private creditors because there is less financing risk. Finally, using cash flow volatility as a proxy for the risk of default, the negative coefficient of this variable supports our model prediction that firms, which are more likely to be inefficiently liquidated, prefer private debt.

The coefficient estimates on the control variables are also consistent with the existing literature. Specifically, the positive coefficient on firm size supports Fama's (1985) argument that larger firms find it more economical to produce the information required for public securities, i.e. that issuance costs are relatively less important for these firms (see also Blackwell and Kidwell (1988) and Krishnaswami, Spindt, and Subramaniam (1999) for a related argument). In addition, firms with a higher leverage, higher cash holdings, and an investment grade rating have a higher probability to issue public debt (see for example Erel, Julio, Kim, and Weisbach, 2012, or Denis and Mihov, 2003).

To assess the robustness of our results, we estimate a number of additional specifications. We include industry fixed effects to control for broad industry effects, estimate a logit model with random firm-effects, restrict the sample to years around investment spikes, and include the firm's default probability as additional control variable.

Insert Table 7 Here

The specification in column 1 of Table 7 is estimated with FIC-300 industry fixed effects. These industry fixed effects are based on the fixed industry classification using product descriptions, which are available in the Hoberg and Phillips data library.[14] Reassuringly, the estimates in column 1 are very similar to the estimates in Table 6. In column 2, we estimate a logit specification with random effects to address unobserved firm heterogeneity, and in column 3 we estimate a specification with random effects and industry fixed-effects. Again, the estimates in both columns are very similar to those obtained in Table 6. Next,

[14] We obtain very similar results when we use SIC fixed effects.

in column 4 we restrict the sample to bond and loan issues around investment spikes. More specifically, we only keep bond and loan issues that were issued between three years before to one year after an investment spike. This sample restriction allows us to more closely tie firms' financing patterns to corporate investment. Note that while the sample size decreases to 1,568, the results are similar to the results of the full sample. In particular, the coefficients on growth options, bargaining power of shareholders in default, and competition are positive, while the coefficients of credit supply and volatility are negative.

In columns 5 and 6, we include the firm's default probability as an additional control variable and interact it with shareholders' bargaining power in default. The model predicts that firms with high default risk prefer private debt to avoid inefficient liquidation. Moreover, the effect of shareholders' bargaining power should be more important for firms with high default risk, implying that the interaction term between default risk and bargaining power is positive. The coefficient of default probability is significantly negative in both columns 5 and 6, supporting the hypothesis that riskier firms prefer private debt. Importantly, the coefficient of the interaction term is positive and statistically significant, while the direct effect of bargaining power is small and statistically insignificant. These findings suggest that shareholders' bargaining power in default matters for debt choice mostly for firms with high default risk. Overall, these additional estimations corroborate our main results and lend further support to the model's predictions.

Lastly, we estimate several specifications in which we use alternative proxies for growth options, bargaining power in default, credit supply, and competition. Table 8 presents the estimation results. In column 1, we use sales growth as an alternative proxy for growth options. Consistent with the model, the coefficient is positive and statistically significant, corroborating the results using the market-to-book ratio as proxy for growth options. Next, in column 3 we use the fraction of shares owned by top executives as an alternative proxy for bargaining power. The coefficient is positive (although insignificant), consistent with the model's predictions and the previous empirical results.[15] In columns 3 and 4, we use an expansion dummy and GDP growth as proxies for credit supply. Consistent with our previous findings, the coefficients are significantly negative in both columns. Finally, columns 5 and

[15] The sample size in this specification is much smaller due to the limited coverage of Execucomp data. As a result of the large reduction of the sample size, some of the variables lose statistical significance.

6 use alternative proxies for product market competition based on Compustat data (Competition (Compustat)) and on product descriptions (Competition (TNIC)). The coefficients of competition are positive and statistically significant, supporting the findings in Table 6.

3.3. Investment hazards

In addition to its implications for the choice between public and private debt, the model also has implications for corporate investment. In this section, we test these predictions by analyzing firms' investment rates (hazard rates) using a multivariate duration analysis. That is, we investigate how much time passes by until a firm invests and which variables speed up or delay investment (see, e.g., Leary and Roberts, 2005, Whited, 2006, or Akdogu and MacKay, 2008 for recent studies using duration analysis). To do so, we estimate a mixed proportional hazard model as described in equation (7), in which t is the time to investment.

In our estimations, we follow Whited (2006) and define investment spikes in terms of the deviation of the ratio of investment to total assets from the firm-level median of this ratio. An investment spike occurs in the data if the ratio of investment to total asset is two times greater than the firm median. Our sample includes firms without any investment spike (censored firms) as well as firms with several investment spikes. Overall, we observe in our sample 5,829 investment spikes, corresponding to a fraction of 11.88% of spikes in the data. The average (uncensored) time between investment spikes (inaction spell) is 2.23 years. These values are similar to those reported by Whited (2006). The model is estimated using maximum likelihood.

Table 9 presents estimates of the proportional hazard model. These estimates are shift parameters showing whether and by how much a variable moves the baseline hazard rate up or down. The estimations in Table 9 are without unobserved heterogeneity, which we introduce in Table 10. Moreover, we do not include any year dummies because these would eliminate the variation in our credit supply proxies.

Consistent with our model, columns 1 to 5 of Table 9 show that growth options shift hazard rates up. If growth options are more profitable (or if the firm holds more growth options), the firm invests sooner. The coefficient of growth options is positive and statistically significant in all columns. In addition, the effect is economically large. For instance, in column 1 the coefficient has a value of 0.110. This coefficient implies that a one standard deviation increase in the market-to-book ratio increases the investment hazard rate by 16.1% (i.e., $\exp(0.11 \times 1.36) - 1$), holding all other variables constant.

Insert Table 9 Here

In columns 2, we add shareholders' bargaining power in default as an additional covariate. The coefficient on bargaining power is negative and statistically significant. Hence, this variables shifts hazard rates down. Specifically, a one standard deviation increase in bargaining power decreases the investment hazard rate by 5.5% (i.e., $\exp(-0.197 \times 0.29) - 1$). Higher shareholders' bargaining power in default increases the cost of financing and makes investment opportunities less attractive. As a result, firms delay investment.

Our estimates also show that credit supply shifts hazard rates up. The coefficient of credit supply is positive and statistically significant in columns 3 to 5. When the supply of lenders is strong, the availability of capital increases and its cost decreases. As a consequence, investment opportunities are more attractive and firms speed up investment, consistent with our model's predictions.

Next, we observe that competitive threat shifts hazard rates up. Specifically, the coefficient of competition is positive and statistically significant in columns 4 and 5. For instance, the coefficient in the fourth column implies that a one standard deviation increase in competition increases the investment hazard rate by 8.1%. Intuitively, in more competitive industries, firms face a preemption risk if they wait too long before investing. Hence, competition speeds up investment by increasing financing risk. This result is consistent with the findings of Akdogu and MacKay (2008), who find that investment speeds are higher in competitive versus concentrated industries.

Finally, we add liquidation costs as an additional explanatory variable. The coefficient on liquidation costs is negative and statistically significant. Hence, this variable shifts hazard rates down. Similar to shareholders' bargaining power, higher liquidation costs in default increase the cost of financing and make investment opportunities less attractive. Note that the coefficients on the control variables are as expected. Firms with high cash flows invest sooner (see also Whited, 2006), while large firms and firms with volatile cash flows tend to delay investment. Taken together, the results from these proportional hazard estimations provide strong support for the model's predictions.

Insert Table 10 Here

We perform two sets of robustness tests. The estimates of the first set are reported in Table 10. In column 1 we add FIC-300 industry fixed effects. In the second column we add the default probability as an additional control variable. In columns 3 and 4 we vary the threshold for investment spikes. Finally, in columns 5 and 6 we allow for unobserved heterogeneity, which helps absorbing the cumulative effect of potentially omitted covariates. As in Whited (2006) or Leary and Roberts (2005), we assume that the unobserved heterogeneity has a normal (column 5) or gamma (column 6) distribution. In all six columns, the estimates are very similar to those reported in Table 9.

Insert Table 11 Here

In the second set of robustness tests, we use alternative proxies for our main explanatory variables. Table 11 shows the results from these tests. In the first column, we use sales growth as an alternative proxy for growth options. The coefficient on sales growth is positive and statistically significant, further corroborating our results. In columns 2 and 3, we use alternative proxies for credit supply: an NBER expansion dummy in column 2 and GDP growth in column 3. In both columns, a greater supply of lenders shifts hazard rates up. In columns 4 and 5, we replace the measure of product market fluidity with competition proxies based on Compustat data and product descriptions (Competition(TNIC)). The coefficients on competition remain positive, supporting the results of Table 9. Finally, in column 6 we use intangibility as an alternative proxy for liquidation costs. The coefficient is negative and marginally significant, supporting our previous findings.

4. Conclusion

This paper develops a dynamic model to study the choice between public and private debt in a firm's marginal financing decision and its effects on corporate investment. Using this model, the paper shows how various firm and industry characteristics affect the mix of debt financing that borrowers demand and corporate investment and provides a number of unique empirical predictions. Notably, we show that firms with more growth options, higher bargaining power in default, low cash flow volatility, operating in more competitive product markets, and facing lower credit supply are more likely to issue public debt. We also demonstrate that firms with high liquidation costs and high bargaining power of shareholders in default delay investment, while firms operating in competitive product markets, facing a strong supply of lenders, or having profitable growth options speed up investment.

The paper also provides supportive evidence for the predictions of the model using a large sample of U.S. firms for the period 1986-2007. Specifically, we estimate logit models predicting financing choices and find that our various proxies for the profitability of growth options, liquidation costs, shareholders' bargaining power, product market competition, cash flow volatility, and credit supply have economically and statistically significant explanatory power in ways consistent with our theory. We also identify the effects of our explanatory variables on firms' investment rates using a multivariate duration analysis and find that the results from these estimations provide strong support for the model's predictions.

Appendix

A. Firm value after investment

Denote by $\underline{X}_i$ the default threshold selected by shareholders, for $i = B, D$ where $i = B$ (resp. $i = D$) when the firm issues bank (resp. market) debt, and by T_i the first time to reach this threshold. We can then write firm value after investment for $X > \underline{X}_i$ as:

$$\begin{aligned} V_2(X; b, c) &= \mathbb{E}\left\{\int_0^{T_i} e^{-rt}\left[(1-\tau)\pi X_t + \tau\left(c1_{i=D} + b1_{i=B}\right)\right]dt\right\} \\ &\quad + \mathbb{E}\left\{\int_{T_i}^{+\infty} e^{-rt}\left[1 - \alpha\left(1_{i=D} + q1_{i=B}\right)\right](1-\tau)\pi X_t dt\right\}, \end{aligned}$$

The first term on the right hand side of this equation represents the present value of the cash flows accruing to claimholders before default. The second term accounts for the firm cash flows after default. Using standard calculations (see e.g. Leland, 1994), we have that $V_2(X; b, c)$ satisfies for $X > \underline{X}_i$:

$$V_2(X; b, c) = \pi\Lambda X + \frac{\tau}{r}\left(c1_{i=D} + b1_{i=B}\right)\left[1 - \left(\frac{X}{\underline{X}_i}\right)^{\nu}\right] - \alpha(1_{i=D} + q1_{i=B})\pi\Lambda\underline{X}_i\left(\frac{X}{\underline{X}_i}\right)^{\nu},$$

where $\nu < 0$ is the negative root of $\frac{1}{2}\sigma^2 y(y-1) + \mu y - r = 0$. The value of equity is then given by

$$\begin{aligned} E_2(X; b, c) &= \pi\Lambda X - \frac{(1-\tau)\left(c1_{i=D} + b1_{i=B}\right)}{r} \\ &\quad - \left[\left(1 - (1-q)\,\eta\alpha 1_{i=B}\right)\pi\Lambda\underline{X}_i - \frac{(1-\tau)\left(c1_{i=D} + b1_{i=B}\right)}{r}\right]\left(\frac{X}{\underline{X}_i}\right)^{\nu} \end{aligned}$$

and the default threshold that maximizes equity value satisfies:

$$\underline{X}_i^* = \frac{\nu}{\nu-1}\frac{r-\mu}{\pi r}\left(c1_{i=D} + \frac{b1_{i=B}}{1-(1-q)\,\eta\alpha}\right) \text{ for } i = B, D.$$

The first order conditions with respect to b and c are given by

$$\frac{\partial V_2(X; b, 0)}{\partial b} = 0, \text{ and } \frac{\partial\left[V_2(X; 0, c) - \iota D(X; c)\right]}{\partial c} = 0,$$

where the value of market debt satisfies

$$D(X; c) = \frac{c}{r} + \left[(1-\alpha)\,\pi\Lambda\underline{X}_i - \frac{c}{r}\right]\left(\frac{X}{\underline{X}_i}\right)^{\nu}.$$

The solutions to these first order conditions are given by (one can easily check that the second order condition for this optimization problem is negative, ensuring optimality):

$$\begin{aligned} c^* &= X\Lambda\pi\frac{r(\nu-1)}{\nu(1-\tau)}\left[1 - \nu - \nu\left(\alpha + \iota(1-\alpha)\right)\frac{1-\tau}{\tau-\iota}\right]^{1/\nu}, \\ b^* &= \pi\Lambda X\frac{r(\nu-1)}{\nu(1-\tau)}\left[1-(1-q)\,\eta\alpha\right]\left[1 - \nu - \frac{\nu(1-\tau)\,\alpha q}{\left(1-(1-q)\,\eta\alpha\right)\tau}\right]^{1/\nu}. \end{aligned}$$

Plugging the expressions for the value maximizing coupon payments and default thresholds in $V_2(X; b, c) - \iota D(X; c)$ and simplifying yields the expressions reported in the main text.

B. Value before investment

B.1 System of ODEs

In the model, credit supply is governed by a Poisson process N with intensity δ. The cash flow shock and the Poisson process are independent and the firm can only issue private debt at jump times of the Poisson process (i.e. when informed creditors arrive). The nth jump time of the Poisson process is denoted by T_n with the conventions $T_0 \equiv 0$ and $T_\infty \equiv \infty$. In the following, we will use $\mathcal{L}$ to denote the infinitesimal generator of the geometric Brownian motion X. We thus have

$$(\mathcal{L}u)(X) = \frac{1}{2}X^2\sigma^2 u''(X) + \mu X u'(X), \qquad \text{for all } X.$$

It is natural to guess that the optimal strategy takes the following form

$$T^* = \inf\{T_n : n \geq 1, X_{T_n} \geq \overline{X}_B^*\},$$

where $\overline{X}_B^* > I$. Since it is optimal to continue when the cash flow shock is below $\overline{X}_B^*$, we have

$$-rE_1(X) + \mathcal{L}E_1(X) + (1-\tau)X + \lambda\left[\Lambda X - E_1(X)\right] = 0, \qquad \forall X \in (0, \overline{X}_B^*).$$

When $X \geq \overline{X}_B^*$, the firm cannot invest unless it finds informed private lenders. In the small interval of length dt, the firm has a probability δdt of finding private debt investors and a probability λdt of being preempted. As a result, we have for $X \in (X_{I,B}^*, \overline{X}_D^*)$:

$$E_1(X) = \lambda dt\left\{\Lambda X\right\} + \delta dt\left\{E_1(X) + \theta\left[\Phi X - I - E_1(X)\right]\right\} + (1-(\delta+\lambda)\,dt)\mathbb{E}\left[e^{-rdt}\,E_1(X_{dt})\middle|\, X_0 = X\right],$$

or

$$\begin{aligned} E_1(X) \;&=\; \lambda dt\left\{\Lambda X\right\} + \delta dt\left\{E_1(X) + \theta\left[\Phi X - I - E_1(X)\right]\right\} \\ &\quad + (1-(\delta+\lambda)\,dt)\left\{E_1(X) + \left[-rE_1(X) + \mathcal{L}E_1(X) + (1-\tau)X - \phi\right]dt\right\}, \end{aligned}$$

which yields

$$-rE_1(X) + \mathcal{L}E_1(X) + (1-\tau)X - \phi + \delta\theta\left[\Phi X - I - E_1(X)\right] + \lambda\left[\Lambda X - E_1(X)\right] = 0, \qquad \forall X \in (\overline{X}_B^*, \overline{X}_D^*).$$

Combining these results, we get the desired system of ODEs.

B.2 Proof of Proposition 1

The value of equity before investment satisfies

$$\begin{aligned} &(r+\lambda)\,E_1(X) = (\mathcal{L}E_1)(X) + (1-\tau+\lambda\Lambda)\,X, && X < \overline{X}_B^*, \\ &(r+\lambda+\delta\theta)\,E_1(X) = (\mathcal{L}E_1)(X) + (1-\tau+\lambda\Lambda+\delta\theta\Phi)\,X - \delta\theta I - \phi, && X \in [\overline{X}_B^*, \overline{X}_D^*). \end{aligned}$$

The general solution to this set of equations is

$$E_1(X) = \begin{cases} AX^\xi + BX^\vartheta + \frac{1-\tau+\lambda\Lambda}{r+\lambda-\mu}X, & \text{for } X < \overline{X}_B^*, \\ CX^\beta + DX^\zeta + \frac{1-\tau+\lambda\Lambda+\delta\theta\Phi}{r+\lambda+\delta\theta-\mu}X - \frac{\delta\theta I+\phi}{r+\lambda+\delta\theta}, & \text{for} \in [\overline{X}_B^*, \overline{X}_D^*), \end{cases}$$

where A, B, C, D are constant parameters, $\xi > 1$, $\zeta > 1$ and $\beta < 0$ are defined in Proposition 1, and $\vartheta < 0$. The condition $E_1(0) = 0$ implies that $B = 0$. Simple algebraic manipulations of the other boundary conditions yield

$$\begin{aligned}
A &= \left\{ \left[\Phi - \frac{1-\tau+\lambda\Lambda}{r+\lambda-\mu} \right] \overline{X}_B^* - I \right\} \left(\overline{X}_B^* \right)^{-\xi}, \\
C &= \left\{ \frac{\zeta-1}{\zeta-\beta} \left[\Psi - \Sigma \right] \overline{X}_D^* - \frac{\zeta}{\zeta-\beta} \frac{(r+\lambda) I - \phi}{r+\lambda+\delta\theta} \right\} \left(\overline{X}_D^* \right)^{-\beta}, \\
D &= \left\{ \frac{\beta-1}{\beta-\zeta} \left[\Psi - \Sigma \right] \overline{X}_D^* - \frac{\beta}{\beta-\zeta} \frac{(r+\lambda) I - \phi}{r+\lambda+\delta\theta} \right\} \left(\overline{X}_D^* \right)^{-\zeta}, \\
C &= \left\{ \left[\frac{\zeta-\xi}{\zeta-\beta} \Phi + \frac{\xi-1}{\zeta-\beta} \frac{1-\tau+\lambda\Lambda}{r+\lambda-\mu} - \frac{\zeta-1}{\zeta-\beta} \Sigma \right] \overline{X}_B^* - \frac{\zeta (r+\lambda) I - \zeta\phi - \xi (r+\lambda+\delta\theta) I}{(\zeta-\beta)(r+\lambda+\delta\theta)} \right\} \left(\overline{X}_B^* \right)^{-\beta}, \\
D &= \left\{ \left[\frac{\xi-\beta}{\zeta-\beta} \Phi - \frac{\xi-1}{\zeta-\beta} \frac{1-\tau+\lambda\Lambda}{r+\lambda-\mu} + \frac{\beta-1}{\zeta-\beta} \Sigma \right] \overline{X}_B^* - \frac{\xi (r+\lambda+\delta\theta) I - \beta (r+\lambda) I + \beta\phi}{(\zeta-\beta)(r+\lambda+\delta\theta)} \right\} \left(\overline{X}_B^* \right)^{-\zeta}.
\end{aligned}$$

where $\Sigma = \frac{1-\tau+\lambda\Lambda+\delta\theta\Phi}{r+\lambda+\delta\theta-\mu}$. Define $z = \overline{X}_B^* / \overline{X}_D^* < 1$. Using the two equations for C and D, one can show that:

$$\overline{X}_D^* = \frac{\frac{\zeta[(r+\lambda)I-\phi]\left(1-z^{-\beta}\right)+\xi(r+\lambda+\delta\theta)Iz^{-\beta}}{(\zeta-\beta)(r+\lambda+\delta\theta)}}{\frac{\zeta-1}{\zeta-\beta}\Psi + \frac{\zeta-1}{\zeta-\beta}\frac{1-\tau+\lambda\Lambda+\delta\theta\Phi}{r+\lambda+\delta\theta-\mu}\left(z^{1-\beta}-1\right) - \frac{\zeta-\xi}{\zeta-\beta}\Phi z^{1-\beta} - \frac{\xi-1}{\zeta-\beta}\frac{1-\tau+\lambda\Lambda}{r+\lambda-\mu}z^{1-\beta}},$$

and

$$\overline{X}_D^* = \frac{\frac{\beta[(r+\lambda)I-\phi]\left(z^{-\zeta}-1\right)-\xi(r+\lambda+\delta\theta)Iz^{-\zeta}}{(\zeta-\beta)(r+\lambda+\delta\theta)}}{\frac{1-\beta}{\zeta-\beta}\Psi + \frac{1-\beta}{\zeta-\beta}\frac{1-\tau+\lambda\Lambda+\delta\theta\Phi}{r+\lambda+\delta\theta-\mu}\left(z^{1-\zeta}-1\right) - \frac{\xi-\beta}{\zeta-\beta}\Phi z^{1-\zeta} + \frac{\xi-1}{\zeta-\beta}\frac{1-\tau+\lambda\Lambda}{r+\lambda-\mu}z^{1-\zeta}}.$$

Using these two equations, we then have that z is the solution to equation (5).

C. Simulation procedure

Our analysis of the determinants of investment hazards and financing choices is based on a panel of simulated firms (as in Strebulaev, 2007, or Morellec and Schürhoff, 2011). We assume that the economy consists of a large number of firms. Each firm i is characterized by the model parameters $(\sigma, \mu, \alpha, \tau, \eta, \theta, \iota, \delta, \lambda, \pi)$, which may be firm- or industry-specific. We use the parameter values of Figure 1 in our base case environment. The variables that determine investment and financing strategies in our setting are the firms' growth potential (as measured by π), the bargaining power of shareholders in default η, liquidation costs α, cash flow volatility σ, credit supply δ, and product market competition λ. We introduce variation across firms by drawing for each firm separate parameters from their natural domains. As in Morellec and Schürhoff (2011), we opt for perturbations of the base parametrization in Figures 1 and 2. That is, we start with the base parametrization $\delta = 3$, $\lambda = 1$, $\sigma = 0.2886$, $\alpha = 0.45$, $\eta = 0.5$, and $\pi = 1.25$ and draw each of the parameters from uniform distributions with the same bounds as in Figures 1 and 2 while keeping the other parameters fixed. We simulate a total of $N = 237,400$ firms.

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Table 1
Debt choice logistic regressions: Simulated data

Table 1 reports estimates from debt choice regressions on simulated data. The dependent variable is a dummy equal to one if a firm issues public debt and zero otherwise. The independent variables are the profitability of growth options π, shareholders' bargaining power in default η, the arrival rate of informed lenders δ, the arrival rate of competitors λ, and cash flow volatility σ. The symbol *** indicates statistical significance at the 1% level.

	(1)	(2)	(3)	(4)	(5)
Growth options	2.205***	2.224***	2.245***	2.251***	2.381***
	(0.018)	(0.019)	(0.019)	(0.019)	(0.019)
Bargaining power in default		0.766***	0.784***	0.780***	1.065***
		(0.019)	(0.019)	(0.019)	(0.019)
Credit supply			-0.302***	-0.305***	-0.343***
			(0.0.007)	(0.007)	(0.007)
Competition				0.202***	0.192***
				(0.007)	(0.007)
Volatility					-4.112***
					(0.040)
Observations	237,400	237,400	237,400	237,400	237,400
Log likelihood	-137365	-136499	-135606	-135207	-129551

Table 2
Investment hazard model estimates: Simulated data

Table 2 reports estimates from semi-parametric investment hazard models on simulated data. The independent variables are the profitability of growth options π, shareholders' bargaining power in default η, the arrival rate of informed lenders δ, the arrival rate of competitors λ, and cash flow volatility σ. The symbol *** indicates statistical significance at the 1% level.

	(1)	(2)	(3)	(4)	(5)	(6)
Growth options	1.103***	1.104***	1.105***	1.105***	1.106***	1.378***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.012)
Liquidation costs		-0.387***	-0.411***	-0.412***	-0.413***	-0.192***
		(0.020)	(0.021)	(0.021)	(0.021)	(0.024)
Bargaining power in default			-0.229***	-0.229***	-0.230***	-0.051***
			(0.010)	(0.010)	(0.011)	(0.012)
Credit supply				0.022***	0.022***	0.007
				(0.004)	(0.004)	(0.005)
Competition					0.047***	0.041***
					(0.004)	(0.005)
Volatility						-4.787***
						(0.031)
Observations	237,400	237,400	237,400	237,400	237,400	237,400
Log likelihood	-97053	-96874	-96636	-96621	-96555	-80293

Table 3
Data definitions

Variable	Variable Definition	Source
Book debt	Debt in current liabilities (dlc) + long-term debt (dltt)	Compustat
Growth options (Market-to-book ratio)	Market equity (csho + prcc_f) + Book debt + Preferred stock (pstk) - Deferred taxes and investment tax credits (txditc)) / Assets total (at)	Compustat
Growth options (sales growth)	Growth in sales (sale) from $t-1$ to t	Compustat
Liquidation costs	1 - Net PPE (ppent)	Compustat
Liquidation costs (intang)	1 - (0.715 * Receivables (rect) + 0.547 * Inventories (invt) + 0.535 * Net PPE (ppent) + Cash (che)) / Assets total (at)	Compustat
Bargaining power	Fraction of stock owned by institutional investors	Thomson Reuter's
Bargaining power (top)	Fraction of stock owned by the top 5 executives	Execucomp
Credit supply (Fed survey)	(-1) * Net percentage of banks tightening credit standards to large and middle-market firms	Federal Reserve
Credit supply (GDP)	Real GDP growth (quarterly)	BEA
Credit supply (expansion)	Dummy variable equal to one if the economy is in an expansion in a quarter, zero otherwise	NBER
Competition (fluidity)	Product market fluidity, available at http://www.rhsmith.umd.edu/industrydata/	Hoberg-Phillips
Competition (Compustat)	1 - HHI at the three-digit SIC industry level computed from net sales (sale)	Compustat
Competition (TNIC)	1 - HHI based on product descriptions, available at http://www.rhsmith.umd.edu/industrydata/	Hoberg-Phillips
Cash flow	(Income before extraordinary items (ib) + depreciation and amortization (dp)) / Assets total (at)	Compustat
Volatility	Annual standard deviation of cash flows over five fiscal years (at least three consecutive obs.)	Compustat
Size	Logarithm of net sales (sale)	Compustat
Market leverage	Book debt / (Market equity + Assets total (at) - Common equity (ceq))	Compustat
Cash	Cash and short-term investments (che) / Assets total (at)	Compustat
IG rating	Dummy variable equal to one if the firm has an investment grade rating and zero otherwise	Compustat
Investment	Capital expenditures (capx) / Assets total (at) at the beginning of the fiscal year	Compustat
Default probability	Estimate of firm's default probability based on market values following Bharath and Shumway (2008)	Compustat-CRSP

Table 4
Descriptive statistics

Table 4 presents descriptive statistics for the main variables used in the analysis. Panel A shows statistics for the firm-level variables. Panel B presents statistics for the macroeconomic and competition variables. The sample period is 1986-2007. Table 3 provides a detailed definition of the variables.

Panel A: Firm-level variables

	Mean	S.D.	25%	50%	75%	Obs
Market-to-book ratio	1.529	1.362	0.786	1.111	1.743	49,063
Sales growth	0.162	0.504	-0.013	0.086	0.218	49,063
Bargaining power in default	0.456	0.289	0.205	0.451	0.684	36,811
Bargaining power in default (top)	0.042	0.082	0.003	0.009	0.035	17,728
Liquidation costs	0.694	0.227	0.560	0.751	0.876	49,063
Liquidation costs (intang)	0.498	0.137	0.423	0.485	0.574	49,063
Investment	0.076	0.092	0.025	0.049	0.092	49,063
Volatility	0.077	0.106	0.020	0.039	0.085	49,063
Market leverage	0.201	0.182	0.048	0.159	0.306	49,063
Log(sales)	5.862	2.022	4.480	5.846	7.222	49,063
IG rating	0.175	0.380	0.000	0.000	0.000	49,063
Cash	0.128	0.164	0.018	0.060	0.172	49,063
Cash flow	0.048	0.168	0.030	0.080	0.125	49,063
Default probability	0.189	0.309	0.000	0.004	0.266	43,256

Panel B: Macroeconomic and competition variables

	Mean	S.D.	25%	50%	75%	Obs
Banks tightening lending (%)	6.295	20.166	-9.075	-0.275	19.625	46,569
GDP growth	0.055	0.012	0.049	0.060	0.064	49,063
Expansion dummy	0.928	0.198	1.000	1.000	1.000	49,063
Product market fluidity	6.601	3.257	4.195	6.028	8.400	27,337
HHI (Compustat)	0.148	0.133	0.058	0.111	0.184	49,063
HHI (TNIC)	0.209	0.218	0.064	0.124	0.268	29,625

Table 5: Descriptive statistics for bond and loan issues

Table 5 presents descriptive statistics for the number of bond and loan issues in the sample. Columns 1 and 2 show the number of bond and loan issues by year. Columns 3 to 6 display the number of bond and loan issues for sub-samples split at the median firm size using sales. Columns 7 and 8 show the proportion of firms issuing only loans or bonds during a given year. The sample period is 1986-2007.

			Small firms		Large firms		Proportion of firms issuing	
Year	# of bonds	# of loans	# of bonds	# of loans	# of bonds	# of loans	only loans	only bond
1988	75	309	13	198	62	111	0.54	0.03
1989	158	396	8	227	150	169	0.59	0.04
1990	131	416	8	245	123	171	0.55	0.03
1991	141	362	11	253	130	109	0.50	0.06
1992	196	398	40	243	156	155	0.48	0.05
1993	179	685	33	411	146	274	0.56	0.06
1994	91	914	23	480	68	434	0.57	0.02
1995	147	708	31	416	116	292	0.53	0.04
1996	195	768	32	466	163	302	0.59	0.05
1997	316	950	81	535	235	415	0.56	0.05
1998	483	961	141	576	342	385	0.53	0.07
1999	351	985	89	586	262	399	0.56	0.05
2000	192	985	47	560	145	425	0.58	0.02
2001	367	1,131	105	636	262	495	0.55	0.04
2002	305	1,221	68	726	237	495	0.58	0.03
2003	368	1,180	93	691	275	489	0.53	0.04
2004	374	1,245	128	697	246	548	0.53	0.05
2005	293	1,155	106	601	187	554	0.50	0.03
2006	270	1,011	71	542	199	469	0.54	0.04
2007	336	822	100	458	236	364	0.49	0.06
Total	4,968	16,602	1,228	9,547	3,740	7,055	0.54	0.04

Table 6
Debt choice logistic regressions: Main results

Table 6 presents coefficient estimates of logistic regressions. The dependent variable is a dummy equal to one if a firm issues public debt and zero if a firm issues bank debt in a given month. Table 3 provides a detailed definition of the variables. The sample period is 1986-2007. All specifications include yearly dummies. Standard errors adjusted for heteroskedasticity and within-firm clustering are in parentheses below the coefficient estimates. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)
Growth options	0.164***	0.162***	0.169***	0.174***
	(0.031)	(0.035)	(0.036)	(0.040)
Bargaining power		0.947***	0.973***	0.616***
		(0.154)	(0.157)	(0.176)
Credit supply (Fed Survey)			-0.742***	-0.830***
			(0.249)	(0.291)
Competition (fluidity)				0.087***
				(0.012)
Volatility	-0.946**	-0.926*	-0.923*	-1.464**
	(0.460)	(0.537)	(0.534)	(0.626)
Market leverage	4.157***	4.882***	4.981***	4.943***
	(0.223)	(0.236)	(0.242)	(0.273)
Size	0.367***	0.383***	0.377***	0.411***
	(0.026)	(0.030)	(0.030)	(0.034)
IG dummy	0.722***	0.748***	0.708***	0.406***
	(0.088)	(0.088)	(0.090)	(0.103)
Cash	0.600	0.920**	0.855**	0.200
	(0.391)	(0.409)	(0.414)	(0.441)
Constant	-5.595***	-6.065***	-6.404***	-6.701***
	(0.257)	(0.276)	(0.281)	(0.317)
Observations	15,410	12,573	12,006	8,413
Log likelihood	-7,322.56	-6,095.78	-5,853.36	-4,237.13

Table 7
Debt choice logistic regressions: Robustness tests

Table 7 presents coefficient estimates of logistic regressions. The dependent variable is a dummy equal to one if a firm issues public debt and zero if a firm issues bank debt in a given month. Column 1 includes FIC-300 industry fixed effects. The specification in columns 2 and 3 are estimated with random firm effects (column 3 including industry fixed effects). Column 4 restricts the sample to years around investment spikes. In particular, it only considers bond and loan issues that are issued up to three years before to one year after an investment spike. Columns 5 contains the market value based default probability as an additional control variable, and column 6 includes the interaction term between the default probability and shareholders' bargaining power in default. Table 3 provides a detailed definition of the variables. The sample period is 1986-2007. All specifications include yearly dummies. Standard errors (adjusted for heteroskedasticity and within-firm clustering in columns 1 and 4) are in parentheses below the coefficient estimates. ρ is the ratio of the heterogeneity variance to one plus the heterogeneity variance. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Growth options	0.204***	0.176***	0.186***	0.135**	0.174***	0.173***
	(0.037)	(0.044)	(0.047)	(0.069)	(0.039)	(0.039)
Bargaining power	0.758***	0.606***	0.790***	0.561	0.468**	0.207
	(0.174)	(0.187)	(0.188)	(0.350)	(0.182)	(0.201)
Credit supply (Fed Survey)	-0.755**	-1.097***	-1.037***	-1.517**	-0.889***	-0.896***
	(0.300)	(0.323)	(0.326)	(0.660)	(0.295)	(0.294)
Competition (fluidity)	0.057***	0.099***	0.059***	0.123***	0.081***	0.080***
	(0.017)	(0.013)	(0.018)	(0.034)	(0.012)	(0.012)
Volatility	-1.279**	-1.464**	-1.415**	-3.443**	-0.976	-0.954
	(0.600)	(0.648)	(0.668)	(1.626)	(0.603)	(0.585)
Market leverage	4.558***	5.812***	5.318***	5.534***	6.143***	6.121***
	(0.280)	(0.307)	(0.313)	(0.608)	(0.357)	(0.357)
Size	0.426***	0.580***	0.574***	0.358***	0.416***	0.407***
	(0.035)	(0.041)	(0.043)	(0.076)	(0.034)	(0.034)
IG dummy	0.301***	0.628***	0.439***	0.649**	0.347***	0.371***
	(0.104)	(0.117)	(0.118)	(0.272)	(0.103)	(0.104)
Cash	1.129**	0.685	1.444***	2.013**	0.608	0.610
	(0.472)	(0.446)	(0.486)	(0.785)	(0.436)	(0.434)
Default probability					-1.149***	-1.814***
					(0.201)	(0.336)
Bargaining power ×						1.316***
Default probability						(0.484)
Constant	-6.932***	-8.790***	-8.713***	-7.102***	-6.781***	-6.534***
	(0.455)	(0.399)	(0.502)	(0.791)	(0.319)	(0.323)
ρ		0.343***	0.280***			
		(0.023)	(0.024)			
Observations	8,051	8,413	8,354	1,568	8,137	8,137
Log likelihood	-3,987.04	-4,013.27	-3,847.73	-665.23	-4,137.60	-4,131.01

Table 8
Debt choice logistic regressions: Robustness tests

Table 8 presents coefficient estimates of logistic regressions. The dependent variable is a dummy equal to one if a firm issues public debt and zero if a firm issues bank debt in a given month. Column 1 uses sales growth as alternative proxy for growth options. Column 2 uses stocks owned by top executives as a proxy for shareholders' bargaining power in default. Columns 3 and 4 use alternative proxies for credit supply. Columns 5 and 6 use alternative proxies for competition. Table 3 provides a detailed definition of the variables. The sample period is 1986-2007. All specifications include yearly dummies. Standard errors adjusted for heteroskedasticity and within-firm clustering are in parentheses below the coefficient estimates. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Growth options		0.162***	0.174***	0.177***	0.167***	0.169***
		(0.043)	(0.040)	(0.040)	(0.036)	(0.036)
Growth options (sales growth)	0.356***					
	(0.079)					
Bargaining power	0.631***		0.608***	0.618***	0.990***	0.603***
	(0.180)		(0.176)	(0.176)	(0.157)	(0.173)
Credit supply (Fed survey)	-0.867***	-0.772**			-0.744***	-0.739***
	(0.293)	(0.349)			(0.250)	(0.284)
Competition (fluidity)	0.083***	0.039***	0.087***	0.087***		
	(0.012)	(0.013)	(0.012)	(0.012)		
Bargaining power (top)		0.282				
		(0.731)				
Credit supply (expansion)			-0.360***			
			(0.124)			
Credit supply (GDP Growth)				-0.033**		
				(0.016)		
Competition (Compustat)					0.620***	
					(0.226)	
Competition (TNIC)						0.602***
						(0.199)
Volatility	-1.213*	-0.392	-1.458**	-1.464**	-0.959*	-0.944*
	(0.644)	(0.622)	(0.627)	(0.631)	(0.530)	(0.574)
Market leverage	4.584***	4.978***	4.939***	4.939***	4.972***	5.118***
	(0.257)	(0.383)	(0.273)	(0.273)	(0.242)	(0.268)
Size	0.411***	0.292***	0.412***	0.412***	0.378***	0.397***
	(0.034)	(0.044)	(0.034)	(0.034)	(0.030)	(0.034)
IG dummy	0.469***	0.480***	0.403***	0.404***	0.712***	0.438***
	(0.102)	(0.111)	(0.102)	(0.102)	(0.090)	(0.099)
Cash	0.537	-1.034**	0.181	0.186	0.774*	0.740*
	(0.415)	(0.520)	(0.443)	(0.442)	(0.416)	(0.437)
Constant	-6.478***	-4.724***	-6.429***	-6.538***	-6.926***	-6.563***
	(0.303)	(0.401)	(0.327)	(0.324)	(0.342)	(0.313)
Observations	8,413	5,892	8,413	8,413	12,006	8,894
Log likelihood	-4,234.28	-3,288.68	-4,237.47	-4,239.73	-5,846.02	-4,525.24

Table 9
Investment hazard model estimates: Main results

Table 9 presents estimates of proportional hazard models for investment rates. An investment spike occurs in the data if the ratio of investment to total asset is two times greater than the firm median. Table 3 provides a detailed definition of the variables. The sample period is 1986-2007. Standard errors are in parentheses below the coefficient estimates. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
Growth options	0.110***	0.112***	0.105***	0.096***	0.100***
	(0.008)	(0.009)	(0.009)	(0.012)	(0.012)
Bargaining power		-0.197***	-0.224***	-0.410***	-0.389***
		(0.069)	(0.070)	(0.092)	(0.092)
Credit supply (Fed survey)			0.393***	0.296***	0.287**
			(0.088)	(0.113)	(0.113)
Competition (fluidity)				0.024***	0.021***
				(0.007)	(0.007)
Liquidation costs					-0.613***
					(0.100)
Volatility	0.020	-0.176	-0.164	-0.265	-0.134
	(0.132)	(0.178)	(0.180)	(0.224)	(0.226)
Market leverage	0.118	0.032	0.011	0.105	-0.155
	(0.078)	(0.098)	(0.103)	(0.135)	(0.143)
Size	-0.144***	-0.137***	-0.141***	-0.171***	-0.171***
	(0.007)	(0.011)	(0.011)	(0.016)	(0.016)
Cash flow	0.884***	0.813***	0.813***	0.908***	0.767***
	(0.087)	(0.112)	(0.113)	(0.144)	(0.143)
Constant	-2.146***	-2.166***	-2.105***	-1.892***	-1.405***
	(0.221)	(0.254)	(0.254)	(0.272)	(0.283)
Observations	49,063	36,811	35,051	22,115	22,115
Log likelihood	-16,812.84	-12,057.47	-11,215.51	-6,405.298	-6,387.289

Table 10
Investment hazard model estimates: Robustness tests

Table 10 presents estimates of proportional hazard models for investment rates. An investment spike occurs in the data if the ratio of investment to total asset is two times (or 2.5 or three times) greater than the firm median. Column 1 includes FIC-300 industry fixed effects. Column 2 includes the default probability as an additional control variable. In column 3, the threshold for an investment spike is 2.5 times the firm median, and in column 4 the threshold is three times the median. Columns 5 and 6 estimate the proportional hazard model with unobserved heterogeneity (frailty). In column 5, we assume that unobserved heterogeneity is normally distributed, whereas in column 6 we assume that it is gamma distributed. Table 3 provides a detailed definition of the variables. The sample period is 1986-2007. ρ is the ratio of the heterogeneity variance to one plus the heterogeneity variance. σ^2 is the estimate of the heterogeneity variance. Standard errors are in parentheses below the coefficient estimates. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Growth options	0.115***	0.100***	0.116***	0.135***	0.109***	0.105***
	(0.013)	(0.013)	(0.014)	(0.016)	(0.017)	(0.016)
Bargaining power	-0.340***	-0.391***	-0.590***	-0.701***	-0.197	-0.214*
	(0.099)	(0.100)	(0.118)	(0.144)	(0.123)	(0.119)
Credit supply (Fed survey)	0.350***	0.246**	0.331**	0.419**	0.392***	0.427***
	(0.115)	(0.121)	(0.144)	(0.175)	(0.137)	(0.132)
Competition (Fluidity)	0.036***	0.015**	0.019**	0.032***	0.021**	0.020**
	(0.010)	(0.008)	(0.009)	(0.011)	(0.010)	(0.009)
Liquidation costs	-1.087***	-0.557***	-0.673***	-0.768***	-0.839***	-0.813***
	(0.137)	(0.105)	(0.128)	(0.153)	(0.148)	(0.146)
Volatility	-0.099	-0.085	0.255	0.342	-0.443	-0.429
	(0.235)	(0.246)	(0.264)	(0.306)	(0.319)	(0.306)
Market leverage	-0.258*	0.378*	-0.347*	-0.053	-0.373*	-0.375**
	(0.155)	(0.212)	(0.185)	(0.218)	(0.191)	(0.184)
Size	-0.194***	-0.184***	-0.171***	-0.190***	-0.193***	-0.184***
	(0.018)	(0.016)	(0.020)	(0.023)	(0.022)	(0.021)
Cash flow	0.991***	0.649***	0.752***	0.618***	1.320***	1.287***
	(0.153)	(0.153)	(0.170)	(0.192)	(0.201)	(0.194)
Default probability		-1.301***				
		(0.287)				
Constant	-0.934***	-0.603***	-2.082***	-2.280***	-1.939***	-1.583**
	(0.337)	(0.139)	(0.413)	(0.488)	(0.619)	(0.622)
ρ					0.418***	
					0.048	
σ^2						0.904***
						0.194
Observations	21,935	20,040	22,115	22,115	21,813	21,813
Log likelihood	-6,083.99	-5,718.57	-4,492.25	-3,344.06	-5,533.57	-5,537.52

Table 11
Investment hazard model estimates: Robustness tests

Table 11 presents estimates of proportional hazard models for investment rates. An investment spike occurs in the data if the ratio of investment to total asset is two times greater than the firm median. Column 1 uses sales growth as an alternative proxy for growth options. Columns 2 and 3 use alternative proxies for credit supply. Columns 4 and 5 use an alternative proxy for competition. Finally, column 6 uses intangibility as a proxy for liquidation costs. Table 3 provides a detailed definition of the variables. The sample period is 1986-2007. All specifications include two-digit SIC dummies. Standard errors are in parentheses below the coefficient estimates. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Growth options		0.100***	0.096***	0.107***	0.107***	0.093***
		(0.012)	(0.012)	(0.009)	(0.011)	(0.012)
Growth options (sales growth)	0.341***					
	(0.021)					
Bargaining power	-0.364***	-0.374***	-0.371***	-0.205***	-0.383***	-0.417***
	(0.093)	(0.092)	(0.092)	(0.070)	(0.087)	(0.092)
Credit supply (Fed survey)	0.201*			0.379***	0.347***	0.297***
	(0.113)			(0.088)	(0.112)	(0.113)
Competition (fluidity)	0.020***	0.022***	0.023***			0.023***
	(0.007)	(0.007)	(0.007)			(0.007)
Liquidation costs	-0.543***	-0.615***	-0.611***	-0.552***	-0.547***	
	(0.100)	(0.101)	(0.101)	(0.073)	(0.095)	
Credit supply (Expansion)		0.215**				
		(0.106)				
Credit supply (GDP growth)			0.104***			
			(0.020)			
Competition (Compustat)				0.296**		
				(0.136)		
Competition (TNIC)					0.154	
					(0.100)	
Liquidation costs (intang)						-0.306*
						(0.160)
Volatility	0.026	-0.148	-0.111	-0.080	-0.132	-0.283
	(0.223)	(0.226)	(0.226)	(0.182)	(0.216)	(0.224)
Market leverage	-0.452***	-0.171	-0.165	-0.185*	-0.113	0.169
	(0.139)	(0.143)	(0.143)	(0.107)	(0.136)	(0.139)
Size	-0.166***	-0.173***	-0.171***	-0.142***	-0.172***	-0.164***
	(0.016)	(0.015)	(0.015)	(0.011)	(0.015)	(0.016)
Cash flow	0.940***	0.773***	0.736***	0.712***	0.678***	0.920***
	(0.146)	(0.143)	(0.143)	(0.113)	(0.134)	(0.144)
Constant	-1.363***	-1.569***	-1.933***	-1.916***	-1.427***	-1.774***
	(0.283)	(0.295)	(0.302)	(0.284)	(0.278)	(0.279)
Observations	22,115	22,115	22,115	35,051	23,837	22,115
Log likelihood	-6,324.12	-6,388.4	-6,376.87	-11,184.99	-7,090.03	-6,403.46

Figure 1. Ratio of optimal investment triggers.

Figure 1 plots the ratio of the investment triggers $z \equiv \overline{X}_B^* / \overline{X}_D^*$ as a function of the arrival rate of informed lenders δ, the bargaining power of shareholders in default η, the size of the growth option π, cash flow volatility σ, liquidation costs α, and the arrival rate of competitors λ. Parameter values are set as in the base case environment.

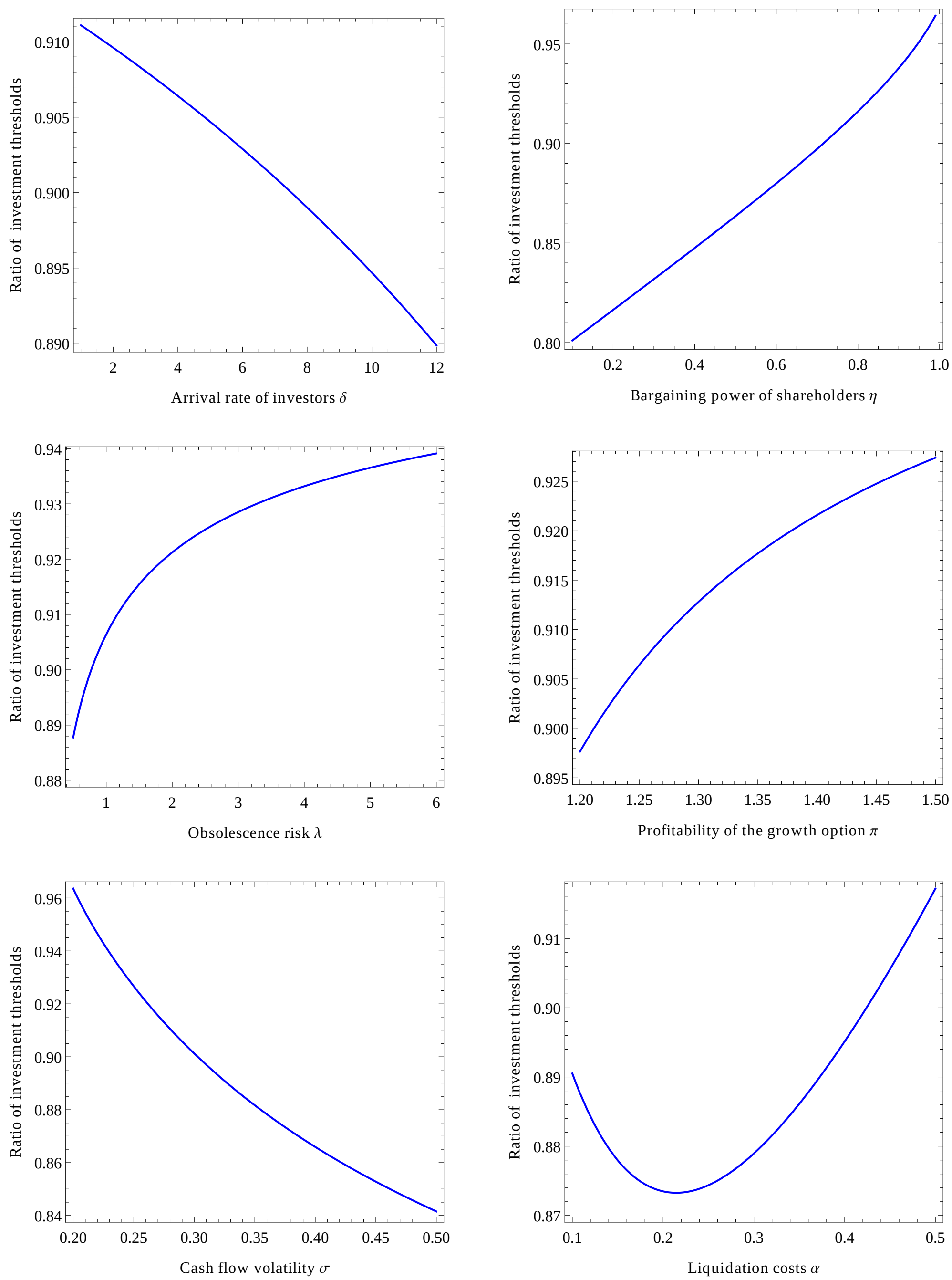

Figure 2. Optimal investment triggers $\overline{X}_B^*$ and $\overline{X}_D^*$.

Figure 2 plots the investment triggers $\overline{X}_B^*$ (solid blue line) and $\overline{X}_D^*$ (dashed red line) as functions of the arrival rate of private creditors δ, the bargaining power of shareholders in default η, the size of the growth option π, cash flow volatility σ, liquidation costs α, and the arrival rate of competitors λ. Parameter values are set as in the base case environment.