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THREE ESSAYS IN DYNAMIC CORPORATE FINANCE

THESE

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par

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THREE ESSAYS IN DYNAMIC CORPORATE FINANCE

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Chapter I

Introduction

The three essays constituting this thesis focus on firms' financing and cash management policy. The first essay aims to shed light on why firms issue debt so conservatively. In particular, it examines the effects of shareholder and creditor protection on capital structure choices. It starts by building a contingent claims model where financing policy results from a trade-off between tax benefits, contracting costs and agency costs. In this setup, controlling shareholders can divert part of the firms' cash flows as private benefits at the expense of minority shareholders. In addition, shareholders as a class can behave strategically at the time of default leading to deviations from the absolute priority rule. The analysis demonstrates that investor protection is a first order determinant of firms' financing choices and that conflicts of interests between firm claimholders may help explain the level and cross-sectional variation of observed leverage ratios.

The second essay focuses on the practical relevance of agency conflicts. Despite the theoretical development of the literature on agency conflicts and firm policy choices, the magnitude of manager-shareholder conflicts is still an open question. This essay proposes a methodology for quantifying these agency conflicts. To do so, it examines the impact of managerial entrenchment on corporate financing decisions. It builds a dynamic contingent claims model in which managers do not act in the best interest of shareholders, but rather pursue private benefits at the expense of shareholders. Managers have discretion over financing and dividend policies. However, shareholders can remove the manager at a cost. The analysis demonstrates that entrenched managers restructure less frequently and issue less debt than optimal for shareholders. I take the model to the data and use observed financing choices to provide firm-specific estimates of the degree of managerial entrenchment. Using structural econometrics, I find costs of control challenges of 2-7% on average (.8-5% at median). The estimates of the agency costs vary with variables that one expects to determine managerial incentives. In addition, these costs are sufficient to resolve the low- and zero-leverage puzzles and explain the time series of observed leverage ratios. Finally, the analysis shows that governance mechanisms significantly affect the value of control and firms' financing decisions.

The third essay is concerned with the documented time trend in corporate cash holdings by Bates, Kahle and Stulz (BKS,2003). BKS find that firms' cash holdings double from 10% to 20% over the 1980 to 2005 period. This essay provides an explanation of this phenomenon by examining the effects of product market competition on firms' cash holdings in the presence of financial constraints. It develops a real options model in which cash holdings may be used to cover unexpected operating losses and avoid inefficient closure. The model generates new predictions relating cash holdings to firm and industry characteristics such as the intensity of competition, cash flow volatility, or financing constraints. The empirical examination of the model shows strong support of model's predictions. In addition, it shows that the time trend in cash holdings documented by BKS can be at least partly attributed to a competition effect.

Chapter II

Shareholder Protection, Bondholder Protection and Firm Financing Policy

1 Introduction

Investor protection and its impact on valuations and firms' policy choices have been the subject of considerable research in financial economics. Despite the substantial development of this literature, little attention has been paid to the relation between investor protection and financing decisions. This is relatively surprising since economic intuition suggests that investor protection should be an important determinant of asset prices, and thus, of the relative costs of equity and debt. For example, the ability of controlling shareholders to extract concessions from minority shareholders affect the value, and thus the cost, of outside equity. Similarly, the ability of creditors to repossess collateral affects their payoff in default and hence the cost of debt financing. Yet, existing models of firms' financing decisions typically ignore this essential dimension so that the analysis of the legal determinants of capital structure choices remains uncharted territory.[1]

In this paper, I attempt to explore this territory. For doing so, I develop a model in which cash flows to claimholders depend not only on the cash flows rights of securities but also on the ability of investors to enforce those rights. In particular, I consider that firms are not widely held, but rather have controlling shareholders. Moreover, these controlling shareholders have the power to pursue private benefits at the expense of minority shareholders, within the limits imposed by investor protection. The recent "law and finance" literature following Shleifer and Vishny (1997) argues that the expropriation of minority shareholders by controlling shareholders is at the core of agency conflicts in most countries. To examine the impact of shareholder protection on financing decisions, I consider a setting in which firms are set up by controlling shareholders, also referred to as

[1]Some papers have examined the impact of imperfect creditor protection on leverage choices (see for example Fan and Sundaresan (2000), François and Morellec (2000), and Hege and Mella-Barral (2003)). However, these papers typically ignore imperfect shareholder protection in the choice between equity and debt financing.

entrepreneurs. At any date, these entrepreneurs can divert part of the firms' cash flows as private benefits at the expense of minority shareholders [as in La Porta et al. (2002)]. In this environment, I examine the impact of the opportunistic behavior of entrepreneurs on firms' financing decisions.

Another legal dimension of firm financing policy is the treatment of claimholders in default. In my framework, default can lead either to liquidation of firm's assets or to renegotiation of the debt contract. Since liquidation is costly and debtholders bear liquidation costs, there is room for strategic default. Shareholders may thus extract concessions from bondholders by renegotiating outstanding claims at the time of default. I characterize creditor protection by the bargaining power of bondholders at the time of default.[2]

To make the intuition as clear as possible, I use a simple generalization of the standard Leland (1994) framework in which agency conflicts exist not only between creditors and shareholders but also between the controlling shareholder and minority shareholders. These agency conflicts affect the valuation of cash flows, thereby distorting the firm policy choices. While investor protection may be relevant to all firm decisions, I focus in this paper on financing policy. Several important results follow from this analysis. First, the model demonstrates how investor protection affects valuations. Second, it characterizes the implications of the relation between investor protection and valuations for financing decisions. Third, it shows that imperfect shareholder and bondholder protection can help explain the level and variation of observed leverage ratios.

When capital structure is chosen by the controlling shareholder, the actual choice of debt differs from the optimal one. In particular, because debt reduces private benefits, the debt level selected by the controlling shareholder always is lower than the debt level that maximizes firm value. In addition, when creditor

[2]Frank and Torous (1989) find that deviations from the absolute priority rule (APR) are frequent.

protection is imperfect, shareholders have incentives to default earlier to extract concessions from bondholders. That is, weak creditor protection favors strategic default and hence encourages default. Bondholders rationally anticipate shareholders' strategic behavior and require a higher rate of return. As a consequence, cost of debt rises and the selected debt level decreases.

The remainder of paper is organized as follows. Section 2 describes the model. The objective of the entrepreneur is derived in section 3. Section 4 presents a benchmark case with perfect investor protection. Section 5 and 6 introduce imperfect shareholder and creditor protections. Section 7 examines the impact of endogenous ownership on financing decisions. Section 8 concludes.

2 Model and assumptions

Throughout the paper, agents are risk-neutral and discount cash flows at a constant interest rate $r > 0$. I consider a model of financing decisions in which a firm is established by a controlling shareholder, also called entrepreneur. The technology of the firm has constant returns to scale and firm size is denoted by K. For simplicity, I presume that the capital stock is chosen at time 0 by the entrepreneur and stays constant over time. The entrepreneur owns a fixed fraction θ of the firm and makes two types of decisions.[3] First, he decides on the level of private benefits to pursue. Second, he chooses the financing policy of the firm. For now, I exogenously set θ and K. Section 7 endogenizes both of these quantities and shows how they interact with the entrepreneur policy choices.

Within the model, the allocation of control rights implies that the entrepreneur has complete decision power over the firm.[4] Empirically, La Porta et al. (1999)

[3]La Porta et al. (2002) state that ownership of controlling shareholder is extremely stable over time.

[4]See Zingales (1995), La Porta et al. (2002) and Shleifer and Wolfenzon (2002).

document that the control of a firm is indeed heavily concentrated in the hands of a founding family in many countries. Typically, the entrepreneur controls a higher fraction of votes than of cash flow rights, by owning shares with superior voting rights, ownership pyramids, cross ownership, and controlling the board (Bebchuk et al. (2000)).

Cash flows from operations. I consider that the firm is infinitely lived. As long as the firm is in operation, its assets generate an instantaneous operating cash flow X that depends on the capital stock K and a stochastic demand shock ϵ. In particular, I have $X = K \times \epsilon$ where the process X is governed by the geometric Brownian motion

$$d\,X_t = \mu X_t\,dt + \sigma X_t\,dZ_t. \tag{1}$$

In equation (1) $(Z_t)_{t\geq 0}$ is a standard Brownian motion, and μ and σ are constant. This equation implies that the growth rate of cash flows is normally distributed with mean $\mu\Delta t$ and variance $\sigma^2\Delta t$ over time interval Δt. In what follows I denote by x a realization of the process X. In addition, the growth rate of cash flows satisfies $\mu < r$ to ensure that firm value is finite (as in the Gordon growth model).

Financing policy. I presume that corporate taxes are paid at a constant rate τ on corporate income. As a result, the entrepreneur may have an incentive to issue debt to shield operating profit from taxation. To stay in a simple time-homogeneous setting, I consider debt contracts that are characterized by a perpetual flow of coupon payments c and a principal payment P that shareholders have to repay before getting any payment in default. I assume that debt is issued at par, determining its market value D and coupon rate c/D. Proceeds from the debt issue are paid as a cash distribution to shareholders on a *pro rata* basis at the time of flotation.

Once debt has been issued, shareholders have the option to default on their debt obligations. In the event of default at time t, the default value of the firm is $(1-\alpha)\,A\,(x)$, where $\alpha \in (0,1)$ is a proportional default cost, $X_t = x$, and

$$A(x) = \mathbb{E}_x \left[\int_0^{\infty} e^{-rt} \, (1-\tau) \, X_t \, dt \right] = \left(\frac{1-\tau}{r-\mu} \right) x, \tag{2}$$

is the abandonment value of unlevered assets. This equation shows that the firm's abandonment value is equal to the present value of a perpetuity that grows at the rate μ (similar to the Gordon formula). It also reflects the fact the firm loses all future tax benefits of debt in default.

Investor protection. I am interested in determining the impact of investor protection on asset values and firms' financing decisions. Within the present model, I consider two types of investor protection: shareholder protection and creditor protection.

Shareholder protection. Agency conflicts between the entrepreneur and minority shareholders are introduced by considering that the entrepreneur pursues private benefits and can extract a fraction $s \in (0,1)$ of the firm's net cash flows as private benefits. This tunneling of funds toward socially inefficient usage may take a variety of forms such as excessive salary, transfer pricing, employing relatives and friends who are not qualified for the jobs in the firm, and perquisites, just to name a few.[5] In general, expropriation is costly (see Burkart et al. (1998) and La Porta et al. (2002)) and less important when investor protection is stronger. I model the degree of shareholder protection by using a cost function for cash diversion. Anticipating that the firm is going to issue debt with coupon payment c, the cost $\Phi(s,x)$ of diverting a fraction s of net income is given

[5] Barclay and Holderness (1989) provide empirical evidence supporting private benefits of control.

by:

$$\Phi(s,x) = \frac{\eta}{2}\, s^2\, \pi\,(x)\,, \tag{3}$$

where $\eta > 0$, $s \in [0,1]$, and $\pi\,(x)$ is the firm's net income. This quadratic form of the cost function is similar to the quadratic cost function of diverting cash in a static environment of La Porta et al. (2002). This cost function is increasing and convex in the fraction s of net cash flows that the entrepreneur decides to divert for private benefits. Thus, it is increasingly costly to divert cash for private benefits. Furthermore, the cost of diverting given fraction s of cash from a larger firm is assumed to be higher, because a larger amount of earnings after tax is diverted.

Following La Porta et al. (2002), I interpret the parameter η as a measure of shareholder protection. A higher η implies a larger marginal cost of diverting cash for private benefits. When $\eta = 0$, diverting cash is costless and the financing channel completely breaks down, because no investor anticipates any payback from the firm after they sink their funds in any firm. As a result, *ex ante*, no investor is willing to invest in the firm. On the contrary, when $\eta \to \infty$, the marginal cost of pursuing a marginal unit of private benefits is infinity. This corresponds to the case of perfect shareholder protection.

Creditor protection. While imperfect shareholder protection introduces conflicts of interest between the controlling and minority shareholders, shareholders as a class may also try to extract concessions from debtholders. In particular, because liquidation is costly, shareholders may extract some surplus from the bondholders by renegotiating outstanding claims at the time of default. In this paper, I interpret creditor protection as the bargaining power of bondholders at the time of default. In the case of perfect creditor protection, creditors have all the bargaining power and shareholders's payoff in default is dictated by the absolute priority rule (APR). In the case of imperfect creditor protection, bondholders grant concessions to shareholders in default, leading to violations of the APR to the benefit of shareholders.

3 Objective of the entrepreneur

The objective of the entrepreneur is to maximize his lifetime utility. For doing so, the entrepreneur can make three types of decisions: (*i*) issue debt in order to shield the firm's operating profits from taxation; (*ii*) pursue private benefits; and (*iii*) select the firm's default policy. I denote the entrepreneur's utility before the flotation of corporate debt by $W(x, c)$. This *ex ante* utility is given by the sum of the present value of the cash flows accruing to the entrepreneur after debt has been issued $U(x, c)$ and the fraction of the proceeds from the debt issue accruing to the entrepreneur. That is,

$$W\left(x, c\right) = U(x, c) + \theta\left(1 - \delta\right) D\left(x, c\right), \tag{4}$$

where $D\left(x, c\right)$ is the market value of corporate debt and δ measures flotation costs. When choosing financing policy, the objective of the entrepreneur is to maximize his *ex ante* utility (4) by selecting the appropriate coupon payment c. Thus, he solves

$$\sup_{c}\ W(x, c)\,. \tag{5}$$

In a rational expectations model, the solution to this problem reflects the fact that following the flotation of corporate debt, the entrepreneur chooses the level of private benefits s and default trigger policy z to maximizes his *ex post* utility $U(x, c)$. That is, for any coupon payment c, the entrepreneur chooses s and z to solve

$$\sup_{s,z}\ U(x, c)\,. \tag{6}$$

Intuitively, the entrepreneur solves his intertemporal optimization problem in the following three steps:

1. Determine the level of cash diversion s, taking the firm's coupon payment c and default trigger z as given.
2. Solve for the default trigger strategy z, taking the coupon payment c as given.
3. Derive the coupon payment c, incorporating his optimal decisions in the future.

Before solving the entrepreneur's optimization problem, it will be useful to derive explicit expressions for the present value of the cash flows accruing to the entrepreneur after the issuance of corporate debt $U(x, c)$ and the market value of corporate debt $D(x, c)$. Consider first $U(x, c)$. This quantity is equal to the sum of the present value of the cash flows the entrepreneur receives when the firm is in operation and the present value of his cash flows in default.

As long as the firm is in operation, the entrepreneur derives utility from both the private benefits of control and the dividends he receives as a shareholder in the firm. Notably, the entrepreneur receives at each time t a cash flow N_t given by the sum of the dividend payment $\theta(1 - s_t)\pi(X_t)$ and his private benefits of control $s_t\pi(X_t)$, minus the cost of diversion $\Phi(s_t, X_t)$. Combining these components yields a cash flow to the entrepreneur given by

$$N_t = n_t\pi(X_t), \tag{7}$$

where

$$n_t = \theta(1 - s_t) + s_t - \frac{\eta}{2}s_t^2. \tag{8}$$

In addition to these cash flows, the entrepreneur may also obtain a fraction of firm value in default. I denote by $R_d(z)$ and $R_e(z)$ the payoffs to debtholders and shareholders if the firm defaults at trigger level z. As I show below, the specific functional forms of these residual values depend on the bargaining power of debtholders in default. The payoff to the entrepreneur also depends on his ability to extract concessions from minority shareholders following default. To keep the analysis simple, I presume that the shareholder protection is unaffected by default. As a result, for any given coupon payment c, default trigger z and cash diversion s, the entrepreneur's utility *after the issuance of corporate debt* is given by:

$$U(x,c) = \mathbb{E}_x \left[\int_0^{T(z)} e^{-rt}\, n_t\, \pi\left(X_t\right)\, dt + \, e^{-rT(z)}\, n_{T(z)}\, R_e(z) \right], \tag{9}$$

where $T\left(z\right)$ is the default time i.e. the first time the process X reaches z. This equation shows that the utility of the entrepreneur has two components. First, it includes the present value of the cash flow stream he receives in continuation (first term in the square bracket). Second, it incorporates the present value of the entrepreneur's payoff in default (second term in the square bracket).

The specification for the private benefits of control implies that at each time t, a fraction s_t of the firm's net cash flows are diverted. As a result, for any given default trigger z and coupon payment c, the equity and debt values satisfy:

$$E\left(x,c\right) = \mathbb{E}_x \left[\int_0^{T(z)} e^{-rt} \left(1 - s_t\right) \pi\left(X_t\right) dt + e^{-rT(z)} \left(1 - s_{T(z)}\right)\, R_e(z) \right], \tag{10}$$

and

$$D\left(x,c\right) = \mathbb{E}_x \left[\int_0^{T(z)} e^{-rt} c\, dt + e^{-rT(z)} R_d\left(z\right) \right]. \tag{11}$$

In both (10) and (11), the first term of the right hand side represents the present value of future cash flows until the time of default. The second terms in the square brackets of (10) and (11) represent the expected present value of the cash flows to equityholders and debtholders in default.

The Appendix shows that at any point in time the entrepreneur optimally chooses to divert a constant fraction ξ of net income, so that

$$s_t = \xi = \frac{1-\theta}{\eta}. \tag{12}$$

Equation (12) reveals that the level of private benefits pursued by the controlling shareholder decreases with both ownership and shareholder protection. In addition, it implies that the cash diversion decision is effectively a simple static trade-off problem between "private benefits" and the resulting reduction of present value of dividends that the entrepreneur receives from the firm. As a result, for all t, n_t in (8) is constant and given by

$$n_t = n = \theta\,(1+\beta)\ , \tag{13}$$

where

$$\beta = \frac{(1-\theta)^2}{2\eta\,\theta}, \tag{14}$$

is the net private benefit of control per unit of ownership. Importantly, this net private benefit of control decreases with both ownership and shareholder protection. This result is a direct consequence of the impact of these two factors on the level of private benefits pursued by the entrepreneur.

Using the expression for n in (9), I may simplify the optimization problem (6) as follows:

$$\sup_z\ \theta\left(\frac{1+\beta}{1-\xi}\right)\ E(x,c)\,, \tag{15}$$

where β is given in (14). Note that the entrepreneur first chooses the coupon payment c at time 0 and then decides on the default trigger z. Therefore, I may solve the optimization problem (6) by first conditioning on a given coupon payment policy c and then search over admissible default trigger levels z. By standard arguments (see Dumas (1991)), the entrepreneur determines the trigger level z by using the smooth-pasting condition:

$$\left.\frac{\partial U\,(x,c)}{\partial\,x}\right|_{x=z} = \theta\,\left(\frac{1+\beta}{1-\xi}\right)\left.\frac{\partial E\,(x,c)}{\partial\,x}\right|_{x=z} = 0. \tag{16}$$

Equation (16) states that the entrepreneur chooses the default trigger to maximize his *ex post* utility, i.e. his utility after the debt issuance. Because the entrepreneur's utility is proportional to equity value, the default trigger is equivalently determined by a smooth pasting condition for equity value.

Using the solution to (16), I may express the entrepreneur's *ex ante* utility as:

$$W(x,c) = \theta \left[V(x,c) + \frac{\beta + \xi}{1 - \xi} E(x,c) \right], \tag{17}$$

where $V(x,c) = E(x,c) + (1 - \delta) D(x,c)$ is firm value after debt issuance. I note that the *ex ante* utility is larger than his share of the entrepreneur's *ex post* firm value, when shareholder protection is imperfect. Below, I solve the entrepreneur's optimization problem under three different scenarios: (i) perfect investor protection, (ii) imperfect shareholder protection, and (iii) imperfect shareholder and bondholder protection.

4 Perfect investor protection

I start by analyzing capital structure decisions in a benchmark economy with perfect investor protection. Let $E^*(x,c)$, $D^*(x,c)$, and $V^*(x,c)$, represent equity value, debt value and firm value in this benchmark economy. Equation (17) implies that $W^*(x,c) = \theta V^*(x,c)$, when investor protection is perfect. Thus, the coupon rate selected by the entrepreneur solves: $\max_c V^*(x,c)$. Denote the solution to this problem by $C^*(x)$. Given the functional form of $A(\cdot)$, I also know that it is optimal for shareholders to default when equity value is zero so that the values of bondholders and shareholders claims in default are respectively equal to $R_d(z) = (1 - \alpha) A(z)$ and $R_e(z) = 0$. I then have the following result (see the Appendix).

Proposition 1 *Consider a benchmark economy in which the entrepreneur acts in the best interest of minority shareholders and the APR is enforced in default. In this economy, I have* $s = 0$*,* $R_d(z) = (1-\alpha)\,A(z)$ *and* $R_e(z) = 0$*, and the values of corporate debt and equity satisfy*

$$D^*(x,c) = \frac{c}{r} + \left[(1-\alpha)\,A(z^*) - \frac{c}{r}\right]\left(\frac{x}{z^*}\right)^{-\gamma}, \tag{18}$$

and

$$E^*(x,c) = A(x) - \frac{(1-\tau)\,c}{r} + \left[\frac{(1-\tau)\,c}{r} - A(z^*)\right]\left(\frac{x}{z^*}\right)^{-\gamma}, \tag{19}$$

where $\gamma > 0$ *and* $(x/z^*)^{-\gamma}$ *is the present value of one dollar to be received in default. The default threshold* z^* *that maximizes the value of equity is given by*

$$z^* = \left(\frac{\gamma}{\gamma+1}\right)\left(\frac{r-\mu}{r}\right)c, \tag{20}$$

and the coupon payment that maximizes firm value is given by

$$C^*(x) = x\left(\frac{\gamma+1}{\gamma}\right)\left(\frac{r}{r-\mu}\right)\left[1+\gamma\,(1-\delta)\,\frac{1-(1-\tau)\,(1-\alpha)}{\tau-\delta}\right]^{-1/\gamma}. \tag{21}$$

Proposition 1 characterizes asset prices and the value-maximizing financing policy in the benchmark economy. As shown in this proposition, the values of corporate securities can be written as the sum of the present values of the cash flows in continuation plus the change in present value of these cash flows that arises in default (terms in square brackets). The coupon payment that maximizes firm value is unique and, as shown in the Appendix, increases with the corporate tax rate and decreases with default costs.

While minority shareholders would like the entrepreneur to implement this financing policy, the preferences of the entrepreneur will typically induce deviations of selected policies from value-maximizing policies. I now turn to the analysis of leverage decisions under imperfect shareholder protection.

5 Imperfect Shareholder Protection

This section analyzes the impact of imperfect shareholder protection on agency costs and the firm's financing and default policies. Because this section assumes perfect creditor protection, the cash flow to shareholders in default is zero and the functional form of the default threshold selected by the entrepreneur is the same as the one reported in Proposition 1. In addition, for any given coupon payment c, the entrepreneur's *ex ante* utility is

$$W\left(x,c\right)=\theta V^{*}(x,c)+\theta\beta E^{*}\left(x,c\right)\ , \tag{22}$$

that is, the sum of the value of his shareholdings in the firm (first term) and the value of the private benefits he can extract from minority shareholders (second term). Before solving for the financing policy that maximizes $W\left(x,c\right)$, I impose the following condition:

Condition 2 *If the private benefits that the entrepreneur extracts from the firm are not too high, in that*

$$\left(1-\delta\right)-\left(1-\tau\right)\left(1+\beta\right)>0,$$

then it is optimal for the entrepreneur to issue some amount of debt.

I then have the following result (see the Appendix).

Proposition 3 *Assume that Condition 2 is satisfied. Then, the values of debt and equity under imperfect shareholder protection respectively satisfy*

$$D\left(x,c\right)=D^{*}\left(x,c\right), \tag{23}$$

and

$$E(x,c)=\left(1-\xi\right)E^{*}(x,c)\,, \tag{24}$$

where $D^* (x,c)$ and $E^* (x,c)$ are the values of corporate securities under perfect investor protection. For any given financing policy, imperfect shareholder protection does not affect the firm's default policy. The coupon payment selected by the entrepreneur is given by

$$C(x) = x \left(\frac{\gamma+1}{\gamma}\right) \left(\frac{r}{r-\mu}\right) \left[1 + \gamma (1-\delta) \frac{1-(1-\tau)(1-\alpha)}{(1-\delta)-(1-\tau)(1+\beta)}\right]^{-1/\gamma}. \tag{25}$$

As in Proposition 1, the selected debt level described in Proposition 3 balances the benefits and costs of debt to the entrepreneur. Within the present model, debt increases the utility of the entrepreneur by reducing taxes. At the same time, issuing debt entails flotation and default costs and limits possible cash flow extractions. Using the expression reported in Proposition 2 for the selected coupon payment, it is immediate to show that the entrepreneur's utility-maximizing coupon payment displays the following properties (see the Appendix):

$$\frac{\partial C(x)}{\partial \tau} > 0, \ \frac{\partial C(x)}{\partial \alpha} < 0, \text{ and } \frac{\partial C(x)}{\partial \delta} < 0. \tag{26}$$

Thus, the entrepreneur's utility-maximizing coupon payment increases with the corporate tax rate and decreases with bankruptcy and flotation costs. In addition to these standard comparative statics effects, the Appendix shows that I have

$$\frac{\partial C(x)}{\partial \eta} > 0, \text{ and } \frac{\partial C(x)}{\partial \theta} > 0. \tag{27}$$

That is, the utility-maximizing coupon payment increases with the degree of shareholder protection as well as with the entrepreneur's ownership. In particular, when $\theta \uparrow 1$ or $\eta \uparrow \infty$, the net private benefit $\beta \downarrow 0$, and the coupon payment selected by the entrepreneur converges to the value-maximizing coupon payment $C(x) \uparrow C^*(x)$. By contrast, when $\theta < 1$ and η is finite, the debt level selected by the entrepreneur always is *lower* than the debt level that maximizes firm value.

The following proposition summarizes these results.

Proposition 4 *The coupon payment given in (25) is larger when shareholder protection is stronger or the entrepreneur's ownership is larger.*

Using this model, I can also examine the impact of shareholder protection on firm value and book leverage. Firm value is equal to the sum of the equity value and the debt value, net of the issuance costs. I thus have

$$V\left(x,c\right) = V^{*}(x,c) - \xi\, E^{*}(x,c), \tag{28}$$

where $V^{*}(x,c)$ and $E^{*}(x,c)$ are the firm and equity values derived under perfect investor protection. Assume that debt is issued at par so that the book value of debt equals its market value at the time of flotation. By definition, book leverage is equal to the ratio of book debt over book assets:

$$B\left(x,C\left(x\right)\right) = \frac{D\left(x,C\left(x\right)\right)}{K}. \tag{29}$$

I then have the following result (see the Appendix for a proof).

Proposition 5 *Firm value and book leverage are larger under stronger shareholder protection and larger ownership, in that*

$$\frac{\partial V\left(x,C\left(x\right)\right)}{\partial \eta} > 0, \text{ and } \frac{\partial B\left(x,C\left(x\right)\right)}{\partial \eta} > 0, \tag{30}$$

and

$$\frac{\partial V\left(x,C\left(x\right)\right)}{\partial \theta} > 0, \text{ and } \frac{\partial B\left(x,C\left(x\right)\right)}{\partial \theta} > 0. \tag{31}$$

Proposition 5 shows that when ownership is exogenous, book leverage increases with both investor protection and ownership. This result is a direct consequence of the impact of these two factors on the selected coupon payment. Within the present model, debt financing imposes two costs on the entrepreneur. First, it induces bankruptcy costs. Second, it reduces the value of the private benefits of control for any level of cash flow extraction s that the entrepreneur selects. As the values of θ and η increase, the optimal level of private benefits s decreases, making debt less costly to the entrepreneur. As a result, the selected coupon payment increases with both θ and η.

Proposition 5 also reveals that when ownership is exogenous, firm value increases with both investor protection and ownership. Within the present model, these factors have two distinct effects on firm value. First, stronger investor protection and larger ownership imply a lower degree of private benefits and thus a lower degree of inefficiency in the allocation of cash flows from the firm's assets. Second, as ownership or the degree of investor protection increase, the controlling shareholder select a financing policy that is closer to the value maximizing one, thereby increasing firm value.

6 Imperfect creditor protection

In this section, I extend the basic framework to allow for both imperfect creditor and imperfect shareholder protection. The setting I consider is one in which shareholders default strategically and try to extract some surplus from bondholders at the time of default. As before I presume that shareholders default on their debt obligations the first time operating cash flows reach the (lower) level y. At that time, claimholders bargain over the sharing of firm value. I consider a Nash bargaining game in default and denote the bargaining power of creditors in default by $\phi \in [0, 1]$. Within the model, this quantity measures the degree of creditor protection. The bargaining power of shareholders is then $1 - \phi$. I also denote the proportional cost of renegotiation by κ and the proportional cost of liquidation by α.

Because liquidation is socially more costly than reorganization ($\alpha > \kappa$), there is a surplus $(\alpha - \kappa)\, A(y)$ associated with renegotiation. The allocation of this surplus between firm claimants can be determined as follows. If default leads to liquidation, equity is worthless upon default while the value of bondholders' claim is $(1-\alpha)\,A\,(y)$. By contrast, if claimants can renegotiate to avoid liquidation, firm value in default is increased from $(1-\alpha)A(y)$ to $(1-\kappa)A(y)$. Assuming that the total renegotiation surplus is shared among firm claimants according to the sharing rule φ, the incremental value accruing to bondholders is $\varphi\,(\alpha-\kappa)\,A\,(y)$ whereas the incremental value accruing to shareholders is $(1-\varphi)\,(\alpha-\kappa)\,A\,(y)$. Therefore the sharing rule for the renegotiation surplus upon default solves

$$\max_{\varphi} \quad \left\{(1-\varphi)^{1-\phi}\,\varphi^{\phi}\right\}(\alpha-\kappa)\,A\,(y)\ ,$$

the solution to which is simply given by $\varphi=\phi$. This equation shows that the bargaining game allocates the surplus between financial stakeholders in proportion to their bargaining power. Under perfect creditor protection, I have $\phi=1$, and the cash flow to bondholders in default is $(1-\kappa)\,A\,(y)$. This is the case studied in Section 4.

Using (10), (11), (15), and (17) and the sharing rule $\varphi=\phi$ in default, I have the following result (see the Appendix):

Proposition 6 *Assume that Condition 2 is satisfied. Then, under imperfect investor protection, the values of corporate debt and equity satisfy*

$$D\,(x,c)=\frac{c}{r}+\left[(1-\kappa+\phi\,(\alpha-\kappa))\,A\,(y)-\frac{c}{r}\right]\left(\frac{x}{y}\right)^{-\gamma}\ , \tag{32}$$

and

$$E(x,c)=(1-\xi)\,\widehat{E}(x,c), \tag{33}$$

where

$$\widehat{E}\,(x,c)=A(x)-\frac{(1-\tau)\ c}{r}+\left[\frac{(1-\tau)\ c}{r}-(1-(1-\phi)\,(\alpha-\kappa))\,A(y)\right]\left(\frac{x}{y}\right)^{-\gamma}. \tag{34}$$

The default threshold y that maximizes $U(x,c)$ is given by

$$y=\left(\frac{\gamma}{\gamma+1}\right)\left(\frac{r-\mu}{r}\right)\frac{c}{1-(1-\phi)\,(\alpha-\kappa)}, \tag{35}$$

and the coupon payment selected by the entrepreneur satisfies

$$C\left(x\right)=x\left(\frac{\gamma+1}{\gamma}\right)\left(\frac{r}{r-\mu}\right)\left(1-\left(1-\phi\right)\left(\alpha-\kappa\right)\right)\Gamma^{-1/\gamma}\,, \tag{36}$$

where Γ *is given in (54).*

Proposition 6 underlines several interesting features of imperfect creditor protection. First, for any given financing and default policies, creditor protection affects the cash flows accruing to shareholders and bondholders in default, and hence the value of their claims. Second, for any given financing policy, the entrepreneur's incentive to default decreases with creditor protection, in that $dy/d\phi < 0$. Indeed, when default leads to liquidation ($\phi = 1$), the decision to default is irreversible and it is optimal for the entrepreneur to default when equity is worthless. When it is possible to renegotiate the debt contract in default, the decision to default no longer is irreversible and the entrepreneur has incentives to default earlier in order to extract concessions from bondholders. That is, weak creditor protection favors strategic default and hence encourages default.

Using the expressions reported in Proposition 6, I also find that the entrepreneur's *ex ante* utility at the selected debt level is given by

$$W(x,C(x))=\theta\left(1+\beta\right)\left[A(x)+\left(\frac{1-\delta}{(1+\beta)(1-\tau)}-1\right)\left(1-\left(1-\phi\right)\left(\alpha-\kappa\right)\right)A(y)\right] \tag{37}$$

where the default trigger y is given in Proposition 6. Recall that the entrepreneur's utility without any debt issuance is simply $\theta(1+\beta)A(x)$, proportional to all-equity firm value. Equation (37) shows that the entrepreneur's *ex ante* utility is larger when there is a greater tax advantage of debt. Condition 2 ensures that there the tax advantage is greater than the costs of debt from the entrepreneur's perspective. If Condition 2 is not satisfied, in that $1-\delta < (1-\tau)(1+\beta)$, then the entrepreneur optimally chooses not to issue debt and $W(x,0) = U(x,0) = \theta(1+\beta)A(x)$.

The next proposition characterizes the effects of shareholder protection, creditor protection and ownership on the selected coupon payment $C(x)$ (see the Appendix for a proof).

Proposition 7 *The coupon payment given in (36) is larger when shareholder protection or creditor protection is stronger or the entrepreneur's ownership is larger, in that*

$$\frac{\partial C\left(x\right)}{\partial \eta} > 0, \ \frac{\partial C\left(x\right)}{\partial \theta} > 0, \ \text{and} \ \frac{\partial C\left(x\right)}{\partial \phi} > 0. \tag{38}$$

Proposition 7 shows that the utility-maximizing coupon payment increases with the degree of investor protection as well as with the entrepreneur's ownership. Notably, when $\phi \uparrow 1$ and $\theta \uparrow 1$ or $\eta \uparrow \infty$, the coupon payment selected by the entrepreneur converges to the value-maximizing coupon payment $C(x) \uparrow C^{*}(x)$. By contrast, when either $\phi < 1$, $\theta < 1$, or η is finite, the debt level selected by the entrepreneur always is *lower* than the debt level that maximizes firm value. Thus, the debt level selected by the firm always increases with the degree of investor protection.

This model also allows for a characterization of the impact of creditor protection on firm value and book leverage. Notably, I have the following result (see the Appendix for a proof):

Proposition 8 *Firm value and book leverage are larger under stronger creditor protection in that*

$$\frac{dV\left(x, C\left(x\right)\right)}{d\phi} > 0 \ \text{and} \ \frac{dB\left(x, C\left(x\right)\right)}{d\phi} > 0. \tag{39}$$

Proposition 8 shows that firm value increases with the degree of creditor protection. Within the present model, creditor protection has two opposite effects on firm value. First, better creditor protection decreases the likelihood of default. Second, it increases the cost of default. At the selected debt level, the first effect dominates, leading to a positive relation between firm value and creditor protection. Consider next book leverage. Within the present model, the selected coupon payment balances the benefits of debt with its cost. Thus, by reducing the cost of default, better creditor protection increases the selected coupon payment and book leverage.

7 Endogenous ownership

I so far have derived implications of imperfect investor protection for firm value and financing decisions, assuming that both firm size K and the ownership of the controlling shareholder θ were exogenously given. However, ownership concentration and the size of the capital markets typically are endogenously determined by the degree of investor protection. For example, Kumar et al. (2001) report empirical evidence suggesting that better shareholder protection is associated with larger firms in terms of sales and assets. La Porta et al. (1999) and Claessens et al. (2000) document a negative relation between ownership and legal protection. In this section, I endogenize the capital stock K and ownership concentration θ and show how these measures interact with the financing policy choices of the entrepreneur.[6]

Let h be the initial endowment of the entrepreneur. The entrepreneur can invest this wealth either in the current project or in alternative projects that generate the risk-free rate of return r. I denote the dollar amount invested by the entrepreneur in the project by K_e and the dollar amount invested by the outside shareholders in the project by K_o. Therefore, the initial capital stock in

[6]Shleifer and Wolfenzon (2002) to analyze capital stock and ownership concentration in a static environment using the Becker's (1968) framework of crime and punishment. Lan and Wang (2003) study the determination of firm size and ownership structure in a dynamic model of investment.

the firm is $K = K_e + K_o$. I assume that the entrepreneur issues outside equity before floating debt. Then, the equity market equilibrium condition implies

$$K_o = (1 - \theta) V(\epsilon K) \;, \tag{40}$$

where ϵ is the initial value of the market demand shock. The right hand side of (40) is the time-0 market value of equity held by outside minority shareholders. The left hand side is their contribution to the capital stock of the firm.

The entrepreneur chooses his initial investment K_e and ownership θ to maximize his lifetime utility:

$$J(K_e, \theta) = h - K_e + W(\epsilon K, C(\epsilon K)) \,, \tag{41}$$

subject to the equity market equilibrium condition (40). The first-order condition (FOC) with respect to K_e is

$$\frac{\partial}{\partial K_e} J(K_e, \theta) = -1 + w(\theta)\, \epsilon \,, \tag{42}$$

where the normalized *ex ante* utility $w(\theta) = W(x, C(x))/x$ does not depend on x. Thereafter, I assume that the initial productivity shock satisfies $\epsilon > 1/w(\theta)$ so that the initial capital stock is positive. Using the FOC (42), I can see that the entrepreneur invests all his wealth in the project ($K_e = h$), when his project is sufficiently good ($\epsilon > 1/w(\theta)$). Condition (40) leads to $K = h\, m(\theta)$, where

$$m(\theta) = \frac{1}{1 - (1 - \theta)\; v(\theta)\, \epsilon} \tag{43}$$

and $v(\theta) = V(x, C(x))/x$ is also independent of x. I may interpret $m(\theta)$ as the capital-stock multiplier. For each unit of the capital stock that the entrepreneur contributes to the firm, the entrepreneur is able to raise $(m(\theta) - 1)$ units of capital from the equity market. As a result, the firm's total capital stock is $m(\theta)$ times $K_e = K$. In order to rule out unrealistic situations in which the firm's project is so good that the firm is able to raise infinite amount of outside capital, I require that $1-(1-\theta)\,v(\theta)\epsilon > 0$. Combining the restrictions on the initial market demand shock ϵ, I have the following condition.

Condition 9 *The initial market demand shock satisfies*

$$\frac{1}{w(\theta)} < \epsilon < \frac{1}{(1-\theta)\,v(\theta)}.$$

The lower bound ensures positive investment. The upper bound ensures finite investment.

Before analyzing the impact of investor protection on firm size and the entrepreneur's ownership, I first present the following result:

Proposition 10 *The change in the entrepreneur's normalized* ex ante *utility $w(\theta)$ associated with an infinitesimal change in the entrepreneur's ownership θ is equal to the normalized firm value $v(\theta)$:*

$$w'(\theta) = v(\theta)\,. \tag{44}$$

Proof Total differentiation of $w(\theta)$ with respect to θ gives

$$\frac{dw(\theta)}{d\theta} = \frac{\partial w(\theta)}{\partial c}\frac{dc}{d\theta} + \frac{\partial w(\theta)}{\partial \theta} = \frac{\partial w(\theta)}{\partial \theta} = (v^*(\theta) + \beta\, e^*(\theta)) - (\xi+\beta)\, e^*(\theta) = v(\theta)\,.\blacksquare$$

The entrepreneur's objective is to maximize his lifetime utility in (41) by selecting his ownership θ in the firm. His objective function can be written as

$$\max_{\theta\in[0,1]} \; m\,(\theta)\, w\,(\theta)\ . \tag{45}$$

Intuitively, the entrepreneur chooses his ownership θ by trading off the quantity effect with the value effect. For any given amount of outside capital that he raises, a larger θ implies a higher $w(\theta)$, *ceteris paribus*. For any given entrepreneur's valuation w of each unit of capital, a larger m implies a larger capital stock and thus a higher lifetime utility. The first order condition associated with (45) is

$$\frac{w'(\theta^*)}{w(\theta^*)} + \frac{m'(\theta^*)}{m(\theta^*)} = 0\,. \tag{46}$$

Solving this program yields the following result (see the Appendix):

Proposition 11 *Ownership is less concentrated and firm size is bigger under stronger shareholder protection, in that*

$$\frac{d\theta^*}{d\eta} < 0 \text{ and } \frac{dK}{d\eta} > 0.$$

The result in Proposition 11 implies that endogenous ownership mitigates the impact of investor protection on firm value and book leverage. Notably, I can write the total effect of shareholder protection on the selected coupon payment and firm value as follows:

$$\frac{df(x)}{d\eta} = \frac{\partial f(x)}{\partial \eta} + \frac{\partial f(x)}{\partial \theta}\frac{d\theta^*}{d\eta} \text{ for } f = C, V.$$

It is immediate to see that while the first term on the right hand side of these equations is positive, the second term is negative. Because the expression of θ^* is complex, it is not possible to sign these total effects. Below, I provide numerical examples that are based on parameters representing standard U.S. firms.

Numerical application. Input parameter values for the numerical application are provided in Table 1. I set the initial value of these cash flows at $x = 1$. (This choice does not affect the results since optimal leverage ratios do not depend on this parameter.) The risk free rate is taken from the yield curve on Treasury bonds. The value of the volatility parameter has been chosen to match the volatility of equity returns in the US economy. The growth rate of cash flows has been selected to generate a payout ratio consistent with observed payout ratios.[7] The tax advantage of debt $\tau = 0.35$ reflects recent estimates by Graham

[7] In the model, the firm's payout ratio is given by: $((1-\tau)x + \tau c)/V(x,c)$ where c is the selected coupon payment. In general, the payout ratio of a given firm reflects the sum of the payments to bondholders and shareholders. Following Huang and Huang (2002), I empirically estimate this quantity by taking the weighted averages between the average dividend yields (4% according to Ibbotson and Associates) and the average historical coupon rate (close to 9%), with weights given by the median leverage ratio of S&P 500 firms (approximately 20%).

of the marginal tax rate for US corporations. Liquidation costs are defined as the firm's going concern value minus its liquidation value, divided by its going concern value. Using this definition, Alderson and Betker (1995) and Gilson (1997) report liquidation costs equal to 36.5% and 45.5% for the median firm in their samples. Finally, I assume that the cost of renegotiation is low, relying on the empirical estimates of Gilson, John, and Lang (1990). The cost of debt issuance is fixed to 1.5% consistent with estimates of 1.09% found by Altinkhic and Hansen (2000) and 1.29% found by Kim, Palia, and Saunders (2007).

Consistent with Proposition 9, Figure 1 shows that the endogenous ownership selected by the entrepreneur is negatively related to the degree of shareholder protection. Figure 1 also shows that the endogenous ownership is also negatively related to the degree of bondholder protection. I assume that shareholder protection satisfies $\eta \in [2, 10]$. In addition, the bargaining power of bondholders belongs to the closed interval $\phi \in [0.25, 0.75]$. Additional input parameter values are set as in Table 1.

Figure 2 plots the selected coupon payment $C(x)$ as a function of the degree of investor protection. The main conclusion I can draw from Figure 2 is that endogenous ownership does not seem to reverse the positive relation between investor protection and book leverage. For the selected input parameter values, it also seems that shareholder protection has a larger impact on firm's financing policies than bondholder protection.

8 Conclusion

This paper examines the effects of shareholder and creditor protection on firm financing decisions. For doing so, I develop a model in which cash flows to claimholders depend not only on the cash flows rights of securities but also on the ability of investors to enforce those rights. Specifically, I consider a firm with an exclusive access to a project that yields a random stream of cash flows. The project can be financed by equity or debt. In equilibrium, the firm chooses to issue some debt because debt financing protects operating profits from taxation. However, leverage is limited because debt financing increases expected default costs and affects the ability of the controlling shareholder to extract concessions from minority shareholders.

In addition, in this framework, default can lead either to liquidation of firm's assets or to renegotiation of the debt contract. Since liquidation is costly and debtholders bear liquidation costs, there is room for strategic default. Shareholders may thus extract concessions from bondholders by renegotiating outstanding claims at the time of default.

In this environment, I analyze the impact of investor protection on assets prices, firm financing choices and firm value. First, I demonstrate how the various determinants of leverage interact to determine capital structure decisions. Second, I characterize the implications of the relation between investor protection and valuations for financing decisions. Finally, I show that imperfect shareholder and bondholder protection can help explain the level and cross-sectional variation of observed leverage ratios.

9 Appendix

Derivations of Results in Section 3

First consider the entrepreneur's optimality over cash diversion s. Prior to default, the entrepreneur's first-order optimality may be summarized by the HJB equation:

$$r\,U(x,c) = \sup_s \left\{ n\,(x-c) + \mu\,x\,U_x(x,c) + \frac{\sigma^2}{2}\,x^2\,U_{xx}(x,c) \right\}\,. \tag{47}$$

Because cash diversion only enters n, the cash diversion decision simply becomes a static problem, in that the entrepreneur chooses s for each period to solve

$$\max_s\ \theta\,(1-s) + s - \frac{\eta}{2}s^2.$$

The solution is given in (12). Similarly, at the point of default, the entrepreneur solves an analogous cash diversion problem and derives the same solution (12).

Proof of Proposition 1

Because the value of equity and the value of corporate debt admit a similar expression, I only report the derivation for the former. Within the present model, the value of equity satisfies

$$E^*\,(x,c) = (1-\tau)\;\mathbb{E}_x\left[\int_0^{T(z)} e^{-rt}\;(X_t - c)\;dt\right]\,, \tag{48}$$

where z is the trigger level associated with the hitting time. Using the strong Markov property of Brownian motion (see e.g. Karatzas and Shreve (1991)), I have:

$$\mathbb{E}_x\left[\int_0^{T(z)} e^{-rt}\,(X_t - c)\;dt\right] = G(x) - \mathbb{E}_x\left(e^{-rT(z)}\right)G(z)\,, \tag{49}$$

where

$$G(w) = \mathbb{E}_w\left[\int_0^{\infty} e^{-rt}\;(X_t - c)\;dt\right] = \frac{w}{r-\mu} - \frac{c}{r}\,, \tag{50}$$

for any positive constant w. Standard results from stopping-time analysis (Harrison (1985)) imply

$$\mathbb{E}_x\left(e^{-rT(z)}\right) = \left(\frac{x}{z}\right)^{-\gamma}, \quad x > z$$

where

$$\gamma = \frac{1}{\sigma^2}\left[\left(\mu - \frac{\sigma^2}{2}\right) + \sqrt{\left(\mu - \frac{\sigma^2}{2}\right)^2 + 2r\sigma^2}\right]. \tag{51}$$

The default threshold is determined by condition (16). Differentiating firm value with respect to c yields the desired expression for the value-maximizing coupon payment.

Proof of Proposition 3

Next, I derive the optimal coupon payment from the perspective of the controlling shareholder. First, differentiating the value of corporate debt $D^*(x,c)$ in (18) with respect to the coupon payment c gives

$$\frac{dD^*(x,c)}{dc} = \frac{1}{r}\left[1 + \left[(1-\alpha)(1-\tau)\gamma - (\gamma+1)\right]\left(\frac{x}{z^*}\right)^{-\gamma}\right].$$

Second, differentiating equity value $E^*(x,c)$ in (19) with respect to coupon payment c, taking the dependence of trigger strategy z^* of (20) on c into account, gives

$$\frac{dE^*(x,c)}{dc} = -\frac{1-\tau}{r}\left[1 - \left(\frac{x}{z^*}\right)^{-\gamma}\right].$$

This is consistent with the intuition that equity value decreases in coupon payment, *ceteris paribus*. It is easy to show that $E^*(x,c)$ is convex in c. The FOC of $W(x,c)$ with respect to c therefore is given by

$$\frac{dW(x,c)}{dc} = \theta(1-\delta)\frac{dD^*(x,c)}{dc} + \theta(1+\beta)\frac{dE^*(x,c)}{dc} = 0.$$

Solving the above equation gives (25). The second order condition for this optimization problem is given by

$$\frac{d^2W(x,c)}{dc^2} = -\theta\left[\gamma(1-\delta)(1-(1-\tau)(1-\alpha)) + (1-\delta) - (1-\tau)(1+\beta)\right]\frac{\gamma}{r}\frac{1}{c}\left(\frac{x}{z^*}\right)^{-\gamma}.$$

Under Condition 1, this quantity is negative, ensuring the optimality of the solution.

The entrepreneur's utility-maximizing coupon payment satisfies

$$C(x) = x\left(\frac{\gamma+1}{\gamma}\right)\left(\frac{r}{r-\mu}\right)\left[1+\gamma(1-\delta)\frac{1-(1-\tau)(1-\alpha)}{\tau-\delta}\right]^{-1/\gamma}.$$

Taking the first order derivatives give

$$\begin{aligned}
\frac{\partial C(x)}{\partial \tau} &= (1-\delta)\frac{1-(1-\alpha)(1-\delta)}{(\tau-\delta)^2}\Pi x > 0 \\
\frac{\partial C(x)}{\partial \alpha} &= -(1-\delta)\frac{1-\tau}{\tau-\delta}\Pi x < 0
\end{aligned}$$

where

$$\Pi = \left(\frac{\gamma+1}{\gamma}\right)\left(\frac{r}{r-\mu}\right)\left[1+\gamma(1-\delta)\frac{1-(1-\tau)(1-\alpha)}{\tau-\delta}\right]^{-(\gamma+1)/\gamma} > 0. \quad (52)$$

Proof of Proposition 4

The entrepreneur's utility-maximizing coupon payment satisfies

$$C(x) = x\left(\frac{\gamma+1}{\gamma}\right)\left(\frac{r}{r-\mu}\right)\left[1+\gamma(1-\delta)\frac{1-(1-\tau)(1-\alpha)}{(1-\delta)-(1-\tau)(1+\beta)}\right]^{-1/\gamma}.$$

Taking the first order derivatives give

$$\begin{aligned}
\frac{\partial C(x)}{\partial \tau} &= (1-\delta)\frac{(1+\beta)-(1-\alpha)(1-\delta)}{[1-\delta-(1-\tau)(1+\beta)]^2}\Pi x > 0 \\
\frac{\partial C(x)}{\partial \alpha} &= -(1-\delta)\frac{1-\tau}{1-\delta-(1-\tau)(1+\beta)}\Pi x < 0 \\
\frac{\partial C(x)}{\partial \delta} &= -\frac{(1-\tau)(1+\beta)[1-(1-\tau)(1-\alpha)]}{[(1-\delta)-(1-\tau)(1+\beta)]^2}\Pi x < 0
\end{aligned}$$

and

$$\begin{aligned}
\frac{\partial C(x)}{\partial \eta} &= (1-\delta)\frac{[1-(1-\tau)(1-\alpha)](1-\tau)}{[(1-\delta)-(1-\tau)(1+\beta)]^2}\frac{\beta}{\eta}\Pi x > 0 \\
\frac{\partial C(x)}{\partial \theta} &= (1-\delta)\frac{[1-(1-\tau)(1-\alpha)](1-\tau)}{[(1-\delta)-(1-\tau)(1+\beta)]^2}\left(\frac{\beta\eta+1-\theta}{\theta\eta}\right)\Pi x > 0
\end{aligned}$$

where

$$\Pi = \left(\frac{\gamma+1}{\gamma}\right)\left(\frac{r}{r-\mu}\right)\left[1+\gamma\left(1-\delta\right)\frac{1-\left(1-\tau\right)\left(1-\alpha\right)}{\left(1-\delta\right)-\left(1-\tau\right)\left(1+\beta\right)}\right]^{-(\gamma+1)/\gamma} > 0\,. \tag{53}$$

Proof of Proposition 5

I now proceed to sign the effect of investor protection on firm value. I have

$$\begin{aligned}\frac{dV(x,c)}{d\eta} &= \frac{d}{d\eta}\left[V^*(x,c)-\left(\frac{1-\theta}{\eta}\right)E^*(x,c)\right]\\ &= \frac{\partial V^*(x,c)}{\partial c}\frac{\partial C\left(x\right)}{\partial\eta}+\left(\frac{1-\theta}{\eta^2}\right)E^*(x,c)-\left(\frac{1-\theta}{\eta}\right)\frac{\partial E^*(x,c)}{\partial c}\frac{\partial C\left(x\right)}{\partial\eta}\end{aligned}$$

Since the coupon payment $C\left(x\right)$ selected by the entrepreneur is less debt than $C^*\left(x\right)$, I know that I have $V_c^*(x,c)>0$ at $c=C\left(x\right)$. Because $E_c^*(x,c)<0$ for all c and $\partial C\left(x\right)/\partial\eta>0$, I have the desired result.

The effect of ownership on firm value is given by

$$\frac{dV(x,c)}{d\theta} = \frac{\partial V^*(x,c)}{\partial c}\frac{\partial C\left(x\right)}{\partial\theta}+\frac{1}{\eta}E^*(x,c)-\left(\frac{1-\theta}{\eta}\right)\frac{\partial E^*(x,c)}{\partial c}\frac{\partial C\left(x\right)}{\partial\theta}$$

Because $V_c^*(x,c)>0$ at $c=C\left(x\right)$, $E_c^*(x,c)<0$ for all c, and $\partial C\left(x\right)/\partial\theta>0$, I have the desired result.

The effect of investor protection on debt value is given by

$$\frac{\partial D\left(x,c\right)}{\partial\eta} = \frac{\partial D^*\left(x,c\right)}{\partial c}\frac{\partial C\left(x\right)}{\partial\eta}.$$

Since $E_c^*(x,c)<0$ for all c, I have $D_c^*(x,c)>0$ at $c=C\left(x\right)$, which yields the desired result. Finally, a similar line of reasoning applies to the effect of ownership on debt value.

Proof of Proposition 6

Taking the endogenous relationship between coupon payment and default trigger into account, I have

$$\frac{dD(x,c)}{dc} = \frac{1}{r}\left[1 + \left[\left(1 - \frac{\kappa}{1-(1-\phi)(\alpha-\kappa)}\right)(1-\tau)\,\gamma - (\gamma+1)\right]\left(\frac{x}{y}\right)^{-\gamma}\right].$$

Second, differentiating equity value $\widehat{E}(x,c)$ with respect to coupon payment c, taking the dependence of trigger strategy y on c into account, gives

$$\frac{d\widehat{E}(x,c)}{dc} = -\frac{1-\tau}{r}\left[1 - \left(\frac{x}{y}\right)^{-\gamma}\right].$$

The optimal coupon payment c is chosen to set

$$\frac{dW(x,c)}{dc} = \theta\left[(1-\delta)\frac{dD(x,c)}{dc} + (1+\beta)\frac{d\widehat{E}(x,c)}{dc}\right] = 0\,.$$

The SOC can be verified using the same procedure as in the proof of Proposition 1.

Proof of Proposition 7

The entrepreneur's utility-maximizing coupon payment is given by (36). Taking the first order derivaties gives

$$\begin{aligned}
\frac{\partial C(x)}{\partial \phi} &= x\,\frac{\gamma+1}{\gamma}\,\frac{r}{r-\mu}\,(\alpha-\kappa)\left[\frac{\kappa\Upsilon\Gamma^{-(\gamma+1)/\gamma}}{[1-(1-\phi)(\alpha-\kappa)]} + \Gamma^{-1/\gamma}\right] > 0 \\
\frac{\partial C(x)}{\partial \eta} &= x\,\frac{\gamma+1}{\gamma}\,\frac{r}{r-\mu}\Gamma^{-(\gamma+1)/\gamma}\Psi\Upsilon\frac{(1-\theta)^2}{2\theta\eta^2\,[(1-\delta)-(1+\beta)(1-\tau)]} > 0 \\
\frac{\partial C(x)}{\partial \theta} &= x\,\frac{\gamma+1}{\gamma}\,\frac{r}{r-\mu}\Gamma^{-(\gamma+1)/\gamma}\Psi\Upsilon\frac{(1-\theta)(2\eta+(1-\theta))}{2\theta\eta^2\,[(1-\delta)-(1+\beta)(1-\tau)]} > 0
\end{aligned}$$

where

$$\Gamma = 1+\frac{\gamma\left(1-\delta\right)}{\left(1-\delta\right)-\left(1+\beta\right)\left(1-\tau\right)}\Psi>0 \tag{54}$$

$$\Psi = 1-\left(1-\tau\right)\left(1-\frac{\kappa}{1-\left(1-\phi\right)\left(\alpha-\kappa\right)}\right)>0 \tag{55}$$

$$\Upsilon = \frac{\left(1-\delta\right)\left(1-\tau\right)}{\left[\left(1-\delta\right)-\left(1+\beta\right)\left(1-\tau\right)\right]}. \tag{56}$$

Proof of Proposition 8

The effect of creditor protection on debt value is given by

$$\frac{\partial D\left(x,c\right)}{\partial\phi}=\frac{\partial D\left(x,c\right)}{\partial c}\frac{\partial C\left(x\right)}{\partial\phi}.$$

Since $E_c(x,c)<0$ for all c, I have $D_c(x,c)>0$ at $c=C\left(x\right)$, yielding the desired result.

I now proceed to sign the effect of creditor protection on firm value. I have

$$\frac{dV\left(x,c\right)}{d\phi}=\frac{\partial V\left(x,c\right)}{\partial c}\frac{\partial C\left(x\right)}{\partial\phi}+\frac{\partial V\left(x,c\right)}{\partial\phi}$$

Simple but lengthy calculations yield:

$$\begin{aligned}V\left(x,c\right) &= \left(\frac{1-\tau}{r-\mu}\right)x+\frac{\tau-\delta}{r}c\\ &\quad -c\left[\frac{\tau-\delta}{r}+\left(\frac{1-\tau}{r}\right)\left(\frac{\gamma}{\gamma+1}\right)\frac{\kappa+\delta\left(1-\alpha+\phi\left(\alpha-\kappa\right)\right)}{1-\left(1-\phi\right)\left(\alpha-\kappa\right)}\right]\left(\frac{x}{z}\right)^{-\gamma}.\end{aligned}$$

Using this expression, I can show that $\partial V(x,c)/\partial\phi>0$. In addition, since the entrepreneur underlevers the firm, I know that I have $V_c(x,c)>0$ at $c=C\left(x\right)$. This result together with $\partial C\left(x\right)/\partial\phi>0$ yields the desired result.

Proof of Proposition 11

I prove Proposition 11 by employing the implicit function theorem. I denote $F(\theta;\,\eta)$ as the left-hand side of the FOC (46):

$$F(\theta;\,\eta)=\frac{w'(\theta)}{w(\theta)}+\frac{m'(\theta)}{m(\theta)}\,. \tag{57}$$

Applying the implicit function theorem to (57) gives

$$\frac{d\theta}{d\eta} = -\frac{\partial F(\theta;\eta)/\partial\eta}{\partial F(\theta;\eta)/\partial\theta} = -\frac{F_\eta}{F_\theta}\,. \tag{58}$$

I thus need to sign both F_η and F_θ in order to show how shareholder protection determines the entrepreneur's ownership.

Taking the derivative of the FOC (57) with respect to θ gives the following SOC:

$$\begin{aligned}
\frac{\partial\, F(\theta;\,\eta)}{\partial\,\theta} &= \frac{w''(\theta)}{w(\theta)} - \frac{w'(\theta)^2}{w(\theta)^2} - \frac{m'(\theta)^2}{m(\theta)^2} + \frac{m''(\theta)}{m(\theta)}\,, && (59)\\
&= \frac{v'(\theta)}{w(\theta)} - \frac{2\,m'(\theta)^2}{m(\theta)^2} + \frac{m''(\theta)}{m(\theta)}\,, && (60)\\
&= \frac{v'(\theta)}{w(\theta)} - \frac{m'(\theta)}{m(\theta)}\left[-\frac{m''(\theta)}{m'(\theta)} + \frac{2\,m'(\theta)}{m(\theta)}\right], && (61)\\
&= \frac{v'(\theta)}{w(\theta)} + \frac{w'(\theta)}{w(\theta)}\left[-\frac{d\log(-m'(\theta))}{d\theta} + \frac{2\,d\log(m(\theta))}{d\theta}\right], && (62)\\
&= \frac{v'(\theta)}{v(\theta)}\,\frac{v(\theta)}{w(\theta)} + \frac{v(\theta)}{w(\theta)}\left[-\frac{d\log(v(\theta)-(1-\theta)v'(\theta))}{d\theta}\right], && (63)\\
&= \frac{v(\theta)}{w(\theta)} \times \left[-\frac{d}{d\theta}\,\log\left(1 - \frac{(1-\theta)v'(\theta)}{v(\theta)}\right)\right], && (64)
\end{aligned}$$

where (60) follows from the FOC (46) and $w'(\theta) = v(\theta)$ (Proposition 10); and (63) in addition uses the result that $m'(\theta) = -\epsilon\,[v(\theta) - (1-\theta)v'(\theta)]\; m(\theta)^2 < 0\,.$

The monotonicity of the logarithmic transformation implies that the sign of the SOC (64) is equal to that of

$$\frac{d}{d\theta}\left[(1-\theta)\,\frac{v'(\theta)}{v(\theta)}\right] = \frac{v''(\theta)(1-\theta) - v'(\theta)}{v(\theta)} - (1-\theta)\left(\frac{v'(\theta)}{v(\theta)}\right)^2 < 0. \tag{65}$$

The inequality in the above equation follows from $v'(\theta) > 0$ (Proposition 5) and $v''(\theta) < 0$, shown below.

Next, I show that $v(\theta)$ is concave in the entrepreneur's ownership θ. The second-order effect of ownership on firm value is given by

$$\frac{d^2V}{d\theta^2} = V_{cc}^* \left(\frac{\partial C(x)}{\partial\theta}\right)^2 + V_c^* \frac{\partial^2 C(x)}{\partial\theta^2} + \frac{2}{\eta} E_c^* \frac{\partial C(x)}{\partial\theta} - \xi E_{cc}^* \left(\frac{\partial C(x)}{\partial\theta}\right)^2 - \xi E_c^* \frac{\partial^2 C(x)}{\partial\theta^2}. \tag{66}$$

Because $V_c^*(x,c) > 0$ and $V_{cc}^*(x,c) < 0$, $E_c^*(x,c) < 0$ and $E_{cc}^*(x,c) > 0$, at $c = C(x)$, and $\partial C(x)/\partial\theta > 0$, and $\partial^2 C(x)/\partial\theta^2 < 0$, I thus have the desired result.

Next, I sign F_η by noting that

$$\frac{\partial F(\theta;\,\eta)}{\partial\eta} = \frac{1}{w}\frac{\partial w'}{\partial\eta} - \frac{w'}{w^2}\frac{\partial w}{\partial\eta} + \frac{1}{m}\frac{\partial m'}{\partial\eta} - \frac{m'}{m^2}\frac{\partial m}{\partial\eta}, \tag{67}$$

$$= \frac{v}{w}\frac{\partial \log v}{\partial\eta} - \frac{v}{w}\frac{\partial \log w}{\partial\eta} + \frac{m'}{m}\frac{\partial \log(-m')}{\partial\eta} - \frac{m'}{m}\frac{\partial \log m}{\partial\eta}, \tag{68}$$

$$= \frac{v}{w}\left[\frac{\partial \log v}{\partial\eta} - \frac{\partial \log w}{\partial\eta} - \frac{\partial}{\partial\eta}\log\left[(v-(1-\theta)v')\,m^2\right] + \frac{\partial \log m}{\partial\eta}\right], \tag{69}$$

$$= \frac{v}{w}\left[\frac{\partial \log v}{\partial\eta} - \frac{\partial \log w}{\partial\eta} - \frac{\partial \log m}{\partial\eta} - \frac{\partial \log\left(v-(1-\theta)v'\right)}{\partial\eta}\right], \tag{70}$$

$$= \frac{v}{w}\left[-\frac{\partial}{\partial\eta}\log\left(1-\frac{(1-\theta)v'}{v}\right) - \frac{\partial\,\log\left(w\,m\right)}{\partial\eta}\right]. \tag{71}$$

The equality (68) follows from envelope condition $w'(\theta) = v(\theta)$, and (69) uses FOC (46) and $m'(\theta) = (v(\theta) - (1-\theta)v'(\theta))\; m^2(\theta) < 0$.

The monotonicity of logarithmic transformation implies that

$$\text{Sign}\left(-\frac{\partial}{\partial\eta}\log\left(1-\frac{(1-\theta)v'}{v}\right)\right) = \text{Sign}\left(\frac{\partial}{\partial\eta}\frac{(1-\theta)v'}{v}\right), \tag{72}$$

where

$$\frac{\partial}{\partial\eta}\frac{(1-\theta)v'}{v} = \frac{(1-\theta)}{v}\frac{\partial^2 v}{\partial\theta\partial\eta} - \frac{(1-\theta)}{v^2}\frac{\partial v}{\partial\theta}\frac{\partial v}{\partial\eta} < 0, \tag{73}$$

using $\partial v/\partial\theta > 0$, $\partial v/\partial\eta > 0$ and $\partial^2 v/\partial\eta\partial\theta < 0$. Together with $\partial\,(w\,m)\,/\partial\eta > 0$, I have $\partial F(\theta;\,\eta)/\partial\eta < 0$.

The SOC and the above result ($\partial F(\theta;\,\eta)/\partial\eta < 0$) together imply that the entrepreneur's ownership decreases with the level of shareholder protection, in that $d\theta^*/d\eta < 0$. The firm's capital stock increases in shareholder protection, in that

$$\frac{dK}{d\eta} = \epsilon\, m^2(\theta^*) \left[-v(\theta) \frac{d\theta^*}{d\eta} + (1-\theta)\, \frac{dv(\theta)}{d\eta} \right] . \tag{74}$$

I note that $d\theta^*/d\eta < 0$ and $dv(\theta)/d\eta > 0$ imply capital stock increases in shareholder protection.

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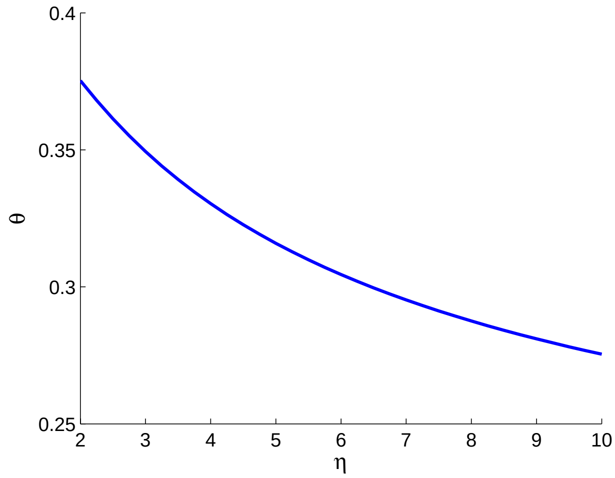
Table 1: Base Case Parameter Values.

Table 1 reports base case input parameter values.

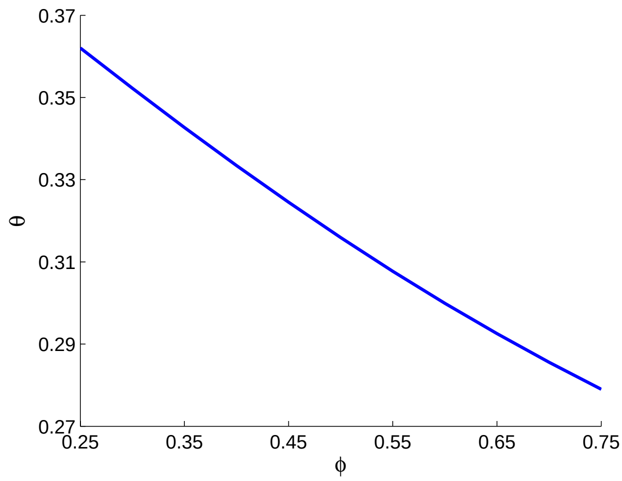
	Parameter Choices
Risk free interest rate	$r = 0.06$
Growth rate of cash flows	$\mu = 0.01$
Volatility of returns	$\sigma = 0.30$
Tax advantage of debt	$\tau = 0.35$
Liquidation costs	$\alpha = 0.40$
Renegotiation costs	$\kappa = 0.05$
Proportional flotation cost	$\delta = 0.02$

Figure 1: Investor Protection and Endogenous Ownership.

Figure 1 plots ownership as a function of the degree of shareholders protection for $\eta \in [2, 10]$ and the degree of bondholders protection for $\phi \in [0.25, 0.75]$. Additional input parameter values are set as in Table 1.



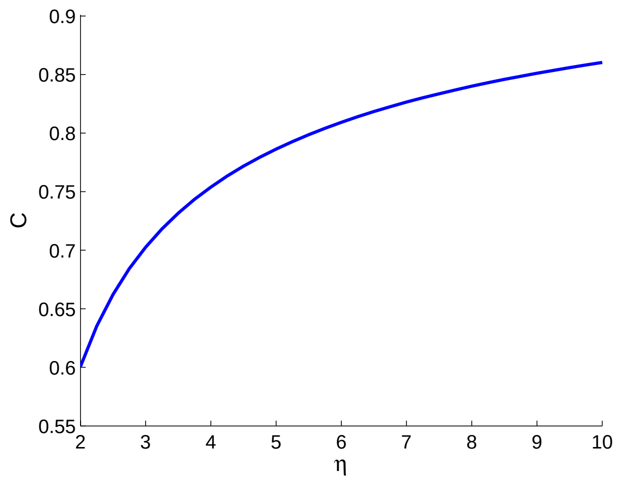
(a) Endogenous ownership θ as a function of the degree of shareholders protection η



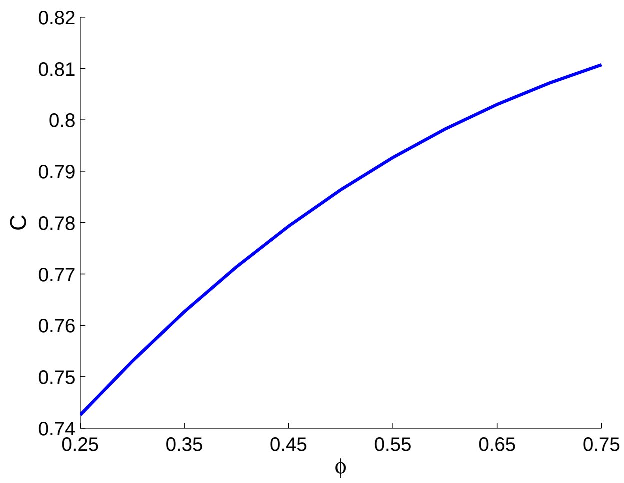
(b) Endogenous ownership θ as a function of the degree of bondholder protection ϕ

Figure 2: Investor Protection, Endogenous Ownership, and Financing Decisions.

Figure 2 plots the selected coupon payment C as a function of the degree of shareholders protection for $\eta \in [2, 10]$ and the degree of bondholders protection for $\phi \in [0.25, 0.75]$. Additional input parameter values are set as in Table 1.



(a) Coupon C as a function of the degree of shareholders protection η



(b) Coupon C as a function of the degree of bondholder protection ϕ

Chapter III

Dynamic Capital Structure under Managerial Entrenchment: Evidence from a Structural Estimation

(with Erwan Morellec and Norman Schürhoff)

1 Introduction

Since the seminal paper by Jensen and Meckling (1976), economists have devoted much effort to studying the effects of agency conflicts on firm's financing decisions. Because debt limits the flexibility of management (Jensen (1986)), a large fraction of this literature argues that managers do not always adopt capital structures that maximize shareholder wealth. This is particularly true when managers are not under the pressure of a disciplining force since, by definition, entrenched managers have discretion over their firm's leverage choices. The capital structure of a firm should then be determined not only by real market frictions, such as taxes or bankruptcy costs, but also by the degree of managerial entrenchment. Despite the substantial development of this literature, the magnitude of manager-shareholder conflicts and their effects on financing decisions is still an open question.

Empirical researchers have used an array of methods to examine the relation between managerial entrenchment and capital structure choices. For example, Jung, Kim and Stulz (1996) identify security issue decisions that seem inconsistent with shareholder value maximization. Friend and Lang (1988), Mehran (1992) and Berger, Ofek, and Yermak (1997) find in cross-sectional studies that leverage levels are lower when CEOs do not face pressure from the market for corporate control. Berger, Ofek, and Yermak also find that leverage increases in the aftermath of shocks reducing the degree of managerial entrenchment or after managers are subjected to greater performance incentives. Garvey and Hanka (1999) find that firms protected by "second generation" state antitakeover laws substantially reduce their use of debt, and that unprotected firms do the reverse. Yet in another study, Kayhan (2005) confirms that entrenched managers prefer low leverage.

In this paper, we use observed corporate financing choices to infer the degree of managerial entrenchment and the effects of manager-shareholder conflicts on financing decisions. We begin by formulating a dynamic trade-off model that emphasizes the role of manager-shareholder conflicts in shaping capital structure choices. The model features corporate and personal taxes, refinancing costs, and bankruptcy costs. In the model, each firm is run by a partially-entrenched manager who sets the firm's payout and financing policies. Managers act in their own interests to maximize the present value of the cash flows they will take from the firm's operations. However, the policy choices of the manager are constrained by the threat of control challenges by shareholders, who can replace the manager at a cost. In this environment, we determine the optimal leveraging decision of managers and examine the effects of managerial entrenchment on firms' financing decisions. Several important results follow from this analysis. First, we show how the various determinants of leverage interact to determine capital structure choices. Second, we derive implications relating managerial entrenchment to the firm's target leverage and the pace and size of capital structure changes. Third, we take the model to the data and provide firm-specific estimates of the degree of managerial entrenchment. Fourth, we show that the separation between ownership and control can explain why some firms issue little or no debt – low- and zero-leverage puzzles – despite the known tax benefits of debt (see Graham (2000) and Strebulaev and Yang (2007)) as well as the dynamics of leverage ratios through time.

As in prior dynamic capital structure models, our analysis emphasizes the role of external financing costs in affecting the time-series of observed leverage ratios. Due to capital market frictions, firms are not able to keep their leverage at the target at all times. As a result, leverage is best described not just by a number, the target, but by its entire distribution – including target and restructuring (refinancing) boundaries. In contrast to prior work, our dynamic capital structure model generates *unique* predictions relating managerial entrenchment to the debt level selected by the manager, the frequency and size of capital structure changes, and the likelihood of default. Notably, our model predicts that high (low) managerial entrenchment leads to low (high) target leverage and less (more) frequent capital structure rebalancings. Managerial entrenchment lowers the firm's target leverage and raises the debt issuance trigger. As a result, financial inertia becomes more pronounced and the range of leverage ratios widens as the degree of managerial entrenchment increases.

The intuition underlying these predictions is that debt restructurings adversely affect the manager's rents as the benefits of restructuring accrue to shareholders. Cash distributions are made on a pro rata basis to shareholders, so that when new debt is issued management gets a small fraction of the distributions. Management's stake in the firm, however, exceeds its direct ownership due to entrenchment, rendering restructurings less favorable to management than to shareholders. Debt also constrains managers by limiting the cash flows available as hidden rents (as in Jensen (1986), Hart and Moore (1995) or Zwiebel (1996)). As a remedy, entrenched managers restructure less frequently (lower refinancing trigger) and issue less debt (lower target and default trigger) than optimal for shareholders.

The paper also provides new evidence on the relation between governance mechanisms and capital structure dynamics. Specifically, we take the model to the data and use observed financing choices to provide firm-specific estimates of the degree of managerial entrenchment, or, equivalently, of the cost of control challenges. We exploit not only the conditional mean of leverage (as in a regression) but also distributional tails – in short, the conditional moments of the time-series distribution of leverage. This allows a characterization of managerial responses to the incentives created by various governance mechanisms. Using structural econometrics, we find that costs of control challenges of 2-7% on average (.8-5% at median) are sufficient to resolve the low- and zero-leverage puzzles and explain the time series of observed leverage ratios. The variation in cost of control challenges, and hence agency conflicts, across firms is sizeable. This suggests that while leverage ratios should revert to the (manager's) target leverage over time, the variation in the degree of managerial entrenchment should lead to persistent cross-sectional differences in leverage ratios. We also find that agency costs vary with business cycle conditions and with variables that one expects to determine managerial incentives. Firms with large growth opportunities are subject to more managerial resource diversion than other firms. External and internal governance mechanisms strongly affect managerial entrenchment and firms' financing decisions.

The analysis in the present paper relates to the literature that analyzes the relation between managerial discretion and financing decisions.[1] The paper that is closest to our is Zwiebel (1996) in that it also builds a dynamic capital structure model in which financing and payout policies are selected by a partially-entrenched manager. However, while in Zwiebel's model, firms are always at their target leverage, in our model refinancing costs create some inertia and some persistence in capital structure. Second, from a modeling perspective, this paper relates to the dynamic contingent claims models of Fisher, Heinkel, and Zechner (1989), Goldstein, Ju, and Leland (2001), or Strebulaev (2007). In this literature, conflicts of interest between managers and shareholders have been largely ignored (see however the static models of Morellec (2004), or Lambrecht and Myers (2008)). Third, our model also relates to the dynamic trade-off models of Hennessy and Whited (HW 2005, 2007). Their models feature a richer tax environment and consider the role of internally generated funds. However they do not allow for default (HW, 2005) and ignore manager-shareholder conflicts.

[1]See Stulz (1990), Chang (1993), Hart (1993), Hart and Moore (1994, 1995), Zwiebel (1996), or Barclay, Morellec and Smith (2006). While this literature has provided a rich intuition on the effects of managerial discretion on financing decisions, it has been so far mostly qualitative, focusing on directional effects.

Another important difference is that our model allows us derive a closed-form expression for the time series distribution of leverage ratios. We can then look at all the moments of the leverage distribution (including target leverage, refinancing frequency, and default probability) instead of focusing on a limited number of moments. Finally, our paper is related to the analysis in Lemmon, Roberts and Zender (LRZ, 2008) who find that traditional determinants of leverage (such as size, profitability, market-to-book, industry, ...) account for relatively little of the variation in capital structure. Instead they show that the majority of the variation in capital structures is driven by an unobserved effect (or determinant). Our analysis reveals that the (unexplained) capital structure heterogeneity is structurally related to a number of corporate governance mechanisms, thereby providing an economic interpretation for their results.

This paper extends the literature on financing decisions in two important dimensions. First, we develop the first dynamic model of capital structure decisions that includes taxes, bankruptcy costs, refinancing costs, and manager-shareholder conflicts. This allows us to make clear predictions regarding the effects of these various determinants of financing policies on target leverage and the pace and size of capital structure changes. Second, our analysis adds to the literature by providing firm-specific estimates of the degree of managerial entrenchment and showing that the separation between ownership and control can explain the low- and zero-leverage puzzles as well as the dynamics of leverage ratios. To the best of our knowledge, our paper is the first that provides structural estimates of the magnitude of manager-shareholder conflicts and their effects on dynamic capital structure decisions.

The remainder of the paper is organized as follows. Section 2 describes the model. Section 3 discusses the data and our empirical methodology. Section 4 provides firm-specific estimates of manager-shareholder conflicts and relates these estimates to various corporate governance mechanisms. Section 5 concludes.

Technical developments are gathered in Appendix A. In Appendix B, we show that the results of regressions on simulated data from our model are consistent with those reported in the empirical literature.

2 The Model

Most capital structure models make the simplifying assumption that managers choose capital structure in the interests of shareholders. Recent research, however, has explicitly recognized that managers' self interest can lead to financial policies that do not maximize shareholder wealth. This section presents a model that extends the contingent claims framework to incorporate the impact of manager-shareholder conflicts on *dynamic* capital structure choices.

2.1 Assumptions

The model closely follows Goldstein et al. (2001), Leland (1998), and Strebulaev (2007). 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. We consider an economy with a large number of heterogeneous firms. Firms are infinitely lived and have monopoly access to a set of assets, which are operated in continuous time. The firm-specific state variable is the cash flow generated by the operation of the firm's assets, denoted by X_i. This operating cash flow is independent of capital structure choices and governed, under the risk neutral probability measure, by the process:[2]

$$dX_{it} = \mu_i X_{it} dt + \sigma_i X_{it} dZ_{it}, \qquad X_{i0} > 0, \tag{1}$$

where $\mu_i < r$ and $\sigma_i > 0$ are constants and $(Z_{it})_{t\geq 0}$ is a standard Brownian motion. Equation (1) implies that the growth rate of cash flows from operations is Normally distributed with mean $\mu_i \Delta t$ and variance $\sigma_i^2 \Delta t$ over the time interval Δt under the risk-neutral probability measure. It also implies that the mean growth rate of cash flows is $m_i \Delta t = (\mu_i + \beta_i \varkappa)\Delta t$ under the physical probability measure, where $\beta_i \neq 0$ and $\varkappa$ is the market risk premium.

Cash flows from operations are taxed at a constant rate τ^c. As a result, firms may have an incentive to issue debt to shield profits from taxation. To stay in a simple time-homogeneous setting, we consider debt contracts that are characterized by a perpetual flow of coupon payments c_i and a principal P_i. Debt is callable and issued at par. The firm's initial debt structure remains fixed without time limit until either the firm goes into default or the firm calls its debt and restructures with newly issued debt. We consider that firms can adjust their capital structure upwards at any point in time by incurring a proportional cost

[2] This corresponds to a model in which the firm is allowed to invest in new assets at any time $t \in (0, \infty)$ and investment is perfectly reversible. To see this, assume that operation of the firm's assets produces output with the production function $F : R_+ \to R_+$, $F(k_t) = k_t^\gamma$, where $\gamma \in (0,1)$ and that capital depreciates at a constant rate $\delta > 0$. Define the firm's after tax profit function f_{it} by

$$f_{it} = \max_{k\geq 0} \; [(1-\tau^c)(X_{it} k_t^\gamma - \delta k_t) - r k_t].$$

Solving this maximization problem for k_t and replacing k_t by its expression in the firm's after-tax profit function gives $f_{it} = (1-\tau_i^c) Y_{it}$ where $(Y_{it})_{t\geq 0}$ is a (capacity-adjusted cash flow) shock governed by

$$dY_{it} = \mu_Y Y_{it} dt + \sigma_Y Y_{it} dW_t, \qquad Y_{i0} = A X_{i0} > 0,$$

where $\mu_Y = \vartheta \mu_i + \vartheta(\vartheta - 1)\sigma_i^2/2$, $\sigma_Y = \vartheta \sigma_i$, and $(A, \vartheta) \in \mathbb{R}^2_{++}$ are constant parameters.

λ, but that they can reduce their indebtedness only in default.[3] A restructuring occurs if the cash flow shock reaches a level X_U ($> X_0$) prior to default. Default occurs if the cash flow shock falls to a level X_B ($< X_0$) prior to the calling of debt. The personal tax rate on dividends τ^d and on coupon payments τ^i are identical for all investors. These features are shared with numerous other capital structure models, including Leland (1998), Goldstein, Ju, and Leland (2001), Hackbarth, Miao, and Morellec (2006), or Strebulaev (2007).

We are interested in building a model in which financing choices reflect not only the trade-off between the tax benefit of debt and contracting costs, but also agency conflicts. Agency conflicts between the manager and shareholders are introduced by considering that each firm is run by a partially-entrenched manager who sets the firm's payout and financing policies. Managers act in their own interests to maximize the present value of the cash flows they will take from the firm's operations. However, the policy choices of the manager are constrained by the threat of control challenges by shareholders, who can replace the current manager at a cost.[4] As in Lambrecht and Myers (2008) and Kuhnen and Zwiebel (2008) (and in contrast to Stulz, 1990, Zwiebel, 1996, or Morellec, 2004), we do not assume that managers always want to expand. Rather, our model gives managers the possibility to capture cash flow within the limits imposed by the costs of control challenges.

Specifically, we consider that the cost of control challenges implies that the firm's net income is reduced by a constant factor ϕ after a control challenge. That is, the net payoff to investors when they take control is $\max[V^*(X,c) - B(X,c) - \phi F^*(X,c); 0]$, where $\phi \in (0,1)$, $V^*(X,c)$ is the value of the firm under perfect

[3] While in principle management can both increase and decrease future debt levels, Gilson (1997) finds that transaction costs discourage debt reductions outside of renegotiation.

[4] As in Lambrecht and Myers (2008), we do not allow for ex post renegotiation by considering that the manager is removed if he does not bring enough value to shareholders.

shareholder protection (i.e. absent manager-shareholder conflicts), $B(X, c)$ is the value of outstanding debt, and $F^*(X, c)$ is the present value of the firm's net income under perfect shareholder protection.[5] In our analysis, ϕ represents the cost of a control challenge or, equivalently, the degree of managerial entrenchment. This cost must be interpreted as the cost that shareholders must face to replace the manager, due to the specific human capital of the manager, legal challenges, search costs, or any other type of replacement costs. In our model, the threat of a control challenge constrains the manager, but the cost of control challenges ϕ creates the space for managerial rents. Our objective in this paper is to estimate the magnitude of ϕ.

In addition to the cash flows they receive when the firm is in operation, shareholders may obtain a fraction of firm value in default. In the analysis that follows, we assume that default can lead either to liquidation or to the renegotiation. We denote the proportional cost of renegotiation and liquidation by κ and α, respectively. Because liquidation is typically more costly than reorganization, there exists a positive surplus associated with renegotiation.[6] In our model, this surplus represents a fraction $\alpha - \kappa$ of the value of the firm's assets in default. Following Fan and Sundaresan (2000), we consider a Nash bargaining game in default that leads to a debt-equity swap. We denote the bargaining power of shareholders by $\eta \in [0, 1]$. Assuming that the renegotiation surplus is shared according to some sharing rule ϖ, the generalized Nash bargaining solution is

[5] In the static version of our model, this specification implies that shareholders can realize a fraction $1 - \phi$ of equity value if they mobilize to remove management (see Appendix A 6.2). Hence this specification can be seen as the dynamic counterpart of that in Lambrecht and Myers (2008). While other specifications are possible, we show below that this specification is also similar to that used in the law and finance literature, in which controlling shareholders can extract part of the firm cash flows as private benefits.

[6] In our model default always lead to renegotiation. The model can be extended to incorporate an exogenous probability of liquidation, as in Davydenko and Strebulaev (2007).

simply given by $\varpi = \eta$. The Nash bargaining solution implies that shareholders get a fraction $\eta(\alpha - \kappa)$ of the firm's assets in default. In addition to the estimation of ϕ, the paper also provides a structural estimation of η.

2.2 Model Solution

In this section we solve for the financing policy selected by the manager. We do so in the following three steps. First, we determine the values of debt and equity, taking the firm's financing and default policies as given. Second, we solve for the firm's default policy, taking financing as given. Third, we derive the selected financing policy, that is the amount of debt issued and the call policy. In our model, the value of equity depends on the payout policy $p(X_t)$ selected by the manager, which in turn depends on the cost of control challenges. In the analysis that follows, we consider that the manager can capture a fraction ϕ of net income as private benefits, so that the cash flows to shareholders at any time t are given by $(1 - \phi)(1 - \tau^c)(X_t - c)$.[7] We show below that this payout policy implies that the "control challenge constraint" is always binding (i.e. equity value equals $V^*(X, c) - B(X, c) - \phi F^*(X, c)$).

Consider first the valuation of corporate securities. In our model, the firm's initial debt structure remains fixed until either the cash flow shock reaches X_B and the firm goes into default or the cash flow shock reaches X_U and the firm calls its debt. Let $e(X)$ denote the present value of the cash flows to shareholders over

[7]This tunneling of funds toward socially inefficient usage may take a variety of forms such as excessive salary, transfer pricing, employing relatives and friends who are not qualified for the jobs in the firm, and perquisites, just to name a few. Importantly, while we emphasize conflicts between managers and shareholders, our model is observationally equivalent to the models that emphasize agency conflicts between controlling and minority shareholders (see e.g. La Porta, Lopez-de Silanes, Shleifer, and Vishny (2002) or Albuquerque and Wang (2008)), in which controlling shareholders face a convex cost function for cash diversion and extract part of the firm cash flows as private benefits at the expense of minority shareholders.

one refinancing cycle (i.e. for the period over which the firm does not change its debt policy). At each time t, shareholders receive the cash flows from operations minus the coupon payment c to debtholders, the fraction of cash flows captured by the manager, and the taxes paid on corporate and personal income. As a result, the value of shareholders' claim over one refinancing cycle is given by

$$e\left(X\right)=\mathbb{E}^{\mathcal{Q}}\left[\int_{t}^{T}e^{-r(s-t)}\left(1-\tau\right)\left(1-\phi\right)\left(X_{s}-c\right)ds\middle|\,X_{t}=X\right], \tag{2}$$

where the tax rate $\tau = 1-(1-\tau^c)(1-\tau^d)$ reflects corporate and personal taxes, $\mathcal{Q}$ denotes the risk neutral probability measure and $T = \inf\{T_U, T_B\}$ with $T_i = \inf\{t \geq 0 : X_t = X_i\}$, $i = U, B$. This expression gives the value of shareholders' claim over one refinancing cycle as the present value of the cash flows that they receive until either the firm increases its debt level to shield more profits from taxation or defaults on its debt obligations (i.e. until time T). Importantly, this value does not incorporate any of the cash flows that accrue to shareholders after a debt restructuring. These cash flows belong to the next financing cycle and will be incorporated in the total value of equity.

Denote by ξ and ν the positive and negative roots of the quadratic equation $\frac{1}{2}\sigma^2\beta(\beta-1)+\mu\beta-r=0$ and let $\Pi(X)$ represent the present value of a perpetual stream of cash flows $(1-\tau)(1-\phi)X_t$ starting at $X_t = X$:

$$\Pi(X)=\mathbb{E}^{\mathcal{Q}}\left[\int_{t}^{\infty}e^{-r(s-t)}\left(1-\tau\right)\left(1-\phi\right)X_{s}\,ds\middle|\,X_{t}=X\right]=\left(1-\tau\right)\left(\frac{1-\phi}{r-\mu}\right)X. \tag{3}$$

In addition, let $p_U(X)$ denote the present value of \$1 to be received at the time of refinancing, contingent on refinancing occurring before default, and let $p_B(X)$ denote the present value of \$1 to be received at the time of default, contingent on default occurring before refinancing. Using this notation, we can write the solution to equation (3) as:

$$\begin{aligned} e(X) &= \Pi(X) - p_U(X)\Pi(X_U) - p_B(X)\Pi(X_B) \\ &\quad - \frac{(1-\tau)(1-\phi)c}{r}[1 - p_U(X) - p_B(X)], \end{aligned} \tag{4}$$

where [see e.g. Revuz and Yor (1999, pp. 72) and Appendix A 6.3]

$$p_B(X) = \frac{X^\xi - X^\nu X_U^{\xi-\nu}}{X_B^\xi - X_B^\nu X_U^{\xi-\nu}} \text{ and } p_U(X) = \frac{X^\xi - X^\nu X_B^{\xi-\nu}}{X_U^\xi - X_U^\nu X_B^{\xi-\nu}}.$$

Equation (4) incorporates only the cash flows that accrue to shareholders until date T. In this expression, we have $p_U(X) = 1$ and $p_B(X) = 0$, for $X \geq X_U$. Similarly, we have $p_U(X) = 0$ and $p_B(x) = 1$, for $X = X_B$. That is, if the cash flow shock reaches X_B or X_U, the firm changes its capital structure and starts a new financing cycle.

Consider next the total value of equity's claim to cash flows from operations, denoted by $F(x)$. As discussed above, when the cash flow shock reaches X_U prior default, debt will be retired at par value and a new debt will be issued. The time at which debt is called is termed a restructuring point. We show in Appendix A 6.1 that in the static model in which the firm cannot restructure, the default threshold X_B is linear in the coupon payment c. In addition, the selected coupon rate c is linear in X. This implies that if two firms i and j are identical except that $X_0^i = \theta X_0^j$, then the selected coupon rate and default threshold $c^i = \theta c^j$ and $X_B^i = \theta X_B^j$, and every claim will be larger by the same factor θ. For the dynamic model, this scaling feature implies that at the first restructuring point, all claims are scaled up by the same proportion $\rho \equiv X_U/X_0$ that asset value has increased (i.e. it is optimal to choose $c^1 = \rho c^0$, $X_B^1 = \rho X_B^0$, $X_U^1 = \rho X_U^0$). Subsequent restructurings will again scale up these variables by the same ratio. If default occurs prior to restructuring, firm value is reduced by a constant factor $\eta(\alpha-\kappa)\gamma$ with $\gamma \equiv X_B/X_0$ and all claims are scaled down by the same proportion $\eta(\alpha-\kappa)\gamma$.

As a result, we have over the region $X_B \leq X \leq X_U$:

$$F(X) = e(X) + p_U(X)\,\rho F(X_0) + p_B(X)\,\eta(\alpha - \kappa)\gamma F(X_0)\,. \tag{5}$$

This equation shows that the value of shareholders' claim over all the financing cycles is equal to the cash flows they get until the next restructuring plus the value of the cash flows they get after the restructuring (last two terms on the right hand side). Since a restructuring can happen in default or when the state variable has increased sufficiently, the formula takes into account these two possibilities. Using this expression, we can solve for the total value of equity's claim to cash flows from operating assets at the initial date as:

$$F(X_0) = \frac{e(X_0)}{1 - p_U(X_0)\,\rho - p_B(X_0)\,\eta\,(\alpha - \kappa)\,\gamma}. \tag{6}$$

Since managers capture a fraction ϕ of net income, we also have that $F(X) \equiv (1-\phi)F^{*}(X)$ where $F^{*}(X)$ is the total value of equity's claim to cash flows from operations in the absence of manager-shareholder conflicts.

The same arguments apply to the valuation of corporate debt. Consider first the value $B(X)$ of the debt issued at time $t = 0$. Since the issue is called at par if the firm's cash flows reach X_U before X_B, the current value of corporate debt satisfies at any time $t \geq 0$:

$$B(X) = b(X) + p_U(X)\,B(X_0)\,, \tag{7}$$

where

$$b(X) = \frac{(1-\tau^{i})\,c}{r}\left[1 - p_U(X) - p_B(X)\right] + p_B(X)\left[1 - (\kappa + \eta\,(\alpha - \kappa))\right]\Pi(X_B)\,, \tag{8}$$

represents the value of corporate debt over one refinancing cycle, i.e. ignoring the value of the debt issued after a restructuring or after default. The first term on the right hand side of equation (8) represents the present value of the coupon payments accruing to debtholders until the firm defaults or restructures. The second term represents the cash flow to initial debtholders in default. These debtholders get the value of the firm's assets minus renegotiation costs and the fraction of the renegotiation surplus captured by shareholders.

As in the case of equity, the total value of corporate debt $D(X)$ includes not only the cash flows accruing to debtholders over one refinancing cycle, i.e. $b(X)$, but also the new debt that will be issued in default or at the time of a restructuring. As a result, the value of the total debt claim, incorporating all future coupon flows, is given by

$$D(X_0) = \frac{b(X_0)}{1 - p_U(X_0)\rho - p_B(X_0)\eta(\alpha-\kappa)\gamma}, \tag{9}$$

This equation shows that, because the value of the firm is reduced by a constant factor $\eta(\alpha-\kappa)\gamma$ in default, so is the value of corporate debt that will be issued at that time.

Because flotation costs are incurred each time the firm adjusts its capital structure, the total value of the firm at the restructuring date is

$$V(X_0) = \frac{e(X_0) + b(X_0) - \lambda B(X_0)}{1 - p_U(X_0)\rho - p_B(X_0)\eta(\alpha-\kappa)\gamma}, \tag{10}$$

Finally, since firm value satisfies $V(X) = E(X) + B(X)$, the total value of equity is given by:

$$E(X) = e(X) + p_U(X)[\rho V(X_0) - B(X_0)] + p_B(X)\eta(\alpha-\kappa)\gamma V(X_0). \tag{11}$$

Denote by $V^*(X)$ the value of the firm value when there are no manager-shareholder conflicts. The payout policy $p(X) = (1-\phi)(1-\tau^c)(X-c)$ implies that the manager captures the rents $\phi F^*(X)$. As a result, we have for any given financing policy $V^*(X) = V(X) + \phi F^*(X)$.[8] This in turn implies that $E(X) =$

[8]In the Appendix, we show that if a control challenge occurred off-equilibrium, the replacement manager would implement the same financing policy as the incumbent.

$V^*(X) - B(X) - \phi F^*(X)$, confirming our earlier claim that the aforementioned payout policy will be implemented by the manager.

Consider next financing decisions. In this paper, we follow Zwiebel (1996), Morellec (2004), and Lambrecht and Myers (2008) by considering that the manager has decision rights over financing policy. When selecting the coupon payment c and the restructuring threshold X_U, the objective of management is to maximize the value of its claims. In the analysis below, we assume that the manager owns a fraction φ of the firm's equity and that the proceeds from the debt issue are distributed on a pro rata basis to shareholders. The present value of the manager's cash flows, denoted by $\mathcal{M}(X)$, is then given by the sum of the proceeds from the debt issue and the present value of the cash flows received from the firm once debt has been issued. As a result, we can express the value of the manager's claims as $\mathcal{M}(X) = \varphi V(X) + \phi F^*(X)$ or

$$\mathcal{M}(X) = \underbrace{\varphi V^*(X)}_{\text{Equity stake}} + \underbrace{\phi (1-\varphi) F^*(X)}_{\text{PV of managerial rents}} \tag{12}$$

In equation (12), φ represents the fraction of the firm's equity owned by the manager and ϕ represents the fraction of the firm's net income that can be captured by the manager.

When determining the firm's financing policy, the objective of the manager is to choose $\{c, \rho\}$ to maximize the present value of the cash flows received from the firm, i.e $\mathcal{M}(X)$. Since $F^*(X)$ decreases with c, equation (12) implies that, whenever $\phi > 0$, the efficient choice of debt (optimal for shareholders) differs from the entrenchment choice (optimal for managers). In particular, the model predicts that the coupon payment decreases with ϕ and that the debt level selected by the manager is always *lower* than the debt level that maximizes firm value. In addition, the model predicts that some firms will be unlevered despite the tax benefit of debt. Finally, the selected default threshold results from a tradeoff between continuation values outside of default and the values of claims in default. Our model implies that all claims are scaled down by the same factor in default so that the manager and shareholders agree on the firm's default policy.[9] The selected default threshold can then be determined by solving the smooth-pasting condition satisfied at $X = \gamma X_0$ as in Leland (1998).

2.3 Model Predictions

The comparative statics for the dynamic model with agency costs are reported in Table 2. Input parameter values for our base case environment are set as follows: the risk-free interest rate $r = 4.21\%$, the initial value of the cash flow shock $X_0 = 1$, the growth rate and volatility of the cash flow shock $\mu = 1\%$ and $\sigma = 25\%$, the corporate tax rate $\tau^c = 35\%$, the tax rate on dividends $\tau^d = 11.6\%$, the tax rate on coupon payments $\tau^i = 29.3\%$, liquidation costs $\alpha = 50\%$, renegotiation costs $\kappa = 5\%$, shareholders' bargaining power $\eta = 50\%$, managerial incentives $\varphi = 7\%$, and the cost of control challenges $\phi = 1\%$. These parameter values are discussed in section 3 below.

The numerical results reported in Table 2 show that managerial entrenchment affects the selected debt level, the refinancing trigger, and the default trigger – and hence the frequency of capital structure changes and the likelihood of default. Specifically, high (low) managerial entrenchment leads to low (high) leverage and less (more) capital structure rebalancings. Figure 3 illustrates the comparative statics for the model-implied time-series distribution of leverage depending on various firm characteristics. Managerial entrenchment, measured by ϕ, lowers

[9] This follows from the fact that manager-shareholder conflicts are unaffected by default and that managers stay in control after default. The latter assumption allows us to reflect the fact that managers stay in control after debt is renegotiated privately or after court supervised debt renegotiation under Chapter 11 of the U.S. bankruptcy code (see e.g. Gilson (1989) for empirical evidence).

both the target leverage and the debt issuance trigger while it raises the default trigger. As a result, the range of leverage ratios widens with the degree of managerial entrenchment. We will use this property of the time-series distribution of leverage to identify ϕ in the data.

The intuition underlying this result is simple. In the dynamic model, debt restructurings adversely affect the manager's rents as the benefits of restructuring accrue to the shareholders. Cash distributions are made on a pro rata basis, so that when new debt is issued management gets a fraction φ of the distributions. Management's stake in the firm, however, exceeds direct ownership φ due to entrenchment ϕ, rendering restructurings less favorable to management than to shareholders. Debt also constrains managers by limiting the cash flows available as hidden rents (as in Jensen (1986), Zwiebel (1996), or Morellec (2004)). As a remedy, entrenched managers issue less debt (lower target and default boundary) and restructure less frequently (higher refinancing trigger) than optimal for shareholders.

High bargaining power leads to accelerated default, as shareholders capture a larger fraction of the surplus in default. Higher bargaining power also results in costlier debt as bondholders anticipate shareholders' strategic action in default and require a higher premium. An increase in the bargaining power of shareholders therefore decreases target leverage and the low and high restructuring bounds. As a result, the leverage distribution shifts to the left. Figure 3 also reveals that the cost of debt issuance affects predominantly the low leverage tail and has qualitatively similar effects as entrenchment on the distribution of leverage. The drift of cash flows affects neither the target nor the bounds but the dispersion in leverage. The volatility of cash flows impacts mainly the support of the distribution, with lower volatility narrowing the support (the option value of waiting to default or restructure being lower).

3 Empirical Analysis

In this section we take the model derived in Section 2 to the data. Specifically, we use observed financing choices to obtain firm-specific estimates of the degree of managerial entrenchment (as reflected by ϕ) and of shareholder's bargaining power in default (as reflected by η). In a second stage, we also show how these estimates vary across firms and economic conditions. Our objective is to empirically assess whether agency conflicts can explain the low- and zero-leverage puzzles as well as the time series of observed leverage ratios

The standard approach in the empirical capital structure literature is to specify in reduced form how cross-sectional determinants affect the conditional mean of leverage, including various proxies for internal and external governance mechanisms (see however Leary and Roberts (2005)). Observed leverage ratios, however, exhibit highly nonlinear behavior, including heteroskedasticity, asymmetry, fat tails, and truncation. These features are difficult to capture in standard linear regression studies – rendering standard least-squares estimates inconsistent. An additional complication is that the *target* leverage ratio, the main quantity of economic interest in most studies, typically does not correspond to the (un)conditional mean of leverage that is estimated in a standard regression. Finally, debt-to-equity ratios generally represent the cumulative result of years of separate decisions. Hence, cross-sectional tests based on a single aggregate are likely to have low power (see also Welch (2006)).

In this paper, we take a different route. Specifically, we exploit the structural restrictions of the dynamic model derived in Section 2. Our objective is to estimate from real data the degree of managerial entrenchment (or equivalently the cost of control challenges) that best explains observed financing behavior (a similar approach is used for example in Hennessy and Whited (2007)). In a second stage, we examine whether these estimates are related to a number of variables reflecting the quality of a firm's governance structure.

3.1 Estimation Strategy

Our identification strategy exploits the panel nature of the data and the model's predictions for different moments of leverage. For an individual firm, the model implies a specific time-series behavior of the firm's leverage ratio. The policy predictions include (but are not restricted to) the target leverage, the refinancing frequency, and default probability. In addition to the time-series predictions, the model yields comparative statics of the leverage distribution that predict how leverage varies in the cross-section of firms. We exploit both types of predictions to identify the parameters in the data and to disentangle cross-sectional heterogeneity from the impact of inertia on leverage.

The structural estimation we perform is based on the Maximum Likelihood principle. (Simulated) maximum likelihood estimation of the model parameters is more efficient than the simulated method of moments techniques (used for instance in Hennessy and Whited, 2007), but it is often practically infeasible. In our setting SML is tractable since for the model described in Section 2 we can derive an explicit expression for the (conditional and stationary) distribution function of financial leverage (see Appendix A 6.3).

In the analysis, each firm i is characterized by a set of parameters $\theta \in \Theta$ that determine the growth rate and volatility of the firm's cash flows, the firm's systematic risk exposure, as well as the cost of control challenges and the bargaining power of shareholders in default. The likelihood function $\mathcal{L}$ of the parameters θ given the data is based on the probability of observing the leverage ratio y_{it} for firm i at date t. Assume there are N firms in the sample and let n_i be the number of observations for firm i. The observations within the same firm are correlated due to autocorrelation in the cash flow process given by equation (1). Across firms, the model parameters are allowed to vary with observable characteristics, denoted by x_{it}, and with an unobserved firm-specific random effect ϵ_i that varies randomly, with distribution $f(\epsilon_i|\theta)$. We show below (section 4.4) that the measure of managerial entrenchment constructed from our empirical estimates of the parameters governing driving the distribution of ϵ_i is structurally related to a number of governance mechanisms.

Given these assumptions, the joint probability of observing the leverage ratios y_{it} for firm i at time t and the firm-specific unobserved effects ϵ_i, given the observable characteristics x_{it}, for $t = 1, \ldots, n_i$, is given by

$$\begin{aligned} f\left(y_i, \epsilon_i|\theta, x_i\right) &= f\left(y_i|\epsilon_i;\theta, x_i\right) f\left(\epsilon_i|\theta\right) \\ &= \left(f(y_{i1}|\epsilon_i;\theta, x_i) \prod_{t=2}^{n_i} f(y_{it}|y_{it-1}, \epsilon_i;\theta, x_i) \right) f\left(\epsilon_i|\theta\right). \end{aligned} \tag{13}$$

We obtain the (marginal) log-likelihood by integrating out the random effects from the joint likelihood $f\left(y, \epsilon|\theta, x\right) = \prod_{i=1}^{N} f\left(y_i, \epsilon_i|\theta, x_i\right)$. We get:

$$\begin{aligned} \ln \mathcal{L}\left(\theta; y, x\right) &= \ln \int_{\epsilon} f\left(y, \epsilon|\theta, x\right) d\epsilon \\ &= \sum_{i=1}^{N} \ln \int_{\epsilon_i} \left(f(y_{i1}|\epsilon_i;\theta, x_i) \prod_{t=2}^{n_i} f(y_{it}|y_{it-1}, \epsilon_i;\theta, x_i) \right) f\left(\epsilon_i|\theta\right) d\epsilon_i, \end{aligned} \tag{14}$$

since ϵ_i is drawn independently across firms from the distribution $f\left(\epsilon_i|\theta\right)$.

For the model described in Section 2, explicit expressions for the stationary and conditional densities $f(y_{it}|\theta, x_i)$ and $f(y_{it}|y_{it-1}, \epsilon_i;\theta, x_i)$ can be derived (see Appendix A 6.3). We evaluate the integral in equation (14) using Monte Carlo simulations.[10] The simulated maximum likelihood estimator is now defined as[11]:

$$\widehat{\theta} = \arg\max_{\theta} \ln \mathcal{L}(\theta).$$

This estimator answers the following question: What magnitude of agency costs best explains observed financing patterns?

3.2 Empirical Specification

The main focus of inference in the estimation is on the firm-specific estimates of the cost of control challenges ϕ. In the empirical specification, we allow ϕ to depend on both the observable characteristics x_{it} and the firm-specific unobserved determinants ϵ_i. In addition to ϕ, we also estimate shareholders' bargaining power in default, η.

In the empirical implementation, we need to specify the functional forms for $(\phi_{it}, \eta_{it}) \in [0,1]$. Our empirical specification of the key parameters is as follows:

$$\phi_{it} = h(x_{it}'\beta_\phi + \epsilon_i^\phi), \text{ and } \eta_{it} = h(x_{it}'\beta_\eta + \epsilon_i^\eta), \tag{15}$$

where $h = \Phi \in [0,1]$ is the cumulative standard normal distribution function.[12] The explanatory variables x_{it} capture observable determinants of ϕ and η, while the ϵ_i are bivariate random variables capturing the firm-specific unobserved heterogeneity. For all firms $i = 1, ..., N$, the firm-specific random effects are dis-

[10]The empirical analog to the log-likelihood can be expressed as

$$\ln \mathcal{L}(\theta) = \sum_{i=1}^{k} \ln \frac{1}{S} \sum_{s_i=1}^{S} \left(f(y_{i1}|\epsilon_i^{s_i}; \theta, x_i) \prod_{t=2}^{n_i} f(y_{it}|y_{it-1}, \epsilon_i^{s_i}; \theta, x_i) \right),$$

where S is the number of random draws per firm and $\epsilon_i^{s_i}$ is the realization in draw s_i for firm i.

[11]The results reported in the paper are based on the stationary density. Results based on the conditional density are similar and omitted for saving space.

[12]Alternatively, we have used the inverse logit transformation for h. The results are very similar and omitted.

tributed

$$\begin{pmatrix} \epsilon_i^\phi \\ \epsilon_i^\eta \end{pmatrix} \sim \mathcal{N}\left(0, \begin{bmatrix} \sigma_\phi^2 & \sigma_{\phi\eta} \\ \sigma_{\phi\eta} & \sigma_\eta^2 \end{bmatrix}\right). \tag{16}$$

Across firms, the $(\epsilon_i^\phi, \epsilon_i^\eta)$ are assumed independent for all i. This setup is sufficiently flexible to capture cross-sectional variation in the parameter values while imposing the model-implied structural restrictions on the domains of the parameters.

3.3 Data

Estimating the model derived in Section 2 requires merging data from various sources. We collect financial statements from Compustat, managerial compensation data from ExecuComp, stock price data from CRSP, analysts forecasts from I/B/E/S, governance data from IRRC (governance, directors and blockholders), and institutional ownership data from Thomson Financial. Following the literature, we remove all regulated (SIC $4900-4999$) and financial firms (SIC $6000-6999$). Observations with missing SIC code, total assets, market value, sales, long term debt, debt in current liabilities are also excluded from the final sample. In addition, we restrict our sample to firms that have total assets over 10 millions. As a result of these selection criteria, we obtain a panel dataset with $13,159$ observations for 809 firms, for the time period between 1992 and 2004 at the quarterly frequency.

The main parameters describing the firm characteristics are (m, μ, σ). The Institutional Brokers' Estimate System (I/B/E/S) provides analysts forecasts for the long-term growth rate m_i. We proxy the firm-specific growth rate of cash flows m_i by the mean long-term growth rate per industry, where we use SIC level 2 to define industries. For robustness, we also use the firm-specific five-year least squares annual growth rate of operating income before depreciation provided by

Compustat. The results are unchanged to the specification of m.

The firm's cash flow volatility can be written as $\sigma_{it} = \sigma_{it}^E \frac{\partial E_t}{\partial X_t} \frac{X_t}{E_t}$, where σ_{it}^E is the volatility of the firm's stock price and $\frac{\partial E_t}{\partial X_t}$ is computed using equation (11). Stock returns are obtained from the Center for Research in Security Prices (CRSP) database. For each firm, equity volatility is computed as the standard deviation of monthly equity returns over the past five years. We use the Capital Asset Pricing Model to obtain an estimate of μ_{it}. We obtain estimates of market betas from CRSP monthly equity returns. The firm- and time-specific estimates are based on 60 months rolling-window regressions. To capture any measurement error we specify a linear relation between the true parameter value and its empirical proxy, instead of equalizing them. We have the following specification:

$$\sigma_{it} = \alpha_\sigma + \beta_\sigma \widehat{\sigma}_{it}, \ m_{it} = \alpha_m + \beta_m \widehat{m}_{it}, \text{ and } \mu_{it} = m_{it} - \widehat{\beta}_{it} \widehat{\varkappa}_t, \tag{17}$$

where $\widehat{\varkappa}_t$ is the risk premium.

ExecuComp provides data on managerial compensation schemes, allowing us to measure the extent to which managerial incentives are aligned with shareholders' interests (as reflected by the parameter φ in our model). We construct firm-specific measures for the five highest paid executives. Following Core and Guay (1999), we construct the managerial *delta* – the sensitivity of option value to a one percent change in the stock price – and the managerial *vega* – the sensitivity of the option value to a one percent change in stock price volatility. In addition, following Jensen and Murphy (1990), we construct a managerial incentives measure, defined as the change in managerial wealth per dollar change in the wealth of shareholders. Our incentives measure thus accounts for both a direct component, managerial share ownership, and an indirect component, the pay-performance sensitivity due to options awards. A detailed description of the managerial incentives measure is provided in Appendix A 6.5.

The remaining parameters are standard. The risk free rate is based on the yield curve on Treasury bonds. The risk premium is set to the consensus value of 6%. The relevant tax rates are based on estimates of Graham (1996). We use the mean over the sample period for the tax rate on dividends and interest income, τ_d and τ_i, respectively. The tax rate on corporate income, τ_c, is set to 35%. Gilson and Lang (1990) find that renegotiation costs are economically insignificant. We thus fix renegotiation costs, κ, to zero and check for robustness by varying κ across specifications. Following Berger, Ofek, and Swary (1996), we define firm- and time-specific liquidation costs, α_{it}, as:

$$\alpha_{it} = 1 - (\text{Tangibility}_{it} + \text{Cash}_{it})/\text{Total Assets}_{it}. \tag{18}$$

In equation (18), Berger, Ofek, and Swary (1996) estimate tangibility as:

$$Tangibility_{it} = 0.715 * Receivables_{it} + 0.547 * Inventory_{it} + 0.535 * Capital_{it}.$$

The model is written in terms of debt issuance cost as a fraction of total debt outstanding (λ). Several empirical studies provide estimates for issuance costs as a function of the amount of debt issued. It is easy to show that in the model the cost of debt issuance as a fraction of the issue size is given by $\frac{\rho}{\rho-1}\lambda$, where ρ is the restructuring threshold multiplier. Since our estimates yield a mean value of 2 for ρ, we set the cost of debt issuance parameter to 0.5%. This number is consistent with the debt issuance cost estimates of 1.09% found by Altinkhic and Hansen (2000) and 1.29% found by Kim, Palia, and Saunders (2007). We also check for robustness by varying λ across specifications.

Tables 3 and 4 provide detailed definitions and descriptive statistics of the variables of interest.

4 Estimation Results

4.1 Dynamic Capital Structure without Agency Conflicts

Figure 4 plots the distribution of leverage across Compustat firms in our sample. Depending on the leverage measure, the peak of the distribution is between 0% and 20% and the distribution is highly skewed to the right. This illustrates that firms typically choose very low leverage ratios, but occasionally exhibit very high leverage ratios.

The classical dynamic trade-off theory proposed by Fischer, Heinkel, and Zechner (1989) and Goldstein, Ju, and Leland (2001) is a competing explanation to the agency theory for the conservative leverage observed in the data. In particular, as illustrated by Figure 3, an increase in refinancing costs has similar effects as an increase in agency costs on the times series distribution of financial leverage (it widens the support of the distribution and reduces its mean). Since the models mentioned above are nested in ours if we set $\phi_{it} = 0$ and $\eta_{it} = 0$, we can readily estimate the level of refinancing costs necessary to explain observed leverage choices using the procedure described in section 3. Figure 5 shows the histogram of the predicted cost of debt issuance, $\widehat{\mathbb{E}}(\lambda_{it}|y_{it}, x_{it}; \theta)$, in the dynamic capital structure model *without* agency conflicts. We obtain the predicted values from a separate structural estimation in which $\phi_{it} = 0$, $\eta_{it} = 0$ and λ_{it} is allowed to vary across firms as follows:

$$\lambda_{it} = h(x_{it}'\beta_\lambda + \epsilon_i^\lambda),$$

where ϵ_i^λ is a firm-specific unobserved determinant of λ_{it}.

The histogram in Figure 5 plots the cost of debt issuance for each firm-quarter as a fraction of the total debt outstanding. The estimates reveal that the cost of debt issuance would have to be in the order of 15% to 60% of the issue size, with typical value at around 25%. These numbers are unreasonably high and inconsistent with empirically observed values. Thus, while the dynamic capital structure theories that ignore agency conflicts can reproduce *qualitatively* the financing patterns observed in the data (see Strebulaev (2007)), they do not provide a reasonable *quantitative* explanation for firms' financing policies. In that respect, our results are in line with the recent study by LRZ (2008), who find that the traditional determinants of capital structure explain little of the observed variation in leverage ratios. The next section investigates whether the dynamic trade-off theory augmented by agency costs performs better than the standard explanations exclusively based on financing frictions.

4.2 The Estimated Cost of Control Challenge and Bargaining Power

We now turn to the estimation of the model with agency conflicts. Table 5 provides estimates of the structural parameters underlying the empirical specification described in section 3.2. The parameters representing the degree of managerial entrenchment and the bargaining power of shareholders in default are well identified in the data. The variance estimates for the random effects are economically and statistically significant. This suggests sizeable variation in the degree of managerial entrenchment and in the bargaining power of shareholders across firms. (We show in section 4.4 below that our measure of the degree of managerial entrenchment constructed from these parameter estimates is structurally related to a number of corporate governance mechanisms.) Moreover, the cross-sectional covariation between the degree of managerial entrenchment and shareholders' bargaining power is negative, suggesting that shareholders can extract a greater surplus from bondholders in default when managers and shareholders' interests are more aligned.[13] The auxiliary parameters capture the volatility and growth

[13] In unreported tests, we find that the bargaining power of shareholders decreases with R&D or the firm's market-to-book ratio and increases with asset size. These results are consistent

rate of cash flows. Our empirical proxy of cash flow volatility, $\widehat{\sigma}_{it}$, performs well. The parameter β_σ is close to one and statistically significant while α_σ is economically and statistically insignificant. The growth rate of cash flows is more difficult to estimate. This is reflected in the estimate of β_m close to zero.

Using the structural parameter estimates, we can construct firm-specific measures of the degree of managerial entrenchment and of shareholders' bargaining power in default. In Appendix A 6.4, we show that the conditional expectations of the cost of control challenges ϕ_{it} and shareholders' bargaining power η_{it}, given the data (y_{it}, x_{it}), satisfy:

$$\mathbb{E}[\phi_{it}|y_{it}, x_{it};\theta] = \frac{\int_{\epsilon_i^\eta}\int_{\epsilon_i^\phi} h(x'_{it}\beta_\phi + \epsilon_i^\phi) f(y_{it}|\epsilon_i^\phi, \epsilon_i^\eta, x_{it};\theta) f(\epsilon_i^\phi, \epsilon_i^\eta|x_{it};\theta) d\epsilon_i^\phi d\epsilon_i^\eta}{\int_{\epsilon_i^\eta}\int_{\epsilon_i^\phi} f(y_{it}|\epsilon_i^\phi, \epsilon_i^\eta, x_{it};\theta) f(\epsilon_i^\phi, \epsilon_i^\eta|x_{it};\theta) d\epsilon_i^\phi d\epsilon_i^\eta} \tag{19}$$

and

$$\mathbb{E}[\eta_{it}|y_{it}, x_{it};\theta] = \frac{\int_{\epsilon_i^\eta}\int_{\epsilon_i^\phi} h(x'_{it}\beta_\eta + \epsilon_i^\eta) f(y_{it}|\epsilon_i^\phi, \epsilon_i^\eta, x_{it};\theta) f(\epsilon_i^\phi, \epsilon_i^\eta|x_{it};\theta) d\epsilon_i^\phi d\epsilon_i^\eta}{\int_{\epsilon_i^\eta}\int_{\epsilon_i^\phi} f(y_{it}|\epsilon_i^\phi, \epsilon_i^\eta, x_{it};\theta) f(\epsilon_i^\phi, \epsilon_i^\eta|x_{it};\theta) d\epsilon_i^\phi d\epsilon_i^\eta}. \tag{20}$$

In these equations, $f(y_{it}|\epsilon_i^\phi, \epsilon_i^\eta, x_{it};\theta)$ is the distribution of leverage implied by the model and given in Appendix A 6.3, $f(\epsilon_i^\phi, \epsilon_i^\eta|x_{it};\theta)$ is a bivariate normal density, and θ are the estimated parameters. Equations (19) and (20) provide estimates of the cost of control challenges and of shareholders' bargaining power for each firm in our sample. We evaluate these expectations using Monte Carlo integration.

We present in Figure 6 histograms of the predicted cost of control challenges, $\mathbb{E}[\phi_{it}|y_{it}, x_{it};\theta]$, and the predicted bargaining power of shareholders in default, $\mathbb{E}[\eta_{it}|y_{it}, x_{it};\theta]$ for each firm-quarter. The results reported in Figure 6 imply sizeable variation in the degree of managerial entrenchment across firms. Hence, while our dynamic capital structure model suggests that leverage ratios should

with those of prior studies by Betker (1995) or Franks and Torous (1989). In Table 8 below, we show that these right hand side variables have the opposite effects on the manager's private benefits of control .

revert to the (manager's) target leverage over time, the differences in the degree of managerial entrenchment observed in Figure 6 should lead to persistent cross-sectional differences in leverage ratios.

Table 7 provides summary statistics for the predicted values of ϕ_{it} and η_{it}. In the basic specification, the mean (median) cost of control challenges is 5% (2.6%). Its distribution is strongly positively skewed and exhibits sizeable variance and kurtosis. The coefficient of variation is around one. The mean (median) predicted bargaining power of shareholders is 55% (55%). Given the magnitude of bankruptcy and renegotiation costs, this implies that shareholders can capture 25% of firm value by renegotiating outstanding claims in default. Importantly, the distribution of shareholders' bargaining power is bimodal, negatively skewed, and exhibits less variation and lower kurtosis than that of ϕ_{it}.

Overall the results suggest that small conflicts of interests between managers and shareholders are sufficient to resolve the leverage puzzles identified in the empirical literature and to explain the time series of observed leverage ratios. This in turn suggests that the trade-off theory augmented with agency costs performs orders of magnitude better than the standard explanations based *exclusively* on financing frictions.

4.3 Robustness Checks

In Table 5 we perform a set of robustness checks. First, we use the alternative definition of leverage and re-estimate the model. Second, we vary the cost of debt issuance and set it to 1%. This produces a cost of debt issuance representing 2% of the issue size, corresponding to the upper range of the values found in the empirical literature. Third, we set managerial incentives, φ, equal to management's equity ownership, neglecting option compensation. Fourth, we set the renegotiation cost of debt to 15% (Andrade and Kaplan (1997) estimate financial distress cost to be 10% to 20% of firm value).

The estimates reported in Table 5 exhibit similar features as in the base case. The parameters for the cost of control challenges are economically and statistically significant, and the cross-sectional variation in the bargaining power of shareholders is about three times the variation in the cost of control challenges. The correlation between the two parameters is negative except in the case of $\kappa = 15\%$. We do not have a clear explanation for this difference. Finally, cash flow volatility is well captured. The likelihood function is the highest in the base case, corroborating our choice of parameters.

Table 7 reports the predicted cost of control challenges, $\mathbb{E}[\phi_{it}|y_{it}, x_{it}; \theta]$, and the predicted bargaining power of shareholders, $\mathbb{E}[\eta_{it}|y_{it}, x_{it}; \theta]$ under the alternative specifications. The estimates of the degree of managerial entrenchment are larger under the alternative definition of leverage (which produces lower leverage ratios) and under the alternative ownership definition. The estimates are lower under larger restructuring and renegotiation costs since an increase in these costs lowers the predicted leverage ratios. The estimates of shareholders' bargaining power are larger under the alternative definition of ownership and renegotiation costs and lower under the alternative definition of leverage and restructuring costs. Overall, the variation across specifications is small and the order of magnitude remains unchanged, suggesting that our measures are robustly estimated.

In Appendix B, we report some additional empirical tests based on simulated data from the model that provide further support for our dynamic capital structure model with agency conflicts. Specifically, we simulate a number of dynamic economies and replicate the empirical analysis conducted by cross sectional capital structure studies. We show that the results of regressions on simulated data are consistent with those reported in the empirical literature.

4.4 The Determinants of entrenchment and financing decisions

Many studies have identified a number of factors that purport to explain variation in corporate capital structures. However, as shown by LRZ (2008), little of the (cross-sectional and time-series) variation in observed capital structures is captured by traditional determinants of financing decisions (such as size, market-to-book, profitability, ...). Instead, LRZ find that the majority of the variation in leverage ratios is driven by an unobserved firm-specific effect. This paper argues that one potential explanation for these findings is that managers have discretion over financing decisions, so that leverage ratios should determined not only by real market frictions but also by the degree of managerial entrenchment. In this section, we provide a test of this hypothesis by examining which factors affect the firm-specific estimates of the degree of managerial entrenchment obtained in the structural estimation. We classify the determinants of entrenchment into three groups: governance mechanisms, firm characteristics, and economic conditions. The definition and construction of the dependent and explanatory variables is summarized in Table 3. Table 4 provides the sample-wide means and standard deviations of these variables.

To relate our estimates of entrenchment (as reflected by ϕ_{it}) to the firms' governance structure, we use the data provided by the Investor Responsibility Research Center (IRRC) on various governance mechanisms. We use the data from IRRC to construct the Entrenchment index of Bebchuk, Cohen and Farell (2004), Eindex. The Eindex is based on six provisions followed by IRRC that describe shareholder rights.[14] One would expect firms with anti-takeover provisions

[14]These six provisions are staggered boards, limits to shareholder bylaw amendments, supermajority requirements for mergers, supermajority requirements for charter amendments, poison pills and golden parachutes.

(high Eindex) to have higher costs of control challenges and less debt. IRRC Blockholders provides data on blockholder ownership, an additional determinant of private benefits of control. In the analysis we use both the number of independent blockholders and their ownership share as governance indicators. As argued by Shleifer and Vishny (1986), the existence of large independent shareholders makes a takeover or a proxy contest easier. Thus, we expect the cost of control challenges to be negatively correlated with both of these measures. Finally, IRRC Directors provides data on directors' characteristics.

We build two proxies for board governance – board independence and board committees. Board independence represents the proportion of independent directors. Board committees is the sum of four dummy variables capturing the existence and independence (more than 50% of committee directors are independent) of audit, compensation, nominating, and corporate governance committees. These two measures are motivated by the SOX Act. Institutional ownership is another important governance mechanism. We collect data on institutional ownership from Thomson Financial. Our proxy for CEO power is CEO tenure, which we obtain from Execucomp.

In addition to these corporate governance variables, we include in our regressions standard control variables for other firm attributes. To control for company profitability, we use a returns on assets (ROA) variable defined as EBITDA divided by total assets at the start of the year. We measure firm size as the natural log of sales. Two variables are included to measure the uniqueness of assets: R&D (R&D expenses divided by total assets) and tangibility (PP&E net divided by total assets). Table 8 reports estimation results for the second stage regression of the predicted cost of control challenges, $\widehat{\mathbb{E}}[\phi_{it}|y_{it}, x_{it}; \theta]$, expressed in basis points, on various explanatory variables. Most of the control variables have signs in line with accepted theories and, to conserve space, we confine our discussion to those variables related to the hypothesis about the relation between managerial entrenchment and leverage.

External governance mechanisms, represented by institutional ownership and outside blockholder ownership, are negatively related to the cost of control challenges in Table 8, suggesting that independent outside monitoring of management is effective. In addition, the results suggest that institutional ownership and board blockholders act as monitoring complements. Anti-takeover provisions are another important external mechanism in governing corporate control. We employ the Eindex for anti-takeover provisions to construct dummy regressor "Eindex - Dictatorship", which equals one if the Eindex is above its mean, zero otherwise. In addition, we add the Inverse Mills Ratio to the regression specification – following Heckman's (1979) approach to control for endogeneity. The coefficient on Eindex - Dictatorship is positive and significant.[15] This is consistent with the notion that anti-takeover provisions lead to greater entrenchment.

Internal governance mechanisms are captured in Table 8 by different managerial characteristics and characteristics of the board of directors. CEO tenure intuitively proxies for CEO entrenchment. Across estimations, we consistently find a positive relation of CEO tenure with entrenchment. Not surprisingly, board independence – proxied by the number of independent directors or by the existence of independent audit, compensation, nominating, and corporate governance committees – is negatively related to the cost of control challenges. This is consistent with the intuition that a more independent board of directors is a stronger monitor of management.

The effect on private benefits of control of managerial delta, a proxy for managerial incentive alignment, is U-shaped and on average positive.[16] This is consis-

[15] We have run the regressions also with dummy "GIM index - Dictatorship". The coefficient estimates are mostly insignificant and available upon request from the authors.

[16] If having debt in the firm's capital structure increases shareholder wealth, one would expect leverage ratios to increase with managerial ownership. However, to the extent that managerial

tent with the incentives versus entrenchment literature [see Claessens, Djankov, Fan, and Lang (2002)]. Table 8 also reveals that, consistent with economic intuition, managerial entrenchment (proportionally) increases with firm performance, market-to-book ratio, research and development expenses, and tangibility and (proportionally) decreases with firm size. Economic conditions also affect the magnitude of manager-shareholder conflicts. The slope of the yield curve is positively and the credit spread is negatively related to managerial entrenchment.

Overall, two facts emerge from this analysis. First, we find that our estimates of the degree of managerial entrenchment are structurally related to a number of corporate governance mechanisms. Variables associated with stronger monitoring have negative connections with our firm-specific estimates of the cost of control challenges. Institutional ownership, anti-takeover provisions, and market-to-book have the largest impact on managerial entrenchment and, hence, on capital structure decisions. Second, the adjusted R-square from a regression of the predicted degree of managerial entrenchment on a number of firm specific and governance variables is 47%, highlighting the importance of accounting for governance and entrenchment measures in empirical tests of leverage ratios.

5 Conclusion

This paper uses structural econometrics to estimate the magnitude of conflicts of interests between managers and shareholders and their effects on financing

ownership protects management against outside pressures (Stulz (1988)), one would expect the cost of control challenge to increase and leverage to decrease with managerial ownership. To test this relation, we have performed the analysis on two subsamples, low (lowest quartile) and high (highest quartile) managerial delta. In the low managerial delta subsample, we find that an increase in delta yields lower entrenchment [coefficient -25.51 (2.63)]. In the high managerial delta subsample, an increase in delta yields higher entrenchment [coefficient 8.09 (10.81)]. The results are omitted for brevity and available upon request.

decisions. We build a dynamic contingent claims model in which financing policy results from a trade-off between tax benefits, agency conflicts, and contracting frictions. In our setting, managers do not act in the best interest of shareholders, but rather pursue private benefits at the expense of shareholders. Managers have discretion over financing and dividend policies. However, shareholders can remove the manager at a cost. Our analysis demonstrates that entrenched managers restructure less frequently and issue less debt than optimal for shareholders.

The paper provides new evidence on the relation between governance mechanisms and capital structure dynamics. Specifically, we take the model to the data and use observed financing choices to provide firm-specific estimates of the degree of managerial entrenchment, or, equivalently, of the cost of control challenges. We exploit not only the conditional mean of leverage (as in a regression) but also distributional tails – in short, the conditional moments of the time-series distribution of leverage. We find that costs of control challenges of 2-7% on average (.8-5% at median) are sufficient to resolve the low- and zero-leverage puzzles and explain the time series of observed leverage ratios. Our estimates of the agency costs vary with variables that one expects to determine managerial incentives. Governance mechanisms significantly affect the value of control and firms' financing decisions. This suggests that part of the heterogeneity in capital structures documented in Lemmon, Roberts, and Zender (2008) may be driven by the observed variation in the governance structure of firms.

6 Appendix A: Proofs and data definitions

6.1 Scaling property

We denote the values of equity and corporate debt by $E(X)$ and $B(X)$ respectively and assume that the net payoff to outside investors when they take control of the levered firm is $(1-\phi)\max[V(X)-B(X);0]$. Assuming that the firm has issued debt with coupon payment c, the cash flow accruing to shareholders over each interval of time of length dt under the conjectured payout policy is: $(1-\tau)(1-\phi)(X-c)dt$. In addition to this cash flow, shareholders receive capital gains of $\mathbb{E}[dE]$ over each time interval. The required rate of return for investing in the firm's equity is r. Applying Itô's lemma, it is then immediate to show that the value of equity satisfies for $X > X_B$:

$$rE = \frac{1}{2}\sigma^2 X^2 \frac{\partial^2 E}{\partial X^2} + \mu X \frac{\partial E}{\partial X} + (1-\tau)(1-\phi)(X-c).$$

The solution of this equation is

$$E(X) = AX^{\xi} + BX^{\nu} + \Pi(X) - (1-\tau)(1-\phi)\frac{c}{r},$$

where $\Pi(X)$ is defined in (3) and ξ and ν are the positive and negative roots of the equation $\frac{1}{2}\sigma^2 y(y-1) + \mu y - r = 0$. This ordinary differential equation is solved subject to the following two boundary conditions:

$$E(X)|_{X=X_B} = \eta(\alpha-\kappa)\Pi(X_B), \text{ and } \lim_{X\to\infty}[E(X)/X] < \infty.$$

The first condition equates the value of equity with the cash flow to shareholders in default. The second condition is a standard no-bubble condition. In addition to these two conditions, the value of equity satisfies the smooth pasting condition: $\partial E/\partial X|_{X=X_B} = \eta(\alpha-\kappa)\Pi_X(X_B)$ at the endogenous default threshold (see Leland (1994)). Solving this optimization problem yields the value of equity in the presence of manager-shareholder conflicts as

$$\begin{aligned} E(X,c) &= \Pi(X) - \frac{(1-\tau)(1-\phi)c}{r} - \\ &\quad \left\{[1-\eta(\alpha-\kappa)]\Pi(X_B) - \frac{(1-\tau)(1-\phi)c}{r}\right\}\left(\frac{X}{X_B}\right)^{\nu} \end{aligned}$$

In these equations, the tax rate $\tau = 1 - (1-\tau^c)(1-\tau^d)$ reflects both corporate and personal taxes and the default threshold X_B satisfies

$$X_B = \frac{\nu}{\nu-1}\,\frac{r-\mu}{r}\,\frac{c}{1-\eta(\alpha-\kappa)}.$$

Taking the trigger strategy X_B as given, the value of corporate debt satisfies in the region for the cash flow shock where there is no default

$$rB = \frac{1}{2}\sigma^2 X^2 \frac{\partial^2 B}{\partial X^2} + \mu X \frac{\partial B}{\partial X} + \left(1-\tau^i\right)c.$$

This equation is solved subject to the no-bubbles condition $\lim_{X\to\infty} B(X) = c/r$ and the value-matching condition $B(X)|_{X=X_B} = [1-\kappa-\eta(\alpha-\kappa)]\Pi(X_B)$. Solving this valuation problem gives the value of corporate debt as

$$\begin{aligned} B(X,c) &= \frac{(1-\tau^i)c}{r} - \\ &\quad \left\{\frac{(1-\tau^i)c}{r} - [1-\alpha+(1-\eta)(1-\phi)(\alpha-\kappa)]\Pi(X_B)\right\}\left(\frac{X}{X_B}\right)^{\nu}. \end{aligned}$$

Using the above expressions for the values of corporate securities, it is immediate to show that the present value $\mathcal{M}(X)$ of the cash flows that the manager gets from the firm satisfies:

$$\mathcal{M}(X) = [\varphi + \phi(1-\varphi)]\Pi(X) + \frac{(1-\tau^f)c}{r} - \left[\frac{(1-\tau^f)c}{r} + \zeta\Pi(X_B)\right]\left(\frac{X}{X_B}\right)^{\nu},$$

where $\zeta = \varphi\kappa + \phi[1-\varphi-(1-\phi\varphi\eta)(\alpha-\kappa)]$ measures the net cost of default for the manager (including the reduction in managerial rents occurring at the time of default). Plugging the expression for the default threshold in the manager's value function $\mathcal{M}(X)$, it is immediate to show that $\mathcal{M}(X)$ is concave in c. As a result, the selected coupon payment can be derived using the first order condition: $\partial \mathcal{M}(X_0)/\partial c = 0$. Solving this FOC yields

$$c = X_0 \left(\frac{\nu - 1}{\nu}\right) \frac{r\left[1 - \eta(\alpha - \kappa)\right]}{r - \mu} \left[1 - \nu - \frac{1 - \tau}{1 - \tau^f} \frac{\nu\zeta}{1 - \eta(\alpha - \kappa)}\right]^{\frac{1}{\nu}}.$$

These expressions demonstrate that in the static model the default threshold X_B is linear in c. In addition, the selected coupon rate c is linear in X. This implies that if two firms i and j are identical except that $X_0^i = \theta X_0^j$, then the optimal coupon rate and default threshold $c^i = \theta c^j$ and $X_B^i = \theta X_B^j$, and every claim will be larger by the same factor θ.

6.2 Off-equilibrium restructurings

Index by n the managers over the lifetime of the firm. Assume that the cost of a control challenge in round n is proportional to the present value of cash flows $F_n^*(X)$ and equal to

$$Cost_n(X) = (\phi_n - \phi_{n+1})F_n^*(X),$$

where ϕ_n, $n \in \mathbb{N}$, are constant coefficients. For the cost to be positive, we require $0 < \phi_{n+1} < \phi_n < 1$. If the cost coefficient ϕ_n decreases by a constant fraction δ every round, we can also write $Cost_n(X) = \phi_n \delta F^*(X)$. In general, an increase in managerial ownership implies a better alignment of managers' incentives with shareholders' interests as well as an increased cost of removing management. To capture this intuition, we let the cost of collective action be proportional to managerial ownership (relative to ownership by outsiders) in the following way:

$$\phi_n = \chi \left(\frac{\varphi_n}{1 - \varphi_n}\right) \text{ for all } n,$$

where χ is a positive constant and φ denotes management's share ownership.

Denote by $\psi_n(X)$ the fraction of cash flows diverted by management. We now guess and verify that the manager optimally steals a constant fraction $\psi_n(X) =$

ϕ_n of cash flows. Under this conjecture, shareholders in round n realize

$$E_n(X) = V_n^*(X) - B_n(X) - \phi_n F_n^*(X). \tag{21}$$

Managerial rents in round n are given by

$$R_n(X) = \varphi_n V_n^*(X) + \phi_n (1 - \varphi_n) F_n^*(X) = \varphi_n [V_n^*(X) + \chi F_n^*(X)].$$

Since the weights on V^* and F^* are the same for all n, the leverage and the restructuring policies (c_n, γ_n, ρ_n) chosen by every manager will be identical and independent of n. We then have $V_n^*(X) = V_{n+1}^*(X)$, $B_n(X) = B_{n+1}(X)$, and $F_n^*(X) = F_{n+1}^*(X)$ for all n and X.

Upon a control challenge in round n, shareholders realize in round $n+1$

$$V_{n+1}^*(X) - B_{n+1}(X) - \psi_{n+1}(X) F_{n+1}^*(X) - Cost_n(X) = V^*(X) - B(X) - \phi_n F^*(X),$$

where again management diverts a constant fraction $\psi_{n+1}(X) = \phi_{n+1}$ of cash flows. This expression coincides for all X with the equity valuation (21) before a control challenge. Shareholders are therefore indifferent between keeping and replacing the current manager for all X. The manager cannot extract more rents because of the threat of being fired but the manager does not want to extract less rents either. The conjectured policy of capturing a constant fraction $\psi_n(X) = \phi_n$ for all X and n is therefore optimal.

6.3 Time-Series Distribution of Leverage

In the following we derive the time-series distribution of the leverage ratio y_t. The leverage ratio y_t being a monotonic function of the interest coverage ratio $x_t \equiv X_t/c_t$, we can write $y_t = L(x_t)$ with $L : \mathbb{R}^+ \to \mathbb{R}^+$ and $L' < 0$. The process for x_t follows a Brownian Motion with drift μ and volatility σ, that is regulated at both the lower boundary x_B and the upper boundary x_U. The process x_t is reset to the target level $x_S \in (x_B, x_U)$ whenever it reaches either x_B or x_U. The target leverage ratio can be expressed as $L(x_S)$. Denote the restructuring date by $\tau = \min(\tau_B, \tau_U)$, where for $i = B, U$ the random variable τ_i is defined by $\tau_i = \inf\{t \geq 0 : x_t = x_i\}$. Let $f_x(x)$ be the density of the interest coverage ratio. The density of leverage can be written in terms of f_x and the Jacobian of L^{-1} as follows:

$$f_y(y) = f_x\left(L^{-1}(y)\right)\left|\frac{\partial}{\partial y}L^{-1}(y)\right| = f_x\left(L^{-1}(y)\right)\left|\left(\frac{\partial y}{\partial L^{-1}(y)}\right)^{-1}\right|. \tag{22}$$

To compute the time-series distribution of leverage, we need the functional form of the density of the interest coverage ratio f_x. The latter can be determined as follows.

Stationary density

To determine f_x we first need to derive the distribution of occupation times of the process x_t in closed intervals of the form $[x_B, x]$, for any $x \in [x_B, x_U]$. For every Borel set $B \in \mathcal{B}(\mathbb{R})$, we define the occupation time of B by the Brownian Z path up to time t as

$$\Gamma_t([x_B, x]) \triangleq \int_0^t 1_B(Z_s)\,ds = \text{meas}\{0 \leq s \leq t : Z_s \in B\}$$

where meas denotes Lebesgue measure. We will be interested in the occupation time of the closed interval $[x_B, x_U]$ by the interest coverage ratio x given by $\Gamma_t([x_B, x])$. Let $G(x, x_0)$, with initial value x_0 equal to the target value x_S for the interval $[x_B, x]$, be defined by:

$$G(x, x_0) = \mathbb{E}^{\mathcal{Q}}_{x_0}[\Gamma_\tau([x_B, x])].$$

Using the strong Markov property of Brownian motion, we can write

$$G(x, x_0) = \mathbb{E}^{\mathcal{Q}}_{x_0}\left[\int_0^\infty 1_{[x_B,x]}(x_s)\,ds\right] - \sum_{i,j=U,B,i\neq j}\mathbb{E}^{\mathcal{Q}}_{x_0}[1_{\tau_i<\tau_j}]\,\mathbb{E}^{\mathcal{Q}}_{x_i}\left[\int_0^\infty 1_{[x_B,x]}(x_s)\,ds\right].$$

To compute $G(x, x_0)$, we will use the following lemma (Karatzas and Shreve (1991) pp 272).

Lemma 12 *If $f:\mathbb{R}\to\mathbb{R}$ is a piecewise continuous function with*

$$\int_{-\infty}^{+\infty} |f(x+y)|\, e^{-|y|\sqrt{2\gamma}} dy < \infty; \forall x \in \mathbb{R},$$

for some constant $\gamma > 0$, and $(Z_t, t \geq 0)$ is a standard Brownian motion, then the resolvent operator of Brownian motion, $K_\gamma(f) \equiv \mathbb{E}[\int_0^{+\infty} e^{-\gamma t} f(Z_t)\, dt]$, equals

$$K_\gamma(f) = \frac{1}{\sqrt{2\gamma}} \int_{-\infty}^{+\infty} f(y)\, e^{-|y|\sqrt{2\gamma}} dy.$$

Let $b = \frac{1}{\sigma}(\mu - \frac{\sigma^2}{2})$, $\vartheta = -\frac{2b}{\sigma}$, and $h(x,y) = \ln(x/y)$. Using the above Lemma, we obtain after simple but lengthy calculations the following expression for the occupation time measure (similar calculations can be found e.g. in Morellec (2004)):

$$G(x, x_0) = \begin{cases} \frac{1}{2b^2}\left[e^{\vartheta h(x_0,x)} - e^{\vartheta h(x_0,x_B)}\right] - \frac{p_B}{b\sigma} \ln\left(\frac{x}{x_B}\right) \\ -\frac{p_U}{2b^2}\left[e^{\vartheta h(x_U,x)} - e^{\vartheta h(x_U,x_B)}\right], \quad \text{for } x \leq x_0, \\ \frac{1}{2b^2}\left[1 - e^{\vartheta h(x_0,x_B)}\right] + \frac{1}{b\sigma}\ln\left(\frac{x}{x_0}\right) - \frac{p_B}{b\sigma}\ln\left(\frac{x}{x_B}\right) \\ -\frac{p_U}{2b^2}\left[e^{\vartheta h(x_U,x)} - e^{\vartheta h(x_U,x_B)}\right], \quad \text{for } x > x_0, \end{cases} \tag{23}$$

where

$$p_B = \frac{x_0^\vartheta - x_U^\vartheta}{x_B^\vartheta - x_U^\vartheta} \text{ and } p_U = \frac{x_0^\vartheta - x_B^\vartheta}{x_U^\vartheta - x_B^\vartheta}. \tag{24}$$

The stationary density function of the interest coverage ratio x_t is now given by

$$f_x(x) = \frac{\frac{\partial}{\partial x} G(x, x_0)}{G(x_U, x_0)}. \tag{25}$$

Conditional density

To implement our empirical procedure, we also need to compute the conditional distribution of leverage at time t given its value at initial date 0 (in the data we observe leverage ratios at quarterly frequency). To determine this conditional density, we first compute the conditional density of the interest coverage ratio $x_t = X_t/c_t$ at time t given its value x_0 at time 0, $\mathbb{P}(x_t \in dx|x_0)$, and then apply the transformation (22). For ease of exposition, introduce the regulated arithmetic Brownian motion $W_t = \frac{1}{\sigma}\ln(x_t)$ with initial value $w = \frac{1}{\sigma}\ln(x_0)$, drift $b = \frac{1}{\sigma}(\mu - \frac{\sigma^2}{2})$ and unit variance, and define the upper and lower boundaries as $H = \frac{1}{\sigma}\ln(x_U)$ and $L = \frac{1}{\sigma}\ln(x_B)$, respectively. Denote the first exit time of the interval (L, H) by

$$\tau_{L,H} = \inf\{t \geq 0 : W_t \notin (L, H)\}.$$

The conditional distribution F_x of the interest coverage ratio x is then related to that of the arithmetic Brownian motion W by the following relation:

$$F_x(x|x_0) = \mathbb{P}(W_t \leq \frac{1}{\sigma}\ln(x)|W_0^b = w). \tag{26}$$

Given that the interest coverage ratio is reset to the level x_S whenever it reaches the boundaries, W is regulated at L and H, with reset level at $S = \frac{1}{\sigma}\ln(x_S)$ and we can write its dynamics as

$$dW_t = bdt + dZ_t + 1_{\{W_{t-}=L\}}(S - L) + 1_{\{W_{t-}=H\}}(S - H).$$

We would like to compute the cumulative distribution function of the process W at some horizon t:

$$G(w, y, t) \equiv \mathbb{P}(W_t \leq y|w) = \mathbb{E}_w[1_{\{W_t \leq y\}}], \quad (w, y, t) \in [L, H]^2 \times (0, \infty). \tag{27}$$

Rather than trying to compute this probability directly, consider its Laplace transform in time (for notational convenience we drop the dependence of $\mathbb{L}$ on λ):

$$\begin{aligned} \mathbb{L}(w, y) &= \int_0^\infty e^{-\lambda t} G(w, y, t)dt \\ &= \int_0^\infty e^{-\lambda t}\mathbb{E}_w[1_{\{W_t \leq y\}}]dt = \mathbb{E}_w[\int_0^\infty e^{-\lambda t} 1_{\{W_t \leq y\}}dt]. \end{aligned} \tag{28}$$

The second equality in (28) follows from the boundedness of the integrand and Fubini's theorem. Since the process is instantly set back at S when it reaches either of the barriers, we must have that

$$\mathbb{L}(H, y) = \mathbb{L}(L, y) = \mathbb{L}(S, y) \text{ for all } y. \tag{29}$$

Now let $W_t^0 = w + bt + Z_t$ denote the unregulated process. Using the Markov property of W and the fact that W and W^0 coincide up to the first exit time of W^0 from the interval $[L, H]$, we deduce that the function $\mathbb{L}$ satisfies

$$\mathbb{L}(w, y) = \Psi(w, y) + \mathbb{L}(S, y)\Phi(w), \tag{30}$$

where we have set

$$\Psi(w, y) = \mathbb{E}_w[\int_0^{\tau_{L,H}} e^{-\lambda t} 1_{\{W_t^0 \le y\}} dt] \text{ and } \Phi(w) = \mathbb{E}_w[e^{-\lambda \tau_{L,H}}].$$

Setting $w = S$ and solving for $\mathbb{L}(S, y)$ we obtain

$$\mathbb{L}(S, y) = \frac{\Psi(S, y)}{1 - \Phi(S)}. \tag{31}$$

Plugging this back into the equation for $\mathbb{L}$ shows that the desired boundary condition is satisfied.

We now have to solve for Φ and Ψ. The Feynman-Kac formula shows that the function Ψ is the unique bounded and *a.e.* $\mathcal{C}^1$ solution to the second order differential equation

$$\frac{1}{2} \frac{\partial^2}{(\partial w)^2} \Psi(w, y) + b \frac{\partial}{\partial w} \Psi(w, y) - \lambda \Psi(w, y) + 1_{\{w \le y\}} = 0 \tag{32}$$

on the interval (H, L) subject to the boundary condition $\Psi(H, y) = \Psi(L, y) = 0$. Solving this equation, we find that the function Ψ is given by

$$\Psi(w, y) = \begin{cases} \Lambda(w) + A_L(y)\Delta_L(w), & \text{if } w \in [L, y], \\ A_H(y)\Delta_H(w), & \text{if } w \in [y, H], \end{cases} \tag{33}$$

where we have set

$$\Lambda(w) = \frac{1}{\lambda}[1 - e^{(v+b)(L-w)}], \text{ and } \Delta_{L,H}(w) = e^{(v-b)w}[1 - e^{2v((L,H)-w)}], \tag{34}$$

with $\upsilon = \upsilon(\lambda) = \sqrt{b^2 + 2\lambda}$. Because the function $1_{\{w \le y\}}$ is (piecewise) continuous, the function $\Psi(w, y)$ is piecewise $\mathcal{C}^2$ (see Theorem 4.9 pp. 271 in Karatzas and Shreve, 1991). Therefore, $\Psi(w, y)$ is $\mathcal{C}^0$ and $\mathcal{C}^1$ and satisfies the continuity and smoothness conditions at the point $w = y$. This gives

$$\Lambda(y) + A_L \Delta_L(y) = A_H \Delta_H(y), \text{ and } \Lambda'(y) + A_L \Delta'_L(y) = A_H \Delta'_H(y).$$

Solving this system of two linear equations, we obtain the desired constants as

$$\begin{aligned} A_L &= A_L(y, \lambda) = \frac{\Lambda(y)\Delta'_H(y) - \Lambda'(y)\Delta_H(y)}{\Delta_H(y)\Delta'_L(y) - \Delta_L(y)\Delta'_H(y)}, && (35) \\ A_H &= A_H(y, \lambda) = \frac{\Lambda(y)\Delta'_L(y) - \Lambda'(y)\Delta_L(y)}{\Delta_H(y)\Delta'_L(y) - \Delta_L(y)\Delta'_H(y)}. && (36) \end{aligned}$$

Let us now turn to the computation of Φ. The Feynman-Kac formula shows that the function Φ is the unique bounded and *a.e.* $\mathcal{C}^1$ solution to the second order differential equation

$$\frac{1}{2}\Phi''(w) + b\Phi'(w) - \lambda\Phi(w) = 0 \tag{37}$$

on the interval (H, L) subject to the boundary condition $\Phi(H) = \Phi(L) = 1$. Solving this equation, we find that the function Φ is given by

$$\Phi(w) = B_L \Delta_L(w) + B_H \Delta_H(w), \tag{38}$$

where

$$B_L = B_L(\lambda) = -\frac{e^{(\upsilon+b)H}}{e^{2\upsilon L} - e^{2\upsilon H}}, \text{ and } B_H = B_H(\lambda) = \frac{e^{(\upsilon+b)L}}{e^{2\upsilon L} - e^{2\upsilon H}}. \tag{39}$$

The conditional density function $g(w, y, t) = \frac{\partial}{\partial y} G(w, y, t)$ can be obtained by differentiating the Laplace transform (28) with respect to y. We obtain

$$\begin{aligned} \frac{\partial}{\partial y}\mathbb{L}(w, y) &= \int_0^\infty e^{-\lambda t} g(w, y, t) dt \\ &= \frac{\partial}{\partial y}\Psi(w, y) + \frac{\Phi(w)}{1 - \Phi(S)} \frac{\partial}{\partial y}\Psi(S, y), && (40) \end{aligned}$$

where

$$\frac{\partial}{\partial y}\Psi(w,y)=\begin{cases} A_L'(y)\Delta_L(w), & \text{if } w\in[L,y],\\ A_H'(y)\Delta_H(w), & \text{if } w\in[y,H],\end{cases}$$

and

$$\begin{aligned} A_L'(y) &= \left(\frac{A_H(y)\Delta_H''(y)-A_L(y)\Delta_L''(y)-\Lambda''(y)}{\Delta_H(y)\Delta_L'(y)-\Delta_L(y)\Delta_H'(y)}\right)\Delta_H(y), && (41)\\ A_H'(y) &= \left(\frac{A_H(y)\Delta_H''(y)-A_L(y)\Delta_L''(y)-\Lambda''(y)}{\Delta_H(y)\Delta_L'(y)-\Delta_L(y)\Delta_H'(y)}\right)\Delta_L(y). && (42)\end{aligned}$$

The last step involves the inversion of the Laplace transform (40) for $g(w,y,t)$ using standard numerical methods.

Jacobian of L^{-1}

Quasi-market leverage is defined by

$$y_t \equiv \frac{D(X_0)}{D(X_0)+E(X_t)},$$

where the book value of debt equals $D(X_0)$ and the market value of equity at time t for $X_t=X$ is given by equation (11).We now have

$$\frac{\partial y_t}{\partial L^{-1}(y_t)}=-D(X_0)\left[D(X_0)+E(X)\right]^{-2}\frac{\partial E(X)}{\partial X},$$

with

$$\begin{aligned}\frac{\partial E(X)}{\partial X} &= \frac{\partial e(X)}{\partial X}+\left[\frac{X_U}{X_0}V(X_0)-D(X_0)\right]\frac{\partial p_U(X)}{\partial X}\\ &\quad +\frac{X_B}{X_0}\eta(\alpha-\kappa)V(X_0)\frac{\partial p_U(X)}{\partial X}.\end{aligned}$$

6.4 Conditional Predictions of the Structural Parameters

Leverage is denoted y_{it}, the explanatory variables are x_{it} and the parameter vector is θ; subscript i refers to a firm and t to a date. Conditional expectations of shareholders' bargaining power given the data (y_{it}, x_{it}) satisfy:

$$\begin{aligned} \mathbb{E}[\eta_{it}|y_{it}, x_{it}; \theta] &= \mathbb{E}[h(x'_{it}\beta_\eta + \epsilon_i^\eta)|y_{it}, x_{it}; \theta] \\ &= \int_{\epsilon_i^\eta}\int_{\epsilon_i^\phi} h(x'_{it}\beta_\eta + \epsilon_i^\eta) f(\epsilon_i^\phi, \epsilon_i^\eta | y_{it}, x_{it}; \theta) d\epsilon_i^\phi d\epsilon_i^\eta \\ &= \int_{\epsilon_i^\eta}\int_{\epsilon_i^\phi} h(x'_{it}\beta_\eta + \epsilon_i^\eta) \frac{f(\epsilon_i^\phi, \epsilon_i^\eta, y_{it}|x_{it}; \theta)}{f(y_{it}|x_{it}; \theta)} d\epsilon_i^\phi d\epsilon_i^\eta \\ &= \frac{\int_{\epsilon_i^\eta}\int_{\epsilon_i^\phi} h(x'_{it}\beta_\eta + \epsilon_i^\eta) f(y_{it}|\epsilon_i^\phi, \epsilon_i^\eta, x_{it}; \theta) f(\epsilon_i^\phi, \epsilon_i^\eta | x_{it}; \theta) d\epsilon_i^\phi d\epsilon_i^\eta}{\int_{\epsilon_i^\eta}\int_{\epsilon_i^\phi} f(y_{it}|\epsilon_i^\phi, \epsilon_i^\eta, x_{it}; \theta) f(\epsilon_i^\phi, \epsilon_i^\eta | x_{it}; \theta) d\epsilon_i^\phi d\epsilon_i^\eta}, \end{aligned} \tag{43}$$

where $f(y_{it}|\epsilon_i^\phi, \epsilon_i^\eta, x_{it}; \theta)$ is given by (22) and $f(\epsilon_i^\phi, \epsilon_i^\eta|x_{it}; \theta)$ is a bivariate normal distribution. The conditional expectation of the manager's private benefits of control satisfies a similar expression with η replaced by ϕ. Given parameter estimates for θ obtained in a first stage SML estimation, the expression in (43) can be evaluated using Monte-Carlo integration.

One can show that these conditional expectations are unbiased. Let z_{it} be omitted explanatory variables. Then

$$\mathbb{E}[g_{it}|y_{it}, x_{it}, z_{it}; \theta] = \mathbb{E}[g_{it}|y_{it}, x_{it}; \theta] + e_{it},$$

where $g \in \{\phi, \eta\}$ with the following moment condition on the error e_{it}:

$$\begin{aligned} \mathbb{E}(e_{it}|y_{it}, x_{it}; \theta) &= \mathbb{E}(\mathbb{E}(g_{it}|y_{it}, x_{it}, z_{it}; \theta) - \mathbb{E}(g_{it}|y_{it}, x_{it}; \theta)|y_{it}, x_{it}; \theta) \\ &= \mathbb{E}(\mathbb{E}(g_{it}|y_{it}, x_{it}, z_{it}; \theta)|y_{it}, x_{it}; \theta) - \mathbb{E}(\mathbb{E}(g_{it}|y_{it}, x_{it}; \theta)|y_{it}, x_{it}; \theta) \\ &= 0. \end{aligned}$$

6.5 Data Definitions

Managerial pay-performance sensitivity *delta* and *vega*

We compute both the *delta* – the sensitivity of the option value to a change in the stock price – and the *vega* – the sensitivity of the option value to a change in stock price volatility – based on the Black-Scholes (1973) formula for European call options, as modified to account for dividend payouts by Merton (1973):

$$\text{Call } = Se^{-dT}N(Z) - Xe^{-rT}N(Z - \sigma T^{1/2}),$$

where $Z = [\ln(S/X) + (r - d + \sigma^2/2)\,T] \,/\, \left(\sigma T^{1/2}\right)$, S is the price of the underlying stock, X the exercise price of the option, T the time-to-maturity of the option in years, r the risk-free interest rate, d the expected dividend yield on the underlying stock, σ expected stock return volatility, and N is the standard normal probability distribution function.

We follow the methodology of Core and Guay (1999) to compute *delta* and *vega*. There are four type of securities: new option grants, previous unexercisable options, previous exercisable options and portfolio of stocks. In order to avoid double counting of the new option grants, the number and realizable value of previous unexercisable options is reduced by the number and realizable value of new option grants. If the number of new option grants is greater than the number of previous unexercisable options, then the number and realizable value of previous exercisable options is reduced by the difference between the number and realizable value of new option grants and previous exercisable options.

Managerial delta is computed as the sum of *delta* of new option grants, *delta* of previous unexercisable options, *delta* of previous exercisable options and *delta* of portfolio of stock. Managerial *vega* is computed as the sum of *vega* of new option grants, *vega* of previous unexercisable options and *vega* of previous exercisable options where we define:

1. **New option grants:** S, K, T, d, and σ are available from ExecuComp. The risk-free rate r is obtained from the Federal Reserve, where we use one-year bond yield for $T = 1$, two-year bond for $2 \leq T \leq 3$, five-year bond yield for $4 \leq T \leq 5$, seven year bond yield for $6 \leq T \leq 8$ and ten-year bond yield for $T \geq 9$.

2. **Previous unexercisable options:** S, d, σ and r are obtained as explained above. The strike price K is estimate as: [stock price - (realizable value/number of options)]. Time-to-maturity, T, is estimated as one year less than time-to-maturity of new options grants or nine years if no new grants are made.

3. **Previous exercisable options:** S, d, σ and r are obtained as explained above. The strike price K is estimated as: K = [stock price - (realizable value/number of options)]. Time-to-maturity, T, is estimated as three years less than the time-to-maturity of unexercisable options or six years if no new grants are made.

4. **Portfolio of stocks:** *delta* is estimated by the product of the number of stocks owned and one percent of stock value. *vega* is assumed to be zero.

Managerial incentive alignment φ

Managerial incentives are defined as the change in managerial wealth per dollar change in the wealth of shareholders. Incentives are thus composed of a direct component, managerial ownership and an indirect component, the pay-performance sensitivity generated by options awards. Following Jensen and Murphy (1990), we define managerial incentives, φ, as:

$$\varphi = \varphi^E + delta \frac{\text{shares represented by options awards}}{\text{shares outstanding}},$$

where φ^E represents managerial ownership and *delta* is computed as above.

7 Appendix B: Simulated Evidence

The objective of this Appendix is to analyze the cross-sectional properties of leverage ratios in our dynamic economy with agency conflicts. We follow the simulation approach of Berk, Green and Naik (1999) and Strebulaev (2007) among others. Specifically, we simulate a number of dynamic economies and replicate the empirical analysis conducted by cross sectional capital structure studies. One important innovation in this section is that we base our simulation on the parameter estimates of section 4 instead of using "calibrated" parameter values as in previous studies.[17]

The simulation procedure is defined as follows. The initial input parameter values are based on the structural estimation of section 4. The cost of control challenges, ϕ, and bargaining power of shareholders, η, are determined by a single draw of the unobserved heterogeneity random effect. At date zero all firms are at their target leverage. We then simulate 75 years of quarterly data. The first 40 years of data are dropped in order to minimize the impact of initial conditions. The resulting dataset represents a single simulated economy. We run the tests analyzing the cross-sectional properties of leverage ratios on this simulated economy. Finally, we simulate 1000 economies, each characterized by a different draw of the unobserved heterogeneity random effect. The results that we report are means over those 1000 economies. We now turn to the comparison of the results of regressions on simulated data to the results of empirical cross-sectional research.

[17] In fact Strebulaev (2007, pp1763) notes "An important caveat is that for most parameters of interest, there is little evidence permitting precise estimation of sampling distributions or even their ranges [...] Overall then, the parameters used in the simulations must be regarded as ad hoc and approximate."

7.1 Leverage Inertia

We start by investigating the link between capital structure and stock returns. Welch (2004) documents that firms do not rebalance their capital structure in order to offset the mechanistic effect of stock price movements on firms' leverage ratios. He shows that for short horizons the dynamics of leverage ratios are solely determined by stock returns. While this effect attenuates with time, it still remains the main driving force behind leverage ratio changes.

We investigate to what extend this mechanistic effect is reflected in our model. To do so, we replicate Welch's analysis on the simulated data. We run a Fama-MacBeth regression of leverage on past leverage and the implied debt ratio (IDR). The IDR indicates how much leverage should be if no corporate issuance takes place, or how much leverage should change only due to changes in equity. More formally, we estimate the following model:

$$L_t = \alpha_0 + \alpha_1 L_{t-k} + \alpha_2 IDR_{t-k,t} + \epsilon_t$$

where L is the Leverage ratio and k denotes the time horizon in years. In this equation, IDR is the implied debt ratio that comes about if the firm does not issue debt or equity (and let leverage ratios change with stock price movements). If α_1 is equal to 1, firms perfectly offset stock price movements by issuing debt or equity. If α_2 is equal to 1, firms do not readjust their capital structure at all following stock price movements.

Table 9 reports our results. We observe that the estimates based on the simulated data from our model closely match Welch's estimates based on real data. For 1 year time horizon, the ADR coefficient is close to 1. For longer time-horizons, this coefficient is monotonically decreasing. We also observe that our estimates are slightly higher and better replicate real data than those reported by Strebulaev (2007). This was expected since, in our model, managerial entrenchment leads to less frequent capital structure rebalancing and thus more inertia in leverage dynamics.

7.2 Mean Reversion in Leverage

Mean-reversion is another well documented pattern of leverage ratios [see Fama and French (2002) and Flannery and Rangan (2006)]. Following Fama and French (2002), we perform a Fama-MacBeth estimation of the partial-adjustment model:

$$L_t - L_{t-1} = \alpha + \lambda_1 TL_{t-1} + \lambda_2 L_{t-1} + \epsilon_t$$

where L is Leverage and TL is firm's Target Leverage. If λ_1 is equal to 1, firms perfectly readjust leverage to the target. If λ_2 is equal to -1, firms are completely inactive. The partial-adjustment model predicts that λ_1 and λ_2 are equal in absolute value and measures the speed of adjustment by λ_1. In this specification, TL is determined in a preliminary step by estimating the following equation

$$L^m = a_0 + a_1\pi^m + a_2\sigma + a_3\alpha + a_4\eta + a_5\varphi + a_6\phi + \epsilon \tag{44}$$

where L is the leverage ratio, π is profitability and remaining independent variables are firms specific characteristics. In our setup, profitability is defined as: $\pi_t = [X_t + \Delta A_t]/A_{t-1}$, where X is cash flows from operation and A is the book value of assets. Following Strebulaev (2007), we assume that the book value of assets and cash flows from operation have the same drift under the physical measure. Table 10 reports our results.

As shown in Table 10, leverage is mean-reverting at the speed of 6% per year, which is close to the mean-reversion coefficient of 7% reported by Fama-French (2002) for dividend payers. As in Fama and French, the average slopes on lagged leverage are similar in absolute value to those on target leverage and are therefore consistent with the partial adjustment model.

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Table 2: Comparative statics for the dynamic model.

Table 2 reports the main comparative statics of the dynamic model regarding the firm's financing and default policies, the recovery rate in default, corporate spreads and the tax benefit of debt (TAD). The TAD is defined as the percentage increase in firm value due to the tax savings associated with debt financing. Input parameter values are set as in the base case environment.

	Quasi-Market Leverage at			Target		
	Restructuring	Target	Default	Spread	Recovery	TAD
Benchmark	12.85	27.80	87.53	125.23	42.22	8.77
$\lambda = 0.0025$	14.96	27.20	87.42	130.55	42.39	9.40
$\lambda = 0.0075$	11.33	27.95	87.63	120.45	42.04	8.23
$\phi = 0.005$	20.54	37.11	86.23	208.19	46.06	11.69
$\phi = 0.015$	2.74	10.13	89.41	35.11	37.51	1.74
$\varphi = 0.05$	4.18	13.33	89.08	47.89	38.24	3.35
$\varphi = 0.10$	18.16	34.49	86.65	180.32	44.78	10.92
$\eta = 0.25$	15.06	32.45	94.09	129.45	42.30	10.49
$\eta = 0.75$	10.65	23.16	80.17	120.41	41.94	7.07
$\alpha = 0.45$	13.34	28.83	89.05	126.22	42.25	9.16
$\alpha = 0.55$	12.36	26.77	85.97	124.22	42.17	8.39
$\kappa = 0.00$	15.02	31.81	85.39	151.33	46.44	10.53
$\kappa = 0.10$	11.41	25.01	89.36	109.13	38.72	7.62
$\tau_c = 0.30$	1.02	5.75	89.15	19.74	39.16	0.13
$\tau_c = 0.40$	20.73	36.21	86.69	207.66	42.13	17.43
$\mu = 0.005$	12.73	27.55	87.80	134.14	41.58	7.64
$\mu = 0.015$	12.99	28.07	87.24	117.30	42.71	10.37
$\sigma = 0.20$	16.12	32.03	86.19	80.85	47.26	9.22
$\sigma = 0.30$	10.61	24.66	88.58	179.14	38.24	8.62

Table 3: Data Definitions.

Table 3 presents definitions and source of data used.

Variable (Data Source)	Variable Definition
Financial Indicators (Compustat):	
Book debt	Liabilities total (item 181) + Preferred stock (item 10) - Deferred taxes (item 35)
Book debt II	Long term debt (item 9) + Debt in current liabilities (item 34)
Book equity	Assets total (item 6) - Book debt
Book equity II	Assets total (item 9) - Book debt II
Leverage	Book Debt/(Assets total (item 6) - Book equity + Market value (item 25 * item 6))
Leverage II	Book Debt II/(Assets total (item 6) - Book equity II + Market value (item 25 * item 6))
Return on assets	(EBIT (item 18) + Depreciation (item 14))/Assetstotal (item 6)
Market-to-Book	(Market value (item 25 * item 6) + Book debt)/Assetstotal (item 6)
Tangibility	Property, plant and equipment total net (item 8)/Assetstotal (item 6)
Size	log(Sales net (item 12))
R&D	Research and development expenses (item 46)/Assets total (item6)
Earnings Growth (I/B/E/S):	
EBIT growth rate	Mean analysts forecast for long-term growth rate per SIC-2 industry
Volatility and Beta (CRSP):	
Equity volatility	Standard deviation of monthly equity returns over the past 5 years
Market model beta	Market model regression beta on monthly equity returns over past 5 years
Executive Compensation (ExecuComp):	
Managerial incentives	see Appendix A 6.5
Managerial ownership	Shares owned/Shares outstanding for the 5highest paid executives
Managerial delta	see Appendix A 6.5
Managerial vega	see Appendix A 6.5
CEO tenure	Current year - year became CEO
EBIT growth rate II	5-year least squares annual growth rate of operating income before depreciation
Blockholders (IRRC blockholders):	
Blockholder ownership	Fraction of stock owned by outside blockholders
Directors (IRRC directors):	
Board independence	Number of independent directors/Total number of directors
Board committees	Sum of 4 dummy variables for existence of independent (more that 50% of committee directors are Independent) audit, compensation, nominating and corporate governance committee
Anti-Takeover Provisions (IRRC governance):	
GIM index	24 anti-takeover provisions index by Gompers, Ishii, and Metrick (2003)
Eindex	6 anti-takeover provisions index by Bebchuk, Cohen, and Farell (2004)
Institutional Ownership (Thompson Financial):	
Institutional ownership	Fraction of stock owned by institutional investors
Economy indicators (FED):	
Yield curve slope	Difference between 10 year and 1 year Government bond yield
Credit risk spread	Difference between corporate yield spread (all industries) of Moody's BAA and AAA rating

Table 4: Descriptive Statistics.

Table 4 presents descriptive statistics for the main variables used in the estimation. The sample is based on Compustat quarterly Industrial files, ExecuComp, CRSP, I/B/E/S, IRRC governance, IRRC blockholders, IRRC directors, and Thompson Financial. Table 3 provides a detailed definition of the variables.

	Mean	S.D.	25%	50%	75%	Obs
Leverage (y)	0.32	0.20	0.16	0.29	0.46	13,159
Leverage II (y)	0.20	0.19	0.04	0.16	0.31	13,159
EBIT Growth Rate ($\widehat{m}$)	0.20	0.06	0.15	0.19	0.23	13,159
EBIT Volatility ($\widehat{\sigma}$)	0.29	0.13	0.19	0.26	0.35	13,159
CAPM Beta ($\widehat{\beta}$)	1.06	0.51	0.70	1.01	1.34	13,159
Liquidation Costs ($\widehat{\alpha}$)	0.51	0.12	0.45	0.50	0.58	13,159
Financial Characteristics:						
Return on Assets	4.47	2.41	2.93	4.19	5.69	13,159
Market-to-Book	2.05	1.27	1.23	1.64	2.39	13,159
Tangibility	0.34	0.22	0.16	0.28	0.47	13,159
Firm Size	5.58	1.20	4.74	5.50	6.35	13,159
R&D	0.22	0.80	0.00	0.00	0.00	13,159
Ownership Structure:						
Institutional Ownership	0.60	0.17	0.49	0.62	0.73	11,727
Blockholder Ownership	0.09	0.13	0.00	0.00	0.16	13,159
Managerial Characteristics:						
Managerial Incentives (φ)	0.07	0.09	0.02	0.04	0.08	13,159
Managerial Ownership (φ^E)	0.05	0.08	0.00	0.01	0.05	13,159
Managerial Delta	7.13	13.00	1.11	2.88	7.20	10,895
Managerial Vega	1.83	2.88	0.35	0.86	2.06	11,003
CEO Tenure	8.67	8.78	2.42	5.92	11.90	13,159
Anti-Takeover Provisions:						
GIM index	9.31	2.77	7.00	9.00	11.00	10,853
Eindex	2.35	1.35	1.00	2.00	3.00	10,828
Board Structure:						
Board Independence	0.61	0.18	0.50	0.63	0.75	8,665
Board Committees	2.49	1.10	2.00	2.00	3.00	6,504
Economy indicators:						
Yield Curve Slope	0.01	0.01	0.00	0.01	0.02	13,159
Credit Risk Spread	0.01	0.00	0.01	0.01	0.01	13,159

Table 5: Structural Estimates: Model Parameters.

The structural parameters characterizing the cost of collective action, ϕ, the bargaining power of shareholders, η, the drift and volatility of cash flows, m and σ respectively, are defined as:

$$\begin{aligned}
\phi_{it} &= h(\alpha_\phi + \epsilon_i^\phi), \\
\eta_{it} &= h(\alpha_\eta + \epsilon_i^\eta), \\
\sigma_{it} &= \alpha_\sigma + \beta_\sigma \widehat{\sigma}_{it}, \\
m_{it} &= \alpha_m + \beta_m \widehat{m}_{it},
\end{aligned}$$

where $h = \Phi \in [0,1]$ is the standard normal cumulative distribution function, ϵ is a bivariate normal random variable capturing firm-specific unobserved heterogeneity,

$$\begin{pmatrix} \epsilon_i^\phi \\ \epsilon_i^\eta \end{pmatrix} \sim \mathcal{N}(0, \begin{bmatrix} \sigma_\phi^2 & \sigma_{\phi\eta} \\ \sigma_{\phi\eta} & \sigma_\eta^2 \end{bmatrix}).$$

Across firms i, $(\epsilon_i^\phi, \epsilon_i^\eta)$ are assumed independent. $\widehat{m}_{it}$ and $\widehat{\sigma}_{it}$ are estimates of the growth rate and volatility of cash flows, respectively. Values of t-statistics are reported in parenthesis.

	Coef.	t-Stat
Structural Parameters:		
α_ϕ	-2.65	(-148.48)
α_η	-0.08	(-0.41)
σ_ϕ	1.26	(44.41)
σ_η	2.86	(3.82)
$\sigma_{\phi\eta}$	-1.24	(-4.71)
Auxiliary Parameters:		
α_σ	0.01	(0.19)
β_σ	0.72	(6.59)
α_m	0.34	(1.06)
β_m	0.00	(0.00)
Log-likelihood	8,938	
Observations	13,159	

Table 6: Robustness: Alternative Leverage Measure & Renegotiation Costs.

This table reports parameter estimates for the model in Table 5 under alternative specifications. Values of t-statistics are reported in parenthesis.

	y = leverage II		$\lambda = 0.01$		$\varphi = \varphi^E$		$\kappa = 0.15$	
	Coef.	t-Stat	Coef.	t-Stat	Coef.	t-Stat	Coef.	t-Stat
Structural Parameters:								
α_ϕ	-2.61	(-240.40)	-2.35	(-141.22)	-3.33	(-256.15)	-3.09	(-64.20)
α_η	-0.02	(-0.09)	-0.02	(-0.04)	-0.08	(-0.23)	-0.09	(-0.11)
σ_ϕ	1.24	(34.53)	0.95	(33.69)	1.81	(56.56)	1.10	(13.81)
σ_η	2.75	(2.54)	2.83	(2.63)	2.90	(3.18)	3.95	(1.12)
$\sigma_{\phi\eta}$	-0.85	(-2.43)	-1.47	(-2.15)	-0.58	(-0.81)	1.11	(0.68)
Auxiliary Parameters:								
α_σ	0.00	(0.12)	0.00	(0.04)	0.00	(0.04)	0.01	(0.15)
β_σ	0.95	(9.75)	0.72	(3.86)	0.81	(5.04)	0.64	(5.92)
α_m	0.69	(0.62)	0.39	(0.94)	0.38	(0.82)	0.37	(1.01)
β_m	0.10	(0.02)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
Log-likelihood	-60,809		8,756		8,011		8,802	
Observations	13,159		13,159		13,159		13,159	

Table 7: Model-Implied Cost of Collective Action and Bargaining Power.

Table 7 reports distributional characteristics of the predicted cost of collective action, $\widehat{\mathbb{E}}(\phi_{it}|y_{it}, x_{it}; \theta)$, and the predicted bargaining power of shareholders, $\widehat{\mathbb{E}}(\eta_{it}|y_{it}, x_{it}; \theta)$.

	Mean	S.D.	Skew	Kurt.	5%	25%	50%	75%	95%
Panel A: Basic specification									
$\widehat{\phi}$	0.050	0.054	2.037	7.568	0.008	0.014	0.026	0.070	0.164
$\widehat{\eta}$	0.552	0.198	-0.256	2.094	0.199	0.406	0.549	0.733	0.832
Panel B: Alternative measure of leverage									
$\widehat{\phi}$	0.069	0.066	1.970	7.338	0.010	0.021	0.053	0.088	0.221
$\widehat{\eta}$	0.536	0.164	-0.002	2.471	0.262	0.432	0.516	0.661	0.809
Panel C: Restructuring cost = 1%									
$\widehat{\phi}$	0.039	0.040	2.393	9.520	0.008	0.013	0.023	0.049	0.124
$\widehat{\eta}$	0.549	0.196	-0.376	2.074	0.200	0.398	0.574	0.723	0.812
Panel D: Alternative ownership measure φ^E									
$\widehat{\phi}$	0.061	0.068	1.741	6.067	0.008	0.014	0.025	0.098	0.196
$\widehat{\eta}$	0.579	0.199	-0.354	2.396	0.203	0.445	0.574	0.757	0.861
Panel E: Renegotiation costs = 15%									
$\widehat{\phi}$	0.021	0.030	2.657	10.602	0.002	0.004	0.008	0.024	0.088
$\widehat{\eta}$	0.607	0.181	-0.528	2.614	0.299	0.473	0.635	0.751	0.857

Table 8: The Determinants of the Cost of Collective Action.

Table 8 summarizes parameter estimates from a regression on various determinants of cost of collective action. The dependent variable are the predicted values of managerial entrenchment, $\widehat{\mathbb{E}}(\phi_{it}|y_{it}, x_{it}; \theta)$, expressed in basis points. Values of t-statistics are reported in parenthesis. All regressions include industry dummies.

	(1)	(2)	(3)
Institutional Ownership	-273.33	-113.80	-62.09
	(7.48)	(2.96)	(1.49)
Blockholder Ownership	-109.30	-159.54	-144.36
	(2.43)	(3.52)	(2.92)
Eindex - Dictatorship	563.97	621.92	537.79
	(4.20)	(4.24)	(3.36)
Board Independence	-	-236.06	-
	-	(6.23)	-
Board Committees	-	-	-36.27
	-	-	(6.16)
CEO Tenure	10.70	9.66	9.72
	(13.42)	(10.29)	(9.65)
Managerial Delta	7.92	8.07	7.86
	(10.45)	(9.97)	(9.41)
Managerial Vega	-20.94	-18.95	-16.06
	(8.60)	(7.37)	(6.16)
Return on Assets	22.33	22.21	20.51
	(7.39)	(6.61)	(5.62)
Market-to-Book	182.53	177.45	167.64
	(22.44)	(19.95)	(17.70)
Tangibility	49.74	142.02	172.16
	(1.14)	(2.76)	(2.96)
Size	-130.93	-138.04	-130.60
	(19.17)	(17.84)	(15.99)
R&D	23.24	15.98	15.40
	(2.24)	(1.52)	(1.43)
Yield Curve Slope	17.98	18.82	4.61
	(2.74)	(2.26)	(0.50)
Credit Risk Spread	45.15	65.94	138.10
	(1.54)	(1.75)	(3.11)
Observations	8,035	6,251	4,959
R^2	0.47	0.47	0.48

Table 9: SIMULATION EVIDENCE: LEVERAGE INERTIA.

Table 9 reports parameter estimates from Fama-MacBeth regressions on leverage in levels. The basic specification is as follows:

$$L_t = \alpha_0 + \alpha_1 L_{t-k} + \alpha_2 IDR_{t-k,t} + \epsilon_t$$

where L is the Leverage ratio, IDR is the Implied Debt Ratio and k is the time horizon. Coefficients reported in Panel A are means over 1,000 simulated datasets. Panel B shows IDR coefficients reported by Welch (2004) and Strebulaev (2007). The remaining rows report the 5% and 95% quantiles of IDR coefficients from our model simulations.

	Lag k in years			
	1	3	5	10
PANEL A: Coefficient estimates in simulated data				
Constant	0.00	0.01	0.01	0.02
L_{t-k}	-0.09	0.01	0.08	0.20
$IDR_{t-k,t}$	1.06	0.93	0.84	0.68
R^2	0.98	0.94	0.92	0.87
Observations	13,159	13,159	13,159	13,159
PANEL B: $IDR_{t-k,t}$ coefficients in the literature				
Welch	1.01	0.94	0.87	0.71
Strebulaev	1.03	0.89	0.79	0.59
5% in simulated data	1.05	0.92	0.82	0.66
95% in simulated data	1.07	0.95	0.86	0.70

Table 10: Simulation Evidence: Leverage Mean-Reversion.

Table 10 reports parameter estimates from Fama-MacBeth regressions on leverage changes. The basic specification is as follows:

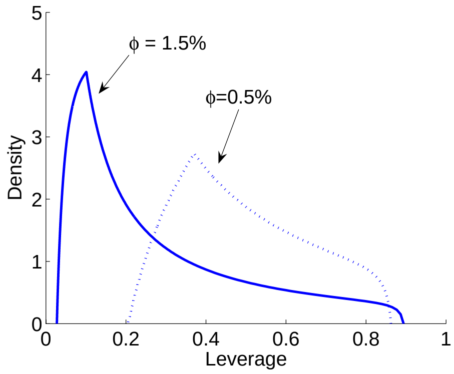
$$L_t - L_{t-1} = \alpha + \lambda_1 TL_{t-1} + \lambda_2 L_{t-1} + \epsilon_t$$

where L is the Leverage ratio and TR is the Target Leverage Ratio. TL is determined on a previous step by running a cross-sectional regression of leverage on determinants. Coefficients are means over 1,000 simulated datasets.

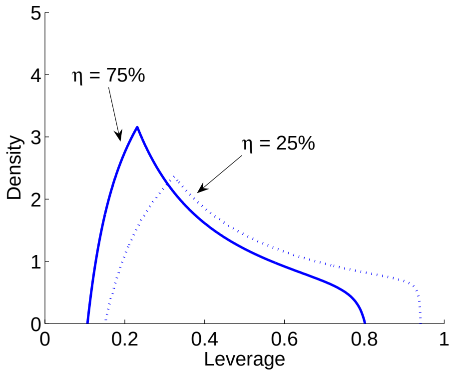
	(1)
Constant	0.00
TL_{t-1}	0.06
L_{t-1}	-0.06
R^2	0.03
Observations	13,159

Figure 3: COMPARATIVE STATICS: FIRM-SPECIFIC LEVERAGE DISTRIBUTION.

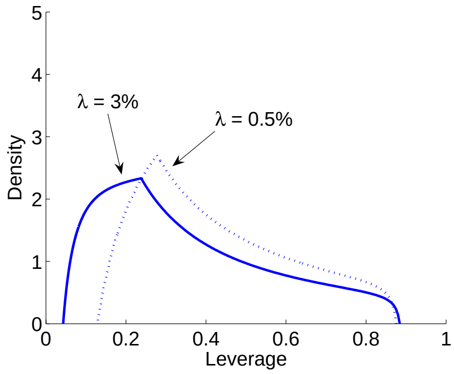
Figure 3 shows comparative statics for the time-series distribution of financial leverage. We vary the cost of collective action ϕ, shareholders' bargaining power η, and the refinancing cost λ.



(a) Shareholders' cost of collective action.



(b) Shareholders' bargaining power.



(c) Refinancing cost.

Figure 4: Empirical Leverage Distribution.

Figure 4 plots the empirical distribution of financial leverage. The solid line uses the standard definition of financial leverage. The dashed line corresponds to the alternative definition of leverage. Table 3 provides a detailed definition of the variables. The data are quarterly observations on industrial firms from Compustat between 1992 and 2004.

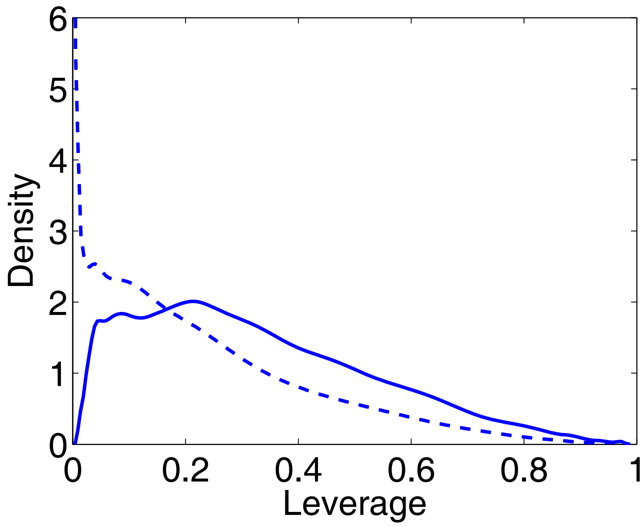


Figure 5: Firm-Specific Predictions of Refinancing Cost in a Dynamic Capital Structure Model Without Managerial Entrenchment.

Figure 5 shows a histogram of the predicted cost of debt issuance, $\widehat{\mathbb{E}}(\lambda_{it}|y_{it}, x_{it}; \theta)$, in the dynamic capital structure model without agency conflicts ($\phi_{it} = 0$ and $\eta_{it} = 0$). The prediction is based on a structural estimate of the model's parameters. The histogram plots the cost of debt issuance for each firm-quarter as a fraction of the total debt outstanding.

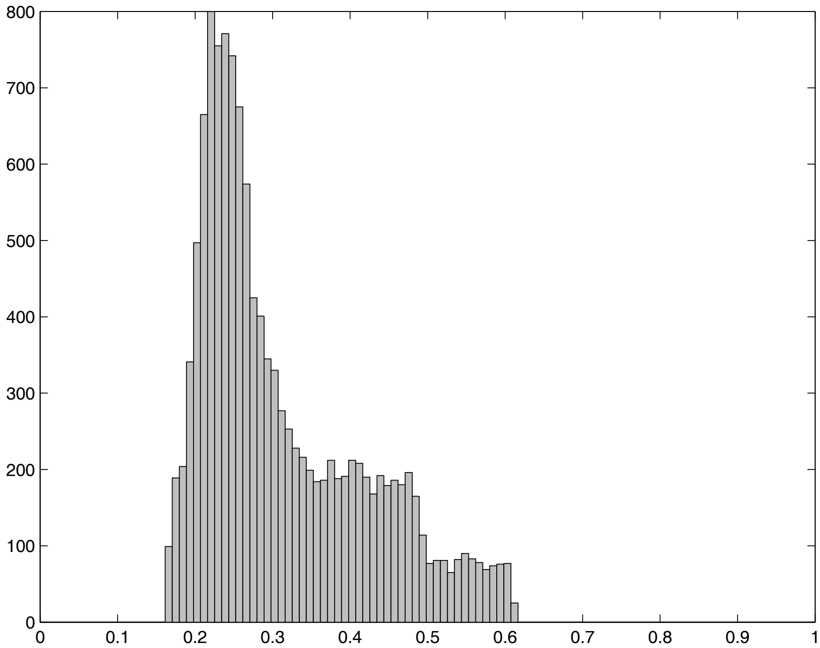
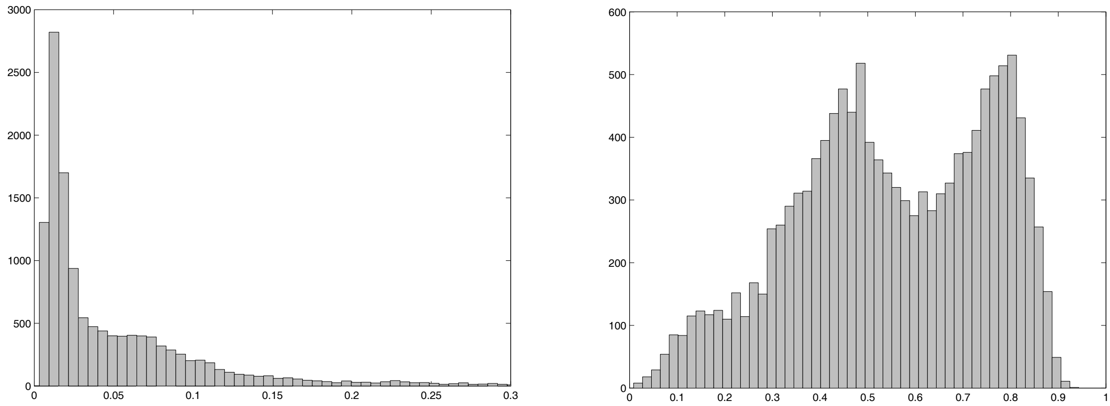
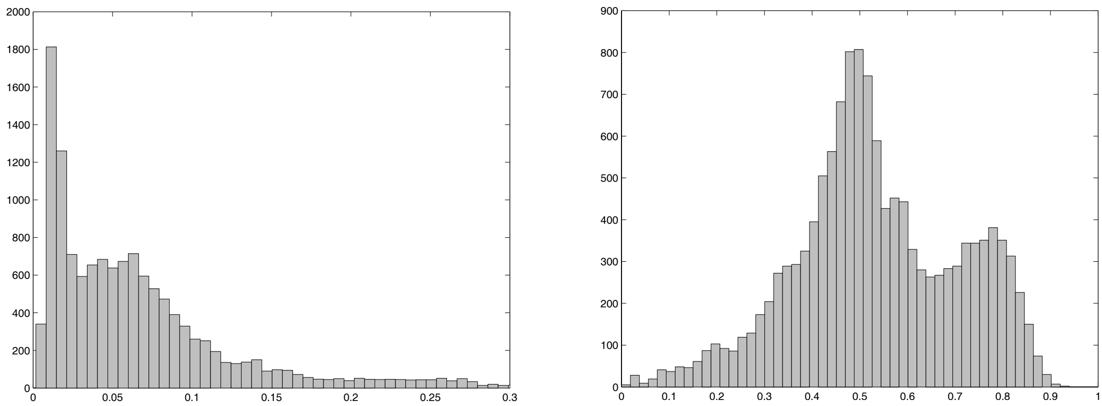


Figure 6: FIRM-SPECIFIC PREDICTIONS OF SHAREHOLDERS' COST OF COLLECTIVE ACTION AND BARGAINING POWER.

Figure 6 shows histograms of the predicted cost of collective action, $\widehat{\mathbb{E}}(\phi_{it}|y_{it}, x_{it}; \theta)$, and the predicted shareholders' bargaining power, $\widehat{\mathbb{E}}(\eta_{it}|y_{it}, x_{it}; \theta)$, in the dynamic capital structure model. The prediction is based on a structural estimate of the model's parameters. The histograms plot the predicted parameters for each firm-quarter.



(a) Predicted cost of collective action (left) and shareholders' bargaining power (right).



(b) Predicted cost of collective action (left) and shareholders' bargaining power (right)—estimated from alternative measure of leverage.

Chapter IV

Cash Holdings and Competition

(with Erwan Morellec)

1 Introduction

In perfect capital markets, firms can fund all positive NPV expenses and there is no role for internal capital. In the presence of market frictions, such as costs of raising funds, investment or survival may depend on a firm's cash holdings. That is, when other sources of funds are costly, limited, or unavailable, firms can use their cash holdings to fund capital expenditures or unexpected operating losses. Consistent with this view, several studies report that firms with greater difficulties in obtaining external capital accumulate more cash and/or save a greater fraction of their cash flow as cash.

While there exists a rich literature that examines the relation between cash holdings and investment, Opler, Pinkowitz, Stulz, and Williamson (OPSW, 1999) find little evidence that excess cash has a large short run impact on capital expenditures or acquisition spendings. Instead, they document that the main reason why firms experience large changes in excess cash is the occurrence of operating losses. In this paper, we thus look at the other side of the profitability spectrum and explore the possibility that cash holdings may be used to fund operating losses and avoid inefficient closure or asset sales. In addition, since a monopolist is less likely to face financial difficulties than a firm facing cutthroat competition, we also examine whether the market structure in which a firm operates has an effect on its cash holdings.

A prerequisite for our analysis is a model that captures in a simple fashion the effects of product market competition and cash holdings on firms' closure policies. In this paper, we construct a stylized real options model in which the managers of the firm can abandon its business if product demand falls to a sufficiently low level. The profitability of assets in place depends on the intensity of competition, and so does the firm's abandonment decision. The managers may abandon voluntarily, or may be forced to do so because of financing constraints.

We analyze the manager's behavior absent financing constraints and then examine what happens if a firm may be forced to abandon assets because of a cash flow shortage. Because the firm cash flows are uncertain and the decision to foreclose is irreversible, there exists a valuable option of waiting. As a result, managers should only abandon assets when operating costs exceed revenues by a potentially large option premium. We show that holding cash may allow firms to finance operating losses and prevent inefficient asset sales or closure. We also demonstrate that the value of the option of waiting increases with both uncertainty and competition so that a firm's propensity to hold large cash balances should be highest when it operates in more competitive and riskier industries.

To test the predictions of the model, we examine the cash holdings of Compustat firms over the 1980 to 2005 period. We find that corporate cash holdings are associated with the intensity of product market competition. Specifically, our results show that a firm is more likely to hold cash reserves when the price-to-cost margin of the firm is low or when the number of firms in the industry is large. These results hold after controlling for profitability, size, and a host of other control variables. Furthermore, we find that the association between competition and cash holdings is more important in riskier industries (as measured by cash flow volatility) and for firms facing greater financing constraints. Because the precautionary motive for holding cash matters more when cash flow risk is more important, these findings suggest that it is this motive that drives our results.

It is well known that there has been a secular increase in cash holdings (see e.g. Bates, Kahle, and Stulz (2006)).[1] Our analysis shows that the increase in cash holdings over the 1980-2005 period can be explained by the increase in idiosyncratic volatility reported by Irvine and Pontiff (2007) (this complements Harford, 1999, who finds in a cross-sectional analysis that cash holdings are positively associated with industry cash flow volatility). Moreover, and as predicted

[1]See also "Unlike consumers, companies are piling up cash," March 4 2008, *New York Times*.

by our theory, we find that there is no time trend in cash holdings for firms that do not face competitive pressure as measured by the price-to-cost margin or the number of firms in the industry. For firms that do face competitive pressure, the mean cash ratio doubles from 1990 to 2005 and the median triples during that same time period. These results suggest that as volatility increases, the likelihood and cost of inefficient closure for firms in competitive markets increase so that these firms optimally respond by hoarding more cash.

Our paper contributes in four ways to the literature on corporate financial policies. First, we increase understanding of how firms' policy choices are related to their product market environment by developing a theory of cash holdings relying on competitive pressure and financing constraints. Following Bolton and Scharfstein (1990), most of this literature has either tried to examine the effects of financial policies on predatory behavior (see e.g. Chevalier, 1995, Kovenock and Phillips, 1997, or Campello, 2003) or, more recently, whether firms take actions in response to predation risk (see e.g. Haushalter, Klasa, and Maxwell, 2007). Our analysis provides insights into why a firm's product environment impacts its financing decisions, even in the absence of predatory risk (i.e. we focus on competitive rather than concentrated industries).

Second, our paper contributes to understanding the role of corporate cash reserves and why cash holdings have significantly increased over the past decade. Specifically, we show that this increase has been mostly observed in competitive industries and for firms facing financing constraints. In addition, our analysis reveals that the increase in cash holdings can be related to the increase in idiosyncratic volatility and in the competition in these industries. Hence, our results suggest that this increase in cash holdings can be at least partly attributed to the possibility to use cash reserves to cover unexpected operating losses.

Third, our analysis complements prior research on the relation between cash holdings and financing constraints. Most of this literature has ignored the effects of competition on this relation. Moreover, most of this work has focused on the effects of cash holdings on investment. In this paper, we focus instead on the other side of the profitability spectrum and examine the relation between cash holdings and a firm's ability to remain active (when optimal to do so).

Finally, our paper also contributes to the line of research that uses real-options models to examine the relation between product market competition and financing decisions by considering the effects of competition on cash holdings. Several papers quantify the possible effects of competition on debt financing in duopolies (see e.g. Lambrecht (2001) or Morellec and Zhdanov (2008)) or in perfectly competitive industries (see Miao (2005)). However, to the best of our knowledge, there is no paper that examines the relation between competition, foreclosure, and cash holdings.

The remainder of paper is organized as follows. Section two describes the model and derives our main testable hypotheses. Section three describes the data. Section four presents our empirical results. Section five concludes.

2 Model

This section introduces testable hypotheses that establish how cash holdings are related to product market competition. To generate these hypotheses, we build a stylized real options model in which the managers of the firm can abandon its business if product demand falls to a sufficiently low level. In the model, the closure decision depends on the intentisty of product market competition. It also depends on the financing constraints faced by the firm. A simple model of optimal cash holdings and abandonment decisions is developed under these assumptions.

2.1 Assumptions

Throughout the paper, agents are risk neutral and discount cash flows at a constant rate r. We consider an industry composed of n infinitely-lived firms producing output with their capital stock and variable factors of production. Each firm i has a fixed amount of capital k_i. Each unit of capital produces one unit of output at a cost $C_i(k_i) = ck_i + F$, where c is a constant marginal and F is a fixed cost of production.[2] The produced good is non-storable, so that output equals demand. The output price depends on total industry output $Q = \Sigma_{i=1}^{n} k_i$ and an industry-wide shock X. Specifically, we assume that for any realization x of the shock X, the price for any one firm's unit of output is given by $p\,(x) = xQ^{-1/\gamma}$, where $\gamma > 1$ is the (constant) elasticity of demand. In the following analysis, we consider that the industry shock is governed by the process:

$$dX_t = \mu X_t \, dt + \sigma X_t \, dZ_t, \qquad X_0 > 0. \tag{1}$$

In equation (1), $\mu < r$ and $\sigma > 0$ are constant parameters and $(Z_t)_{t \geq 0}$ is a standard Brownian motion. Below, we assume that all firms have the same production capacity $k_i = k$ and we let $K = nk_i$ denote the industry capacity. The instantaneous cash flow of any firm $i \in [1, n]$ at time t is then given by:

$$\pi_i(K, x) = \frac{1}{n} \left[xK^{(\gamma-1)/\gamma} - cK \right] - F,$$

with $\partial \pi_i(K, x)/\partial n < 0$.

Although their assets may be operated forever, firms can also choose to abandon them. We assume for simplicity that the firms' assets have no resale value so that firm value upon closure is zero.[3] Different environments will lead to

[2] In the Appendix, we present an extension of the model in which firms can choose their output. All of our predictions go through in this more general setting.

[3] Introducing asset sales prior to closure would not affect any of the results derived in the paper. Morellec (2001) examines the effects of asset liquidity on asset sales and firms' closure policies.

alternative closure triggering cash flows. For firms that do not face financing constraints, abandonment will be initiated endogenously when shareholders will no longer be willing to raise additional equity to meet the fixed costs of operation and there will be no role for cash holdings. For financially constrained firms, the abandonment decision will be determined by a liquidity constraint and there will be a role for cash holdings.

2.2 Firm value and optimal abandonment

Before analyzing the effects of cash holdings on firm value, it will be useful to identify the sources of value within the firm. When shareholders have the option to abandon operations, the value of the firm is given by the sum of a perpetual stream of cash flows from assets in place and the value of the abandonment option. Assume for now that the firm has no cash on hands and denote by $V_i\left(x\right)$ the value of firm i. As long as it is in operation, the firm delivers a cash flow stream $\pi_i(K,x)$. In addition to this cash flow stream, investors also get capital gains $\mathbb{E}\left[dV_i\right]$ over each interval dt. The required rate of return for investing in the firm's assets is r. As a result, in the region for the industry shock where there is no abandonment, firm value satisfies the equilibrium condition

$$rV_i(x)dt = \left[\frac{1}{n}\left(xK^{(\gamma-1)/\gamma} - cK\right) - F\right]dt + \mathbb{E}\left[dV_i\right].$$

The left hand side of this equation represents the rate of return required by investors. The right hand side corresponds to the realized return, which comes in the form of a cash flow stream and capital gains. Applying Itô's lemma to the second term on the right hand side of this equation, we can rewrite the above equilibrium condition as:

$$rV_i(x) = \frac{1}{n}\left(xK^{(\gamma-1)/\gamma} - cK\right) - F + \mu x V_i'(x) + \frac{1}{2}\sigma^2 x^2 V_i''(x). \qquad (2)$$

When the firm does not face any financing constraint, shareholders inject funds in the firm as long as firm value is positive. This implies that shareholders abandon the firm's assets the first time firm value is equal to zero. As a result, for firms that are not financially constrained, equation (2) is solved subject to the following value-matching and smooth-pasting conditions at the endogenous closure threshold $\underline{x}_E$: $V_i(\underline{x}_E) = 0$, and $V_i'(\underline{x}_E) = 0$. The ordinary differential equation (2) is also subject to the no-bubbles condition $\lim_{x\to\infty}(V_i(x)/x) < \infty$.

Denote by $\Pi_i(K, x)$ the present value of a perpetual stream of cash flows $\pi_i(K, \cdot)$ starting at $X_0 = x$:

$$\Pi_i(K,x) = \mathbb{E}\left[\int_0^\infty e^{-rt}\pi_i(K,X_t)\,dt \Big| \, X_0 = x\right] = \frac{1}{n}\left\{\frac{x}{r-\mu}K^{(\gamma-1)/\gamma} - \frac{cK+nF}{r}\right\}.$$

Solving shareholders' optimization problem yields the following expression for the value of the firm (the proof is standard and omitted):

$$V_i(K,x) = \Pi_i(K,x) - \Pi_i(K,\underline{x}_E)\left(\frac{x}{\underline{x}_E}\right)^\xi, \quad \text{for } x > \underline{x}_E, \tag{3}$$

where $\xi < 0$ is the negative root of the quadratic equation $\frac{1}{2}\sigma^2 y(y-1)+\mu y - r = 0$ and the value-maximizing closure threshold $\underline{x}_E$ is given by:

$$\underline{x}_E = \frac{\xi}{\xi-1}\,\frac{r-\mu}{r}\,\frac{ck+F}{k^{(\gamma-1)/\gamma}}\,n^{1/\gamma}. \tag{4}$$

Equation (3) shows that value of the firm is the sum of two terms. First, it incorporates the value of a perpetual entitlement to the current flow of income, given by the first term on the right hand side of equation (3). Second, it reflects the value of shareholders' option to abandon the firm's assets, which is the product of the surplus created by this option ($-\Pi_i(K,\underline{x}_E) > 0$) and a stochastic discount factor, given by $x^\xi \underline{x}_E^{-\xi}$. The endogenous closure threshold $\underline{x}_E$ reflects the degree of competition through the factor $n^{1/\gamma}$ as well as the option value of waiting to exit through the factor $\xi/(\xi-1)$. If this option had no value, shareholders would follow the simple NPV rule, according to which one should abandon assets as soon as net worth is negative (i.e. as soon as $x < (r-\mu)(cK+nF)K^{-(\gamma-1)/\gamma}/r$).

From this expression it is immediate to see that the firm's cash flows are negative upon closure and that the greater competition, the greater the likelihood of abandonment.

Let us now turn to the case of the financially constrained firm. When the firm is financially constrained, it has no (or limited) access to outside funds and closure is triggered by the firm's inability to fund operating losses. Let us denote the value of the closure threshold associated with the financing constraint by $\underline{x}_L$. This threshold solves the equation

$$\frac{1}{n}\left[\underline{x}_L K^{(\gamma-1)/\gamma} - cK\right] = F,$$

the solution to which is given by

$$\underline{x}_L = \frac{ck + F}{k^{(\gamma-1)/\gamma}}\, n^{1/\gamma}. \tag{5}$$

This expression reveals that the greater product market competition (i.e. the larger the number of firms in the industry), the higher the closure threshold and the greater the likelihood of abandonment. In order to examine the effects of varying financing constraints on firm value, we define

$$\underline{x}_L(\phi) = \phi \underline{x}_L, \quad \text{for } \phi \in [\underline{\phi}, 1],$$

where $\underline{\phi} = \xi(r-\mu)/[r(\xi-1)]$ reflects *the strength of the financing constraint* faced by the firm. When $\phi = \underline{\phi}$, there are no financing constraints as the firm follows the value-maximizing abandonment policy. As ϕ increases, the distortions in the firm's closure policy increase.

Assume for now that $\phi = 1$. An examination of equations (4) and (5) reveals that financial constraints lead to early abandonment of the firm's assets. This early abandonment leads in turn to a reduction in firm value. In particular, denote by $V(K, x; \underline{x}_i)$ the value of the firm when the selected abandonment threshold is

$\underline{x}_i$ for $i = E, L$. The reduction in firm value due to financing constraints is given by $\Delta V(x) = V(K, x; \underline{x}_E) - V(K, x; \underline{x}_L)$ or:

$$\Delta V(x) = \left\{ \frac{\mu(ck + F)}{r(r - \mu)} + \frac{ck + F}{r(1 - \xi)} \left(\frac{\underline{x}_L}{\underline{x}_E} \right)^{\xi} \right\} \left(\frac{x}{\underline{x}_L} \right)^{\xi}. \tag{6}$$

In this expression, both the term in the curly brackets and the stochastic discount factor $(x/\underline{x}_L)^{\xi}$ increase with the volatility of the demand shock (since $\partial\xi/\partial\sigma < 0$). As a result, the cost of financing constraints increases with volatility. In addition, equation (6) reveals that the effects of financing constraints on firm value are greater when operating leverage is higher (i.e. when x is lower or F is greater). Finally, the reduction in firm value due to financing constraints increases with product market competition (i.e. $\partial(\Delta V(x))/\partial n = -\xi \Delta V(x)/(\gamma n) > 0$) implying that the benefits of holding cash increase with competition.

2.3 Optimal cash holdings

Consider now that when setting up the firm, the owners raise additional equity in order to have some cash holdings (alternatively, the firm may use retained earnings to build up its cash reserve). In addition, assume that there is a cost of holding cash. As noted by Opler, Pinkowitz, Stulz, and Williamson (OPSW, 1999), the cost of holding cash includes the lower rate of return on these assets because of a liquidity premium and tax disadvantages (Graham, 2000, finds that cash retentions are tax-disadvantaged because corporate tax rates generally exceed tax rates on interest income). Also, as argued by Shyam-Sunders and Myers (1999), if there was no cost of holding cash no firm would ever distribute funds to shareholders.

Following OPSW (1999), we assume that the marginal cost of holding cash is constant. Specifically, we consider that if the firm has cash holdings α, the value of these funds held as liquid assets within the firm is $(1 - \theta)\alpha$. In such circumstances, the value $V(x)$ of the old shareholders' claims at the time of issuance is given by the value of the firm ignoring cash holdings plus the proceeds from the equity issue net of the costs of holding funds. Since the value of the new shares is equal to the proceeds from the equity issue, the objective of old shareholders when choosing the level of cash holdings is to maximize:

$$V_{\text{old}}(K, x; \underline{x}(\alpha, \phi)) = \Pi_i(x) - \theta\alpha - \Pi_i(\underline{x}(\alpha, \phi)) \left(\frac{x}{\underline{x}(\alpha, \phi)} \right)^{\xi}, \tag{7}$$

where $\underline{x}(\alpha, \phi)$ is the firm's closure threshold when the level of cash holdings is α.

To examine the effects of cash holdings on firm value in the simplest possible setting, we assume that if the firm holds an amount α of cash, its abandonment threshold is given by

$$\underline{x}(\alpha, \phi) = \frac{\alpha}{\kappa + \alpha} \underline{x}_E + \frac{\kappa}{\kappa + \alpha} \phi \underline{x}_L,$$

where $\kappa > 0$ is a positive constant. This specification implies that as the amount of cash holdings increases, the firm's abandonment policy gets closer to first best. In particular, we have $\underline{x}(0, 1) = \underline{x}_L$, $\frac{\partial \underline{x}(\alpha,\phi)}{\partial \alpha} < 0$, $\lim_{\alpha \to \infty} \underline{x}(\alpha, \phi) = \underline{x}_E$, and $\lim_{\phi \to \underline{\phi}} \underline{x}(\alpha, \phi) = \underline{x}_E$.

Replacing $\underline{x}(\alpha, \phi)$ by its expression in equation (7) yields:

$$V_{\text{old}}(K, x; \underline{x}(\alpha, \phi)) = \Pi_i(x) - \theta\alpha - n^{-\xi/\gamma} \mathcal{A}(\alpha) \frac{ck + F}{r} \left(\frac{xk^{(\gamma-1)/\gamma}}{ck + F} \right)^{\xi}, \tag{8}$$

where $\mathcal{A}(\alpha)$ is defined by

$$\mathcal{A}(\alpha) = \left\{ \frac{r}{r - \mu} \frac{\alpha}{\kappa + \alpha} \left[\frac{\xi(r - \mu)}{r(\xi - 1)} + \frac{\kappa}{\alpha} \phi \right] - 1 \right\} \left\{ \frac{\alpha}{\kappa + \alpha} \left[\frac{\xi(r - \mu)}{r(\xi - 1)} + \frac{\kappa}{\alpha} \phi \right] \right\}^{-\xi}.$$

This expression shows we have $\partial \mathcal{A}(\alpha)/\partial \phi > 0$. That is, financing constraints reduce firm value by distorting closure policy. Also, since cash holdings improve the firm's abandonment policy, we have $\partial \mathcal{A}(\alpha)/\partial \alpha < 0$. Finally, since firm value is concave in the selected closure threshold $\underline{x}(\alpha, \phi)$ (because of the concavity of the option to abandon assets), we have that $\partial^2\mathcal{A}(\alpha)/\partial\alpha^2 < 0$. We will use these results below when analyzing the value-maximizing level of cash holdings.

When deciding whether the firm should have cash holdings, shareholders maximize the value of their claims, given by $V_{\text{old}}(K, x; \underline{x}\,(\alpha, \phi))$. As shown by equation (8), cash holdings entails both benefits and costs. The benefit is the improvement in the firm's abandonment policy. This benefit is captured by the third term on the right hand side of equation (8). This benefit is offset by the costs of holding liquid funds, which are captured by the second term on the right hand side of equation (8). Interestingly, this equation suggests that the benefits of cash holdings depend on the value of the option to abandon assets. As a result, the optimal level of cash holdings should depend on the factors that affect the value of this abandonment option. In particular, we expect that a change in the moneyness of the option to abandon operations, due to changes in x and F, or in the volatility of the cash flow shock σ, will lead to changes in the value-maximizing level of cash holdings α^*.

Given that firm value is concave in the firm's closure threshold, the value-maximizing amount of cash holdings is given by the solution to the first order condition

$$\frac{\partial V_{\text{old}}(K, x; \underline{x}\,(\alpha, \phi))}{\partial \alpha} = 0. \tag{9}$$

Solving the first order condition (9) yields:

$$-\,n^{-\xi/\gamma}\mathcal{A}'(\alpha^*)\left(\frac{xk^{(\gamma-1)/\gamma}}{ck+F}\right)^{\xi} = \theta. \tag{10}$$

The left hand side of this equation represents the marginal benefit of holding cash. The right hand side represents the marginal cost of holding cash. Figure 7 shows the marginal cost curve of being short of cash and the marginal cost curve of holding cash. The marginal cost curve of being short of cash is downward sloping and convex as the value of the firm is an increasing and concave function of the selected abandonment threshold. The marginal cost of holding cash is constant, given by θ.

From equation (10), it is immediate to see that the value-maximizing level of cash holdings α^* depends on firm characteristics in the following way:

$$\frac{\partial \alpha^\star}{\partial n} > 0,\ \frac{\partial \alpha^\star}{\partial c} > 0,\ \frac{\partial \alpha^\star}{\partial x} < 0,\ \frac{\partial \alpha^\star}{\partial \phi} > 0,\ \frac{\partial \alpha^\star}{\partial \sigma} > 0, \text{ and } \frac{\partial \alpha^\star}{\partial k} < 0.$$

These equations show that an increase in competition, in financing constraints, or in volatility shifts the marginal cost curve of being short of cash to the right and increases the level of optimal cash holdings. Consider first the effects of competition. As the intensity of product market competition increases (as reflected by an increase in the number of firms in the industry n), the profitability of assets in place decreases and the risk of inefficient closure increases. As a result, firms optimally have larger cash holdings to reduce this risk. We thus have the following testable hypothesis:

Hypothesis 1: *Cash holdings increase with product market competition.*

In addition, the optimal policy for the firm is to have no cash holdings when it does not face any financing constraint and the value-maximizing amount of cash holdings increases with the strength of the financing constraints ϕ faced by the firm. When there is no financing constraint, the firm abandons assets at the value-maximizing trigger $\underline{x}_E$ and, hence, has no need for cash holdings. As financing constraints increase, distortions in the firm's closure policy increase. Firms optimally respond by having greater cash holdings. This leads to the following testable hypothesis:

Hypothesis 2: *Competition affects cash holdings only when the firm faces financing constraints. When the firm is financially constrained, optimal cash holdings increase with the intensity of the financing constraints.*

A third implication of our model is that the optimal amount of cash holdings increases with the moneyness of the firm's option to abandon assets, as reflected by x. In our model, the decision to hold cash balances the cost of holding cash with the change in the firm's abandonment policy due to cash holdings. As the option to exit the industry becomes more valuable (because of a decrease in x), the benefits of holding cash increase and so does the optimal level of cash holdings. It is also immediate to see from equation (10) that an increase in the firm's asset base, as reflected by k, reduces the optimal amount of cash holdings. We thus have the following testable hypothesis:

HYPOTHESIS 3: *Cash holdings decrease with firm size.*

Finally, as volatility increases, the value of the firm's abandonment option increases (being a real option). This implies that the cost of the liquidity constraint and, hence, the benefits of holding cash increase with the volatility of the cash flow shock. This leads to the following testable hypothesis:

HYPOTHESIS 4: *Cash holdings increase with volatility.*

To get more insights on the determinants of cash holdings, Figure 8 plots the optimal amount of cash holdings $\alpha^\star$ as a function of the cost of holding liquid funds θ, the volatility of the industry shock σ, the severity of financing constraints ϕ, and the strength of product market competition n. Input parameter values for the base case environment are set as follows:[4] the risk-free interest rate $r = 5\%$, the volatility and the growth rate of cash flow shock: $\sigma = 25\%$ and $\mu = 1\%$, the cost of holding cash $\theta = 5\%$, the strength of the product market competition $n = 10$, and the costs of production $c = 1$ and $F = 10$. Consistent with the above

[4]The risk free rate is taken from the yield curve on Treasury bonds. The growth rate of cash flows has been selected to generate a payout ratio consistent with observed payout ratios (4% according to Ibbotson and Associates). Similarly, the value of the volatility parameter is chosen to match the (leverage-adjusted) asset return volatility of an average S&P 500 firm's equity return volatility.

discussion, Figure 8 reveals that the optimal amount of liquid funds increases with the volatility of the industry shock σ, the intensity of competition n, and the degree of financing constrains ϕ. It decreases with the cost of holding liquid funds and with the size of the firm x.

Figure 9 plots the value-maximizing amount of cash holdings $\alpha^\star$ as a function of the intensity of product market competition, n, for low, medium, and high intensity of the financial constraint ϕ (i.e. for $\phi = 1$, $\phi = (1 + \underline{\phi})/2$, and $\phi = \underline{\phi}$ in panel A) and as a function of the intensity of the financial constraint, ϕ, for for low, medium, and high intensity of competition n (i.e. for $n = 1$, $n = 5$, and $n = 10$ in panel B). Input parameter values are set as in Figure 8.

Figure 9 shows that, in the absence of financing constraints, the firm would not hold any cash. It also reveals that the effects of product market competition on the value-maximizing level of cash holdings get reinforced by financing constraints. Similarly, the effects of financing constraints on the value-maximizing level of cash holdings are stronger in more competitive environments.

3 Data and Methodology

In this section we discuss how the samples are formed, the methodology used to test the hypotheses derived in section 2, and how the variables of interest are calculated.

3.1 Sample

The sample of firms is based on Compustat Industrial Annual files. Following Bates, Kahle and Stulz (BKS, 2006), we examine firms over the 1980-2005 period. We remove firms from regulated industries (SIC 4900-4999) and financial firms (SIC 6000-6999). In addition, following Clarke (1989), we remove firms with 4-

digit SIC codes ending either by 0 or 9 that group firms with not well defined industry. Observations with missing SIC code, total assets, cash and short term investments, sales and operating income are deleted. The final sample consists of 62,644 firm-year observations, in which industries are defined by their 4-digit SIC code.

3.2 Methodology

We now turn to the methodology used for testing the hypotheses derived in section 2. We run a series of cross-sectional regressions:

$$Cash_{i,t} = \beta_0 + \beta_1 \lambda_{i,t-1} + \beta_2 \phi_{i,t-1} + \beta_3 \Lambda_{i,t-1} + \beta_4 \sigma_{i,t-1} + \beta_5 X_{i,t-1} + \epsilon_{i,t}, \quad (11)$$

with $i = 1, ..., n_t$ and $t = 1980, ..., 2005$, where i and t are firm and time indices, respectively. Equation (11) relates cash holdings to the intensity of product market competition, λ, the intensity of financing constraints, ϕ, firm size, Λ, and cash flow volatility, σ. The set of control variables X includes variables that are commonly believed to affect cash holdings [see BKS (2006) and OPSW (1999)]. The definition and construction of the dependent and explanatory variables are summarized in Appendix B. Fama-MacBeth (1973) parameter estimates are obtained by averaging the coefficients across estimation years. The t-statistics are adjusted for the possibility of first-order autocorrelation. [5]

In equation (11), cash holdings are measured as cash and short term investments deflated by book assets, as suggested by BKS. The cash ratio may be defined in various ways. OPSW use cash deflated by book assets minus cash. Haushalter et al. (2007) use the log of the OPSW measure. The drawback of using these measures is that they both generate extreme outliers. Unreported robustness results show that our conclusions are unaffected by the definition of

[5] Gaspar and Massa (2006) use a similar setup to analyze the link between idiosyncratic volatility and product market competition.

the dependent variable. Volatility is computed as the mean of standard deviations of operating income before depreciation (item 13) deflated by total assets (item 6) over 10 years for firms in the same industry, as defined by the 4-digit SIC code. Firm size is defined as the log of net sales (item 12). We describe below the measures used to reflect the intensity of competition measures and the severity of financing constraints.

In a second step, we estimate the specification in equation (11) when splitting the full sample in two subsamples comprising either financially constrained firms or unconstrained firms. This allows us to assess the effects of financing constraints on the relation between cash holdings and product market competition.

3.3 Intensity of competition measures

We construct two measures to reflect the intensity of product market competition. First, we use the excess price-cost margin (EPCM) [see e.g. Lindenberg and Ross (1981), Nickell (1996), Aghion et al. (2005), or Gaspar and Massa (2006)]. The price-cost margin (PCM) is defined as operating income (before depreciation) over sales. EPCM is defined as the difference between a firm's PCM and the average PCM of its industry. We control for industry PCM in order to account for inter-industry differences unrelated to market power. In this specification, we assume that marginal and average costs are equivalent [see Carlton and Perloff (1989)]. The price-cost margin is used in most of the industrial organization (IO) literature and refers to the ability of the firm to price above marginal cost [see Lerner (1934)]. A greater value of EPCM indicates a greater ability to extract profits and, hence, a lower intensity of competition.

Second, we use the number of firms per industry (see Tirole, 1988, pp222). The number of firms in an industry affects the ability of a given firm to influence prices. In a monopoly, the single firm has market power and can fix prices. In a perfectly competitive environment, firms are price takers. The most common industrial organization structure that we observe in practice, the oligopoly, lies somewhere in between these two cases. We can reasonably think that the intensity of competition is not linear in the number of firms. For example, the entry of a firm in an economy of 2 or 22 firms will have a different impact on the competition among firms. Thus, we use the logarithm of the number of firms to measure the intensity of product market competition.

The Herfindahl-Hirschman index (HHI) is a commonly used measure of industry concentration. The HHI is reported by the Census Bureau every 5 years for manufacturing firms. This index measures the degree of concentration in an industry. Until 1997, the data on manufacturing firms were organized and classified by the Standard Industry Classification (SIC) system. Since 1997, the data are organized and classified by the North American Industry Classification System (NAICS). This industry definition change prevents us from using this measure in an analysis over a sufficiently long time period. More importantly, the structural break in the measurement of this index prevents us from analyzing the effects of competition on the time-trend of cash holdings. (Note however that the HHI is correlated with the number of firms in an industry because its lower bound when there are n firms is $1/n$. In addition, the HHI is $1/n$ when all firms in an industry have equal market shares.)[6]

3.4 Intensity of financing constraint measures

The intensity of firm financing constraint is unobserved. As a result, the literature has proposed an array of methods to measure the severity of financial constraints facing firms. Since there is no agreement on which measure is the best proxy for

[6]Note that in our model, the number of firms is n, the HHI index is $1/n$, and the EPCM is decreasing in n since $\partial p(x)/\partial n = -(1/\gamma)x(nk)^{-(1+\gamma)/\gamma} < 0$.

financial constraints, we rely on four different measures that complement each other.

Payout policy. The literature on financing constraints argues that a firm's payout ratio may be used to measure financial constraints [see Fazzari, Hubbard and Petersen (1988)]. Thus, for every year in our sample, we rank firms based on their payout ratio. Financially constrained (unconstrained) firms are identified as being in the bottom (top) three deciles of the annual payout ratio distribution. Payout ratio is defined as total distributions (dividends and stock repurchases) deflated by operating income.[7]

Firm size. The second measure we use to proxy for firms' financing constraints is firm size [see Gilchrist and Himmerlberg (1995) and Erickson and Whited (2000)]. Small firms are typically young, less known, and more vulnerable to capital market imperfections and, thus, are more likely to face financing difficulties. In addition, larger, more established firms are more likely to have a well functioning treasury department and well established relations with financial institutions rendering access to capital markets easier. For every year, we rank firms based on their size. Financially constrained (unconstrained) firms are identified as being in the bottom (top) three deciles of the annual size distribution. Similar results are obtained if we use firm age instead of firm size.

Bond rating. We use the market assessment of firms' credit risk as third measure of firms' financing constraints [see e.g. Whited (1992), Gilchrist and Himmelberg (1995) and Lemmon and Zender (2004)]. We collect data on firms credit rating and categorize firms as financially constrained if the credit rating is either

[7] All firms having the same payout ratio are assigned to the same group. This may lead to unequal constrained and unconstrained groups. For example, more than 30% of firms have zero payout ratio but all are considered as constrained.

missing or non investment grade. Financially unconstrained firms are firms with an investment grade rating. All unlevered firms are considered as unconstrained. Similar results are obtained if we use instead commercial paper rating.

Whited and Wu financial constraints index. We use Whited and Wu financial constraints index as fourth measure. Whited and Wu (2006) construct an index (WW index) of firms' external finance constraints and show that this index does a better job than the Kaplan and Znigales index at isolating firms with characteristics associated with financing constraints.[8] Firms with high WW index are small firms, that rely mainly on equity financing, exhibit low growth and have low cash flows. Formally, the index is defined as follows:

$$\text{WW} = -0.091\text{CF} - 0.062\text{DIVPOS} + 0.021\text{TLTD} - 0.044\text{LNTA} + 0.102\text{ISG} - 0.035\text{SG}$$

where CF is cash flows from operations, DIVPOS is a dummy variable equal to 1 if the firm pays dividends, TLTD is long term debt over assets, LNTA is the natural logarithm of total assets, ISG is the three-digit SIC industry sales growth rate and SG is the firm sales growth rate. We compute firms' WW index every year. Financially constrained (unconstrained) firms are then identified as being in the top (bottom) three deciles of the WW index annual distribution.

Table 11 reports the number of firm-year observations classified as constrained or unconstrained for the four financial constraints criteria. For example, there are 30,859 constrained firm-year observations and 17,695 unconstrained according to the payout ratio criterion. Table 11 shows that the 4 criteria are positively but not perfectly correlated. Indeed, out of the 30,859 payout constrained firm-year observations, 13,832 are considered constrained and 4,162 unconstrained with respect to the size criterion. The remaining observations are considered as

[8] We do not use Kaplan-Zingales index as Almeida, Campello and Weisbach (2004) document that this index is negatively related to financial constraints. We do not to use Cleary index due to endogeneity problems. Indeed, one of the determinants of this index is cash holdings.

neither constrained nor unconstrained. Each of the four measures thus conveys incremental information, which contributes to the robustness of the analysis.

4 Empirical results

We now investigate whether cash holdings are related to measures of product market competition and firms' financing constraints in a way consistent with the predictions of the model. To this end, we first describe the data that we use in our empirical tests to confirm that they exhibit the same general patterns that have been reported previously in the literature. We then present the results of the tests of the hypotheses derived in the model. The new evidence in this section is strongly supportive of the model's predictions regarding the relation between cash holdings, financing constraints, and product market competition.

4.1 Descriptive Statistics

Table 12 presents descriptive statistics of the sample. Our sample exhibits characteristics similar to those in prior studies. Mean cash holdings are 0.15 with a standard deviation of 0.19. Figure 10 (panel a) plots firms' cash holdings over the sample period. At the beginning of the sample period in 1980, the average cash ratio for the firms in our sample is 10%. At the end of the sample period in 2005, this ratio doubles to 20%.

The mean excess price-cost margin (EPCM), our main proxy for the intensity of competition, is -0.14 with a standard deviation of 0.37. The results on EPCM are in line with those reported by Aghion et al. (2005) or Gaspar and Massa (2006). Figure 10 (panel b) illustrates the time trend in EPCM. We observe a sharp decrease in EPCM consistent with an increase of competition intensity [see also Gaspar and Massa (2006)]. This time-trend in EPCM can be attributed to market deregulation – which reduces barriers to entry that enable market power [see Andrade, Mitchell and Stafford (2001)] – and market globalization [see Ryan (1997) and Bernard, Jensen and Schott (2005)].

Figure 11 illustrates the effects of product market competition on cash holdings. Cash holdings increase for firms that are in a competitive environment since the risk of inefficient closure is greater for these firms. Intuitively, the increase in cash holdings is a natural response to the increase of competition intensity in product markets as shown in Figure 10. Consistent with our model, we observe also that cash holdings remain stable over time for firms enjoying market power. We turn now to the formal testing of the model.

4.2 Hypothesis testing

We turn now to testing hypothesis (1) through (4) derived in the model. In order to do so, we estimate the specification in equation (11). To simplify the interpretation of results, we scale all regressors by their standard deviation. Thus, regression coefficients can be interpreted as the response of the dependent variable to a one standard deviation change in the regressor.

Table 13 reports the estimation results. Consistent with hypothesis (1), we find that cash holdings increase with the intensity of competition as proxied either by EPCM or by the number of firms per industry. A one standard deviation change in the intensity of competition leads to a change of cash holdings of 0.9%. Consistent with model hypothesis (2), we find that a one standard deviation change in the severity of financing constraints, as proxied either by firm size, bond rating or dividends, leads to a change of cash holdings in the range of 0.9% to 3.2%.[9] In addition, we find that cash holdings decrease with firm size

[9]We do not include WW index as independent variable because this index is correlated with some of the control variables.

and increase with cash flow volatility, consistent with hypothesis (3) and (4), respectively. A one standard deviation change in firm size or cash flow volatility leads to a change of cash holdings in the range of 0.9% to 1.4% or 1.5% to 1.8%, respectively. All coefficients are significant at the 1% level.

Across specifications, control variables have consistently signs in line with those predicted by the empirical literature [see BKS (2006) and OPSW (1999)]. Specifically, we obtain positive coefficients on market-to-book ratio and R&D and negative coefficients on net working capital, capital expenditures, leverage and acquisitions. Taken together, these first results provide strong evidence that the intensity of product market competition affects cash holdings. In the following, we further characterize the nature of this "competition effect".

Hypothesis (2) states that cash holdings increase with the intensity of firm financing constraint. In addition, according to hypothesis (2) the intensity of competition is an insignificant determinant of cash holdings for financially unconstrained firms and a significant determinant of financially constrained firms. In order to test this refinement of hypothesis (2), we estimate model (11) by splitting the sample into two groups: constrained and unconstrained firms.

Table 14 reports the estimation results for constrained and unconstrained firms. We observe that the set of constrained firms displays significant coefficients on EPCM, while unconstrained firms show insignificant coefficients. The inclusion of instruments for (the absence of) financing constraints markedly increases (decreases) the effects of competition on cash holdings. In particular, one standard deviation change in EPCM leads to a change of cash holdings in the range of 0.9% to 2% for financially constrained firms (twice as high as in Table 13). In addition, this coefficient becomes insignificant for firms that are not financially constrained. The coefficients on size, volatility, and the control variables are overall unaffected by these sample splits. Table 15 presents robustness checks with the alternative proxy of intensity of competition. The results are qualitatively similar.[10] Thus, we observe that results on the relation between cash holdings and the intensity of competition are robust.

The model predicts that firms in riskier industries hold more cash (Hypothesis 4). In addition, the model predicts that risk exacerbates the link between cash holdings and competition, because the cost of financing constraints increases with volatility. To assess the impact of risk on the relation between cash holdings and competition, we estimate a modified version of model (11) in which we allow the effect of competition on cash holdings to be different for firms in low and high volatility industries. Low (high) volatility industries are identified as being in the bottom (top) three deciles of the annual volatility distribution. The new model is:

$$Cash_{i,t} = \beta_0 + \beta_1^L \lambda_{i,t-1} 1_{[\sigma<\sigma_L]} + \beta_1^H \lambda_{i,t-1} 1_{[\sigma>\sigma_H]} + \beta_2 Z_{i,t-1} + \epsilon_{i,t} \tag{12}$$

where $\lambda_{i,t}$ is the intensity of competition, σ is the industry volatility and σ_L and σ_H are the 30%- and 70%-tiles of the annual volatility distribution, respectively. The control variables $Z_{i,t}$ are the same as in model (11). [11] Ultimately, we want to test if $\beta_1^L \neq \beta_1^H$. Table 16 reports estimated coefficients and a difference test.

Consistent with the predictions of the model, the link between cash holdings and competition is magnified by volatility. Coefficients on intensity of competition are roughly 5 times larger for high volatility industries than for low volatility

[10]The coefficient on competition is barely significant for unconstrained firms and insignificant for constrained firms based on the WW index when competition is measured by the number of firms in the industry. The coefficients turn insignificant and significant for financially unconstrained and constrained firms, respectively, if financially (un)constrained firms are identified as being in the (bottom) top two (instead of the top three) deciles of the WW index annual distribution.

[11]The new setup assumes that the effect of control variables is unchanged across industry volatility levels. Unreported results show that results are robust to relaxing this hypothesis.

industries. In addition, for low volatility industries, the competition effect is insignificant. Finally, we observe that the precautionary motive for holding cash is strong for high volatility industries and small or even insignificant for low volatility industries.

4.3 Cash holdings time trend

As shown in Figure 9, the intensity of competition has significantly increased during the sample period. In this section, we want to test if the time trend of competition is related to the time trend of cash holdings documented by Bates, Kahle and Stulz (2006). Specifically, we want to assess how the link between cash holdings and competition behaves through time by combining cross-sectional and time-series regressions.

To implement this test, we use a two-step approach. The first step of our procedure consists of estimating model (11) for constrained and unconstrained firms every year. This yields time-series of coefficients for every independent variable. We collect the coefficients on competition (i.e. β_1) and build a time-series vector Ψ_t. In a second step, we use Ψ_t as dependent variable and regress it on a constant and a time trend:[12]

$$\Psi_t = \eta + \rho Trend + u_t \tag{13}$$

Table 17 reports time trend coefficients (ρ) for constrained and unconstrained firms. We observe that there is an economically and statistically significant time effect on the link between cash holdings and competition for financially constrained firms. In particular, we observe that the coefficient on competition exhibits an increase in the range 0.0013 to 0.0023 in absolute value for every year. We do not find evidence of time effect for unconstrained firms. Hence, our results

[12] Almeida, Campello and Weisbach (2004) use a similar estimation procedure to assess the impact of economic activity and time trend on cash flow sensitivities of cash.

suggest that the increase in cash holdings can be at least partially attributed to a competition effect.

5 Conclusion

This paper examines the effects of product market competition on firms cash policy in the presence of financial constraints. We build a stylized real options model in which the firm managers can abandon its business if product demand falls to a sufficiently low level. The managers may abandon voluntarily, or may be forced to do so because of financing constraints. In our model, financing constraints lead to inefficient early closure. However, managers can use cash holdings to cover operating losses and avoid inefficient closure. The risk of inefficient closure increases with product market competition. In addition, the cost of inefficient closure increase with volatility. Consequently, firms operating in riskier and more competitive industries hold more cash.

We take the model to the data and find that firms operating in more competitive industries hold more cash. Moreover, competition affects cash holdings only in the presence of financing constraints. We also observe that volatility exacerbates the effect of competition on firms' cash holdings. Finally, we document a time trend in the intensity of product market competition. This increase in competition pressure can at least partially explain the secular time trend in cash holdings documented by Bates, Kahle and Stulz (2006).

6 Appendix

6.1 Symmetric Cournot game

Consider a simple extension of the basic model, in which each unit of installed capital can produce one unit of output at a cost $C_i(q_i) = cq_i + F$ where c is a constant marginal cost of production. At any time t, each firm chooses its output to maximize current profits. This choice of output q_i is constrained by the installed capacity k_i and depends on current demand. Thereafter, we will focus on a symmetric Nash equilibrium in which all firms have the same production capacity. Let $K = nK_i$ denote the industry capacity. The instantaneous operating cash flow of firm i at time t in a Cournot equilibrium is given by:

$$\pi_i(K, x) = \max_{0 \leq q_{it} \leq K/n} \left[(xQ_t^{-1/\gamma}) q_{it} - cq_{it} - F \right], \tag{14}$$

the solution to which is given by

$$\pi_i(K, x) = \begin{cases} \frac{1}{n} \left\{ \left(\frac{c}{n\gamma - 1} \right) [A(n,\gamma)]^{-\gamma} x^\gamma \right\} - F, & \text{for } x < A(n,\gamma) K^{1/\gamma} \\ \frac{1}{n} \left(xK^{(\gamma-1)} - cK \right) - F & \text{for } x > A(n,\gamma) K^{1/\gamma} \end{cases} \tag{15}$$

where $A(n, \gamma) = n\gamma c/(n\gamma - 1)$.

The required rate of return for investing in the firm's equity is r. Applying Itô's lemma, it is then immediate to show that the value of the equity project satisfies:

- In the region $x \leq A(n, \gamma) K^{1/\gamma}$,

$$rV_i(x) = \frac{1}{n} \left\{ \left(\frac{c}{n\gamma - 1} \right) [A(n,\gamma)]^{-\gamma} x^\gamma \right\} - F + \mu x V_i'(x) + \frac{1}{2} \sigma^2 x^2 V_i''(x). \tag{16}$$

- In the region $x \geq A(n, \gamma) K^{1/\gamma}$,

$$rV_i(x) = \frac{1}{n} \left(xK^{(\gamma-1)} - cK \right) - F + \mu x V_i'(x) + \frac{1}{2} \sigma^2 x^2 V_i''(x). \tag{17}$$

The left hand side of this equation represents the rate of return required by investors. The right hand side corresponds to the realized return, which comes in the form of a cash flow stream and capital gains.

Solving this optimization problem yields the following expression for firm value:

$$V_i(K,x) \tag{18}$$
$$= \begin{cases} \frac{1}{n}\left[K^{(\gamma-1)}\frac{x}{r-\mu}-\frac{cK+nF}{r}\right]+A_Hx^{\nu}+B_Hx^{\xi}, & \text{for } x>A(n,\gamma)K^{1/\gamma} \\ \frac{1}{n}\left\{\left(\frac{c}{n\gamma-1}\right)\frac{[A(n,\gamma)]^{-\gamma}x^{\gamma}}{r-\gamma\mu-\gamma(\gamma-1)\sigma^2/2}\right\}-\frac{F}{r}+A_Lx^{\nu}+B_Lx^{\xi}, & \text{for } x<A(n,\gamma)K^{1/\gamma} \end{cases}$$

where A_H, B_H, A_L, and B_L are constant parameters and $\nu>0$ and $\xi<0$ are the positive and negative roots of the quadratic equation $\frac{1}{2}\sigma^2y(y-1)+\mu y-r=0$.

When the firm is not financially constrained, shareholders inject funds in the firm as long as firm value is positive. This condition implies that shareholders abandon the firm's assets the first time firm value is equal to zero. As a result, for firms that are not financially constrained, the above ODE is solved subject to the following boundary conditions:

$$V_i(\underline{x}_E) = 0 \tag{19}$$
$$V_i'(\underline{x}_E) = 0 \tag{20}$$
$$\lim_{x\downarrow A(n,\gamma)K^{1/\gamma}} V_i(x) = \lim_{x\uparrow A(n,\gamma)K^{1/\gamma}} V_i(x) \tag{21}$$
$$\lim_{x\downarrow A(n,\gamma)K^{1/\gamma}} V_i'(x) = \lim_{x\uparrow A(n,\gamma)K^{1/\gamma}} V_i'(x) \tag{22}$$

The first two boundary conditions are the value-matching and smooth-pasting conditions at the endogenous abandonment threshold $\underline{x}_E$. Because the firm cash flows are given by a (piecewise) continuous Borel-bounded function, $V_i(\cdot)$ is piecewise $\mathcal{C}^2$ (see Theorem 4.9 pp. 271 in Karatzas and Shreve, 1991). Therefore, $V_i(\cdot)$ is $\mathcal{C}^0$ and $\mathcal{C}^1$ and satisfies the continuity and smoothness conditions (21) and (22). Finally, firm value satisfies the no-bubbles condition: $\lim_{x\to\infty}[V_i(x)/x]<+\infty$, which implies $A_H=0$.

Define $\rho(\gamma)$ by $\rho(\gamma) \equiv r - \gamma\mu - \gamma(\gamma-1)\sigma^2/2$. Plugging the expression for firm value (given by equation (18)) in the boundary conditions (19) through (22) yields the constant parameters B_H, A_L, and B_L as well as the value of the endogenous closure threshold:

$$\begin{aligned}
\underline{x}_E^{\xi} &= \frac{1}{(\nu-\xi)\,B_L}\left\{\nu\frac{F}{r} - \frac{\nu-1}{n}\left[\left(\frac{c}{n\gamma-1}\right)\frac{[A(n,\gamma)]^{-\gamma}\,\underline{x}_E^{\gamma}}{\rho(\gamma)}\right]\right\}, \\
B_L &= -\frac{\underline{x}_E^{-\xi}}{\xi}\left\{\frac{1}{n}\left[\left(\frac{c}{n\gamma-1}\right)\frac{\gamma\,[A(n,\gamma)]^{-\gamma}\,\underline{x}_E^{\gamma}}{\rho(\gamma)}\right] + \nu A_L \underline{x}_E^{\nu}\right\}, \\
A_L &= \frac{\left(A(n,\gamma)K^{1/\gamma}\right)^{-\nu}}{\xi-\nu}\left\{\frac{c\,(\xi-1)}{n\,(n\gamma-1)}\left[\frac{n\gamma K^{\gamma-1+1/\gamma}}{r-\mu} - \frac{K}{\rho(\gamma)}\right] - \frac{\xi}{n}\frac{cK}{r}\right\}, \\
B_H &= B_L + \frac{\left(A(n,\gamma)K^{1/\gamma}\right)^{-\xi}}{\nu-\xi}\left\{\frac{\nu}{n}\frac{cK}{r} - \frac{c\,(\nu-1)}{n\,(n\gamma-1)}\left[\frac{n\gamma K^{\gamma-1+1/\gamma}}{r-\mu} - \frac{K}{\rho(\gamma)}\right]\right\}.
\end{aligned}$$

6.2 Data Definitions

Variable	Variable Definition
Dependent Variable:	
Cash	Cash and Short-Term Investments (item1)/ Assets - Total (item6)
Intensity of Competition:	
PCM	Operating Income Before Deprec. (item 13)/Sales net (item 12)
EPCM	PCM - Industry Value-Weighted PCM
Log Number of Firms	log(Number of Firms per Industry)
Intensity of Financial Constraint:	
Payout	(Dividends - Common (item 21) + Purchase of Common and Pref. Stock (item 115))/Operating Income Before Deprec. (item 13)
Size	log(Sales net (item 12))
Bond Rating Dummy	1 if (item 280) missing or non-investment grade, 0 otherwise
Whited & Wu index	See Section 3.4
Control Variables:	
Volatility	See Section 3.2
Book Debt	Long term debt (item 9) + Debt in current liabilities (item 34)
Book Equity	Assets total (item 6) - Book debt
Market-to-Book	(Market value (item 25 * item 199) + Book debt)/Assets - Total (item 6)
Return on Assets	(Operating Income Before Deprec. (item 13))/Assets - Total (item 6)
Net Working Capital	(Working Capital (item 179) - Cash and Short-Term Investments (item1)/ Assets - Total (item 6)
Capex	Capital Expenditures (item 128)/Assets - Total (item 6)
Leverage	Book Debt/(Assets Total (item 6) - Book equity + Market value (item 25 * item 199))
R&D	Research and development expenses (item 46)/Assets total (item6)
Acquisitions	Acquisitions (item 129)/Assets - Total (item 6)
Dividends Dummy	dummy variable equal to 1 if Dividends - Common (item 21) reported

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Table 11: Constraint Type Cross-Correlations

Table 11 reports constraint type cross-correlations. We use four criteria to classify firm-year observations as constrained (C) or unconstrained (U). The sample is based on Compustat Annual Industrial files over the 1980-2005 period.

		Payout Policy		Firm Size		Bond Rating		WW index	
		(C)	(U)	(C)	(U)	(C)	(U)	(C)	(U)
Payout Policy									
Constrained Firms	(C)	30,859							
Unconstrained Firms	(U)		17,695						
Firm Size									
Constrained Firms	(C)	13,832	464	18,794					
Unconstrained Firms	(U)	4,162	12,436		18,793				
Bond Rating									
Constrained Firms	(C)	30,511	13,648	18,788	14,254	58,002			
Unconstrained Firms	(U)	348	4,047	6	4,539		4,642		
WW index									
Constrained Firms	(C)	14,013	221	14,795	5	18,137	4	18,141	
Unconstrained Firms	(U)	2,511	13,523	11	15,230	13,612	4,529		18,141

Table 12: Descriptive Statistics

Table 12 presents descriptive statistics for the main variables used in the estimation. The sample is based on Compustat Annual Industrial files over the 1980-2005 period. Appendix B provides a detailed definition of the variables.

	Mean	S.D.	25%	50%	75%	Obs
Dependent Variable:						
Cash	0.15	0.19	0.02	0.08	0.22	62,644
Intensity of Competition:						
EPCM	-0.14	0.37	-0.13	-0.03	0.02	62,644
Log Number of Firms	3.47	1.14	2.64	3.47	4.25	62,644
Intensity of Financial Constraint:						
Payout	0.11	0.30	0.00	0.00	0.11	58,937
Size	4.49	2.32	2.84	4.38	6.01	62,644
Bond Rating	0.93	0.26	1.00	1.00	1.00	62,644
Whited & Wu index	-0.21	0.13	-0.30	-0.21	-0.13	60,435
Control Variables:						
Volatility	0.08	0.04	0.06	0.07	0.10	62,644
Market-to-Book	1.78	2.17	0.76	1.11	1.88	62,644
Net Working Captial	0.09	0.31	-0.02	0.11	0.26	61,561
Capex	0.08	0.08	0.02	0.05	0.10	62,644
Leverage	0.26	0.25	0.03	0.18	0.41	62,644
R&D	0.05	0.10	0.00	0.00	0.05	62,644
Aquisitions	0.02	0.05	0.00	0.00	0.00	62,644
Dividends Dummy	0.30	0.46	0.00	0.00	1.00	62,644

Table 13: Cash holdings, Competition and Financing Constraint

Table 13 presents results of yearly cross-sectional regressions of cash holdings on the intensity of competition, intensity of financing constraint and control variables. The sample is based on Compustat Annual Industrial files over the 1980-2005 period. The parameter estimates shown are time-series averages of the individual cross-sectional parameter estimates. Fama-MacBeth t-statistics, adjusted for first-order autocorrelation, are reported in parenthesis.

	(1)	(2)
EPCM	-0.009	-
	(2.77)	-
Number of firms	-	0.009
	-	(2.94)
Bond Rating	0.032	0.029
	(5.94)	(6.15)
Size	-0.009	-0.014
	(2.73)	(5.36)
Dividend	-0.017	-0.015
	(4.35)	(4.52)
Volatility	0.018	0.015
	(12.46)	(16.76)
Market-to-Book	0.011	0.012
	(4.38)	(4.61)
NWC	-0.031	-0.031
	(8.97)	(8.89)
Capex	-0.028	-0.031
	(34.89)	(21.59)
Leverage	-0.060	-0.059
	(27.82)	(30.58)
R&D	0.014	0.016
	(3.82)	(3.71)
Aquisitions	-0.012	-0.013
	(12.27)	(12.08)
Constant	0.182	0.176
	(17.25)	(13.19)
Observations	50,805	50,805
Adjusted R^2	0.29	0.29

Table 14: Cash holdings and Competition for Constrained vs. Unconstrained Firms

Table 14 presents results of yearly cross-sectional regressions of cash holdings on the intensity of competition, as measured by the excess price-cost margin (EPCM), and control variables for constrained and unconstrained firms. We use four criteria to classify firm-year observations as constrained (C) or unconstrained (U). The sample is based on Compustat Annual Industrial files over the 1980-2005 period. The parameter estimates shown are time-series averages of the individual cross-sectional parameter estimates. Fama-MacBeth t-statistics, adjusted for first-order autocorrelation, are reported in parenthesis.

	Payout		Firm Size		Bond Rating		WW index	
	(U)	(C)	(U)	(C)	(U)	(C)	(U)	(C)
EPCM	0.004	-0.016	0.005	-0.020	-0.017	-0.009	-0.002	-0.014
	(0.74)	(5.03)	(0.62)	(3.98)	(1.67)	(2.63)	(0.37)	(2.78)
Size	-0.043	-0.001	-0.023	0.005	-0.019	-0.009	-0.035	-0.019
	(14.07)	(0.37)	(9.28)	(0.42)	(6.78)	(2.51)	(11.23)	(2.40)
Dividend	-	-	-0.024	0.040	-0.034	-0.017	-0.029	0.090
	-	-	(10.22)	(5.28)	(4.20)	(3.80)	(11.86)	(4.58)
Volatility	0.020	0.017	0.015	0.013	0.013	0.018	0.017	0.010
	(17.25)	(9.96)	(8.81)	(8.70)	(4.95)	(12.09)	(7.62)	(6.70)
Market-to-Book	0.019	0.011	0.024	0.002	0.025	0.011	0.026	0.003
	(5.26)	(3.72)	(10.74)	(1.07)	(3.46)	(4.47)	(9.93)	(1.50)
NWC	-0.068	-0.022	-0.045	-0.021	-0.026	-0.031	-0.052	-0.019
	(33.44)	(6.38)	(15.58)	(6.02)	(5.54)	(9.24)	(20.54)	(6.44)
Capex	-0.048	-0.023	-0.030	-0.029	-0.026	-0.029	-0.038	-0.027
	(29.02)	(23.04)	(14.37)	(20.53)	(8.46)	(33.56)	(19.98)	(24.71)
Leverage	-0.045	-0.058	-0.031	-0.080	-0.023	-0.061	-0.036	-0.070
	(19.69)	(29.06)	(26.22)	(25.57)	(5.55)	(26.07)	(27.93)	(22.26)
R&D	0.036	0.013	0.042	0.005	0.057	0.013	0.041	0.010
	(7.36)	(4.41)	(4.68)	(2.06)	(6.94)	(3.51)	(4.48)	(4.21)
Aquisitions	-0.015	-0.011	-0.012	-0.014	-0.012	-0.013	-0.014	-0.012
	(13.22)	(8.72)	(11.45)	(7.24)	(6.34)	(12.03)	(10.65)	(4.86)
Constant	0.287	0.188	0.211	0.236	0.177	0.215	0.267	0.234
	(24.78)	(27.04)	(20.87)	(25.45)	(12.34)	(36.61)	(25.00)	(35.04)
Observations	14,813	24,411	15,637	14,538	3,804	47,001	15,081	13,990
Adjusted R^2	0.35	0.26	0.27	0.22	0.30	0.28	0.30	0.23

Table 15: CASH HOLDINGS AND COMPETITION FOR CONSTRAINED VS. UNCONSTRAINED FIRMS: ROBUSTNESS

Table 15 presents results of yearly cross-sectional regressions of cash holdings on the intensity of competition, as measured by the number of firms per industry, and control variables for constrained and unconstrained firms. We use four criteria to classify firm-year observations as constrained (C) or unconstrained (U). The sample is based on Compustat Annual Industrial files over the 1980-2005 period. The parameter estimates shown are time-series averages of the individual cross-sectional parameter estimates. Fama-MacBeth t-statistics, adjusted for first-order autocorrelation, are reported in parenthesis.

	Payout		Firm Size		Bond Rating		WW index	
	(U)	(C)	(U)	(C)	(U)	(C)	(U)	(C)
Number of Firms	-0.001	0.010	-0.001	0.008	0.000	0.009	-0.002	0.006
	(0.30)	(3.36)	(0.75)	(2.10)	(0.09)	(2.84)	(2.06)	(1.66)
Size	-0.043	-0.010	-0.023	-0.022	-0.018	-0.014	-0.036	-0.035
	(13.76)	(3.58)	(9.12)	(2.99)	(6.94)	(4.98)	(10.93)	(4.94)
Dividend	-	-	-0.024	0.028	-0.033	-0.015	-0.030	0.080
	-	-	(10.96)	(3.74)	(4.09)	(3.90)	(12.42)	(4.29)
Volatility	0.020	0.014	0.016	0.011	0.012	0.015	0.018	0.009
	(16.07)	(9.74)	(8.93)	(7.47)	(4.98)	(15.91)	(7.51)	(6.16)
Market-to-Book	0.021	0.013	0.024	0.004	0.025	0.012	0.026	0.005
	(4.96)	(4.12)	(10.42)	(1.65)	(3.61)	(4.72)	(9.35)	(2.12)
NWC	-0.068	-0.024	-0.045	-0.024	-0.025	-0.032	-0.054	-0.021
	(34.39)	(6.41)	(16.45)	(5.85)	(5.58)	(9.08)	(19.36)	(6.49)
Capex	-0.049	-0.026	-0.029	-0.030	-0.028	-0.031	-0.037	-0.027
	(26.56)	(18.45)	(12.72)	(17.65)	(7.77)	(20.34)	(20.55)	(19.93)
Leverage	-0.045	-0.057	-0.031	-0.081	-0.022	-0.060	-0.036	-0.070
	(19.09)	(30.10)	(26.40)	(26.14)	(5.18)	(28.79)	(28.47)	(25.12)
R&D	0.037	0.016	0.043	0.009	0.057	0.015	0.042	0.013
	(7.53)	(4.94)	(4.72)	(2.83)	(7.38)	(3.41)	(4.60)	(3.71)
Acquisitions	-0.015	-0.012	-0.012	-0.014	-0.012	-0.013	-0.013	-0.013
	(13.34)	(9.40)	(11.55)	(7.55)	(6.56)	(11.80)	(10.56)	(5.38)
Constant	0.287	0.181	0.212	0.256	0.173	0.204	0.275	0.243
	(31.01)	(15.51)	(22.55)	(18.99)	(12.23)	(19.88)	(25.48)	(21.10)
Observations	14,813	24,411	15,637	14,538	3,804	47,001	15,081	13,990
Adjusted R^2	0.34	0.26	0.27	0.21	0.29	0.28	0.30	0.22

Table 16: Cash holdings, Competition and Volatility

Table 16 presents results of yearly cross-sectional regressions of cash holdings on the intensity of competition, as measured by (i) the excess price-cost margin (EPCM) or (ii) the number of firms per industry, and control variables for firms in low and high volatility industries. Each cell displays estimates of the coefficient for the intensity of competition measure. The sample is based on Compustat Annual Industrial files over the 1980-2005 period. The parameter estimates shown are time-series averages of the individual cross-sectional parameter estimates. Fama-MacBeth t-statistics, adjusted for first-order autocorrelation, are reported in parenthesis. We test for difference in coefficients between low and high volatility case. p-values are reported.

EPCM			Nb Firms		
Low Volatility	High Volatility	High-Low p-value	Low Volatility	High Volatility	High-Low p-value
-0.003	-0.012	0.01	0.002	0.014	0.01
(0.68)	(2.52)		(1.46)	(3.41)	

Table 17: Cash holdings and Time Trend

Table 17 reports results on the effect of competition on cash holdings time trend. A two stage procedure is used. In the first stage, cash holdings are regressed on the intensity of competition measure and controls in every year of the sample for financially constrained and unconstrained firms. In the second stage, the time-series coefficients for the intensity of competition are regressed on a constant and a time trend. Each cell displays estimated coefficients on the time trend. We use four criteria to classify firm-year observations as constrained (C) or unconstrained (U). The sample is based on Compustat Annual Industrial files over the 1980-2005 period. Values of robust t-statistics are reported in parenthesis. The standard errors for cross-equation differences are computed via a SUR system that estimates the group regressions jointly.

	EPCM			Nb Firms		
	(U)	(C)	(U) - (C) p-value	(U)	(C)	(U) - (C) p-value
Payout	-0.0008	-0.0013	0.43	0.0007	0.0016	0.00
	(1.33)	(4.94)		(4.10)	(12.47)	
Size	0.0015	-0.0023	0.00	-0.0002	0.0019	0.00
	(1.95)	(6.55)		(2.02)	(10.7)	
Bond Rating	0.0023	-0.0016	0.00	0.0003	0.0018	0.00
	(1.88)	(5.20)		(1.96)	(13.52)	
WW index	-0.0004	-0.0022	0.01	0.0002	0.0017	0.00
	(0.70)	(6.06)		(1.43)	(9.45)	

Figure 7: Marginal Cost and Benefit of Holding Cash.

Figure 7 shows that the optimal amount of cash holdings is given by the intersection of the marginal cost curve of being short of cash and the marginal cost curve of holding cash.

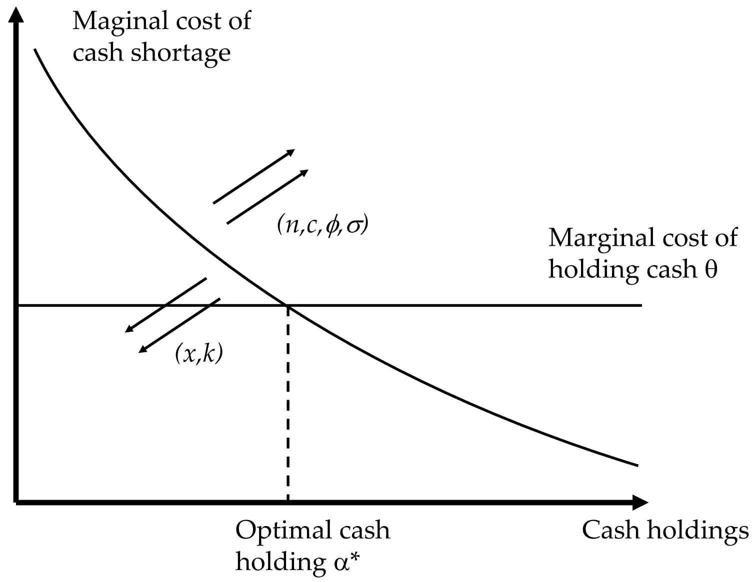


Figure 8: Optimal Cash

Figure 8 plots the optimal amount of cash, α^*, as a function of the intensity of competition, n, the intensity of financial constraint, ϕ, the cost of holding cash, θ, volatility of cash flow shock σ, the moneyness of the option to abandon assets, x, and the fixed cost of production, F.

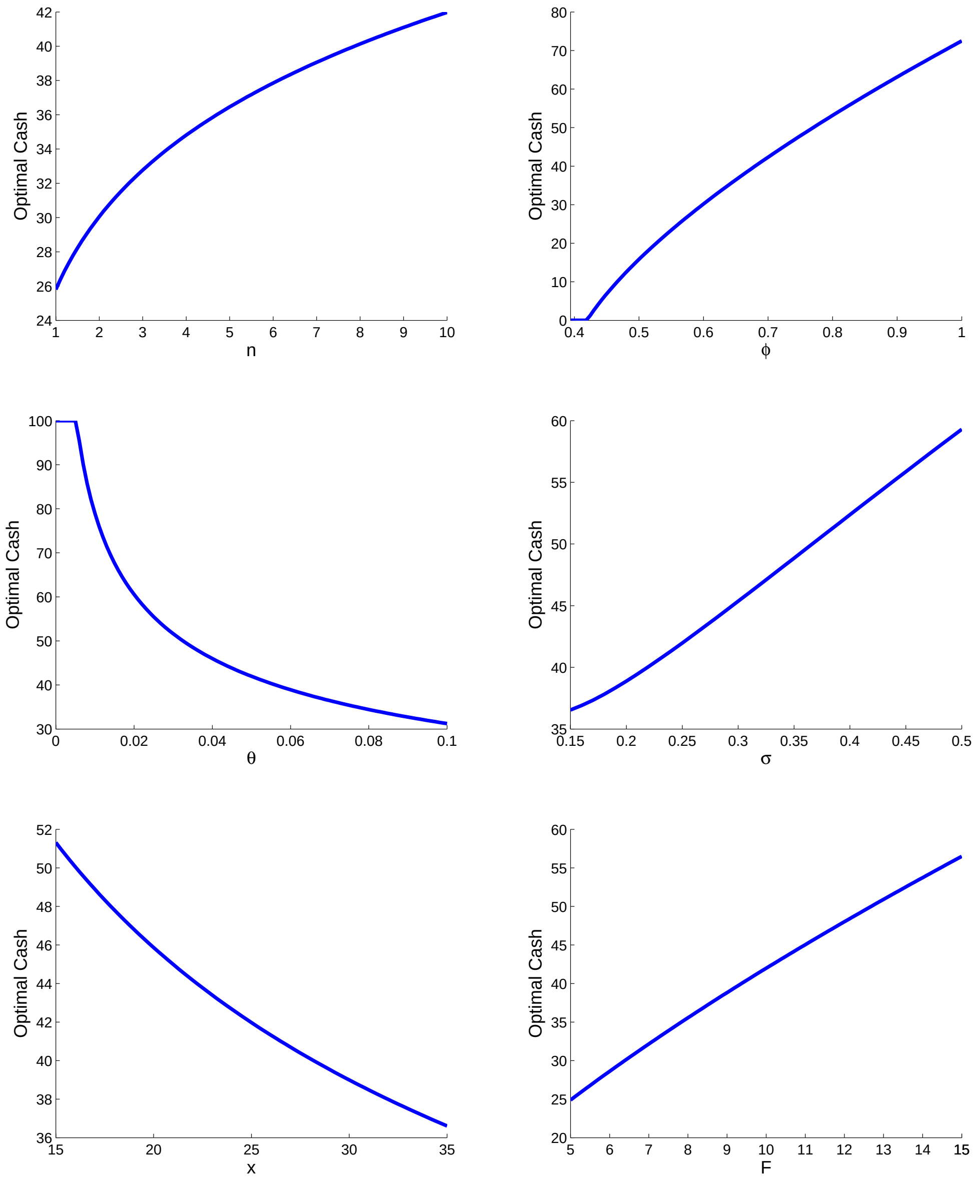
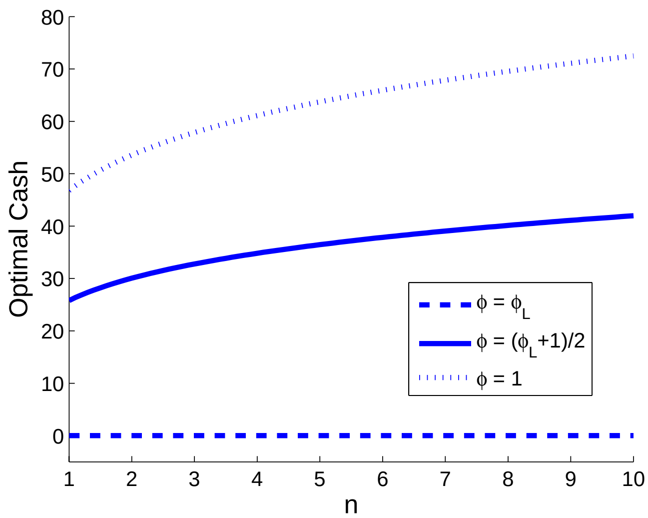


Figure 9: Optimal Cash and Interaction between Intensity of Competition and Intensity of Financing Constraint

Figure 9 plots the optimal amount of cash, α^{*}, as a function of the intensity of competition, n, for low, medium and high intensity of financial constraint, ϕ, and the intensity of financial constraint, ϕ, for low, medium and high intensity of competition, n.



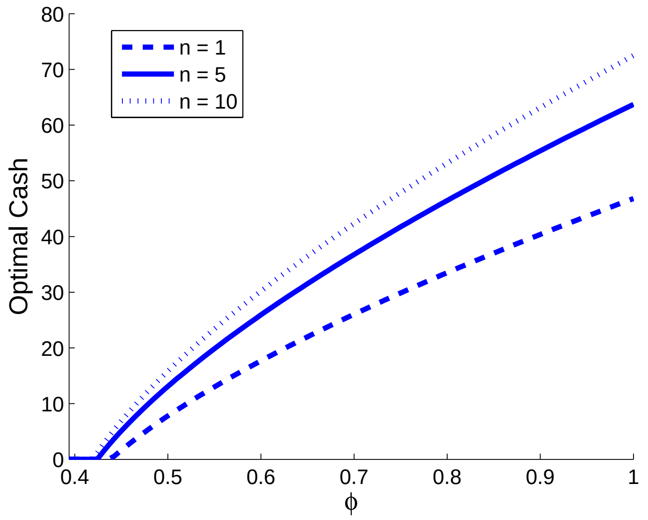
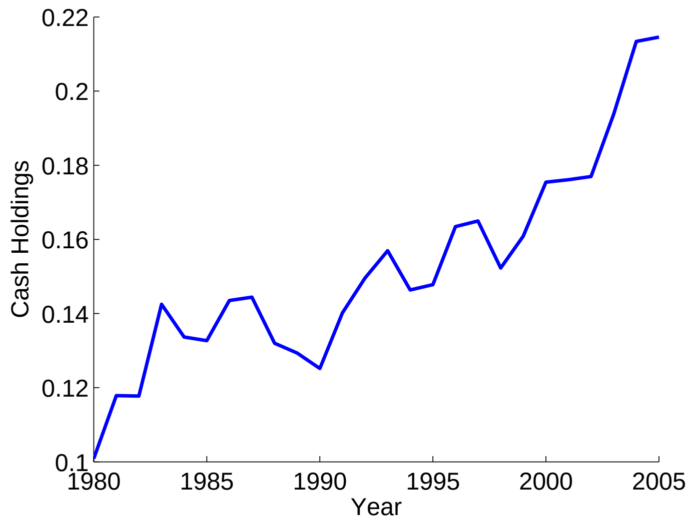
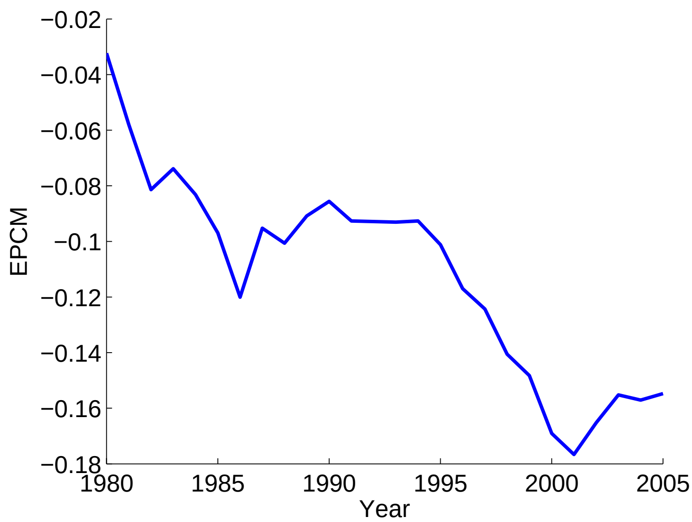


Figure 10: Cash Holdings and Intensity of Competition Time Trend

Figure 10 plots: (a) the average cash ratio through time, and (b) the intensity of competition through time as measured by the excess price-cost margin, EPCM.



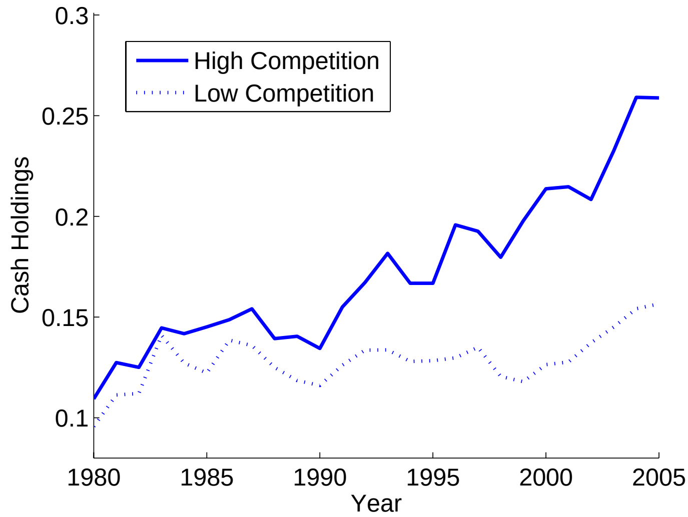
(a) Cash holdings time trend



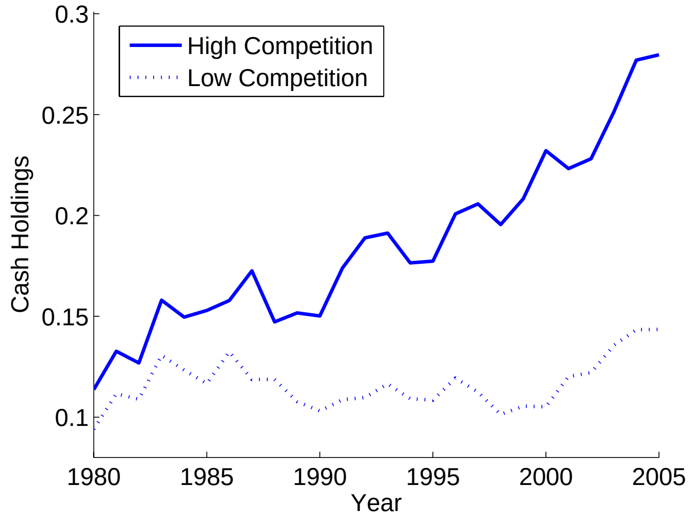
(b) Intensity of competition time trend

Figure 11: Cash Holdings and Intensity of Competition

Figure 11 plots the average cash ratio for firms operating in high or low intensity of competition industries. Intensity of competition is measured by (a) the excess price-cost margin, EPCM , or (b) the number of firms per industry.



(a) Cash holdings time trend for low and high EPCM



(b) Cash holdings time trend for low and high number of firms per industry