Corporate Governance and Capital Structure Dynamics

ERWAN MORELLEC, BORIS NIKOLOV, and NORMAN SCHÜRHOFF *

*Erwan Morellec is with Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Finance Institute, and CEPR. Boris Nikolov is with the William E. Simon Graduate School of Business Administration, University of Rochester. Norman Schürhoff is with the Faculty of Business and Economics at University of Lausanne, Swiss Finance Institute, and CEPR. We thank an anonymous referee, the associate editor, the editor (Campbell Harvey), and Darrell Duffie for many valuable comments and Julien Hugonnier for suggesting an elegant approach to the calculation of conditional densities in our setting. We also thank Tony Berrada, Peter Bossaerts, Bernard Dumas, Michael Lemmon, Marco Pagano, Michael Roberts, René Stulz, Toni Whited (AFA discussant), Marc Yor, Jeff Zwiebel, and seminar participants at Boston College, Carnegie Mellon University, HEC Paris, the London School of Economics, the University of Colorado at Boulder, the University of Lausanne, the University of Pennsylvania, the University of Rochester, the 2008 American Finance Association meetings, 2008 North American Summer Meetings of the Econometric Society, and the conference on “Understanding Corporate Governance” organized by the Fundación Ramón Acéres in Madrid for helpful comments. Erwan Morellec and Norman Schürhoff acknowledge financial support from the Swiss Finance Institute and from NCCR FINRISK of the Swiss National Science Foundation.
ABSTRACT

We develop a dynamic tradeoff model to examine the importance of manager-shareholder conflicts in capital structure choice. In the model, firms face taxation, refinancing costs, and liquidation costs. Managers own a fraction of the firms’ equity, capture part of the free cash flow to equity as private benefits, and have control over financing decisions. Using data on leverage choices and the model’s predictions for different statistical moments of leverage, we find that agency costs of 1.5% of equity value on average are sufficient to resolve the low-leverage puzzle and to explain the dynamics of leverage ratios. Our estimates also reveal that agency costs vary significantly across firms and correlate with commonly used proxies for corporate governance.

JEL Classification Numbers: G12, G31, G32, G34.
A central theme in financial economics is that incentive conflicts within the firm lead to distortions in corporate policy choices and to lower corporate performance. Because debt limits managerial flexibility (Jensen (1986)), a particular focus of the theoretical research has been on the importance of managerial objectives in capital structure choice. A prevalent view in the literature is that self-interested managers do not make capital structure decisions that maximize shareholder wealth. The capital structure of a firm should then be determined not only by market frictions such as taxes, bankruptcy costs, or refinancing costs (as in Fisher, Heinkel, and Zechner (1989)), but also by the severity of manager-shareholder conflicts. While the impact of agency conflicts on financing decisions has been widely discussed for three decades, the literature has been largely silent on the magnitude of this effect. In addition, although we have learned much from this work, most models in this literature are static, making it difficult to develop tests of the connection between agency conflicts and capital structure dynamics.

Our purpose in this paper is to examine the importance of manager-shareholder conflicts in leverage choice and to characterize their effects on the dynamics and cross-section of corporate capital structure. To this end, we develop a dynamic tradeoff model that emphasizes the role of agency conflicts in firms’ financing decisions. The model features corporate and personal taxes, refinancing and liquidation costs, and costly renegotiation of debt in distress. In the model, each firm is run by a manager who sets the firm’s financing, restructuring, and default policies. Managers own a fraction of the firms’ equity and can capture part of free cash flow to equity as private benefits within the limits imposed by shareholder protection. Debt constrains the manager by reducing the free cash flow and potential cash diversion (as in Jensen (1986), Zwiebel (1996), or Morellec (2004)). In this environment, we determine the optimal leveraging decision of managers and characterize the effects of manager-shareholder
conflicts on target leverage and the pace and size of capital structure changes.

As in prior dynamic tradeoff models, our analysis emphasizes the role of capital market frictions in the dynamics of leverage ratios. Due to refinancing costs, 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 refinancing boundaries. The model also reflects the interaction between market frictions and manager-shareholder conflicts, allowing us to generate a number of novel predictions relating agency conflicts to the firm’s target leverage, the frequency and size of capital structure changes, the speed of mean reversion to target leverage, and the likelihood of default. Notably, we show that when making financing decisions, the manager trades off the tax benefits of debt (embedded in the equity stake) against the total costs of debt, which include not only the costs of financial distress but also those associated with the disciplining effect of debt. As a result, incentive conflicts between managers and shareholders lower the firm’s target leverage and its propensity to refinance. That is, the range of leverage ratios widens and financial inertia becomes more pronounced as manager-shareholder conflicts increase.

We explore the empirical implications of our dynamic capital structure model in two ways. First, we use a basic calibration to show that while dynamic models without agency conflicts produce the right qualitative effects to explain the data, the effects of transaction costs alone on debt choices are too small to explain the low debt levels and slow mean reversion of debt observed empirically. We also show with this calibration that by adding reasonable levels of agency conflicts and giving the manager control over the leverage decision, one can obtain capital structure dynamics consistent with the data.

Second, we use panel data on observed leverage choices and the model’s predictions for different statistical moments of leverage to obtain firm-specific estimates of agency costs. We
exploit not only the conditional mean of leverage (as in a regression) but also the variation, persistence, and distributional tails—in short, the conditional moments of the time-series distribution of leverage. Using structural econometrics, we find that agency costs of 1.5% of equity value on average (0.45% at median) are sufficient to resolve the low-leverage puzzle and to explain the time series of observed leverage ratios. We also find that the variation in agency costs across firms is substantial. Thus, while leverage ratios tend to revert to the (manager’s) target leverage over time, the variation in agency conflicts leads to persistent cross-sectional differences in leverage ratios. Finally, we show that the levels of agency conflicts inferred from the data correlate with a number of commonly used proxies for corporate governance, thereby providing additional support for the agency cost channel in explaining financing decisions.

The present paper relates to different strands of literature. First, it relates to the literature that analyzes the relation between manager-shareholder conflicts and firms’ financing decisions. The paper closest to ours is Zwiebel (1996), who also builds a dynamic capital structure model in which financing policy is selected by management. However, while firms are always at their target leverage in Zwiebel’s model, refinancing costs create inertia and persistence in capital structure in our model. Second, our paper relates to the dynamic tradeoff models of Fisher, Heinkel, and Zechn (1989), Goldstein, Ju, and Leland (2001), Ju et al. (2005), and 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 paper relates to the literature examining the effects of stockholder-bondholder conflicts (underinvestment and asset substitution) on firms’ financing decisions (see, for example, Leland (1998), Parrino and Weisbach (1999), Morellec (2001), or Carlson and Lazrak (2010)).
Our model also relates to the tradeoff models of Hennessy and Whited (HW; 2005, 2007). These models consider the role of internal funds. However, they do not allow for default (HW, 2005) and they ignore manager-shareholder conflicts. Our paper is also related to Lemmon, Roberts, and Zender (2008), who find that traditional determinants of leverage account for relatively little of the cross-sectional variation in capital structure. Instead, they show that most of this variation is driven by an unexplained firm-specific determinant. Our analysis reveals that the heterogeneity in capital structure can be structurally related to a number of corporate governance mechanisms, thereby providing an economic interpretation for their results. Finally, our research relates to the recent papers of van Binsbergen, Graham, and Yang (2010) and Korteweg (2010), who provide empirical estimates of the costs of debt as perceived by the agent optimizing financing decisions. We show that for the average firm in our sample, the gross benefits of debt represent 10.7% of asset value, in line with the results in these studies. We also find that the cost of debt to managers is three times the cost of debt to shareholders, with more than half of this cost coming from the disciplining effect of debt.

This paper advances the literature on financing decisions in three important dimensions. First, we show how various capital market imperfections interact with firms’ incentive structures to determine capital structure decisions. Second, we show that while adjustment costs help explain the financing patterns observed in the data, their quantitative effect on debt choices is too small to explain financing decisions. Third, we show that augmenting the dynamic tradeoff theory with small conflicts of interest between managers and shareholders produces a model that can explain why some firms issue little debt despite the known tax benefits of debt (see Graham (2000)) and why leverage ratios exhibit inertia and other robust time-series patterns (see Fama and French (2002), Welch (2004), or Flannery and Rangan
Our empirical analysis also shows that the variation in agency costs across firms is sizeable and that the agency costs inferred from the data correlate with various proxies for corporate governance.

The remainder of the paper is organized as follows. Section I describes the model. Section II illustrates the effects of agency conflicts on leverage levels and dynamics using a calibration of the model. Section III discusses our empirical methodology. Section IV provides firm-specific estimates of manager-shareholder conflicts. Section V relates the estimates of agency costs to various corporate governance mechanisms. Section VI concludes. Technical proofs are provided in the Appendix.

I. The Model

This section presents a model of firms’ financing decisions that extends the dynamic tradeoff framework to incorporate incentive conflicts between managers and shareholders. The model closely follows 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.

A. Assumptions

We consider an economy with a large number of heterogeneous firms, indexed by \( i = 1, \ldots, N \). Firms are infinitely lived and have monopoly access to a set of assets that are operated in continuous time. The firm-specific state variable is the cash flow generated by 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 $Q$ by the process

$$dX_{it} = \mu_i X_{it} dt + \sigma_i X_{it} dB_{it}, \quad X_{i0} = x_{i0} > 0,$$

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

Cash flows from operations are taxed at a constant rate $\tau_c$. 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 $c$ and principal $P$. Debt is callable and issued at par. The proceeds from the debt issue are distributed on a pro rata basis to shareholders at the time of flotation. We assume that firms can adjust their capital structure upwards at any point in time by incurring a proportional cost $\lambda$, but that they can reduce their indebtedness only in default.\(^3\) Under this assumption, the firm’s initial debt structure remains fixed until either the firm goes into default or the firm calls its debt and restructures with newly issued debt. The personal tax rates on dividends $\tau_e$ and coupon payments $\tau_d$ 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), and Strebulaev (2007).

Firms whose conditions deteriorate sufficiently may default on their debt obligations.
In the model, default leads to either liquidation or renegotiation. At the time of default, a fraction of assets are lost as a frictional cost so that if the instant of default is $T$, then $X_T = (1-\alpha)X_{T^-}$ in the case of liquidation and $X_T = (1-\kappa)X_{T^-}$ in the case of renegotiation, with $0 \leq \kappa < \alpha$. Because liquidation is more costly than renegotiation, there exists a surplus associated with renegotiation. This surplus represents a fraction $(\alpha - \kappa)$ of cash flows after default. Following Fan and Sundaresan (2000) and Garlappi and Yan (2011), we assume that in renegotiation shareholders get a fraction $\eta$ of the renegotiation surplus. We also assume that in the case of renegotiation, manager-shareholder conflicts are unaffected by default.

We are interested in building a model in which financing choices reflect not only the tradeoff between the tax benefits of debt and contracting costs, but also manager-shareholder conflicts. Agency conflicts between the manager and shareholders are introduced by assuming that each firm is run by a manager who can capture a fraction $\phi \in [0, 1)$ of free cash flow to equity as private benefits (as in La Porta et al. (2002), Lambrecht and Myers (2008), or Albuquerque and Wang (2008)). That is, the unadjusted cash flows to equity are $(1 - \tau_c)(X_t - c)$, of which shareholders receive a fraction $(1 - \phi)$ and management appropriates a fraction $\phi$. This cash diversion or 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 their jobs in the firm, and perquisites, just to name a few. In the model, we take $\phi$ as a fixed exogenous parameter that reflects the severity of manager-shareholder conflicts. When $\phi = 0$ there is no agency conflict and managers and shareholders agree about corporate policies. Our objective in the empirical section is to estimate the magnitude of $\phi_i$, $i = 1, \ldots, N$, and to relate our estimates to corporate governance mechanisms.

Agency costs of managerial discretion typically depend on the allocation of control rights
within the firm. We follow Zwiebel (1996), Morellec (2004), and Lambrecht and Myers (2008) by assuming that the manager owns a fraction \( \varphi \) of equity and has decision rights over the firm’s initial debt structure as well as restructuring and default policies. When making capital structure decisions, managers act in their own interests to maximize the present value of the total cash flows (managerial rents and equity stake) that they will take from the firm. As in Leland (1998) and Strebulaev (2007), the firm’s debt structure remains fixed until either cash flows reach a sufficiently low level that the firm goes into default or cash flows rise to a sufficiently high level that the manager calls the debt and restructures with newly issued debt. We can thus view the manager’s policy choices as determining the initial coupon payment and the values of the cash flow shock at which the firm will restructure or default on its debt obligations.

\[ \text{Equity stake PV of managerial rents} \]

\[ (2) \]

\[ M(x, c) = \varphi V(x, c) + \phi N(x, c), \]

B. Model Solution

We denote the value of the manager’s claim to cash flows for a value of the cash flow shock \( x \) and a coupon payment \( c \) by \( M(x, c) \). This value is the sum of the manager’s equity stake and the value of private benefits. Because debt is fairly priced, the value of equity at the time of debt issuance is equal to total firm value, denoted by \( V(x, c) \). In addition, since the manager captures a fraction of net income as private benefits, the value of managerial rents is proportional to the value of a claim to net income, denoted by \( N(x, c) \). We can therefore express the value of the manager’s claim to cash flows at the time of debt issuance as

\[ M(x, c) = \varphi V(x, c) + \phi N(x, c), \]

Equity stake PV of managerial rents

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where $\varphi$ represents the manager’s equity stake, $\phi$ represents the fraction of net income captured by the manager, and closed-form expressions for $V(x, c)$ and $N(x, c)$ are derived in Appendix A, Section A.

In the model, the manager maximizes the value of his claims $M(x, c)$ by choosing the initial coupon payment $c$ and the firm’s dynamic restructuring and default policies. Denote by $x_D$ ($< x_0$) the default threshold and by $x_U$ ($> x_0$) the restructuring threshold selected by the manager, given an initial coupon payment $c$. We show in the Internet Appendix that in the static model in which the firm cannot restructure, the default threshold $x_D$ is linear in $c$.$^5$

In addition, the selected coupon rate $c$ is linear in $x$. This implies that if two firms $i$ and $j$ are identical except that $x^i_0 = \Lambda x^j_0$, then the selected coupon rate and default threshold satisfy $c^i = \Lambda c^j$ and $x^i_D = \Lambda x^j_D$, respectively, and every claim will be scaled by the same factor $\Lambda$.

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., $c^1 = \rho c^0$, $x^1_D = \rho x^0_D$, $x^1_U = \rho x^0_U$). Subsequent restructurings scale up these variables again by the same ratio $\rho$. If default occurs prior to restructuring, firm value is reduced by a constant factor $\eta (\alpha - \kappa) \gamma$ with $\gamma \equiv x_D/x_0$, shareholders re-lever the firm, and all claims are scaled down by the same proportion $\eta (\alpha - \kappa) \gamma$ that asset value has decreased (see Appendix A, Section A for details).

When making capital structure decisions, the objective of the manager is therefore to select the coupon level $c$ and scaling factor $\rho$ that maximize the ex-ante value of his claims. Thus, the manager solves

$$
\sup_{c, \rho} M(x, c) \equiv \sup_{c, \rho} \left\{ \varphi V(x, c) + \phi N(x, c) \right\}.
$$

(3)
Since the firm’s net income decreases with $c$, so does $N(x, c)$. As a result, the model predicts that the coupon payment decreases with $\phi$ and that the debt level selected by the manager is lower than the debt level that maximizes firm value whenever $\phi > 0$.

In a rational expectations model, the solution to (3) reflects the fact that the manager chooses a default policy that maximizes the value of his claim after debt has been issued. As in Leland (1994), the default threshold results from a tradeoff between the value of claims outside of default and in default. Assuming that managers stay in control after default (see Gilson (1989) for empirical evidence), all claims are scaled down by the same factor in default and the manager and shareholders agree on the default policy. As a result, the default policy solves

$$\sup_{\gamma} \{V(x, c) - d(x, c)\}, \tag{4}$$

where $d(x, c)$ is the value of outstanding debt derived in Appendix A, Section A.

The problem of managers thus consists of solving (3) subject to (4). A closed-form solution to this optimization problem does not exist and standard numerical procedures are used.

II. A Basic Calibration and Quantitative Analysis

A. Model Predictions

Our objective in this section is to examine the predictions of our model for financing decisions and to provide a first look at the importance of refinancing and agency costs in capital structure choice. To this end, in Table I we report comparative statics describing the effects of the main parameters of the model on the firm’s target leverage, the refinancing
and default thresholds, the recovery rate in default, and the yield spread at target leverage.

Insert Table I Here

Input parameter values for our base case environment are set as follows. The risk-free rate \( r = 4.21\% \) is calibrated to the one-year Treasury rate. The corporate tax rate \( \tau^c = 35\% \) is set at the highest possible marginal tax rate. The tax rates on dividends and interest income are based on estimates in Graham (1999) and set to \( \tau^e = 11.6\% \) and \( \tau^d = 29.3\% \), respectively. In addition, firm-specific parameters are set equal to the values observed in the data at the beginning of the sample period, as described in Section III.B. Notably, we set the initial value of the cash flow shock to \( x_0 = 1 \) (normalized), the growth rate and volatility of the cash flow shock to \( \mu = 0.67\% \) \((m = 8.24\%)\) and \( \sigma = 28.86\% \), liquidation costs to \( \alpha = 48.52\% \), renegotiation costs to \( \kappa = 0\% \), shareholder bargaining power to \( \eta = 50\% \), refinancing costs to \( \lambda = 1\% \), managerial ownership to \( \varphi = 7.47\% \), and private benefits to \( \phi = 1\% \).

Table I reveals that an increase in agency costs, as measured by an increase in \( \phi \) or a decrease in \( \varphi \), lowers both the target leverage and the debt issuance trigger and raises the default trigger. Hence, high (low) agency conflicts lead to low (high) leverage and fewer (more) capital structure rebalancings. As a result, the range of leverage ratios widens and the speed of mean reversion declines (i.e., autocorrelation in leverage ratios rises) as agency costs increase. The intuition underlying this result is that cash distributions are made on a pro-rata basis to shareholders, so that management gets a fraction of the distributions when new debt is issued. Management’s stake in the firm, however, exceeds its direct ownership due to the private benefits of control. Since debt constrains managers by limiting the cash
flows available as private benefits (as in Jensen (1986), Zwiebel (1996), or Morellec (2004)), managers issue less debt (lower target leverage and higher default trigger) and restructure less frequently (lower refinancing trigger) than optimal for shareholders.

More importantly, Table I shows that the quantitative effect of agency conflicts on financing decisions is very strong. For example, an increase of private benefits $\phi$ from 1% to 1.25% leads to a decrease in target leverage from 32.06% to 24.12%. This suggests that agency conflicts represent a plausible channel to explain observed debt choices. The table also reveals that refinancing costs $\lambda$ have similar directional effects as manager-shareholder conflicts on financing choices. The main difference is that refinancing costs have a much smaller quantitative impact on financing decisions than manager-shareholder conflicts. Notably, an increase of $\lambda$ from 1% to 1.25% leads to a decrease in target leverage from 32.06% to 31.91%. The remaining panels of Table I show that the effects of default costs, corporate taxes, and cash flow growth and volatility on the various quantities of interest are similar to those reported previously in the literature (see, for example, Strebulaev (2007)).

B. Model-Implied Leverage Dynamics

The empirical patterns in leverage that emerge from our dynamic model with agency conflicts are difficult to gauge from simple comparative statics. Accordingly, in this section we conduct Monte-Carlo simulations to examine the properties of the statistical distribution of leverage generated by the model. We start by simulating quarterly data for artificial firms, basing our simulation on the parameter values of the previous section. We drop the first half of the data to eliminate the impact of initial conditions. The resulting data set corresponds to a large sample for a representative firm or, equivalently, for a simulated dynamic economy with homogeneous firms in which cash flow innovations are drawn independently across
firms. Finally, we compute various statistical moments for the distribution of leverage in the simulated population of firms.

Insert Table II Here

Table II compares statistical moments of leverage in the actual data to the corresponding moments in the simulated data. The first column of Table II lists a broad choice of data moments. The main moments to consider are the mean, standard deviation, range, and persistence in leverage and quarterly leverage changes. Persistence is measured by quarterly and annual autocorrelations. We also report the median, skew, kurtosis, min, max, and interquartile range. In addition, we list default and issuance probabilities and the size of debt issues as a fraction of firm value. We report model-implied moments for three different parametrizations. In the base case, we set $\lambda = 1\%$ and $\phi = 0\%$. Alternatively, we increase $\lambda$ to 8% or $\phi$ to 1.1%.

A comparison between the empirical moments reported in the first column of the table and the model moments reveals that many features in the actual data are poorly matched when manager-shareholder conflicts are absent from the model. Mean and median leverage are too high in the simulated data, the time-series variation in leverage is too low, and mean reversion in leverage is too high. When refinancing costs are increased to 8% (corresponding to 16% of issue size) or when agency conflicts are introduced by setting $\phi = 1.1\%$, average leverage and other data moments are captured well. A distinctive feature of refinancing costs compared to agency conflicts is that firms’ optimal response to an increase in $\lambda$ is to infrequently issue very large amounts of debt—indicated by the large issue size. As a result, the parametrization with $\lambda = 8\%$ predicts unreasonably high skewness and kurtosis.
in quarterly leverage changes—a feature that is rejected in the data. Another problematic aspect of the transaction costs channel is that the refinancing costs necessary to explain the data on financial leverage are much larger than the issuance costs of debt observed empirically (see Section III.B below).

Overall these results suggest that adjustment costs alone cannot explain low average debt levels and slow mean reversion of debt because the quantitative effect is not strong enough, given reasonable adjustment costs. In Section III, we confirm these preliminary results by estimating from panel data on leverage the levels of refinancing costs and private benefits of control that best explain observed financing decisions.

C. Identification

Before proceeding to the empirical analysis, it will be useful to better understand how we can identify in the data the parameters describing refinancing and agency costs. A sufficient condition for identification is a one-to-one mapping between the structural parameters and a set of data moments of the same dimension. To aid in the intuition of the identification of the model parameters, Table II reports sensitivities of the model-implied moments with respect to the parameters in our base case environment. For comparison with the standard dynamic tradeoff theory without agency conflicts, we also check whether restructuring costs are identified. In the table we focus on moments that are a-priori informative about the parameters we seek to estimate—much like in method-of-moments estimation. Heuristically, a moment $m$ is informative about an unknown parameter $\theta$ if that moment is sensitive to changes in the parameter and the sensitivity differs across parameters. Formally, local identification requires the Jacobian determinant, $\text{det}(\partial m/\partial \theta)$, to be nonzero.

The last two columns in Table II reveal that the model moments exhibit significant
sensitivity to the model parameters. More importantly for identification, the sensitivities differ across parameters, such that one can find moments with $\det(\partial m/\partial \theta) \neq 0$. While the qualitative effect on mean leverage is comparable across parameters, the measures of asymmetry depend very differently on the parameters. The leverage skew and kurtosis increase with private benefits of control and decrease with the refinancing cost—because of a different interplay between issuance frequency and issue size. The difference is reflected also in the sensitivity of quarterly leverage changes. Overall, the different sensitivities reveal that the structural parameters can be identified by combining time-series data on financial leverage with cross-sectional information on variation in leverage dynamics across firms.

III. Structural Estimation

A. Estimation Strategy and Empirical Specification

Our structural estimation of the model uses simulated maximum likelihood (SML) and 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 the target leverage, the refinancing frequency, and the default probability. In addition to the time-series predictions, the model yields comparative statics that describe how financial policies and financial leverage vary in the cross-section of firms. We exploit both types of predictions to identify the structural parameters in the data and to disentangle cross-sectional heterogeneity from the impact of transaction cost-driven inertia on financial leverage.

In the analysis, each firm $i = 1, \ldots, N$ is characterized by a set of parameters $\tilde{\theta}_i$ that determine the cash flow growth rate $m_i$ and volatility $\sigma_i$, cash flow beta $\beta_i$, liquidation
costs $\alpha_i$, shareholders’ bargaining power $\eta_i$, management’s equity stake $\varphi_i$, issuance costs $\lambda_i$, private benefits $\phi_i$, corporate and personal taxes $\tau^c$, $\tau^e$, and $\tau^d$, the market risk premium $\psi$, and the risk-free rate $r$.

Estimating the parameter vector $\tilde{\theta}_i$ for each firm using solely data on financial leverage is unnecessary and practically infeasible. We therefore split the parameter vector into two parts: parameters that we calibrate and parameters that we estimate structurally. Given the dimensionality of the estimation problem, we first determine the parameters $\theta^*_i = (m_i, \mu_i, \sigma_i, \beta_i, \alpha_i, \eta_i, \varphi_i, \tau^c, \tau^e, \tau^d, \psi, r)$ using the data sources described below. We keep these parameters fixed when estimating the parameters $\lambda_i$ or $\phi_i$ from data on financial leverage.

The main focus of inference in the empirical analysis is on the firm-specific private benefits of control $\phi_i$. In the structural estimation, we treat this agency parameter as a random coefficient to reduce the dimensionality of the problem and let it vary across firms as follows:

$$\phi_i = h(\alpha_\phi + \epsilon^\phi_i).$$

(5)

In this equation, $h : \mathbb{R} \to [0, 1]$ guarantees that cost estimates are between zero and 100% of firm value and $\epsilon^\phi_i$ is a random variable capturing the firm-specific unobserved heterogeneity. As in linear dynamic random-effects models, the firm-specific random effects $\epsilon^\phi_i$ are assumed independent across firms and normally distributed: $\epsilon^\phi_i \sim \mathcal{N}(0, \sigma^2_\phi)$.

The set of structural parameters that we seek to estimate is $\theta = (\alpha_\phi, \sigma_\phi)$. Assume there are $N$ firms in the sample and let $n_i$ be the number of observations for firm $i$. The likelihood function $\mathcal{L}$ of the parameters $\theta$ given the data and $\theta^*$ is based on the probability of observing the leverage ratio $y_{it}$ for firm $i = 1, ..., N$ at times $t = 1, ..., n_i$. The observations for the
same firm are correlated due to autocorrelation in the cash-flow process (1). Given these assumptions, the joint probability of observing the leverage ratios \( y_i = (y_{i1}, \ldots, y_{in_i})' \) and the firm-specific unobserved effects \( \epsilon_i^\phi \) is given by

\[
f(y_i, \epsilon_i^\phi | \theta) = f(y_i | \epsilon_i^\phi; \theta) f(\epsilon_i^\phi | \theta) = \left( f(y_{i1} | \epsilon_i^\phi_1; \theta) \prod_{t=2}^{n_i} f(y_{it} | y_{it-1}, \epsilon_i^\phi; \theta) \right) f(\epsilon_i^\phi | \theta),
\]

where \( f(\epsilon_i^\phi | \theta) \) is the standard normal density. Integrating out the random effects from the joint likelihood (since the \( \epsilon_i^\phi \) are drawn independently across firms from \( f(\epsilon_i^\phi | \theta) \)), we obtain the marginal log-likelihood function as

\[
\ln L(\theta; y) = \sum_{i=1}^N \ln \int_{\epsilon_i^\phi} \left( f(y_{i1} | \epsilon_i^\phi_1; \theta) \prod_{t=2}^{n_i} f(y_{it} | y_{it-1}, \epsilon_i^\phi; \theta) \right) f(\epsilon_i^\phi | \theta) d\epsilon_i^\phi.
\]

For the model described in Section I, explicit expressions for the stationary density of leverage \( f(y_{it} | \epsilon_i^\phi; \theta) \) and the conditional density \( f(y_{it} | y_{it-1}, \epsilon_i^\phi; \theta) \) can be derived (see Appendix A, Section B). We evaluate the integral in equation (7) using Monte-Carlo simulations. When implementing this procedure, we use the empirical analog to the log-likelihood function, which is given by

\[
\ln L(\theta; y) = \sum_{i=1}^N \ln \frac{1}{K} \sum_{k_i=1}^K \left( f(y_{i1} | \epsilon_i^{\phi,k_i}; \theta) \prod_{t=2}^{n_i} f(y_{it} | y_{it-1}, \epsilon_i^{\phi,k_i}; \theta) \right).
\]

In equation (8), \( K \) is the number of random draws per firm, and \( \epsilon_i^{\phi,k_i} \) is the realization in draw \( k_i \) for firm \( i \). In Appendix B, we investigate how the precision and accuracy of the Monte-Carlo simulations performed as part of the estimation depends on \( K \) and how this affects the finite simulation sample bias in the estimated coefficients. Figure 1 plots the magnitude of the Monte-Carlo simulation error (Panel A) and its impact on the precision.
and accuracy of the simulated log-likelihood (Panels B and C). We find that 1,000 random draws are sufficient to render the simulation error negligible. We therefore set $K = 1,000$ in the estimations.

The SML estimator is now defined as $\hat{\theta} = \arg \max_\theta \ln L(\theta; y)$. This estimator answers the question: What magnitude of agency costs best explains observed financing patterns?

**B. Data**

Estimating the model derived in Section I requires merging data from various standard sources. We collect financial statements from Compustat, managerial compensation data from ExecuComp, stock price data from CRSP, analyst forecasts from the Institutional Brokers’ Estimate System (I/B/E/S), governance data from the Investor Responsibility Research Center (IRRC), and institutional ownership data from Thomson Reuters. Following the literature, we remove all regulated (SIC 4900 − 4999) and financial (SIC 6000 − 6999) firms. Observations with missing SIC code, total assets, market value, sales, long-term debt, or debt in current liabilities are also excluded. In addition, we restrict our sample to firms that have total assets over $10 million. As a result of these selection criteria, we obtain a panel data set with 13,159 observations for $N = 809$ firms between 1992 and 2004 at the quarterly frequency. Tables III and IV provide detailed definitions and descriptive statistics for the variables of interest.

We construct the firm-specific estimates of the parameters in $\theta^*$ as follows. We proxy
for the growth rate of cash flows, \( m_i \), using an affine function of the long-term growth rate per industry, \( \tilde{m}_i \), where we use SIC level 2 to define industries. I/B/E/S provides analysts’ forecasts for long-term growth rates. It is generally agreed, however, that I/B/E/S growth rates are too optimistic and that I/B/E/S predicts too much cross-sectional variation in growth rates. Following Chan, Karceski, and Lakonishok (CKL, 2003), we adjust for these biases by using the following least-squares predictor for the growth rate: \( m_{it} = 0.007264043 + 0.408605737 \times \tilde{m}_{it} \). Using I/B/E/S consensus forecasts, we can predict growth rates reasonably well with this specification.

Next, we use the Capital Asset Pricing Model (CAPM) to estimate the risk-neutral growth rate of cash flows: \( \mu_{it} = m_{it} - \beta_{it} \psi \), where \( \psi = 6\% \) is the consensus market risk premium and \( \beta_{it} \) is the leverage-adjusted cash-flow beta. We estimate market betas from monthly equity returns and unlever them using the model-implied relations. Similarly, we estimate cash-flow volatility \( \sigma_{it} \) using the standard deviation of monthly equity returns and the following relation (implied by Itô’s lemma): \( \sigma_{it} = \sigma_{it}^F / \left( \frac{\partial E(x,c)}{\partial x} \frac{x}{E(x,c)} \right) \), where \( \sigma_{it}^F \) is the volatility of stock returns and \( E(x,c) \equiv V(x,c) - d(x,c) \) is the stock price derived from the model. In these estimations, we use stock returns from the Center for Research in Security Prices (CRSP) database.

ExecuComp provides data on managerial compensation that we use to construct firm-specific measures of managerial ownership \( \varphi_i \) (see Appendix C). Following Core and Guay (1999), we construct the managerial delta, defined as the sensitivity of option value to a 1% change in stock price, for each manager and then aggregate over the five highest-paid executives. Alternatively, following Jensen and Murphy (1990), we define managerial
incentives as

\[ \varphi_{it} = \varphi_{it}^E + \delta_{it} \frac{\text{Shares represented by options awards}_{it}}{\text{Shares outstanding}_{it}}. \]  

(9)

This incentives measure accounts for both a direct component, managerial share ownership \( \varphi^E \), and an indirect component, the pay-performance sensitivity due to options awards.

Gilson, Kose, and Lang (1990) find that renegotiation costs represent a small fraction of firm value. We thus fix renegotiation costs \( \kappa \) to zero in our base case estimation. Shareholders’ bargaining power in default is assumed to be 50%, in line with the Nash bargaining solution. Following Berger, Ofek, and Swary (1996), we estimate liquidation costs as

\[ \alpha_{it} = 1 - (\text{Tangibility}_{it} + \text{Cash}_{it})/\text{Total Assets}_{it}, \]  

(10)

where \( \text{Tangibility}_{it} = 0.715 \times \text{Receivables}_{it} + 0.547 \times \text{Inventory}_{it} + 0.535 \times \text{Capital}_{it}. \)

Several studies provide estimates for issuance costs as a function of the amount of debt being issued. The model, however, is written in terms of debt issuance cost \( \lambda \) as a fraction of total debt outstanding. The cost of debt issuance as a fraction of issue size is given in the model by \( \frac{\rho}{\rho - 1} \lambda \), where \( \rho \) is the restructuring threshold multiplier. Since our estimates yield a mean value of two for \( \rho \), we set \( \lambda = 1\% \). This produces a cost of debt issuance representing 2% of the issue size on average, corresponding to the upper range of the values found in the empirical literature (see, for example, Altinkiliç and Hansen (2000) and Kim, Palia, and Saunders (2008)).

Since the model is written in terms of constant firm-level parameters, we set the parameters \( \theta_i^* \) to their corresponding value in the first period for which we have data (i.e., \( \theta_i^* = \theta_{i1}^*, \forall i \)). In Section IV.D, we check whether our estimates depend on this assumption.
IV. Estimation Results and Predicted Agency Costs

A. Estimation of the Model without Agency Conflicts

The dynamic tradeoff theory proposed by Fischer, Heinkel, and Zechner (1989) forms the benchmark for our analysis. Since this model is nested in ours, we start our empirical analysis by estimating the level of refinancing costs \( \lambda_i \) necessary to explain observed leverage choices. To do so, we estimate the model using an SML estimation in which we set \( \phi_i = 0 \) and let \( \lambda_i \) vary across firms as follows:

\[
\lambda_i = h(\alpha \lambda + \epsilon_i^\lambda),
\]

where \( h = \Phi \) is the standard normal cumulative distribution function and \( \epsilon_i^\lambda \sim \mathcal{N}(0, \sigma^2_\lambda) \) is a firm-specific i.i.d. unobserved determinant of \( \lambda_i \). Table V, Panel A reports the point estimates. Cluster-robust \( t \)-statistics that adjust for cross-sectional correlation in each time period and industry-clustered \( t \)-statistics are reported in parentheses. Both the estimate of the mean, \( \alpha \lambda \), and the variance estimate for the random effect, \( \sigma^2_\lambda \), are statistically significant.

Table V, Panel B reports descriptive statistics for the predicted cost of debt issuance, \( \hat{\lambda}_i = \hat{E}(\lambda_i|y_i; \theta) \), in the model without agency conflicts (the hat indicates fitted values). Appendix A, Section C shows how to compute this conditional expectation. Consistent with our calibration exercise, the data reveal that the cost of debt issuance should be on the order of 12.6% of total debt (or 25% of issue size), with median value around 9.4% (or 19% of issue size), to explain the dynamics of leverage ratios.\(^8\) These numbers are unreasonably high and
inconsistent with empirically observed values. Thus, while dynamic capital structure theories that ignore agency conflicts can qualitatively reproduce 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 study by Lemmon, Roberts, and Zender (2008), who find that traditional determinants of capital structure explain little of the observed variation in leverage ratios.

B. The Estimated Agency Conflicts

We now turn to the estimation of the model with agency conflicts and transaction costs. In the estimation, we allow the structural parameters characterizing agency conflicts to vary across firms as follows:

\[ \phi_i = h(\alpha_\phi + \epsilon_i^\phi), \]  

where, in our base specification, \( h \) is set to the standard normal cumulative distribution function \( \Phi \in [0, 1] \) and \( \epsilon_i^\phi \sim N(0, \sigma_\phi^2) \) is a firm-specific i.i.d. unobserved determinant of \( \phi_i \).

Panel A of Table VI summarizes the maximum likelihood estimates of the structural parameters \( \theta = (\alpha_\phi, \sigma_\phi) \). Cluster-robust \( t \)-statistics that adjust for cross-sectional correlation in each time period and industry-clustered \( t \)-statistics are reported in parentheses. The parameters capturing the private benefits of control are well identified in the data.
Using the structural parameter estimates reported in Panel A, we can construct firm-specific measures of the manager’s private benefits of control \( \phi_i \) (see Appendix A, Section C). Figure 2 plots a histogram of the predicted private benefits of control, \( \hat{\phi}_i = \mathbb{E}[\phi_i | y_i; \theta] \), \( i, \ldots, N \) (the hat indicates fitted values). Panel B of Table VI reports summary statistics for the fitted values in the base specification. We also report in brackets the private benefits of control expressed as a fraction of equity value. The cost of managerial discretion is 1.55% of equity value for the average firm, and 0.45% for the median firm. The figure and the table both show that the variation in agency costs across firms is sizeable. The distribution across firms peaks at zero, is positively skewed, and exhibits sizeable kurtosis—suggesting that most firms manage to limit private benefits. For a number of firms, however, inefficiencies arising from agency conflicts constitute a substantial portion of equity value. Hence, while our dynamic capital structure model suggests that leverage ratios should revert to the (manager’s) target leverage over time, the differences in agency conflicts observed in Figure 2 imply persistent cross-sectional differences in leverage ratios. Overall these results confirm that small conflicts of interest between managers and shareholders are sufficient to resolve the leverage puzzles identified in the empirical literature.

C. Gross and Net Benefits of Debt

In a recent study, van Binsbergen, Graham, and Yang (BGY; 2010) provide empirical estimates of the cost of debt for a large cross-section of firms as a function of company characteristics. In their analysis, BGY (2010) do not distinguish actual costs from costs as they are perceived by managers. Our estimates of agency conflicts allow us to determine the
benefits and costs of debt to both managers and shareholders for each firm in our sample.

To aid in the intuition of the results, Figure 3 plots the marginal benefit of debt and the marginal cost of debt as a function of leverage \( l \). The figure also depicts the optimal leverage ratio (where marginal cost and marginal benefit of debt are equalized) from the perspective of managers and shareholders, denoted by \( l^*_M \) and \( l^*_S \). The gross benefit of debt (area below the marginal benefit curve) includes the tax savings and the disciplining effect of debt. The cost of debt to shareholders (area under the marginal cost of debt curve) includes the costs of default and the issuance costs. The cost of debt to the manager comprises the costs of default, the issuance costs, as well as the disciplining effect of debt. The cost of underleverage to shareholders is the shaded area between the MBDS and MCDS curves between \( l^*_M \) and \( l^*_S \).

Table VII reports the distributional characteristics of the net benefit of debt to managers (NBDM) and shareholders (NBDS), the gross benefit of debt to managers (GBDM) and shareholders (GBDS), the cost of debt to managers (CDM) and shareholders (CDS), as well as the cost of the disciplining effect of debt to the manager (DE) across firms.\(^9\) All values referring to shareholders are reported as a percentage of shareholder wealth. All values referring to managers are reported as a percentage of managerial utility.

The results reported in Table VII show that the gross benefit of debt to shareholders is 10.7% on average, consistent with the numbers in BGY (2010). The table also shows
that the average cost of debt to shareholders is low at the selected leverage ratio (1.1% of shareholder wealth). This is due to the convexity of the marginal cost of debt as a function of the leverage ratio and the fact that most firms are underlevered in our sample due to agency conflicts. Finally, because debt constrains managers, the cost of debt to managers (3.4% of managerial utility) is three times the cost of debt to shareholders for the average firm in our sample, with more than half of this cost coming from the disciplining effect of debt.

D. Robustness Checks and Moment Tests

Our results so far suggest that the model performs well in the sense that the estimated agency conflicts are of economically reasonable magnitude. In this section we are interested in the following three questions. First, how robust are our estimates of agency conflicts? Second, how well does the model fit the data? Third, along which dimensions does the model fail?

D.1. Robustness Checks

To determine whether our estimates of agency conflicts depend on our assumptions, in this section we perform a number of robustness checks. First, we set the cost of debt issuance to 1% of the issue size and re-estimate the model. Second, we set managerial incentives, \( \varphi \), equal to management’s equity ownership net of option compensation. Third, we increase the cost of debt renegotiation from zero to 15%. Fourth, we use a more stringent definition of leverage (see Table III for the definition of this measure). Fifth, we allow parameters to vary period by period assuming managers are myopic about this time variation. Last, we
change the link function $h$ to the inverse logit.

Table VIII reports the predicted private benefits of control under these alternative specifications. The table shows that the estimates are stable across the different parameterizations. Overall, the main conclusions from the estimation seem resilient to the specific parametric assumptions and the observed deviations have an intuitive justification.

In the Internet Appendix we examine the effects of time variation in the model parameters on the manager’s policy choices (target leverage, refinancing and default boundaries) and firm value when managers take this time variation into consideration. The results show that the effects of time variation in the parameters on policy choices are modest. The effect on shareholder wealth is also limited and less than 1% on average.

D.2. Moment Tests

A natural approach to assess the empirical performance of the model is to compare various model moments to their empirical analog. The maximum likelihood estimator defined in Section III.A picks in an optimal fashion as many moments as there are parameters. As a result, there are many conditional moments that the estimation does not match explicitly. Conditional moment (CM) tests exploit these additional moment restrictions and allow us to statistically test for model fit (see Appendix D, Section A).
Table IX lists an extensive set of leverage moments. These include the mean, median, standard deviation, and higher-order moments of leverage. We also compare various dispersion measures (range, interquartile range, minimum, maximum) and the persistence in leverage at the quarterly and annual frequency (“inertia puzzle”). The empirical moments reported in the table are computed analogously to the simulated model moments. We obtain the model moments by simulating artificial economies as described in Appendix D, Section B.

In Table IX, we report test statistics and $p$-values for the goodness-of-fit of each individual moment and assess overall fit (reported in the last row). The model performs well along moments that the literature has identified to be of first-order importance. The average and median levels of leverage are matched reasonably well. The CM test cannot reject the hypothesis that the empirical and simulated moments are the same. The same holds true for leverage persistence at both the quarterly and the annual frequency. The model is statistically rejected for higher-order leverage moments and dispersion measures, though the numerical values are economically quite close. This suggests that there is more going on in the data than the model is able to capture by focusing on major capital restructurings.

Table X further characterizes the cross-sectional properties of leverage ratios in the model with agency conflicts and assesses model fit. To do so, we first simulate a number of dynamic economies (see Appendix D, Section B). We then replicate the empirical analysis in several cross-sectional capital structure studies (see Appendix D, Section C), examining in particular the link between capital structure and stock returns, as in Welch (2004), and the speed of mean reversion to the target, as in Fama and French (2002) and Flannery and Rangan (2006).

The regression results reported in Table X are consistent with those reported in the
empirical literature. In Panel A of Table X, the estimates based on the simulated data from our model closely match Welch’s estimates based on real data. For a one-year time horizon, the IDR coefficient is close to one. For longer time horizons, this coefficient is monotonically declining, consistent with the data. Panel B of Table X reveals that leverage is mean reverting at a speed of 11% per year, which corresponds to the average mean-reversion coefficient reported by Fama and French (2002) (7% for dividend payers and 15% for non-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 consistent with those in partial-adjustment models.

Another way to look at model fit is to construct likelihood-based statistical tests of goodness-of-fit. This allows us to diagnose which modeling assumptions are crucial in fitting the data. In the Internet Appendix we report the results from these tests and confirm that a dynamic tradeoff model with agency costs yields better goodness-of-fit than the classic dynamic tradeoff theory based solely on transaction costs.

V. Governance Mechanisms and Agency Conflicts

Prior empirical research on corporate capital structure documents a negative relation between managerial discretion and firms’ leverage ratios (see Friend and Lang (1988), Mehran (1992), Berger, Ofek, and Yermak (1997), and Kayhan (2008)). The standard approach in the literature is to examine the effects of various governance mechanisms on leverage ratios using OLS analysis. Observed leverage ratios, however, exhibit highly nonlinear behavior, including persistence, heteroskedasticity, asymmetry, fat tails, and truncation. These features are difficult to capture simultaneously in linear regression studies. An additional complication is that the target leverage ratio, the main quantity of economic interest, 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 first use panel data on observed leverage choices and the model’s predictions for different statistical moments of leverage to obtain firm-specific estimates of agency costs. We then relate these estimates to the firms’ governance structure using data on various governance mechanisms provided by IRRC, Thomson Reuters, and ExecuComp. We use the IRRC data to construct the entrenchment index of Bebchuk, Cohen, and Farell (2009), E-index, and the governance index of Gompers, Ishii, and Metrick (2003), G-index. IRRC also provides data on blockholder ownership. In the analysis, we use both the total holdings of blockholders and the holdings of independent blockholders as governance indicators. Institutional ownership is another important governance mechanism. We collect data on institutional ownership using Thomson Reuters’s database of 13f filings.

We build two proxies for internal board governance—board independence and board committees. These two measures are motivated by the Sarbanes-Oxley Act. Board independence represents the proportion of independent directors reported in IRRC. 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. In addition to these governance variables, we include in our regressions standard control variables for other firm attributes. Last, a natural proxy for CEO power is the tenure of the CEO. We obtain data on this measure from ExecuComp. The definition and construction of the dependent and explanatory variables is summarized in
Table III. Table IV provides descriptive statistics for these variables.

Table XI reports regression coefficients of the predicted private benefits of control, \( \hat{\phi}_i = \mathbb{E}[\phi_i | y_{it}; \theta] \), expressed in basis points, on the various explanatory variables. (We vary the sample and regression specification across the different columns in Table XI.) Most of the control variables have signs in line with accepted theories. The general pattern, which is robust across specifications, is that the coefficients on the governance variables are significant and have signs that are consistent with economic intuition. This suggests that our structural estimates indeed measure agency conflicts within the firm.

The estimates in Table XI show that external governance mechanisms, represented by institutional ownership and outside blockholder ownership, are negatively related to agency costs, suggesting that independent outside monitoring of management is effective. The coefficients suggest that a one-standard deviation increase in institutional (outside blockholder) ownership is associated with a decrease of 66-88 (75-100) basis points in private benefits of control. Antitakeover provisions are another important mechanism in governing corporate control. The coefficient on “E-index - Dictatorship” is positive.\(^{12}\) This is consistent with the notion that antitakeover provisions lead to greater entrenchment and larger private benefits.

Internal governance mechanisms are captured in Table XI by managerial characteristics and the characteristics of the board. CEO tenure intuitively proxies for CEO entrenchment and hence for managerial discretion. Across specifications, we consistently find a positive relation of CEO tenure with private benefits of control. 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 agency costs. This is consistent with the idea that a more independent board of directors is a stronger monitor of management.

The relation between private benefits of control and managerial delta is U-shaped and on average positive. This is consistent with the incentives versus entrenchment literature (see Claessens et al. (2002)). In particular, one would expect leverage ratios to increase with managerial ownership so long as debt increases shareholder wealth. However, to the extent that managerial ownership protects management against outside pressures and increases managerial discretion (Stulz (1988)), one expects leverage to decrease with ownership. The positive average relation suggests that executive pay and managerial entrenchment (hidden pay) are complementary compensation mechanisms (see Kuhnen and Zwiebel (2008)). Not surprisingly, the proportion of diverted cash flows decreases with firm size.

In summary, our estimates of agency conflicts are related to a number of corporate governance mechanisms. Variables associated with stronger monitoring have a negative effect on our estimates of agency conflicts. Institutional ownership, antitakeover provisions, and CEO tenure have the largest impact on agency conflicts and hence on financing decisions. The sizeable explanatory power of governance variables ($R^2$ is 35% to 37%) further highlights the importance of accounting for governance in empirical capital structure tests.

VI. Conclusion

This paper examines the importance of agency conflicts in capital structure choice. To do so, we build a dynamic capital structure model in which financing policy results from a tradeoff between tax shields, contracting frictions, and agency conflicts. In the model, each firm is run by a manager who sets the firm’s financing policy. Managers act in their own
interests and capture part of free cash flow to equity as private benefits within the limits imposed by shareholder protection. Debt constrains the manager by reducing the free cash flow and potential cash diversion. In this environment, we determine the optimal leveraging decisions of managers and characterize the effects of agency conflicts on leverage levels and dynamics.

Using data on financing choices and the model’s predictions for different moments of leverage, we show that agency costs of 1.5% of equity value on average are sufficient to resolve the conservative debt policy puzzle and to explain the time series of observed leverage ratios. Our estimates of the agency costs vary with variables that one expects to determine managerial incentives. External and internal governance mechanisms significantly affect the value of control and firms’ financing decisions.

Our structural estimation also reveals that costs of debt issuance would have to be on the order of 25% of the amount issued to explain observed financing choices. Thus, while dynamic capital structure theories that ignore agency conflicts can qualitatively reproduce the financing patterns observed in the data, the effects of refinancing costs alone on debt choices are too small to explain firms’ financing policies. Our evidence also suggests that part of the heterogeneity in capital structures documented in Lemmon, Roberts, and Zender (2008) may be driven by the variation in agency conflicts across firms. Overall, agency conflicts have first-order effects on corporate policies and important value consequences.
Appendix A. Proofs

A. Model Solution

In the model, the cash flow accruing to the manager at each time \( t \) is \([\phi + \varphi(1 - \phi)](1 - \tau)(X_t - c)\), where the tax rate \( \tau = 1 - (1 - \tau^e)(1 - \tau^e) \) reflects corporate and personal taxes. Shareholders’ cash flows are in turn given by \((1 - \phi)(1 - \tau)(X_t - c)\). Since these cash flow streams are proportional to the firm’s net income \((1 - \tau)(X_t - c)\), we start by deriving the value of a claim on net income at time \( t \), denoted by \( N(x, c) \) for \( X_t = x \).

Let \( n(x, c) \) denote the present value of the firm’s net income over one financing cycle, that is, for the period over which neither the default threshold \( x_D \) nor the restructuring threshold \( x_U \) are hit and the firm does not change its debt policy. This value is given by

\[
n(x, c) = \mathbb{E}^Q \left[ \int_t^T e^{-r(s-t)}(1 - \tau)(X_s - c) \, ds \mid X_t = x \right], \tag{A1}
\]

where \( T \) is the first time that the firm changes its debt policy, defined by \( T = \inf \{T_U, T_D\} \) with \( T_s = \inf \{ t \geq 0 : X_t = x_s \}, s = U, D \). Denote by \( p_U(x) \) the present value of $1 to be received at the time of refinancing, contingent on refinancing occurring before default, and by \( p_D(x) \) 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 (A1) as

\[
n(x, c) = (1 - \tau) \left[ \frac{x}{r - \mu} - \frac{c}{r} - p_U(x) \left( \frac{x_U}{r - \mu} - \frac{c}{r} \right) - p_D(x) \left( \frac{x_D}{r - \mu} - \frac{c}{r} \right) \right], \tag{A2}
\]
where
\[ p_D(x) = \frac{x^\xi - x^\nu x_U^\xi - \nu}{x_D^\xi - x_D^\nu x_U^\xi - \nu} \quad \text{and} \quad p_U(x) = \frac{x^\xi - x^\nu x_U^\xi - \nu}{x_U^\xi - x_U^\nu x_U^\xi - \nu} \]

and \( \xi \) and \( \nu \) are the positive and negative roots of the equation \( \frac{1}{2} \sigma^2 \beta (\beta - 1) + \mu \beta - r = 0 \).

Consider next the total value \( N(x, c) \) of a claim to the firm’s net income. We show in the Internet Appendix that in the static model in which the firm cannot restructure, the default threshold \( x_D \) 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 \( x_i^0 = \Lambda x_j^0 \), then the selected coupon rate and default threshold satisfy \( c_i^1 = \Lambda c_j^1 \) and \( x_D^1 = \Lambda x_D^j \), respectively, and every claim will be scaled by the same factor \( \Lambda \). For the dynamic model, this scaling feature implies that at the first restructuring point, all claims are scaled up by the same proportion \( \rho \equiv x_U / x_0 \) as asset value has increased (i.e., it is optimal to choose \( c_1^1 = \rho c_0^1 \), \( x_D^1 = \rho x_D^0 \), \( x_U^1 = \rho x_U^0 \)). Subsequent restructurings scale up these variables again by the same ratio. If default occurs prior to restructuring, firm value is reduced by a constant factor \( \eta(\alpha - \kappa) \gamma \) with \( \gamma \equiv x_D / x_0 \), new debt is issued, and all claims are scaled down by the same proportion \( \eta(\alpha - \kappa) \gamma \). As a result, we have for \( x_D \leq x \leq x_U \)

\[
N(x, c) = n(x, c) + p_U(x) \rho N(x_0, c) + p_D(x) \eta(\alpha - \kappa) \gamma N(x_0, c).
\]

Total value  Value over  PV of claim on net  PV of claim on net
of the claim  one cycle  income at a restructuring  income in default

(A3)

We can therefore express the total value of a claim to the firm’s net income at the initial date as

\[
N(x_0, c) = \frac{n(x_0, c)}{1 - p_U(x_0) \rho - p_D(x_0) \eta(\alpha - \kappa) \gamma} \equiv n(x_0, c) S(x_0, \rho, \gamma), \quad (A4)
\]
where $S(x_0, \rho, \gamma)$ is a scaling factor that transforms the value of a claim to cash flows over one financing cycle at a restructuring point into the value of this claim over all financing cycles.

The same arguments apply to the valuation of corporate debt. Consider first the value $d(x, c)$ 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 $x_D$, the current value of corporate debt satisfies at any time $t \geq 0$

$$d(x, c) = \frac{b(x, c)}{1 - \tau} + \frac{p_U(x) d(x_0, c)}{1 - \mu x_D},$$

(A5)

where $b(x, c)$ represents the value of corporate debt over one refinancing cycle, that is, ignoring the value of the debt issued after a restructuring or after default, and is given by

$$b(x, c) = \frac{1 - \tau}{r} [1 - p_U(x) - p_D(x)] c + p_D(x) [1 - (\kappa + \eta (\alpha - \kappa))] \frac{1 - \tau}{r - \mu} x_D.$$ (A6)

The total value of corporate debt includes not only the cash flows accruing to debtholders over one refinancing cycle, $b(x, c)$, but also the new debt that will be issued in default or when restructuring. As a result, the value of debt over all the financing cycles is given by $b(x_0, c) S(x_0, \rho, \gamma)$, where $S(x_0, \rho, \gamma)$ is defined in (A4). Because flotation costs are incurred each time the firm adjusts its capital structure, the total value of adjustment costs at time $t = 0$ is in turn given by $\lambda d(x_0, c) S(x_0, \rho, \gamma)$. We can then write the value of the firm at the restructuring date as the sum of the value of a claim on net income plus the value of all debt issues minus the present value of issuance costs and the present value of managerial
\[ \mathbf{V}(x_0, c) = \mathbf{S}(x_0, \rho, \gamma) \{ n(x_0, c) + b(x_0, c) - \lambda d(x_0, c) - \phi n(x_0, c) \} . \]  
(A7)

Plugging the expressions for \( \mathbf{V}(c, x) \), \( \mathbf{N}(c, x) \), and \( d(c, x) \) into equations (3) and (4) and using standard numerical procedures, we can solve for the manager’s policy choices. Since the value of equity at the time of default satisfies (value-matching) \( \mathbf{V}(x, c) - d(x, c) = \eta(\alpha - \kappa)\gamma\mathbf{V}(x, c) \), the default threshold can also be determined by solving the smooth-pasting condition

\[ \frac{\partial [\mathbf{V}(x, c) - d(x, c)]}{\partial x} \bigg|_{x=x_D} = \frac{\partial \eta(\alpha - \kappa)\gamma\mathbf{V}(x, c)}{\partial x} \bigg|_{x=x_D} . \]  
(A8)

B. 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 \( z_t \equiv X_t/c_t \), we can write \( y_t = L(z_t) \) with \( L : \mathbb{R}^+ \rightarrow \mathbb{R}^+ \) and \( L' < 0 \). The process for \( z_t \) follows a Brownian motion with drift \( \mu \) and volatility \( \sigma \) that is regulated at both the lower boundary \( z_D \) and the upper boundary \( z_U \). The process \( z_t \) is reset to the target level \( z_S \in (z_D, z_U) \) whenever it reaches either \( z_D \) or \( z_U \). The target leverage ratio can be expressed as \( L(z_S) \). Denote the restructuring date by \( \tau = \min(\tau_B, \tau_U) \), where for \( i = B, U \) the random variable \( \tau_i \) is defined by \( \tau_i = \inf \{ t \geq 0 : z_{x_t} = z_i \} \). Let \( f_z(z) \) be the density of the interest coverage ratio. The density of leverage can be written in terms of \( f_z \) and the Jacobian of \( L^{-1} \) as follows:

\[ f_y(y) = f_z(L^{-1}(y)) \left| \frac{\partial}{\partial y} L^{-1}(y) \right| = f_z(L^{-1}(y)) \left( \left( \frac{\partial y}{\partial L^{-1}(y)} \right)^{-1} \right) . \]  
(A9)
To compute the time-series distribution of leverage, we need the functional form of the density of the interest coverage ratio \( f_z \). The latter can be determined as follows.

### B.1. Stationary Density

To determine \( f_z \) we first need to derive the distribution of occupation times of the process \( z_t \) in closed intervals of the form \([z_D, z]\), for any \( z \in [z_D, z_U] \). For every Borel set \( A \in \mathcal{B(\mathbb{R})} \), we define the occupation time of \( A \) by the Brownian \( W \) path up to time \( t \) as

\[
\Gamma_t(A) \triangleq \int_0^t 1_A (W_s) \, ds = \text{meas} \{ 0 \leq s \leq t : W_s \in A \}, \tag{A10}
\]

where \( \text{meas} \) denotes Lebesgue measure. We will be interested in the occupation time of the closed interval \([z_D, z]\) by the interest coverage ratio given by \( \Gamma_t([z_D, z]) \). Let \( G(z, z_0) \), with initial value \( z_0 \) equal to the target value \( z_S \) for the interval \([z_D, z]\), be defined by

\[
G(z, z_0) = \mathbb{E}^Q_{z_0}[\Gamma_t([z_D, z])]. \tag{A11}
\]

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

\[
G(z, z_0) = \mathbb{E}^Q_{z_0} \left[ \int_0^\infty 1_{[z_D, z]}(z_s) \, ds \right] - \sum_{i,j=U,B,i\neq j} \mathbb{E}^Q_{z_0}[1_{i_i \prec i_j}] \mathbb{E}^Q_{z_i} \left[ \int_0^\infty 1_{[z_D, z]}(z_s) \, ds \right]. \tag{A12}
\]

To compute \( G(z, z_0) \), we use the following lemma (Karatzas and Shreve (1991), pp. 272).

**Lemma 1** If \( f : \mathbb{R} \to \mathbb{R} \) is a piecewise continuous function with

\[
\int_{-\infty}^{+\infty} |f(z + y)| e^{-|y|\sqrt{2\gamma}} \, dy < \infty; \forall z \in \mathbb{R}, \tag{A13}
\]
for some constant $\gamma > 0$, and $(B_t, t \geq 0)$ is a standard Brownian motion, then the resolvent operator of Brownian motion, $K_\gamma (f) \equiv \mathbb{E} [ \int_0^{+\infty} e^{-\gamma t} f (B_t) dt ]$, equals

$$K_\gamma (f) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{+\infty} f (y) e^{-|y|/\gamma} dy.$$  \hfill (A14)

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

$$G(z, z_0) = \begin{cases} \frac{1}{2b^2} [e^{\vartheta h(z_0, z)} - e^{\vartheta h(z_0, z_D)}] - \frac{p_B}{b^2} \ln \left( \frac{z}{z_D} \right) - \frac{p_U}{b^2} \ln \left( \frac{z}{z_U} \right) - \frac{p_U}{b^2} [e^{\vartheta h(z_U, z)} - e^{\vartheta h(z_U, z_D)}], & \text{for } z \leq z_0, \\ \frac{1}{2b^2} [1 - e^{\vartheta h(z_0, z_D)}] + \frac{1}{b^2} \ln \left( \frac{z}{z_0} \right) - \frac{p_B}{b^2} \ln \left( \frac{z}{z_D} \right) - \frac{p_U}{b^2} [e^{\vartheta h(z_U, z)} - e^{\vartheta h(z_U, z_D)}], & \text{for } z > z_0, \end{cases} \hfill (A15)$$

where

$$p_B = \frac{z_D^\vartheta - z_U^\vartheta}{z_D^\vartheta - z_U^\vartheta} \text{ and } p_U = \frac{z_0^\vartheta - z_D^\vartheta}{z_U^\vartheta - z_D^\vartheta}. \hfill (A16)$$

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

$$f_z(z) = \frac{\partial^2 G(z, z_0)}{G(z_U, z_0)} G \left( \frac{z}{z_U} \right). \hfill (A17)$$

### B.2. 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 the quarterly frequency). To determine this conditional density, we first compute the conditional density of the interest coverage ratio $z_t = X_t/c_t$ at time $t$ given its value
at time 0, \( \mathbb{P}(z_t \in dz | z_0) \), and then apply the transformation (A9). For ease of exposition, introduce the regulated arithmetic Brownian motion \( W_t = \frac{1}{\sigma} \ln (z_t) \) with initial value \( w = \frac{1}{\sigma} \ln (z_0) \), drift \( b = \frac{1}{\sigma}(\mu - \frac{\sigma^2}{2}) \), and unit variance, and define the upper and lower boundaries as \( H = \frac{1}{\sigma} \ln(z_U) \) and \( L = \frac{1}{\sigma} \ln(z_D) \), respectively. Denote the first exit time of the interval \((L, H)\) by
\[
\iota_{L,H} = \inf\{ t \geq 0 : W_t \notin (L, H) \}. \tag{A18}
\]
The conditional distribution \( F_z \) of the interest coverage ratio \( z \) is then related to that of the arithmetic Brownian motion \( W \) by the following relation:
\[
F_z(z|z_0) = \mathbb{P}(W_t \leq \frac{1}{\sigma} \ln(z)|W_0^b = w). \tag{A19}
\]
Given that the interest coverage ratio is reset to the level \( z_S \) whenever it reaches the boundaries, \( W \) is regulated at \( L \) and \( H \), with reset level at \( S = \frac{1}{\sigma} \ln(z_S) \), and we can write its dynamics as
\[
dW_t = b dt + dZ_t + 1_{\{W_t=L\}} (S - L) + 1_{\{W_t=H\}} (S - H).
\]
We would like to compute the cumulative distribution function of the process \( W \) at some horizon \( t \):
\[
G(w, y, t) \equiv \mathbb{P}(W_t \leq y|w) = \mathbb{E}_w[1_{\{W_t \leq y\}}], \quad (w, y, t) \in [L, H]^2 \times (0, \infty). \tag{A20}
\]
Rather than try to compute this probability directly, consider its Laplace transform in time (for notational convenience we drop the dependence of \( \mathbb{L} \) on \( \lambda \)):
\[
\mathbb{L}(w, y) = \int_0^\infty e^{-\lambda t} G(w, y, t) dt = \int_0^\infty e^{-\lambda t} \mathbb{E}_w[1_{\{W_t \leq y\}}] dt = \mathbb{E}_w \left[ \int_0^\infty e^{-\lambda t} 1_{\{W_t \leq y\}} dt \right]. \tag{A21}
\]
The second equality in (A21) 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
\[ \mathbb{L}(H, y) = \mathbb{L}(L, y) = \mathbb{L}(S, y) \text{ for all } y. \] (A22)

Now let $W^0_t = w + bt + Z_t$ 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
\[ \mathbb{L}(w, y) = \Psi(w, y) + \mathbb{L}(S, y)\Phi(w), \] (A23)
where we have set
\[ \Psi(w, y) = \mathbb{E}_w \left[ \int_0^{t_{L,H}} e^{-\lambda t} 1_{\{W^0_t \leq y\}} dt \right] \text{ and } \Phi(w) = \mathbb{E}_w [e^{-\lambda t_{L,H}}]. \]

Setting $w = S$ and solving for $\mathbb{L}(S, y)$ we obtain
\[ \mathbb{L}(S, y) = \frac{\Psi(S, y)}{1 - \Phi(S)}. \] (A24)

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

We now have to solve for $\Phi$ and $\Psi$. The Feynman-Kac formula shows that the function $\Psi$ is the unique bounded and a.e. $C^1$ solution to the second-order differential equation
\[ \frac{1}{2} \frac{\partial^2}{(\partial w)^2} \Psi(w, y) + b \frac{\partial}{\partial w} \Psi(w, y) - \lambda \Psi(w, y) + 1_{\{w \leq y\}} = 0 \] (A25)
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 $\Psi$ is given by

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

(A26)

where we have set

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

(A27)

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

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

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

$$
A_L = A_L(y, \lambda) = \frac{\Lambda(y) \Delta_H(y) - \Lambda'(y) \Delta_H(y)}{\Delta_H(y) \Delta_L(y) - \Delta_L(y) \Delta'_H(y)},
$$

(A28)

$$
A_H = A_H(y, \lambda) = \frac{\Lambda(y) \Delta'_L(y) - \Lambda'(y) \Delta'_L(y)}{\Delta_H(y) \Delta'_L(y) - \Delta_L(y) \Delta'_H(y)}.
$$

(A29)

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

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

(A30)
on the interval \((H, L)\) subject to the boundary condition \(\Phi(H) = \Phi(L) = 1\). Solving this equation, we find that the function \(\Phi\) is given by

\[
\Phi(w) = B_L \Delta_L(w) + B_H \Delta_H(w),
\]

where

\[
B_L = B_L(\lambda) = -\frac{e^{(v+b)H}}{e^{2vL} - e^{2vH}}, \quad B_H = B_H(\lambda) = \frac{e^{(v+b)L}}{e^{2vL} - e^{2vH}}.
\]

The conditional density function \(g(w, y, t) = \frac{\partial}{\partial y} G(w, y, t)\) can be obtained by differentiating the Laplace transform (A21) with respect to \(y\). We obtain

\[
\frac{\partial}{\partial y} \mathbb{L}(w, y) = \int_0^\infty e^{-\lambda t} g(w, y, t) dt = \frac{\partial}{\partial y} \Psi(w, y) + \frac{\Phi(w)}{1 - \Phi(S)} \frac{\partial}{\partial y} \Psi(S, y),
\]

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

\[
A'_L(y) = \left( \frac{A_H(y) \Delta''_H(y) - A_L(y) \Delta''_L(y) - \Lambda''(y)}{\Delta_H(y) \Delta'_L(y) - \Delta_L(y) \Delta'_H(y)} \right) \Delta_H(y),
\]

\[
A'_H(y) = \left( \frac{A_H(y) \Delta''_H(y) - A_L(y) \Delta''_L(y) - \Lambda''(y)}{\Delta_H(y) \Delta'_L(y) - \Delta_L(y) \Delta'_H(y)} \right) \Delta_L(y).
\]

The last step involves the inversion of the Laplace transform (A33) for \(g(w, y, t)\).
C. Predictions of the Structural Parameters

Denote by $y_{it}$ the leverage of firm $i$ at date $t$, and collect the observations for firm $i$ in the vector $y_i$. Given $y_i = (y_{it})$, the conditional expectation of private benefits $\phi_i$ in firm $i$ satisfies

\[
\mathbb{E}[\phi_i|y_i; \theta] = \mathbb{E}[h(\alpha_\phi + \epsilon_\phi^i)|y_i; \theta] = \int_{\epsilon_\phi_i} h(\alpha_\phi + \epsilon_\phi^i) f(\epsilon_\phi^i|y_i; \theta) d\epsilon_\phi^i
\]

\[
= \int_{\epsilon_\phi_i} h(\alpha_\phi + \epsilon_\phi^i) \frac{f(\epsilon_\phi^i, y_i|\theta)}{f(y_i|\theta)} d\epsilon_\phi^i
\]

\[
= \frac{\int_{\epsilon_\phi_i} h(\alpha_\phi + \epsilon_\phi^i) f(y_i|\epsilon_\phi^i; \theta) f(\epsilon_\phi^i|\theta) d\epsilon_\phi^i}{\int_{\epsilon_\phi_i} f(y_i|\epsilon_\phi^i; \theta) f(\epsilon_\phi^i|\theta) d\epsilon_\phi^i}
\]

\[
= \frac{\int_{\epsilon_\phi_i} h(\alpha_\phi + \epsilon_\phi^i) f(y_{i1}|\epsilon_\phi^i; \theta) \prod_{t=2}^n f(y_{it}|y_{it-1}, \epsilon_\phi^i; \theta) f(\epsilon_\phi^i|\theta) d\epsilon_\phi^i}{\int_{\epsilon_\phi_i} f(y_{i1}|\epsilon_\phi^i; \theta) \prod_{t=2}^n f(y_{it}|y_{it-1}, \epsilon_\phi^i; \theta) f(\epsilon_\phi^i|\theta) d\epsilon_\phi^i}.
\]  

(A36)

In these equations, $f(y_{i1}|\epsilon_\phi^i; \theta)$ and $f(y_{it}|y_{it-1}, \epsilon_\phi^i; \theta)$ are the unconditional and conditional distributions of leverage implied by the model, given in Appendix A, Section B, $f(\epsilon_\phi^i|\theta)$ is the standard normal density, and $\theta$ are the estimated parameters. Given parameter estimates for $\theta$ obtained in the SML estimation, (A36) can be evaluated using Monte-Carlo integration.

Last, one can show that these conditional expectations are unbiased. Let $z_i$ be omitted explanatory variables. Then

\[
\mathbb{E}[g_i|y_i, z_i; \theta] = \mathbb{E}[g_i|y_i; \theta] + \epsilon_i,
\]  

(A37)
where \( g \in \{ \phi, \eta \} \) with the following moment condition on the error \( e_i \):

\[
\mathbb{E}(e_i|y_i; \theta) = \mathbb{E}(\mathbb{E}(g_i|y_i, z_i; \theta)|y_i, \delta_i; \theta) - \mathbb{E}(\mathbb{E}(g_i|y_i; \theta)|y_i; \theta) = 0. \quad \text{(A38)}
\]

**D. Gross and Net Benefits of Debt**

The net benefit of debt to shareholders and managers are respectively given by the relative change in the value of their claims due to the presence of debt in the firm’s capital structure, or

\[
\text{NBDS}(x, c) = \frac{V(x, c) - V(x, 0)}{V(x, 0)} \quad \text{and} \quad \text{NBDM}(x, c) = \frac{M(x, c) - M(x, 0)}{M(x, 0)}. \quad \text{(A39)}
\]

where \( V(x, c) \) and \( M(x, c) \) are defined as above. Another interesting quantity is the cost of debt, as perceived by shareholders and the manager. This cost of debt is equal to the gross benefits of debt minus the net benefit of debt:

\[
\text{CD}_i(x, c) (\%) = \text{GBD}_i(x_0, c) - \text{NBD}_i(x_0, c), \quad \text{for } i = S, M, \quad \text{(A40)}
\]

where \( \text{GBD}_i(x_0, c) \) is the gross benefit of debt for agent \( i = S, M \) measured in percent and given by

\[
\text{GBDS}(x_0, c) = \frac{S(x_0, \rho, \gamma)}{V(x_0)} \left\{ \frac{[\tau - \tau^d + \phi (1 - \tau)] c}{r} \left[ 1 - p_U(x_0) - p_D(x_0) \right] \right\}, \quad \text{(A41)}
\]

\[
\text{GBDM}(x_0, c) = \frac{\varphi S(x_0, \rho, \gamma)}{M(x_0)} \left\{ \frac{[\tau - \tau^d + \phi (1 - \tau)] c}{r} \left[ 1 - p_U(x_0) - p_D(x_0) \right] \right\}. \quad \text{(A42)}
\]
The gross benefits of debt include the tax savings and the disciplining effects of debt. The cost of debt to shareholders includes the costs of financial distress as well as the issuance costs. The cost of debt to the manager includes the costs of financial distress, the refinancing costs, as well as the disciplining effect of debt. For a given set of policies \((c, \rho, \gamma)\), the disciplining effect increases the cost of debt to the manager by

\[
\text{DE}(x, c) (\%) = \frac{\mathbf{S}(x_0, \rho, \gamma)}{\mathbf{M}(x, 0)} \left\{ \phi (1 - \tau) \frac{c}{r} [1 - p_U (x_0) - p_D (x_0)] \right\}.
\]  

(A43)
Appendix B. Monte-Carlo Simulation Error in SML

A natural question in any simulated maximum likelihood estimation is the choice of random draws, $K$, when integrating out the unobserved random effects from the likelihood function. A known issue in simulation-based estimation is that for finite $K$, the simulation error can lead to both imprecise and biased point estimates. In order to assess precision and accuracy of the simulations performed during the SML estimation and the associated bias in the SML estimates, we perform the following experiment. We vary $K$ from small to large. For a given $K$, we simulate the log-likelihood a total of 100 times at the same parameters. In every round, we draw a different set of random numbers for the realizations of the firm-specific random effects. This experiment yields both a measure of how the precision of the simulated log-likelihood changes with $K$ and how fast the bias in the log-likelihood due to a finite Monte-Carlo simulation sample shrinks. From this, one can infer how the precision of the estimated coefficients is expected to change with $K$ and how fast the bias in the ML estimates shrinks—without having to reestimate the model with different sets of random draws.

Figure 1 reports descriptive statistics for simulation precision and bias. Here we repeatedly simulate the model with $K = 2, 3, 4, 5, 10, 25, 50, 100, 250, 500, 750, 1,000$ (100 times each). In all plots, on the horizontal axis we vary the number of random draws $K$ used to evaluate the log-likelihood. Panel A reports box plots for the simulated values of the log-likelihood across simulation rounds. Depicted are the lower quartile, median, and upper quartile values as the lines of the box. Whiskers indicate the adjacent values in the data. Outliers are displayed with a + sign. The highest simulated log-likelihood value across all simulation rounds is indicated by a dotted line. Panels B and C report descriptive statistics for the precision and accuracy of the Monte-Carlo simulations. We capture precision
by the “variation” in the simulation error across runs (that is, the variation in the simulated log-likelihood) and accuracy by the “average” in the simulation error. More precisely, Panel B depicts the magnitude of the simulation imprecision and Panel C the simulation bias as function of $K$. The simulation imprecision is measured by the 95% quantile minus the 5% quantile across all simulation rounds for given $K$ and normalized by the highest simulated log-likelihood value across all simulation rounds and all $K$ (our proxy for the true log-likelihood value). The simulation bias is measured by the median log-likelihood value across all simulation rounds for given $K$ relative to the highest simulated log-likelihood value across all simulation rounds.

The impact of simulation error on the precision and accuracy of the log-likelihood (and hence on the SML estimates $\hat{\theta}$) becomes negligible when both the imprecision and bias do not drop further ($y$-axis) when we increase the number of random draws $K$ ($x$-axis). We find that $K = 1,000$ draws are sufficient to satisfy both criteria and render the simulation error negligible. Correspondingly, we set the number of draws to $K = 1,000$ in the estimations.
Appendix C. Data Definitions

A. Managerial Pay-Performance Sensitivity Delta

We compute the \( \text{delta} \)—the sensitivity of the option value to a change in the stock price—using the Black-Scholes (1973) formula for European call options. We follow Core and Guay (1999) when computing \( \text{delta} \) and consider four types of securities: new option grants, previous unexercisable options, previous exercisable options, and portfolios of stocks. 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 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 then computed as the sum of \( \text{delta} \) of new option grants, \( \text{delta} \) of portfolio of stock, \( \text{delta} \) of previous unexercisable options, and \( \text{delta} \) of previous exercisable options, where:

1. **New option grants:** \( S, K, T, d, \) and \( \sigma \) are available from ExecuComp. The risk-free rate \( r \) is obtained from the Federal Reserve, where we use the one-year bond yield for \( T = 1 \), two-year bond yield 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 10-year bond yield for \( T \geq 9 \).

2. **Portfolio of stocks:** \( \text{delta} \) is estimated by the product of the number of stocks owned and 1% of stock value.

3. **Previous unexercisable options:** \( S, d, \sigma, \) and \( r \) are obtained as explained above. The strike price \( K \) is estimate as: \([\text{stock price} - (\text{realizable value/number of options})]\). 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.

4. *Previous exercisable options:* \( S, d, \sigma, \) and \( r \) are obtained as explained above. The strike price \( K \) is estimated as: \( K = [\text{stock price} - (\text{realizable value/number of options})] \). 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.

**B. Managerial Incentive Alignment \( \varphi \)**

Managerial incentives are defined as the change in managerial wealth per dollar change in the wealth of shareholders. Incentives thus consist 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, \( \varphi \), as

\[
\varphi = \varphi^E + \delta \frac{\text{Shares represented by options awards}}{\text{Shares outstanding}},
\]

where \( \varphi^E \) represents managerial ownership and \( \delta \) is computed as above.
Appendix D. Robustness Checks

A. Moment Tests

Conditional moment tests allow us to test the hypothesis that the distance between empirical and simulated data moments is zero (see Newey (1985) and Pagan and Vella (1989)). Let the distance for observation $i$ between $J$ data moments and the corresponding (simulated) model moments be $r_i \in \mathbb{R}^{1 \times J}$. Then the hypothesis is that for the true $\theta$, $\mathbb{E}_\theta[r_i] = 0$. Let $n$ be the sample size and $m$ the number of parameters in the SML estimation. Denote by $R$ the $n \times J$ matrix whose $i$th row is $r_i$ and by $G$ the $n \times m$ gradient matrix of the log-likelihood. The sample moment can be written $r \equiv \frac{1}{n} \sum_{i=1}^{n} r_i$. The Wald statistic is defined by

$$nr'\hat{\Sigma}^{-1}r \rightarrow \chi^2(J), \quad (D1)$$

where the degrees of freedom $J$ are the number of moment restrictions being tested and $\hat{\Sigma}$ is defined by $\hat{\Sigma} = \frac{1}{n}[R'RR'G'(G'G)^{-1}G'R]$. 

B. Simulation Approach

We follow the simulation approach of Berk, Green, and Naik (1999) and Strebulaev (2007). We start by simulating a number of dynamic artificial economies that are inhabited by as many firms as we have observations in the actual data. At date 0, all firms are assumed to be at their target leverage. We then simulate 75 years of quarterly data. The first 40 years of data are dropped to eliminate the impact of initial conditions. The resulting data set corresponds to a single simulated economy. One important deviation from prior studies is that we base our simulation on parameter estimates instead of using calibrated parameter
values. Specifically, based on these estimates, we introduce heterogeneity in the private benefits of control, $\phi_t$, by taking a single random draw for the unobserved random effects. We simulate a total of $M = 1,000$ economies, each characterized by different draws for the random effects. The results we report are average values over the $M$ economies.

C. Simulation Evidence on Cross-Sectional Capital Structure Studies

Leverage Inertia: 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. We investigate the extent to which 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 (1973) regression of leverage on past leverage and the implied debt ratio (IDR). In this regression, IDR is the implied debt ratio that comes about if the firm does not issue debt or equity (and lets leverage ratios change with stock price movements). More formally, we estimate the following model:

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

(D2)

where $L$ is the leverage ratio and $k$ denotes the time horizon in years. If $\alpha_1$ is equal to one, firms perfectly offset stock price movements by issuing debt or equity. If $\alpha_2$ is equal to one, firms do not readjust their capital structure at all following stock price movements. Our results are reported in Panel A of Table X. We observe that the estimates based on the simulated data from our model closely match Welch’s estimates based on real data.
Mean Reversion in Leverage: Mean reversion is another well-documented pattern in leverage ratios (see Fama and French (2002) and Flannery and Rangan (2006)). Following Fama and French (2002), we perform a Fama-MacBeth (1973) estimation of the partial-adjustment model

\[ L_t - L_{t-1} = \alpha + \lambda_1 TL_{t-1} + \lambda_2 L_{t-1} + \epsilon_t, \]  

(D3)

where \( L \) is observed leverage and \( TL \) is target leverage. If \( \lambda_1 \) is equal to one, firms perfectly readjust leverage to the target. If \( \lambda_2 \) is equal to minus one, firms are completely inactive. The partial-adjustment model predicts that \( \lambda_1 \) and \( \lambda_2 \) are equal in absolute value, and \( \lambda_1 \) measures the speed of adjustment. In the empirical literature, \( TL \) is determined in a preliminary step as the predicted value from the following reduced-form equation:

\[ L_t = a_0 + a_1 \pi_t + a_2 \sigma + a_3 \alpha + a_4 \varphi + a_5 \phi + \epsilon_t, \]  

(D4)

where \( \pi_t \) denotes profitability and the remaining independent variables are the firm-specific characteristics described in Section III.B. In our setup, profitability is defined as \( \pi_t = (X_t + \Delta A_t)/A_{t-1} \), where \( X_t \) denotes cash flows from operations and \( A_t \) is the book value of assets. Following Strebulaev (2007), we assume that the book value of assets and cash flows from operations have the same drift under the physical measure. Equation (D4) is estimated in a first stage using pooled OLS. Our results are reported in Panel B of Table X. We observe that leverage is mean-reverting at a speed of 11% per year which corresponds to the average mean-reversion coefficient reported by Fama and French (2002).
REFERENCES


and Quantitative Analysis 43, 975-1000.


NOTES

1See Stulz (1990), Chang (1993), Hart and Moore (1995), Zwiebel (1996), Morellec (2004), and Barclay, Morellec, and Smith (2006). While this literature provides a rich intuition on the effects of managerial discretion on financing decisions, thus far it is mostly qualitative, focusing on directional effects.

2This corresponds to a reduced-form specification of 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 the firm’s assets produce output with the production function \( F : \mathbb{R}_+ \to \mathbb{R}_+ \), \( F(k_t) = k_t^\gamma \), 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

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

Solving for \( k_t \) and replacing \( k_t \) by its expression gives \( f_{it} = (1 - \tau^c_i)Y_{it} \), where \( Y \) is governed by

\[ dY_{it} = \mu_Y Y_{it} dt + \sigma_Y Y_{it} dW_t, \quad Y_{i0} = AX_{i0} > 0, \]

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

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

4Two key assumptions are driving the effects of debt financing on private benefits of control in our model. First, we assume that private benefits are a fraction of the equity cash

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flows, rather than the total cash flows of the firm. Second, we assume that private benefits of control are not lost in default. Under the second assumption, permitting additional agency costs related to gross cash flows $X$, beyond those related to equity cash flows $X - c$, would not impact capital structure choice. By contrast, allowing the manager to lose the private benefits of control in default would introduce conflicts of interest regarding the decision to default and would provide an additional motive for the manager to issue less debt than optimal.

The Internet Appendix is located on The Journal of Finance website at http://www.afajof.org/supplements.asp.

Formally, identification obtains when, for a given true parameter vector, no other value of the parameter vector exists that defines the same true population distribution of the observations. In this case, the parameter vector uniquely defines the distribution and hence can be consistently estimated.

A concern with the standard approach is that local identification may not guarantee identification globally. We have therefore simulated the model moments and computed sensitivities in two ways, as marginal effects at different sets of baseline parameters and as average effects over a range of parameter values. Table II reports the sensitivity $\left( \frac{\partial m}{\partial \theta} \right)/m$ in the baseline. Alternatively, we have computed the differential effect as the average sensitivity over the range of parameter values generating nonzero leverage and normalized by the average effect on the mean. The marginal effects capture local identification, while the average effects give an idea of which moments yield global identification and which parameters have strong nonlinear impact on the model moments. We find that average sensitivities are more similar across parameters than marginal effects. Importantly, however, the quantitative
differences in their impact on the model moments remain, warranting identification.

8The estimates are higher than the calibrated value for two reasons. First, the calibration
does not capture nonlinearities between the parameters and leverage. Second, the estima-
tion considers both unconditional and conditional moments, while we have calibrated to
unconditional moments of the pooled data.

9These quantities are determined by simulating the model given the base case estimates
and computing the relevant values at the refinancing point for every firm using the expressions
reported in Appendix A, Section D.

10In the Internet Appendix we examine the effects of time variation in the model param-
eters when managers are fully rational about this variation.

11The numbers reported in Table IX are measured as the time-series average of all obser-
vations per firm, averaged across firms. These numbers can differ from the pooled averages
reported in Table IV.

12Following Heckman’s (1979) approach to address endogeneity, we add the Inverse Mill’s
Ratio to the regression specification. The coefficient is negative and statistically significant
throughout, suggesting that antitakeover provisions are endogenously determined.
Table I
Comparative Statics

The table reports the main comparative statics of the dynamic model regarding the firm’s financing and default policies, the recovery rate in default, and corporate credit yield spreads. We calibrate the base parametrization to the values observed in the data at the beginning of the sample period. Input parameter values for our base case are set as follows: risk-free interest rate $r = 4.21\%$, initial value of the cash flow shock $x_0 = 1$ (normalized), growth rate and volatility of the cash flow shock $m = 8.24\%$, $\mu = 0.67\%$, and $\sigma = 28.86\%$, corporate tax rate $\tau^c = 35\%$, tax rate on dividends $\tau^d = 11.6\%$, tax rate on interest income $\tau^e = 29.3\%$, liquidation costs $\alpha = 48.52\%$, renegotiation costs $\kappa = 0\%$, shareholder bargaining power $\eta = 50\%$, refinancing costs $\lambda = 1\%$, managerial ownership $\varphi = 7.47\%$, and private benefits of control $\phi = 1\%$.

<table>
<thead>
<tr>
<th>Quasi-Market Leverage (%) at Restructuring</th>
<th>Target Credit Spread (%)</th>
<th>Recovery Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base</strong></td>
<td>11.74</td>
<td>32.06</td>
</tr>
<tr>
<td><strong>Cost of debt issuance (Base: $\lambda = 0.01$)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\lambda = 0.0075$</td>
<td>13.12</td>
<td>32.04</td>
</tr>
<tr>
<td>$\lambda = 0.0125$</td>
<td>10.58</td>
<td>31.91</td>
</tr>
<tr>
<td><strong>Private benefits of control (Base: $\phi = 0.01$)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\phi = 0.0075$</td>
<td>15.79</td>
<td>37.61</td>
</tr>
<tr>
<td>$\phi = 0.0125$</td>
<td>7.17</td>
<td>24.12</td>
</tr>
<tr>
<td><strong>Managerial ownership (Base: $\varphi = 0.0747$)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\varphi = 0.05$</td>
<td>2.06</td>
<td>11.15</td>
</tr>
<tr>
<td>$\varphi = 0.1$</td>
<td>16.18</td>
<td>38.09</td>
</tr>
<tr>
<td><strong>Shareholder bargaining power (Base: $\eta = 0.5$)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\eta = 0.25$</td>
<td>13.57</td>
<td>37.00</td>
</tr>
<tr>
<td>$\eta = 0.75$</td>
<td>9.91</td>
<td>27.09</td>
</tr>
<tr>
<td><strong>Liquidation costs (Base: $\alpha = 0.4852$)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\alpha = 0.45$</td>
<td>12.01</td>
<td>32.78</td>
</tr>
<tr>
<td>$\alpha = 0.55$</td>
<td>11.25</td>
<td>30.73</td>
</tr>
<tr>
<td><strong>Renegotiation costs (Base: $\kappa = 0$)</strong></td>
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<td></td>
</tr>
<tr>
<td>$\kappa = 0.05$</td>
<td>9.70</td>
<td>27.35</td>
</tr>
<tr>
<td>$\kappa = 0.1$</td>
<td>8.36</td>
<td>24.05</td>
</tr>
<tr>
<td><strong>Cash flow growth rate (Base: $\mu = 0.0067$)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\mu = 0$</td>
<td>11.78</td>
<td>32.07</td>
</tr>
<tr>
<td>$\mu = 0.0125$</td>
<td>11.70</td>
<td>32.02</td>
</tr>
<tr>
<td><strong>Cash flow volatility (Base: $\sigma = 0.2886$)</strong></td>
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<td></td>
</tr>
<tr>
<td>$\sigma = 0.25$</td>
<td>13.30</td>
<td>34.16</td>
</tr>
<tr>
<td>$\sigma = 0.35$</td>
<td>9.96</td>
<td>29.47</td>
</tr>
<tr>
<td><strong>Corporate tax rate (Base: $\tau^c = 0.35$)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\tau^c = 0.3$</td>
<td>0.28</td>
<td>3.73</td>
</tr>
<tr>
<td>$\tau^c = 0.4$</td>
<td>19.01</td>
<td>39.31</td>
</tr>
</tbody>
</table>
Table II
Calibrated Leverage Distribution and Model Identification

The table presents various data moments and a comparison with the corresponding moments simulated from the model. The table also reports sensitivities of the moments with respect to the model parameters. We obtain the model-implied moments and sensitivities by Monte-Carlo simulation. The column titled “Empirical Moment” reports the value of the statistical moment in the data. The columns titled “Model Moments” report the values of the simulated statistical moments. We report model-implied moments for three different parametrizations. The parameters of interest are set to the following values in the baseline: $\lambda = 1\%$ and $\phi = 0\%$. The remaining parameters are calibrated as in Table I. The columns titled “Sensitivity” report the sensitivity of the model moments, $(\partial m/\partial \theta)/m$, at the baseline parameters for each of the structural parameters.

<table>
<thead>
<tr>
<th>Leverage:</th>
<th>Model Moments</th>
<th>Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empirical Moment</td>
<td>Baseline ($\lambda = 1%$, $\phi = 0%$)</td>
<td>$\lambda$ (Baseline)</td>
</tr>
<tr>
<td>Mean</td>
<td>0.325</td>
<td>0.486</td>
</tr>
<tr>
<td>Median</td>
<td>0.292</td>
<td>0.463</td>
</tr>
<tr>
<td>S.D.</td>
<td>0.203</td>
<td>0.145</td>
</tr>
<tr>
<td>Skew</td>
<td>0.626</td>
<td>0.488</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>2.711</td>
<td>2.392</td>
</tr>
<tr>
<td>IQR</td>
<td>0.297</td>
<td>0.213</td>
</tr>
<tr>
<td>Min</td>
<td>0.007</td>
<td>0.244</td>
</tr>
<tr>
<td>Max</td>
<td>0.980</td>
<td>0.842</td>
</tr>
<tr>
<td>Range</td>
<td>0.973</td>
<td>0.598</td>
</tr>
<tr>
<td>Autocorrelation 1qtr</td>
<td>0.970</td>
<td>0.900</td>
</tr>
<tr>
<td>Autocorrelation 1yr</td>
<td>0.906</td>
<td>0.666</td>
</tr>
</tbody>
</table>

Changes in leverage:

| Mean | 0.003 | 0.002 | 0.001 | 0.001 | -30.782 |
| Median | 0.000 | 0.000 | -0.001 | -0.001 | 326.169 |
| S.D. | 0.057 | 0.060 | 0.049 | 0.044 | 1.859 |
| Skew | 0.369 | 0.302 | 2.427 | 0.502 | 116.173 |
| Kurtosis | 11.165 | 3.533 | 21.659 | 4.980 | 29.899 |
| IQR | 0.051 | 0.074 | 0.042 | 0.048 | -6.082 |
| Min | -0.634 | -0.308 | -0.256 | -0.218 | -11.797 |
| Max | 0.569 | 0.267 | 0.420 | 0.241 | -30.916 |
| Range | 1.203 | 0.574 | 0.676 | 0.459 | -21.753 |
| Autocorrelation 1qtr | -0.076 | -0.061 | -0.013 | -0.023 | -18.471 |
| Autocorrelation 1yr | 0.008 | -0.030 | -0.012 | -0.020 | -59.120 |

Event frequencies:

| Pr(Default) | – | 0.589 | 0.212 | 0.159 | -25.465 |
| Pr(Issuance) | – | 2.476 | 0.527 | 1.151 | -49.890 |
| Issue size (%) | – | 0.150 | 0.381 | 0.156 | 50.482 | 9.344 |
### Table III
#### Variable Definitions

<table>
<thead>
<tr>
<th>Variable (Data Source)</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial Indicators (Compustat):</strong></td>
<td></td>
</tr>
<tr>
<td>Book Debt</td>
<td>Liabilities total (item 181) + Preferred stock (item 10) – Deferred taxes (item 35)</td>
</tr>
<tr>
<td>Book Debt (alternate)</td>
<td>Long-term debt (item 9) + Debt in current liabilities (item 34)</td>
</tr>
<tr>
<td>Book Equity</td>
<td>Assets total (item 9) – Book debt</td>
</tr>
<tr>
<td>Book Equity (alternate)</td>
<td>Assets total (item 6) – Book debt (alternate)</td>
</tr>
<tr>
<td>Leverage</td>
<td>Book debt/(Assets total (item 6) – Book equity + Market value (item 25 * item 6))</td>
</tr>
<tr>
<td>Leverage (alternate)</td>
<td>Book debt (alternate)/(Assets total (item 6) – Book equity (alternate) + Market value (item 25 * item 6))</td>
</tr>
<tr>
<td>Return on Assets</td>
<td>(EBIT (item 18) + Depreciation (item 14))/Assets total (item 6)</td>
</tr>
<tr>
<td>Market-to-Book</td>
<td>(Market value (item 25 * item 6) + Book debt)/Assets total (item 6)</td>
</tr>
<tr>
<td>Tangibility</td>
<td>Property, plant, and equipment total net (item 8)/Assets total (item 6)</td>
</tr>
<tr>
<td>Size</td>
<td>log(Sales net (item 12))</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and development expenses (item 46)/Assets total (item 6)</td>
</tr>
<tr>
<td><strong>Earnings Growth (I/B/E/S):</strong></td>
<td></td>
</tr>
<tr>
<td>EBIT Growth Rate</td>
<td>Mean analyst forecast for long-term growth rate per SIC-2 industry</td>
</tr>
<tr>
<td><strong>Volatility and Beta (CRSP):</strong></td>
<td></td>
</tr>
<tr>
<td>Equity Volatility</td>
<td>Standard deviation of monthly equity returns over past five years</td>
</tr>
<tr>
<td>Market Model Beta</td>
<td>Market model beta based on monthly equity returns over past five years</td>
</tr>
<tr>
<td><strong>Executive Compensation (ExecuComp):</strong></td>
<td></td>
</tr>
<tr>
<td>Managerial Incentives</td>
<td>See Appendix C</td>
</tr>
<tr>
<td>Managerial Ownership</td>
<td>Shares owned/Shares outstanding for the five highest paid executives</td>
</tr>
<tr>
<td>Managerial Delta</td>
<td>See Appendix C</td>
</tr>
<tr>
<td>CEO Tenure</td>
<td>Current year – year became CEO</td>
</tr>
<tr>
<td>EBIT Growth Rate (alternate)</td>
<td>Five-year least squares annual growth rate of operating income before depreciation</td>
</tr>
<tr>
<td><strong>Blockholders (IRRC blockholders):</strong></td>
<td></td>
</tr>
<tr>
<td>Blockholder Ownership</td>
<td>Fraction of stock owned by outside blockholders</td>
</tr>
<tr>
<td><strong>Directors (IRRC directors):</strong></td>
<td></td>
</tr>
<tr>
<td>Board Independence</td>
<td>Number of independent directors/Total number of directors</td>
</tr>
<tr>
<td>Board Committees</td>
<td>Sum of four dummy variables for existence of independent (more than 50% of committee directors are independent) audit, compensation, nominating, and corporate governance committee</td>
</tr>
<tr>
<td><strong>Antitakeover Provisions (IRRC governance):</strong></td>
<td></td>
</tr>
<tr>
<td>E-index</td>
<td>Six antitakeover provisions index by Bebchuk, Cohen, and Ferrell (2009)</td>
</tr>
<tr>
<td><strong>Institutional Ownership (Thompson Financial):</strong></td>
<td></td>
</tr>
<tr>
<td>Institutional Ownership</td>
<td>Fraction of stock owned by institutional investors</td>
</tr>
<tr>
<td><strong>Economy indicators (FED):</strong></td>
<td></td>
</tr>
<tr>
<td>Term Premium</td>
<td>Difference between 10-year and one-year Treasury bond yield</td>
</tr>
<tr>
<td>Default Premium</td>
<td>Difference between corporate yield spread (all industries) of Moody’s BAA and AAA ratings</td>
</tr>
</tbody>
</table>
The table 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 III provides a detailed definition of the variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>S.D.</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>Obs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leverage ($y$)</td>
<td>0.32</td>
<td>0.20</td>
<td>0.16</td>
<td>0.29</td>
<td>0.46</td>
<td>13,159</td>
</tr>
<tr>
<td>Leverage (alternate)</td>
<td>0.20</td>
<td>0.19</td>
<td>0.04</td>
<td>0.16</td>
<td>0.31</td>
<td>13,159</td>
</tr>
<tr>
<td>EBIT Growth Rate ($\bar{m}$)</td>
<td>0.20</td>
<td>0.06</td>
<td>0.15</td>
<td>0.19</td>
<td>0.23</td>
<td>13,159</td>
</tr>
<tr>
<td>EBIT Volatility ($\sigma$)</td>
<td>0.29</td>
<td>0.13</td>
<td>0.19</td>
<td>0.26</td>
<td>0.35</td>
<td>13,159</td>
</tr>
<tr>
<td>CAPM Beta ($\beta$)</td>
<td>1.06</td>
<td>0.51</td>
<td>0.70</td>
<td>1.01</td>
<td>1.34</td>
<td>13,159</td>
</tr>
<tr>
<td>Liquidation Costs ($\alpha$)</td>
<td>0.51</td>
<td>0.12</td>
<td>0.45</td>
<td>0.50</td>
<td>0.58</td>
<td>13,159</td>
</tr>
<tr>
<td><strong>Financial Characteristics:</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return on Assets</td>
<td>4.47</td>
<td>2.41</td>
<td>2.93</td>
<td>4.19</td>
<td>5.69</td>
<td>13,159</td>
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<tr>
<td>Market-to-Book</td>
<td>2.05</td>
<td>1.27</td>
<td>1.23</td>
<td>1.64</td>
<td>2.39</td>
<td>13,159</td>
</tr>
<tr>
<td>Tangibility</td>
<td>0.34</td>
<td>0.22</td>
<td>0.16</td>
<td>0.28</td>
<td>0.47</td>
<td>13,159</td>
</tr>
<tr>
<td>Firm Size</td>
<td>5.58</td>
<td>1.20</td>
<td>4.74</td>
<td>5.50</td>
<td>6.35</td>
<td>13,159</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>0.22</td>
<td>0.80</td>
<td>0.00</td>
<td>0.00</td>
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<td>13,159</td>
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<td><strong>Ownership Structure:</strong></td>
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<tr>
<td>Institutional Ownership</td>
<td>0.60</td>
<td>0.17</td>
<td>0.49</td>
<td>0.62</td>
<td>0.73</td>
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<tr>
<td>Blockholder Ownership</td>
<td>0.09</td>
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<td>0.00</td>
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<td>13,159</td>
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<tr>
<td><strong>Managerial Characteristics:</strong></td>
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<tr>
<td>Managerial Incentives ($\varphi$)</td>
<td>0.07</td>
<td>0.09</td>
<td>0.02</td>
<td>0.04</td>
<td>0.08</td>
<td>13,159</td>
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<tr>
<td>Managerial Ownership ($\varphi^E$)</td>
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<td>0.08</td>
<td>0.00</td>
<td>0.01</td>
<td>0.05</td>
<td>13,159</td>
</tr>
<tr>
<td>Managerial Delta</td>
<td>7.13</td>
<td>13.00</td>
<td>1.11</td>
<td>2.88</td>
<td>7.20</td>
<td>10,895</td>
</tr>
<tr>
<td>CEO Tenure</td>
<td>8.67</td>
<td>8.78</td>
<td>2.42</td>
<td>5.92</td>
<td>11.90</td>
<td>13,159</td>
</tr>
<tr>
<td><strong>Antitakeover Provisions:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-index</td>
<td>2.35</td>
<td>1.35</td>
<td>1.00</td>
<td>2.00</td>
<td>3.00</td>
<td>10,828</td>
</tr>
<tr>
<td>G-index</td>
<td>9.31</td>
<td>2.77</td>
<td>7.00</td>
<td>9.00</td>
<td>11.00</td>
<td>10,853</td>
</tr>
<tr>
<td><strong>Board Structure:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Board Independence</td>
<td>0.61</td>
<td>0.18</td>
<td>0.50</td>
<td>0.63</td>
<td>0.75</td>
<td>8,665</td>
</tr>
<tr>
<td>Board Committees</td>
<td>2.49</td>
<td>1.10</td>
<td>2.00</td>
<td>2.00</td>
<td>3.00</td>
<td>6,504</td>
</tr>
<tr>
<td><strong>Macro Indicators:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Term Premium</td>
<td>0.01</td>
<td>0.01</td>
<td>0.00</td>
<td>0.01</td>
<td>0.02</td>
<td>13,159</td>
</tr>
<tr>
<td>Default Premium</td>
<td>0.01</td>
<td>0.00</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>13,159</td>
</tr>
</tbody>
</table>
Table V
Refinancing Cost Estimates in the Model without Agency Conflicts

The table presents the structural parameters characterizing the cost of refinancing, $\lambda$, in a dynamic capital structure model without agency conflicts ($\phi_i = 0$), defined as

$$\lambda_i = h(\alpha_\lambda + \epsilon_i^\lambda),$$

where $h = \Phi \in [0, 1]$ is the standard normal cumulative distribution function and $\epsilon_i \sim N(0, \sigma_i^2)$, $i = 1, \ldots, N$. Panel A reports the parameter estimates. Cluster-robust $t$-statistics that adjust for cross-sectional correlation in each time period and industry-clustered $t$-statistics are reported in parentheses. Panel B reports distributional characteristics of the predicted model-implied cost of refinancing, $\hat{\lambda}_i = \mathbb{E}(\lambda_i | y_i; \theta)$. The refinancing cost estimates across firms are expressed in percent. The number of observations is 13,159.

### Panel A: Parameter estimates

<table>
<thead>
<tr>
<th></th>
<th>$\alpha_\lambda$</th>
<th>$\sigma_\lambda$</th>
<th>$\ln \mathcal{L}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coef.</td>
<td>-1.594</td>
<td>0.903</td>
<td>2,403</td>
</tr>
<tr>
<td>$t$-stat (time clustered)</td>
<td>(-56.90)</td>
<td>(44.58)</td>
<td></td>
</tr>
<tr>
<td>$t$-stat (industry clustered)</td>
<td>(-46.23)</td>
<td>(33.85)</td>
<td></td>
</tr>
</tbody>
</table>

### Panel B: Refinancing cost estimates across firms (%)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>5%</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\hat{\lambda}_i$</td>
<td>12.63</td>
<td>12.22</td>
<td>1.74</td>
<td>6.14</td>
<td>1.10</td>
<td>3.71</td>
<td>9.44</td>
<td>16.66</td>
<td>42.19</td>
</tr>
</tbody>
</table>
Table VI
Structural Parameter Estimates in the Model with Agency Conflicts

The table presents estimation results of the structural parameters characterizing agency conflicts, defined by

$$\phi_i = h(\alpha_\phi + \epsilon_i^\phi),$$

where $h = \Phi \in [0,1]$ is the standard normal cumulative distribution function and $\epsilon_i^\phi \sim N(0, \sigma^2_\phi)$, $i = 1, \ldots, N$. Panel A reports the parameter estimates. Cluster-robust $t$-statistics that adjust for cross-sectional correlation in each time period and industry-clustered $t$-statistics are reported in parentheses. The number of observations is 13,159. Panel B reports distributional characteristics of the predicted private benefits of control $\hat{\phi}_i = \mathbb{E}(\phi_i | y_i; \theta)$. In brackets we report these agency costs expressed as a fraction of equity value. The private benefits and cost estimates across firms are expressed in percent.

### Panel A: Parameter estimates

<table>
<thead>
<tr>
<th></th>
<th>$\alpha_\phi$</th>
<th>$\sigma_\phi$</th>
<th>$\ln L$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coef.</td>
<td>-2.595</td>
<td>0.791</td>
<td>7,436</td>
</tr>
<tr>
<td>$t$-stat (time clustered)</td>
<td>(-23.05)</td>
<td>(18.85)</td>
<td></td>
</tr>
<tr>
<td>$t$-stat (industry clustered)</td>
<td>(-21.05)</td>
<td>(12.17)</td>
<td></td>
</tr>
</tbody>
</table>

### Panel B: Agency cost estimates across firms (%)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>5%</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\hat{\phi}_i$</td>
<td>1.55</td>
<td>3.04</td>
<td>4.03</td>
<td>22.35</td>
<td>0.02</td>
<td>0.13</td>
<td>0.45</td>
<td>1.71</td>
<td>7.93</td>
</tr>
<tr>
<td></td>
<td>[1.36]</td>
<td>[2.85]</td>
<td>[4.46]</td>
<td>[27.34]</td>
<td>[0.02]</td>
<td>[0.10]</td>
<td>[0.37]</td>
<td>[1.36]</td>
<td>[6.39]</td>
</tr>
</tbody>
</table>
The table reports the distributional characteristics of the net benefit of debt to managers (NBDM) and shareholders (NBDS), the gross benefit of debt to managers (GBDM) and shareholders (GBDS), the cost of debt to managers (CDM) and shareholders (CDS), as well as the cost of the disciplining effect of debt to the manager (DE). All values referring to shareholders are reported as a percentage of shareholder wealth. All values referring to managers are reported as a percentage of managerial utility.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>5%</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>NBDM</td>
<td>6.87</td>
<td>8.47</td>
<td>0.31</td>
<td>10.28</td>
<td>0.00</td>
<td>0.00</td>
<td>4.17</td>
<td>11.20</td>
<td>24.60</td>
</tr>
<tr>
<td>NBDS</td>
<td>9.62</td>
<td>9.91</td>
<td>0.76</td>
<td>2.57</td>
<td>0.00</td>
<td>0.01</td>
<td>9.13</td>
<td>14.73</td>
<td>28.35</td>
</tr>
<tr>
<td>GBDM</td>
<td>10.25</td>
<td>10.63</td>
<td>0.76</td>
<td>2.53</td>
<td>0.00</td>
<td>0.01</td>
<td>9.80</td>
<td>15.86</td>
<td>30.41</td>
</tr>
<tr>
<td>GBDS</td>
<td>10.69</td>
<td>11.03</td>
<td>0.75</td>
<td>2.53</td>
<td>0.01</td>
<td>0.01</td>
<td>10.15</td>
<td>16.46</td>
<td>31.65</td>
</tr>
<tr>
<td>CDM</td>
<td>3.38</td>
<td>4.58</td>
<td>4.33</td>
<td>59.21</td>
<td>0.01</td>
<td>0.03</td>
<td>2.16</td>
<td>5.01</td>
<td>12.30</td>
</tr>
<tr>
<td>CDS</td>
<td>1.07</td>
<td>1.15</td>
<td>0.80</td>
<td>2.63</td>
<td>0.00</td>
<td>0.00</td>
<td>0.88</td>
<td>1.71</td>
<td>3.32</td>
</tr>
<tr>
<td>DE</td>
<td>1.82</td>
<td>3.08</td>
<td>2.56</td>
<td>10.50</td>
<td>0.01</td>
<td>0.02</td>
<td>0.24</td>
<td>2.61</td>
<td>8.18</td>
</tr>
</tbody>
</table>
Table VIII
Robustness: Agency Cost Estimates under Alternative Specifications

The table summarizes distributional characteristics of the fitted private benefits of control, \( \hat{\phi}_i = \hat{E}(\phi_i|y_i; \theta) \), \( i = 1, \ldots, N \), in a number of alternative specifications. In Appendix A, Section C we derive explicit expressions for \( \hat{\phi}_i \). In brackets we report private benefits of control expressed as a fraction of equity value. The cost estimates across firms are expressed in percent.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>5%</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restructuring cost ( \lambda = 0.50% )</td>
<td>( \hat{\phi}_i )</td>
<td>1.82</td>
<td>3.51</td>
<td>3.93</td>
<td>21.41</td>
<td>0.02</td>
<td>0.12</td>
<td>0.52</td>
<td>1.99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[1.64]</td>
<td>[3.43]</td>
<td>[4.34]</td>
<td>[25.81]</td>
<td>[0.01]</td>
<td>[0.09]</td>
<td>[0.42]</td>
<td>[1.58]</td>
</tr>
<tr>
<td>Alternate ownership measure ( \varphi^E )</td>
<td>( \hat{\phi}_i )</td>
<td>1.08</td>
<td>2.68</td>
<td>4.71</td>
<td>29.28</td>
<td>0.01</td>
<td>0.04</td>
<td>0.18</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.97]</td>
<td>[2.55]</td>
<td>[4.90]</td>
<td>[31.64]</td>
<td>[0.00]</td>
<td>[0.03]</td>
<td>[0.15]</td>
<td>[0.66]</td>
</tr>
<tr>
<td>Renegotiation cost ( \kappa = 15% )</td>
<td>( \hat{\phi}_i )</td>
<td>1.10</td>
<td>2.29</td>
<td>4.10</td>
<td>22.96</td>
<td>0.01</td>
<td>0.09</td>
<td>0.31</td>
<td>1.04</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.97]</td>
<td>[2.15]</td>
<td>[4.22]</td>
<td>[23.47]</td>
<td>[0.01]</td>
<td>[0.07]</td>
<td>[0.25]</td>
<td>[0.86]</td>
</tr>
<tr>
<td>Alternate definition of leverage</td>
<td>( \hat{\phi}_i )</td>
<td>3.10</td>
<td>3.98</td>
<td>1.61</td>
<td>5.96</td>
<td>0.03</td>
<td>0.23</td>
<td>0.96</td>
<td>7.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[3.92]</td>
<td>[5.62]</td>
<td>[1.73]</td>
<td>[5.96]</td>
<td>[0.02]</td>
<td>[0.19]</td>
<td>[0.82]</td>
<td>[7.15]</td>
</tr>
<tr>
<td>Parameters ( \theta^* ) set to time-varying estimates ( \theta^*_t )</td>
<td>( \hat{\phi}_i )</td>
<td>1.67</td>
<td>3.42</td>
<td>4.07</td>
<td>22.98</td>
<td>0.01</td>
<td>0.09</td>
<td>0.40</td>
<td>1.77</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[1.50]</td>
<td>[3.10]</td>
<td>[3.87]</td>
<td>[20.81]</td>
<td>[0.01]</td>
<td>[0.07]</td>
<td>[0.34]</td>
<td>[1.44]</td>
</tr>
<tr>
<td>Logit specification for link function ( h )</td>
<td>( \hat{\phi}_i )</td>
<td>1.77</td>
<td>3.80</td>
<td>4.67</td>
<td>29.21</td>
<td>0.02</td>
<td>0.13</td>
<td>0.43</td>
<td>1.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[1.57]</td>
<td>[3.57]</td>
<td>[4.91]</td>
<td>[32.23]</td>
<td>[0.02]</td>
<td>[0.10]</td>
<td>[0.37]</td>
<td>[1.51]</td>
</tr>
</tbody>
</table>
Table IX  
Conditional Moment Tests for Goodness-of-Fit

The table reports the results from conditional moment (CM) tests that use conditional moment restrictions for testing goodness-of-fit. The CM tests check whether the difference between the real data moments listed in each row and the simulated data moments based on our SML estimates is equal to zero. The test statistic for each individual moment is reported in the third column next to the corresponding moment, and the associated $p$-value is in the last column. The Wald test statistic tests for joint fit of the model.

<table>
<thead>
<tr>
<th>Leverage:</th>
<th>Empirical Moment</th>
<th>Simulated Model Moment</th>
<th>CM Test Statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.322</td>
<td>0.325</td>
<td>(-0.26)</td>
<td>[0.79]</td>
</tr>
<tr>
<td>Median</td>
<td>0.317</td>
<td>0.309</td>
<td>(1.38)</td>
<td>[0.17]</td>
</tr>
<tr>
<td>S.D.</td>
<td>0.068</td>
<td>0.101</td>
<td>(-19.19)</td>
<td>[0.00]</td>
</tr>
<tr>
<td>Skew</td>
<td>0.220</td>
<td>0.755</td>
<td>(-23.78)</td>
<td>[0.00]</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>2.308</td>
<td>3.596</td>
<td>(-32.31)</td>
<td>[0.00]</td>
</tr>
<tr>
<td>Range</td>
<td>0.216</td>
<td>0.400</td>
<td>(-34.00)</td>
<td>[0.00]</td>
</tr>
<tr>
<td>IQR</td>
<td>0.100</td>
<td>0.136</td>
<td>(-12.23)</td>
<td>[0.00]</td>
</tr>
<tr>
<td>Min</td>
<td>0.224</td>
<td>0.157</td>
<td>(11.24)</td>
<td>[0.00]</td>
</tr>
<tr>
<td>Max</td>
<td>0.440</td>
<td>0.557</td>
<td>(-14.26)</td>
<td>[0.00]</td>
</tr>
<tr>
<td>Autocorrelation 1qtr</td>
<td>0.916</td>
<td>0.905</td>
<td>(0.23)</td>
<td>[0.82]</td>
</tr>
<tr>
<td>Autocorrelation 1yr</td>
<td>0.737</td>
<td>0.680</td>
<td>(1.21)</td>
<td>[0.23]</td>
</tr>
</tbody>
</table>

Wald test of joint hypothesis $H_0$: All moments equal

(0.34) [1.00]
Table X
Simulation Evidence: Leverage Inertia and Mean Reversion

The table provides simulation evidence on leverage inertia and mean reversion. Panel A reports parameter estimates from Fama-MacBeth (1973) regressions on leverage in levels, similar to Welch (2004). 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 defined in Welch (2004), and \( k \) is the time horizon. Coefficients reported are means over 1,000 simulated data sets. Below our estimated coefficients we report the coefficients on IDR in Welch (2004) and Strebulaev (2007). Panel B reports parameter estimates from Fama-MacBeth (1973) regressions on leverage changes, similar to Fama and French (2002). 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, again, the leverage ratio and \( TL \) is the target leverage ratio. In the first specification, \( TL \) is determined in a prior stage by running a cross-sectional regression of leverage on various determinants. In the second specification, \( TL \) is set to the model-implied target leverage ratio. Coefficients are means over 1,000 simulated datasets.

### Panel A: Leverage Inertia

<table>
<thead>
<tr>
<th>Lag ( k ) in years</th>
<th>1</th>
<th>3</th>
<th>5</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient estimates in simulated data</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Implied Debt Ratio, ( IDR_{t-k,t} )</td>
<td>1.02</td>
<td>0.87</td>
<td>0.75</td>
<td>0.56</td>
</tr>
<tr>
<td>Leverage, ( L_{t-k} )</td>
<td>-0.06</td>
<td>0.05</td>
<td>0.14</td>
<td>0.30</td>
</tr>
<tr>
<td>Constant</td>
<td>0.01</td>
<td>0.02</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.96</td>
<td>0.89</td>
<td>0.83</td>
<td>0.74</td>
</tr>
<tr>
<td>( IDR_{t-k,t} ) coefficients in the literature</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Welch (empirical values)</td>
<td>1.01</td>
<td>0.94</td>
<td>0.87</td>
<td>0.71</td>
</tr>
<tr>
<td>Strebulaev (calibrated values)</td>
<td>1.03</td>
<td>0.89</td>
<td>0.79</td>
<td>0.59</td>
</tr>
</tbody>
</table>

### Panel B: Leverage mean-reversion

<table>
<thead>
<tr>
<th>Two-stage estimated ( TL )</th>
<th>Model-implied ( TL )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target Leverage, ( TL_{t-1} )</td>
<td>0.11</td>
</tr>
<tr>
<td>Leverage, ( L_{t-1} )</td>
<td>-0.11</td>
</tr>
<tr>
<td>Constant</td>
<td>0.00</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.05</td>
</tr>
</tbody>
</table>

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Table XI
The Determinants of Agency Conflicts

The table summarizes the determinants of agency conflicts across firms. The dependent variable is the predicted value of private benefits of control, \( \hat{\phi}_i = \mathbb{E}(\phi_i|y_i; \theta) \) for \( i = 1, \ldots, N \), where \( \theta \) are the parameters estimated in Section IV.B and \( \hat{\phi}_i \) are expressed in basis points. In columns (1) to (4) we report estimation results from cross-sectional regressions. Specifications (1) and (4) use the entire sample. Missing values are imputed with zero and dummy variables that take a value of one for missing values are included in the regression. Specifications (2) and (3) only use observations with no missing data items. In specification (3) we drop the variables with the most missing values from the regression. All specifications are estimated including industry fixed effects. Standard errors are adjusted for sampling error in the generated regressands (see Handbook of Econometrics IV, p. 2183) and are reported in parentheses. Statistical significance at the 10%, 5%, and 1% level is indicated by *, **, and ***, respectively.

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutional Ownership</td>
<td>-201.53***</td>
<td>-205.26***</td>
<td>-233.12***</td>
</tr>
<tr>
<td></td>
<td>(51.26)</td>
<td>(58.01)</td>
<td>(54.82)</td>
</tr>
<tr>
<td>Independent Blockholder Ownership</td>
<td>-112.70*</td>
<td>-117.11</td>
<td>-113.84*</td>
</tr>
<tr>
<td></td>
<td>(68.00)</td>
<td>(72.89)</td>
<td>(67.25)</td>
</tr>
<tr>
<td>CEO Tenure</td>
<td>4.48***</td>
<td>4.81***</td>
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<td>(12.85)</td>
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Observations | 809 | 569 | 634 | 809

\( R^2 \) | 0.35 | 0.37 | 0.35 | 0.35
Panel A: Simulated values of the log-likelihood

Panel B: Simulation precision of the simulated log-likelihood
Panel C: Simulation accuracy of the simulated log-likelihood

Figure 1. Monte-Carlo simulation precision and accuracy. The figure depicts the magnitude of Monte-Carlo simulation error and its impact on the precision and accuracy of the simulated log-likelihood. In all plots, on the horizontal axis we vary the number of random draws $K$ used to evaluate the log-likelihood. For given $K$, we evaluate the log-likelihood 100 times at the same parameters and in each round we vary the set of random numbers used to integrate out the firm-specific random effects from the likelihood function. Panel A reports box plots for the simulated values of the log-likelihood across simulation rounds. Depicted are the lower quartile, median, and upper quartile values as the lines of the box. Whiskers indicate the adjacent values in the data. Outliers are displayed with a + sign. The highest simulated log-likelihood value across all simulation rounds is indicated by a dotted line. Panel B depicts the magnitude of the simulation imprecision and Panel C the simulation bias as function of $K$. The simulation imprecision is measured by the 95% quantile minus the 5% quantile across all simulation rounds for given $K$ and normalized by the highest simulated log-likelihood value across all simulation rounds. The simulation bias is measured by the median log-likelihood value across all simulation rounds for given $K$ relative to the highest simulated log-likelihood value across all simulation rounds.
Figure 2. Predicted agency costs across firms. The figure shows the predicted private benefits of control \( \hat{\phi}_i(y, x; \theta) \), for firms \( i = 1, \ldots, N \), in the dynamic capital structure model. The histograms plot the predicted parameters for each firm-quarter.
Figure 3. Cost of debt and underleverage. The figure plots the marginal benefit of debt, MBDM(\(l\)) and MBDS(\(l\)), and the marginal cost of debt, MCDM(\(l\)) and MCDS(\(l\)), as a function of leverage \(l\) from the perspective of managers and shareholders, respectively. The figure also depicts the optimal leverage ratio (where marginal costs and benefits of debt are equalized) from the perspective of managers and shareholders, denoted by \(l^*_M\) and \(l^*_S\).
Internet Appendix for “Corporate Governance and Capital Structure Dynamics”

ERWAN MORELLEC, BORIS NIKOLOV, and NORMAN SCHÜRHOFF *

*Citation format: Morellec, Erwan, Boris Nikolov, and Norman Schürhoff, 2012, Internet Appendix for “Corporate Governance and Capital Structure Dynamics,” Journal of Finance ???, pp. ???, http://www.afajof.org/supplements.asp. Please note: Wiley-Blackwell is not responsible for the content or functionality of any supporting information supplied by the authors. Any queries (other than missing material) should be directed to the authors of the article. Erwan Morellec is with Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Finance Institute, and CEPR. E-mail: erwan.morellec@epfl.ch. Postal: Ecole Polytechnique Fédérale de Lausanne, Extranef 210, Quartier UNIL-Dorigny, CH-1015 Lausanne, Switzerland. Boris Nikolov is with the William E. Simon Graduate School of Business Administration, University of Rochester. E-mail: boris.nikolov@simon.rochester.edu. Postal: Simon School of Business, University of Rochester, NY 14627 Rochester, USA. Norman Schürhoff is with the Faculty of Business and Economics at University of Lausanne, Swiss Finance Institute, and CEPR. E-mail: norman.schuerhoff@unil.ch. Postal: Ecole des HEC, University of Lausanne, Extranef 239, CH-1015 Lausanne, Switzerland.
This document contains supplementary material to the paper titled “Corporate Governance and Capital Structure Dynamics.” It contains three sections. Section I verifies the scaling property in our model. Section II assesses the effect of time variation in the model parameters on optimal financing choices and firm value. Section III documents additional specification analysis.
I. Scaling Property

Consider a model with static debt policy, as in Leland (1994). Denote the values of equity and corporate debt by $E(x)$ and $B(x)$, respectively. Assuming that the firm has issued debt with coupon payment $c$, the cash flow accruing to shareholders over each interval of time of length $dt$ is $(1 - \tau)(1 - \phi)(x - c)dt$, where the tax rate $\tau = 1 - (1 - \tau^c)(1 - \tau^d)$ reflects both corporate and personal taxes. 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

$$\Pi(x) = \mathbb{E}^Q\left[\int_t^\infty e^{-r(s-t)}(1 - \tau)(1 - \phi)X_s ds|X_t = x\right] = (1 - \tau)\left(\frac{1 - \phi}{r - \mu}\right)x,$$

and $\xi$ and $\nu$ 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 \( \partial E/\partial x \big|_{x=x_B} = \eta (\alpha - \kappa) \Pi_x (x_B) \) 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

\[
E(x, c) = \Pi (x) - \left( \frac{1 - \tau}{r} \right)c - \left\{ [1 - \eta (\alpha - \kappa)] \Pi (x_B) - \left( \frac{1 - \tau}{r} \right)c \right\} \left( \frac{x}{x_B} \right)^{\nu}.
\]

In these equations, 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

\[
rB = \frac{1}{2} \sigma^2 x^2 \frac{\partial^2 B}{\partial x^2} + \mu x \frac{\partial B}{\partial x} + (1 - \tau^i) c.
\]

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

\[
B(x, c) = \left( \frac{1 - \tau^i}{r} \right)c - \left\{ \left( \frac{1 - \tau^i}{r} \right)c - [1 - \kappa - \eta (\alpha - \kappa)] \Pi (x_B) \right\} \left( \frac{x}{x_B} \right)^{\nu}.
\]

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

$$
M(x) = \left[ \varphi + \frac{\phi}{1-\phi} \right] \Pi(x) + \frac{\varphi (1-\tau^i) - (1-\tau) [\phi + \varphi (1-\phi)]}{r} c \left[ 1 - \left( \frac{x}{x_B} \right)^\nu \right] - \left\{ \varphi \kappa + [1-\eta (\alpha - \kappa)] \frac{\phi}{1-\phi} \right\} \Pi(x_B) \left( \frac{x}{x_B} \right)^\nu .
$$

Plugging the expression for the default threshold into the manager’s value function $M(x)$, it is immediate to show that $M(x)$ is concave in $c$. As a result, the selected coupon payment can be derived using the first-order condition: $\partial M(x_0) / \partial c = 0$. Solving this first-order condition yields

$$
c = x \frac{r (\nu - 1) [1-\eta (\alpha - \kappa)]}{\nu (r - \mu)} \left[ \frac{1}{(1-\nu)} - \frac{\nu (1-\tau) \left\{ \varphi (1-\phi) \frac{\kappa}{1-\eta (\alpha - \kappa)} + \phi \right\}^{\frac{1}{\nu}}} {\varphi (1-\tau^i) - (1-\tau) [\phi + \varphi (1-\phi)]} \right] .
$$

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 $\theta$. 


4
II. Time-Varying Model Parameters

In this section, we assess the effect of time variation in the model parameters on optimal financing choices and firm value. We introduce time variation into the model by allowing one parameter at a time to vary according to a finite-state Markov chain. The Markov chain is assumed uncorrelated with the cash flow innovations \(dX_t\). We calibrate the middle state to the mean value in the data and allow for 10 up and 10 down states using equal step sizes. In total, this construction yields a finite-state Markov chain with \(s = 21\) states. The Markov transition matrix \(\Pi_{[s \times s]}\) is defined as follows:

\[
\Pi = \begin{bmatrix}
p_m & 1-p_m & 0 & 0 & 0 & \cdots & 0 \\
p_d & p_m & p_u & 0 & 0 & \cdots & 0 \\
0 & p_d & p_m & p_u & 0 & \cdots & 0 \\
\vdots & \ddots & \ddots & \ddots & \ddots & \ddots & \ddots \\
0 & \cdots & 0 & p_d & p_m & p_u & 0 \\
0 & \cdots & 0 & 0 & p_d & p_m & p_u \\
0 & \cdots & 0 & 0 & 0 & 1-p_m & p_m \\
\end{bmatrix}^{\frac{1}{\Delta t}}
\]

where we impose \(p_d+p_m+p_u = 1\) and \(p_d = p_u\) (symmetry). We introduce significant volatility into the process by setting \(p_m\) to either 0.9 or 0.99 per time step and the size of each time step to \(\Delta t = \frac{1}{100}\) or, respectively, \(\frac{1}{1000}\). This specification yields an ergodic mean-reverting stochastic process with mean value equal to the middle state. The remaining parameters are calibrated as in Section II. To gauge the effect of time variation, we compare the firm’s optimal leverage policies under time-varying parameters when management is fully rational with the myopic policies, in which parameters are assumed constant by management.
Figure IA.1 illustrates the effect on the firm’s policy choices (Panel A) and on firm value of time variation in the model parameters (Panel B). Panel A reports the optimal leverage policies under time-varying parameters (solid line) and the myopic policies under constant parameters as indicated on the horizontal axis (dashed line). For each policy, the top line depicts the default leverage threshold for different parameter values, the middle line the target leverage ratio, and the bottom line the refinancing leverage threshold. Panel B reports the change in firm value from switching from the myopic policy to the optimal policy, as a fraction of the unlevered firm value, for different values of the parameters and leverage. In each panel, the left plot allows for time-varying volatility $\sigma$ and the right plot for time-varying managerial ownership $\varphi$. The range of values is indicated on the corresponding axis.

The figure reveals that even for the parameters with the largest comparative static effect on financial policies ($\sigma$ and $\varphi$), the effect of time variation in the parameters over and above the myopic policy is modest. The effect on valuations is less than 1% on average and does not exceed 13%.
Panel A: Firm’s leverage choices under time-varying volatility $\sigma$ (left) and time-varying managerial ownership $\phi$ (right).
Panel B: Effect on the manager's value function of switching from myopic to optimal policy under time-varying volatility $\sigma$ (left) and time-varying managerial ownership $\varphi$ (right).

Figure IA.1. Effect of time variation in parameters on optimal policy choices and firm value. The figure shows the effect on the firm's policy choices and on firm value of time variation in the model parameters. Panel A reports the optimal leverage policies under time-varying parameters (solid line) and the myopic policies under constant parameters as indicated on the horizontal axis (dashed line). For each policy, the top line depicts the default leverage threshold for different parameter values, the middle line the target leverage ratio, and the bottom line the refinancing leverage threshold. Panel B reports the change in firm value from switching from the myopic policy to the optimal policy, as a fraction of the unlevered firm value, for different values of the parameters and leverage. In each panel, the left plot allows for time-varying volatility $\sigma$ and the right plot for time-varying managerial ownership $\varphi$. Time variation is introduced by modeling the parameter as a finite-state Markov chain with the range of values indicated on the corresponding axis.
III. Specification Analysis

In this section, we conduct specification analysis to diagnose which modeling assumptions are crucial in fitting the data. We consider a set of alternative nested and non-nested models and use two types of likelihood-based hypothesis tests to discriminate between models.

For nested models, we use a standard log-likelihood ratio test to discriminate between model specifications. The log-likelihood ratio test statistic is appropriate only for nested models. Denote by $\ln L_u$ the log-likelihood of the unconstrained model and $\ln L_c$ the log-likelihood of the constrained model. The number of parameter constraints is $J$. The likelihood ratio statistic in this case is defined as

$$LR = 2(\ln L_u - \ln L_c) \rightarrow \chi^2(J).$$

The test statistic $LR$ follows a Chi-squared distribution with degrees of freedom equal to the number of parameter constraints.

For non-nested models, we follow the approach by Vuong (1989). Vuong proposes to discriminate between two model families $F_\theta = \{f(y|\theta); \theta \in \Theta\}$ and $G_\gamma = \{g(y|\gamma); \gamma \in \Gamma\}$ based on the following model selection statistic:

$$LR_V = \frac{\ln \mathcal{L}^f(\theta; y) - \ln \mathcal{L}^g(\gamma; y) - (p - q)}{\omega},$$

where $p$ and $q$ are the degrees of freedom in model $F_\theta$ and $G_\gamma$, respectively. The constant $\omega$ is defined as

$$\omega^2 = \frac{1}{N} \sum_{i=1}^{N} \left[ \log \frac{f(y_i|\hat{\theta})}{g(y_i|\hat{\gamma})} \right]^2 - \left[ \frac{1}{N} \sum_{i=1}^{N} \log \frac{f(y_i|\hat{\theta})}{g(y_i|\hat{\gamma})} \right]^2.$$
Under the null hypothesis,

\[ LR_V \rightarrow N(0, 1). \]

If \( LR_V > c \), where \( c \) is a critical value from the standard normal distribution, one rejects
the null that the models are equivalent in favor of \( \mathbf{F}_\theta \). If \( LR_V < c \), one rejects the null that
the models are equivalent in favor of \( \mathbf{G}_\gamma \). If \( |LR_V| \leq c \), one cannot discriminate between the
two competing models.

Table IA.I summarizes the statistical test results for alternative model specifications. We
consider a total of five models. In addition to the base specification (12), we estimate one
nested model and four non-nested models:

(1) \( \phi \) constant: \( \phi_i = h(\alpha_\phi) \)

(2) firm-specific bargaining power \( \eta \) (non-nested): \( \eta_i = h(\alpha_\eta + \epsilon_i^\eta), \phi_i = 0\% \)

(3) \( \eta \) constant (non-nested): \( \eta_i = h(\alpha_\eta), \phi_i = 0\% \)

(4) firm-specific refinancing costs \( \lambda \) (non-nested): \( \lambda_i = h(\alpha_\lambda + \epsilon_i^\lambda), \phi_i = 0 \)

(5) \( \lambda \) constant (non-nested): \( \lambda_i = h(\alpha_\lambda), \phi_i = 0 \).

Table IA.I reveals that our base specification dominates all alternatives. Specifications
that do not account for cross-sectional heterogeneity (\( \phi, \eta, \) and \( \lambda \) defined as constants)
perform poorly. In our setup, incorporating firm-specific heterogeneity in the estimation
helps dramatically in matching observed leverage ratios. Our base specification also performs
significantly better than specifications assuming perfect corporate governance. Finally, the
specification analysis in Table IA.I (specifically, hypothesis tests against alternatives (4) and
(5)) provides statistical confirmation—complementing the economic intuition from Table
V—that a dynamic trade-off model with agency costs yields better goodness-of-fit than the
classic dynamic trade-off theory based solely on transaction costs.
The table reports likelihood ratio tests to select the best model among alternative model specifications. We report test statistics for nested and non-nested models as derived in Internet Appendix Section III. In addition to the base specification (12), we consider a nested model and four non-nested models: (1) φ constant (φ̂ = h(αφ)), (2) firm-specific bargaining power (η̂ = h(αη + εη), φ̂ = 0%), (3) η constant (η̂ = h(αη), φ̂ = 0%), (4) firm-specific refinancing costs λ (λ̂ = h(αλ + ελ), φ̂ = 0%, η̂ = 50%), and (5) λ constant (λ̂ = h(αλ), φ̂ = 0%, η̂ = 50%). For the nested model, we employ a standard likelihood ratio test (indicated by †). Tests for non-nested models are based on Vuong (1989). *p*-values are reported in brackets. For the nested models, a *p*-value of zero indicates that the null hypothesis that the parameter restrictions are valid is rejected in favor of the model under the alternative. For the non-nested models, a *p*-value of zero indicates that the null hypothesis that the two models are equivalent is rejected in favor of the model under the alternative.

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