Debt Servicing Costs and Capital Structure

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Abstract

In contrast to the standard capital structure theory prediction that builds on a trade-off between interest tax shields and expected bankruptcy costs, public firms use debt quite conservatively. To address this well known debt conservatism puzzle (Graham 2000), I argue that servicing debt drains valuable liquidity for a financially constrained firm and hence endogenously creates '*debt servicing costs*,' which have received little attention in the literature. To examine the influence of debt servicing costs on capital structure choices, I develop and estimate a dynamic corporate finance model with interest tax shields, liquidity management, investments, external debt and equity financing costs, and capital adjustment costs. By using the marginal value of liquidity as a natural measure of the debt servicing costs, I find that (1) an increase in financial leverage results in higher debt servicing costs, even with risk-free debt. (2) a smaller firm tends to experience greater debt servicing costs because of its endogenously large investment demands; and (3) in the majority of cases, equity proceeds are used for cash retention as well as capital expenditure, especially when a firm faces large current and future investment needs. Furthermore, my simulation and empirical analyses cross-sectionally show that large debt servicing costs are closely associated with low leverage and frequent equity financing.

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1 Introduction

Graham (2000) documents that public firms tend to forgo potentially large tax shields and that this tendency is paradoxically more significant for the firms with low financial distress costs. These findings pose strong challenges to the standard capital structure theory that builds on a trade-off between interest tax shields and expected bankruptcy costs (Modigliani and Miller 1958). Graham (2000) concludes that public firms are leaving a significant sum of money on the table by remaining underlevered.

To address this debt conservatism puzzle, I argue that servicing debt drains valuable liquidity for a financially constrained firm and thus endogenously creates *'debt servicing costs.'* A firm retains cash to avoid costly external financing but servicing debt obligations depletes such valuable cash holding. When a firm faces a highly valuable liquidity from large acquisition plans or poor business performance, large debt servicing costs may lead to the firm's conservative debt policy even with a negligible likelihood of financial distress. As servicing debt drains a firm's valuable cash, the debt servicing cost is naturally measured by the marginal value of liquidity, which is also a critical determinant of a firm's net payout and liquidity policies (Bolton, Chen, and Wang 2011, hereafter BCW).

I develop and estimate a dynamic capital structure model with precautionary liquidity holding to examine how debt servicing costs affect a firm's capital structure choice. A firm makes investment, cash retention, capital structure, and payout decisions by considering interest tax shields, external financing costs and capital adjustment costs. Debt and equity financing costs are pivotal elements underlying a firm's precautionary cash saving incentives (BCW). Capital adjustment costs shape intertemporal investment demands and determine the cost of asset sales (DeAngelo, DeAngelo, and Whited 2011, hereafter DDW). An endogenous investment decision crucially influences the value of liquidity, as it utilizes currently accumulated cash stocks.

My model analysis on the relationship between debt servicing costs and a firm's leverage, profitability shock, and capital stock yields a number of interesting results. Most notably, a firm with large debt obligations faces higher debt servicing costs, even with risk-free debt issuance. To pay down large debt obligations, a firm with limited liquidity holding tends to rely more heavily on capital resale and external financing, both of which involve increasing marginal costs. Current asset sales also incur additional future profit losses by reducing a firm's profit generation capacity. The increase in debt servicing costs reflects explicit costs and inefficiency from asset sales and external financing.

This rise in debt servicing costs is closely associated with the debt conservatism puzzle (Graham 2000). Most of all, this finding provides an economic ground for a firm's conservative use of debt even in the face of large unused tax benefits and low financial distress costs. Economic factors closely associated with conservative debt policy also reinforce the potential importance of debt servicing costs in resolving the debt conservatism puzzle; future growth options to fund, large acquisition plans, asset intangibility, and excess cash holding are all closely connected with a large marginal value of liquidity.

Next, a firm with low profitability shocks tends to experience large debt servicing costs. A currently low operating profit realization directly indicates low internal funds to service debt obligations, given a limited amount of cash holding. It further predicts low expected future profits due to the positive serial correlations in a firm's operating profits. Both forces increase a firm's marginal value of liquidity considerably; indeed, they do so in spite of currently small investment demands implied by the low profitability shock realization.

Moreover, a firm with low capital stocks confronts large debt servicing costs. A smaller firm must investment more in the current and future periods, due to a decreasing returns to scale profit technology. Such additional funding demands for capital expenditures raise the marginal value of liquidity, which potentially leads to lower leverage ratios in smaller firms. Consistent with this debt servicing costs prediction, small firms tend to show lower leverage ratios (Frank and Goyal 2003; 2008) and large firms rely more heavily on debt issuance (Shyam-Sunder and Myers 1999). The marginal value of liquidity directly connects large investments in smaller firms with low leverage, even without limited debt capacity considerations as in DDW.

I shall now turn to my model simulation results. Most remarkably, equity proceeds, in the majority of cases, are used for cash retention as well as capital expenditure, especially when a firm faces large current and future investments. While large future investment demands imply highly valuable liquidity for a firm, the firm has to use a considerable amount of cash stocks for currently vast investments. To stockpile a substantial amount of cash stocks, the firm not only uses its operating profits, but also relies on equity financing that does not drain valuable liquidity in the future. Consistent with this finding, equity proceeds are primarily used for near term cash saving (DeAngelo, DeAngelo, and Stulz 2010) and equity financing is concurrent with large current and future investments (Loughran and Ritter 1997; Fama and French 2002). Unlike prior security issuance theories highlighting the use of equity proceeds for debt payments (Strebulaev 2007) or large asymmetric information costs of equity issuance (Myers and Majluf 1984), the model simulation results emphasize the use of equity proceeds for cash retention.

The model simulations for different levels of fixed operating costs and convex capital adjustment costs demonstrate that large debt servicing costs are closely associated with low leverage and frequent equity financing. An increase in fixed operating costs lowers a firm's profitability, but it does not change investment demands significantly. Given a similar investment needs, a firm with lower profits tends to experience a higher marginal value of liquidity. An increase in convex capital adjustment costs is also closely related to large debt servicing costs because it raises the cost of asset sales. In both fixed operating costs and convex capital adjustment costs simulations, firms with large debt servicing costs tend to maintain lower leverage and issue equity more frequently.

These quantitative predictions are in line with prior empirical studies. Kahl, Lunn, and Nilsson (2012) find that higher operating leverage firms tend to use less debt and collect large amounts of equity proceeds, consistent with the fixed operating costs analysis. R&D expenditures are closely associated with large convex capital adjustment costs and R&D intensive firms are well known for their low leverage and frequent equity financing (Hall 2002), as predicted in the quantitative analysis on convex capital adjustment costs.

I conduct two empirical studies to analyze how large debt servicing costs affect a firm's external financing policies. First, I examine the implication of convex capital adjustment costs on external debt and equity financing policies. A modified version of Tobin's Q regression (Eberly 1997) is adopted to estimate a firm-level convex capital adjustment costs. My cross-sectional analysis shows that firms with higher convex capital adjustment costs are closely associated with conservative debt policy and frequent equity financing, even after controlling for both industry and firm characteristics. These results are all consistent with the debt servicing cost predictions.

Next, I examine how future investments influence current capital structure choice. Large future investment demands increase a firm's marginal value of liquidity, after controlling for operating profits. I construct indicator variables based on the relative ranking of future investment-asset ratio and analyze the relationship between these indicator variables and external financing policies. The cross-sectional analysis shows that firms with large future investment tend to exercise more conservative debt policy and rely more heavily on equity financing even with their high profitability. This result contradicts the standard trade-off theory prediction on equity financing where a firm avoids equity issuance in the face of large unused tax shields and high profitability. The inclusion of investment dummy variables also weakens the puzzling negative correlation between profitability and leverage ratio (Frank and Goyal 2008), which suggests a potential role of debt servicing costs restraining debt issuance during high profitability states.

In summary, this paper investigates the interdependence between liquidity policy and capital structure choices, which is a key missing link in existing literature. The standard trade-off theory (Modigliani and Miller 1958) balances the value of tax shields against financial distress costs without liquidity considerations. BCW and Riddick and Whited (2009) highlight the interaction between external equity financing and liquidity management policy but ignore the role of debt financing. Recent dynamic trade-off models with endogenous investments (DDW; Hennessy and Whited 2005; 2007) primarily focus on debt dynamics and pay little attention to liquidity and equity financing policy. Gamba and Triantis (2008) emphasize the relationship between the value of liquidity and economic conditions such as tax environments and external financing costs. Yet, the link between liquidity value and capital structure choice is largely unexamined in their analysis.

The next section introduces the baseline model in detail. Section 3 calibrates the model and analyzes debt servicing costs and equity financing policy implications from the baseline model. Section 4 reports the comparative static analysis results. Section 5 empirically studies the debt servicing costs predictions. Section 6 concludes.

2 Model

A manager decides the representative firm's investment and financing policies for each period to maximize the discounted value of future net dividends stream. Her choice set consists of liquidity management, debt and equity financing, real investment, and dividends payout decisions to shareholders.

2.1 Profits and Investment

The firm's profit function, $\pi(k, z)$, depends on capital stock, k, profitability shock, z, and fixed operating cost, f. I choose a standard functional form for $\pi(k, z)$:

$$\pi(k, z) = zk^{\alpha} - f \tag{1}$$

where α captures the returns to scale of the profit function. The profitability shock, z, follows an AR(1) process in logs:

$$\log z' = \rho \log z + \varepsilon \tag{2}$$

in which ε has normal distribution with mean zero and variance σ^2. All primed variables indicate next period ones.

Investment, I, is defined as the difference between next period capital stock and current capital stock after depreciation:

$$I = k' - (1 - \delta)k, \tag{3}$$

in which δ is the depreciation rate of capital stock.

The installation and resale of capital stock incur organizational adjustment costs, $G^k(k, I)$, that are given by

$$G^k(k, I) = \gamma^k k 1_{I \neq 0} + \frac{\theta^k (I)^2}{k}, \tag{4}$$

where $1_{I \neq 0}$ is an indicator function, the value of which is equal to one if investment is nonzero, and zero otherwise. This functional formulation includes both fixed and convex capital adjustment costs, which is a standard one in empirical literature. The fixed cost is proportional to the level of current capital stock, k and a large fixed cost parameter γ^k implies more lumpy investment. The convex cost is a quadratic function of investment, I and a large convex cost parameter θ^k indicates smoother investment demands and high capital resale costs. See Cooper and Haltiwanger (2006) and DDW for more detailed discussion for this formulation.

2.2 Liquidity and Debt

A state variable, c, represents the firm's cash holding at the end of the previous period. Cash stocks earn interests at the risk-free rate, r, and current liquidity holding is the sum of the previous period cash holding and its interest earnings, $c(1+r)$. Carrying cash stock does not involve any other explicit costs.

The manager issues a one period bond that pays interests at the same risk-free rate, r. The current period principal payment is denoted as b. I introduce a collateral constraint to ensure the risk-free return to creditors:

$$b'(1+r) \leq c'(1+r) + (1-\delta)\,k' + \pi(k', z^{\min}) - Tax(z^{\min}, k', b', c'), \tag{5}$$

where $z^{\min}$ is the lower bound for the profitability shock. The next period debt obligations must be smaller than the sum of liquidity holding, capital stock after depreciation, and minimum after-tax profits in the next period.

Debt issuance involves financing cost that is modeled as a piecewise linear function:

$$G^{b}(b^{'}, b) = \psi^{b} b' + \eta^{b}\,(b' - b)\,1_{(b'-b)>0}, \tag{6}$$

in which $1_{(b'-b)>0}$ equals one if current period net debt issuance, $b'-b$, is positive, and zero otherwise. The first component is proportional to current period debt issuance, b',and ψ_b represents the baseline debt financing cost for all debt proceeds. The second term captures additional debt financing costs when a firm increases its net debt obligations ($b' > b$) and η^b represents the increment of marginal debt financing cost. This cost function reflects the convexity in debt financing costs (Altinkihc and Hansen 2000; Leary and Roberts 2005). Consistent with recent findings in Denis and McKeon (2012), a firm's considerable increase in debt obligations is concurrent with large investments and its deleveraging process is relatively slow under this debt financing cost structure. See Gamba and Triantis (2008) for detailed discussion about this functional formulation.

2.3 Tax, Payout, and Valuation

The firm's earnings before taxes (EBT), g, are equal to the sum of the firm's operating profits and interest earnings less depreciation and interest expenses:

$$g = \pi(k, z) - \delta k - r(b - c). \tag{7}$$

The marginal tax rate depends on the sign of EBT. The tax rate for positive EBT, τ_c^+, exceeds the tax rate for negative EBT, τ_c^-. The positive tax rate for negative EBT is considered as a rebate provided by the government. Accordingly, the firm's tax bill is

$$Tax = \tau_c^+ g \mathbf{1}_{g \geq 0} - \tau_c^- g(1 - \mathbf{1}_{g \geq 0}), \tag{8}$$

where $\mathbf{1}_{g \geq 0}$ is an indicator function that takes one if the firm's EBT are positive, and zero otherwise. This corporate taxation environment is identical to that of Hennessy and Whited (2007).

The manager's payout before equity financing cost, e, is the sum of current profits and net debt issuance less net debt payout, investment, tax bill, capital adjustment costs, and debt financing costs. Thus e can be summarized by the following equation:

$$e(z, k, b, c) = \pi(k, z) + (b' - c') - (b - c)(1 + r) - I - Tax - G^b(b', b) - G^k(k, I). \tag{9}$$

External equity financing, $e < 0$, incurs flotation costs, $G^e(e, k)$. The cost function is modeled in a reduced form that includes both fixed and quadratic components:

$$G^e(e, k) = \left(\gamma^e k^\alpha + \theta^e e^2\right) 1_{e<0}, \tag{10}$$

where $1_{e<0}$ is an indicator function that is equal to one if the firm issues equity, and zero otherwise. Empirical studies such as Altinkihc and Hansen (2000) and Leary and Roberts (2005) confirm the importance of both cost components in explaining public firms' equity issuance activities. Similar to BCW, the fixed cost depends on a firm's profit generation capacity, k^α, and γ^e governs the size of fixed equity financing costs. The second term captures the importance of quadratic costs and θ^ε controls the curvature of the cost function. Hennessy and Whited (2007) and Riddick and Whited (2009) use the same formulation for convex equity financing costs.

The net payout to shareholders, d, is given by:

$$d(z,k,b,c) = (1 - G^e(e,k)1_{e<0})e, \tag{11}$$

in which $1_{e<0}$ is an indicator function that assumes the value one if the firm issues equity and zero otherwise. The shareholders do not pay the tax on dividends income in accordance with DDW.

The manager maximizes the discounted value of net payouts to shareholders. The discount rate for the shareholders takes account of the interest income tax and I assume a flat tax rate of τ_i on the shareholders' interest income. Therefore, the equity value of firm at time 0 is

$$V_0 = E\left[\sum_{t=0}^{\infty}\left(\frac{1}{1+r(1-\tau_i)}\right)^t d_t\right]. \tag{12}$$

The Bellman equation for the firm's equity value is

$$V(z,k,b,c) = \max_{k',b',c'} d(z,k,b,c,k',b',c') + \frac{1}{1+r(1-\tau_i)}EV(z',k',b',c'), \tag{13}$$

where the firm's optimal policy is subjected to the collateral constraint (5). See Hennessy and Whited (2005) for the contraction mapping property of this Bellman equation.

The model includes the following elements: interest tax shields, liquidity management, endogenous investments, persistency in the profitability shock evolution, capital adjustment costs, and external financing costs. Among of the model's features, one period maturity and the following debt financing cost structure are the key elements. Prior models largely ignore debt financing costs (e.g. DDW) or set the maturity structure as infinity (e.g. Gamba and Triantis 2008), even though they share similar tax benefits, profit generation processes, and capital adjustment costs. Without debt financing costs, a firm almost freely rolls over its debt obligations and hence confronts insignificant servicing costs of debt. With the perpetuity maturity structure, a firm may be able to delay the payment of principals indefinitely, which also leads to very low debt servicing costs. A deliberately chosen one period debt structure highlights the importance of debt servicing costs in the model analysis.

3 Quantitative Analysis

3.1 Calibration

To investigate quantitative implications of the model precisely, I choose the baseline parameters via the simulated method of moments (SMM) by following DDW. The SMM estimation finds a set of structural parameters driving the moments of artificially simulated data from the model as close as possible to the corresponding empirical moments. This estimation procedure helps ensure tight connections between the model's quantitative predictions and a firm's financing and investment policy in the real world.

To gain efficiency in the structural estimation procedure, I first parameterize the fixed operating cost as follows:

$$f = \zeta k^{ss},$$

where k^{ss} indicates the steady state level of capital stock. ζ governs the size of the fixed operating costs.

I also fix a group of structural parameters at economically reasonable levels to improve the efficiency of the estimation procedure. The tax rate for positive taxable corporate income, τ_c^+, is set to 0.35, which is the maximum of corporate tax rate during the sample period. DDW use the same value for their corporate tax rate. The tax rate for negative taxable income, τ_c^-, is fixed at 0.09 reflecting the effective tax rate on negative EBT from the taxation function of Hennessy and Whited (2005). The depreciation rate, δ is 0.12 similar to Hennessy and Whited (2005) and DDW. The risk free interest rate, r, is 0.025 and the interest income tax, τ_i, is 0.25, consistent with Hennessy and Whited (2005).

The following parameters are estimated via the SMM procedure: the uncertainty σ, and serial correlation ρ, of the profitability shock; the profit function curvature α; the fixed capital adjustment cost γ^k and convex capital adjustment cost θ^k; the fixed equity financing cost γ^e and convex equity financing cost θ^e; the baseline debt financing cost ψ^b and the additional debt financing cost η^b; and the fixed operating cost parameter ζ.

Table 1 reports the selected moments variables for the identification of the model. The table also documents the empirical moments based on CRSP/Compustat merged database from 1988 to 2010 and the simulated moments from the model at the baseline SMM estimates. These

Table 1: Moments Selection: Acutal and Simulated Values

Variables	Actual Moments	Simulated Moments
Avg. Investment(I/k)	0.1341	0.1314
Avg. Leverage(b/k)	0.2251	0.2267
Avg. Tobin's q$(V+b-c)/k)$	1.7013	1.7095
Avg. Profit (π/k)	0.1731	0.1741
Equity Issuance Freq. ($d<0$)	0.1072	0.1017
Avg. Equity Financing($-d/k, d<0$)	0.0597	0.0554
Avg. Dividends ($d/k, d>0$)	0.0374	0.0323
Var. Investment(I/k)	0.0225	0.0239
Var. Profit (π/k)	0.0045	0.0037
SerialCor. Profit (π/k)	0.6315	0.6327
Var. Leverage(b/k)	0.0124	0.0149
Avg. Cash Holding (c/k)	0.1150	0.1144
Var. Cash Holding (c/k)	0.0170	0.0163

The actual moments calculations are based on a sample of non financial, unregulated firms from the CRSP/Compustat Merged Database. The sample period is 1988–2010. The simulated moments are from the baseline model simulation evaluated at the SMM estimates. All moment variables are self-explanatory and the construction of empirical moments is described in Appendix A.

moments consist of the first and second moments of investment, operating profits, leverage and cash holding. The average of dividends and equity financing, the autocorrelation of operating profits, equity financing frequency and the Tobin's q values are also included. This moment selection is closely related to the identification strategy of DDW. Appendix A contains detailed information about the model's identification, numerical solution, and SMM procedure.

Table 2 reports the baseline economic parameters estimated via the SMM procedure. The estimation results are consistent with the prior estimates. The persistency parameter ρ is 0.6718, the uncertainty parameter σ is 0.1995, and the returns to scale parameter α is 0.7435, all of which are in line with DDW and Hennessy and Whited (2005). The fixed capital adjustment cost parameter γ^k is 0.0090 and the convex capital adjustment cost θ^k is 0.1163. Both parameters estimates are within economically reasonable ranges, consistent with DDW, Cooper and Haltiwanger (2006), and Whited (1992). The convex equity financing cost θ^e is 0.0003, similar to the estimate of Hennessy and Whited (2007). The baseline debt issuance cost ψ_b is 0.11% for all proceeds. The maximum debt financing cost $\left(\psi^b+\eta^b\right)$ is 0.82% of debt proceeds, lower than

Table 2: Structural Parameter Estimation Results

ρ	σ	α	γ^k	θ^k	γ^e	θ^e	ψ^b	η^b	ζ	J-test (p-value)
0.6718	0.1995	0.7435	0.0090	0.1163	0.0045	0.0003	0.0011	0.0071	0.0251	0.2712

This table reports the estimated structural parameters and the result of over-identification test. The value ρ and σ are the persistency and uncertainty of the profitability shock process ($\log z$). α is the curvature of profit function. γ^k and θ^k are the fixed and convex capital adjustment costs. γ^e and θ^e govern the fixed and convex equity financing cost. ψ_1^b is the baseline debt financing cost and ψ_2^b captures the increase in marginal debt financing cost when the firm's net debt issuance is positive. ζ is the fixed operating cost parameter proportional to the steady state state capital stock k^{ss}. The J-test is the χ^2 test for the over-identifying restrictions of the model. Its p-value is reported.

average debt issuance cost in Altinkihc and Hansen (2000).

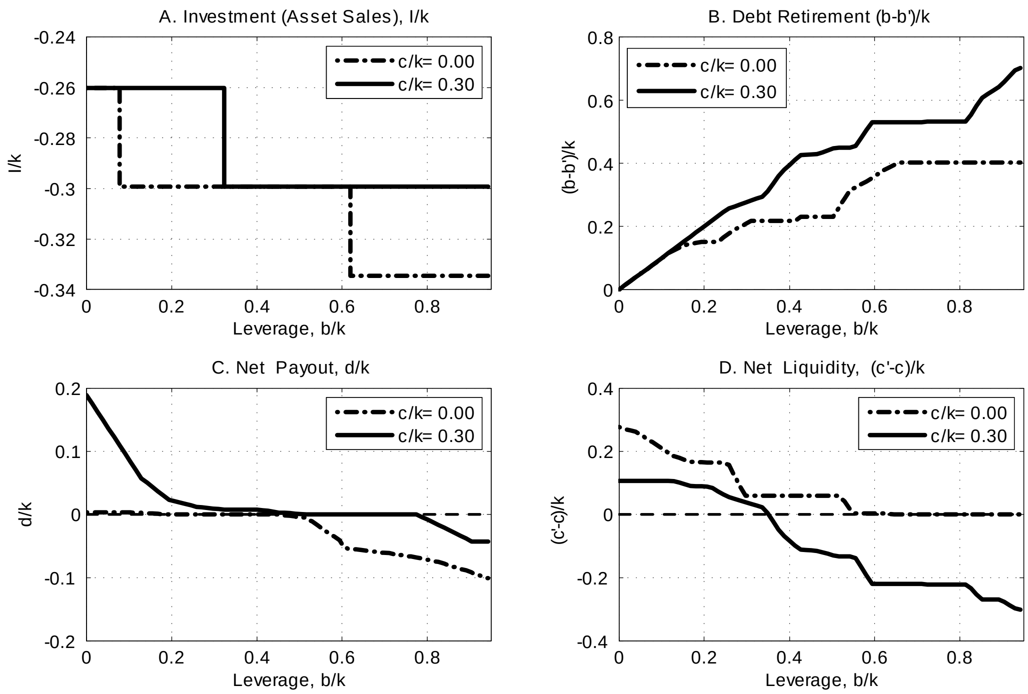
3.2 Growing Debt Obligations: Investment and Financing Policies

This section investigates how a firm changes investment and financing policies to service growing debt obligations.

Figure 1 plots the representative firm's investment and financing policies at the steady level of capital stock (k^{ss}) with a low profitability shock realization ($z = 0.3$). A low profitability state limits available internal funds to service debt payments, which provides an ideal environment to depict a firm's investment and financing policy variations in response to an increase in debt obligations. I investigate low ($c/k = 0.0$) and high ($c/k = 0.30$) liquidity holding states to highlight the role of limited cash stocks. The graphs are plotted along with current debt obligations (b/k) and all variables are normalized by the current capital stock (k).

Panel A shows the effect of growing debt obligations on a firm's investment policy. Most apparently, a greater amount of debt obligations drives additional asset sales for both liquidity holding states. For instance, the firm with high liquidity holding initially sells 26% of its current capital stock and increase its capital resale to 30% when its leverage ratio is higher than 0.3. Interestingly, the firm with low liquidity holding always sells a greater or equal amount of capital stocks than its high liquidity counterpart does. The size of capital resale is initially the same for both low and high cash holding states (26% of the current capital stock) but the low liquidity firm begins to sell 30% of the capital stock when the leverage ratio reaches to 0.05. Although both firms sell the same amount of capital stocks with the leverage ratio ranging from 0.25 to

Figure 1: Growing Debt Obligations: Investment and Financing Policies



Financing and investment policy functions are plotted at the steady state capital stock (k^{ss}) and a low profitability shock ($z = 0.3$). Investment policy, net debt policy, net payout policy and net liquidity policy are illustrated along with the leverage ratio variation in Panels A, B, C, and D respectively.

0.5, the firm with low cash holding increases capital resale again when its leverage ratio is larger than 0.5.

Panel B illustrates how a firm's financial leverage affects its net debt retirement policy ($b - b'$). While both high and low liquidity holding firms try to retire debt for all levels of debt outstanding, the figure clearly indicates that a low liquidity holding firm retires less debt than its high liquidity holding counterpart. For example, the firm with high liquidity holding discharges all debt obligations when its leverage ratio is 0.2. Yet, the net debt retirement by the low liquidity holding firm is 12% of the capital stock or only 60% of current debt obligations, given the same leverage ratio of 0.2. In fact, the high liquidity holding firm always retires debt to a greater extent when the leverage ratio is higher than 0.12.

Panel C depicts the relationship between the amount of debt obligations and a firm's net payout policy (d). The figure demonstrates that large debt obligations decrease a firm's net payout to shareholders and eventually lead to equity financing ($d < 0$) for both high and low liquidity holding firms. Noticeably, the high liquidity holding firm begins to its equity issuance at a higher leverage ratio than the low liquidity holding firm does. The firm with high liquidity holding gradually reduces its dividends payout to zero and sustains its zero payout until the leverage ratio reaches to 0.8. Then the firm begins to use equity financing and increases the amount of equity proceeds afterwards. The low liquidity holding firm maintains zero dividends payout but begins to issue equity when the firm's leverage ratio becomes 0.43.

Panel D describes net cash holding policy ($c' - c$) variations in responses to a firm's growing debt obligations. The net cash holding policy of the high liquidity holding firm is remarkable. The firm initially tries to accumulate additional cash stocks ($c' - c > 0$), but then begins to liquidate current cash to service growing debt obligations ($c' - c < 0$). Eventually, the firm uses up all of its current cash stock, when the leverage reaches to 0.9. Similarly, the firm with zero liquidity holding initially stockpiles its cash balance but ceases its cash stock accumulation, when the leverage ratio becomes 0.5.

Panel D highlights a key aspect of debt servicing costs: servicing debt drains a firm's valuable liquidity. The high liquidity holding firm initially accumulates cash inventory to the future by selling its capital stock, which implies a large value of liquidity given the level of capital and profitability shock. Nevertheless, the firm utilizes its cash holding to service growing debt obligations and eventually uses up all of current cash stocks.

Panels A, B, and C illustrate a firm's investment and external financing policy variations according to its current debt outstanding and liquidity holding. Given the same amount of liquidity holding, a firm with large debt obligations sells a greater amount of capital stock and uses external financing to a larger extent. Both high and low liquidity firms tend to increase the amount of asset sales and collect additional equity proceeds to pay down large debt obligations (Panels A and C). Similarly, given the same amount of debt obligations, a firm with low liquidity holding relies more heavily on capital resale and external financing. The low liquidity firm initiates its equity financing at a lower leverage, retires less debt, and sells a greater amount of capital stock than the high liquidity holding firm does (Panels A, B, and C).

In sum, servicing large debt obligations leads to additional reductions in a firm's valuable cash stocks. A firm with more limited cash holding or with larger debt obligations tends to rely more heavily on costly capital resale or external financing to service debt obligations, which potentially increases debt servicing costs.

3.3 Debt Servicing Costs

This section studies the effect of debt obligations, profitability shocks, and the levels of capital stock on debt servicing costs. I use the marginal value of liquidity as a natural measure of debt servicing costs, as this formulation represents a firm's equity value change from an additional $1 of cash stock. The marginal value of liquidity, given a state of profitability, capital stock, debt obligation and liquidity holding (z, k, b, c), is defined as follows:

$$\text{Marginal Value of Liquidity} = \frac{\partial}{\partial c} V(z, k, b, c). \tag{14}$$

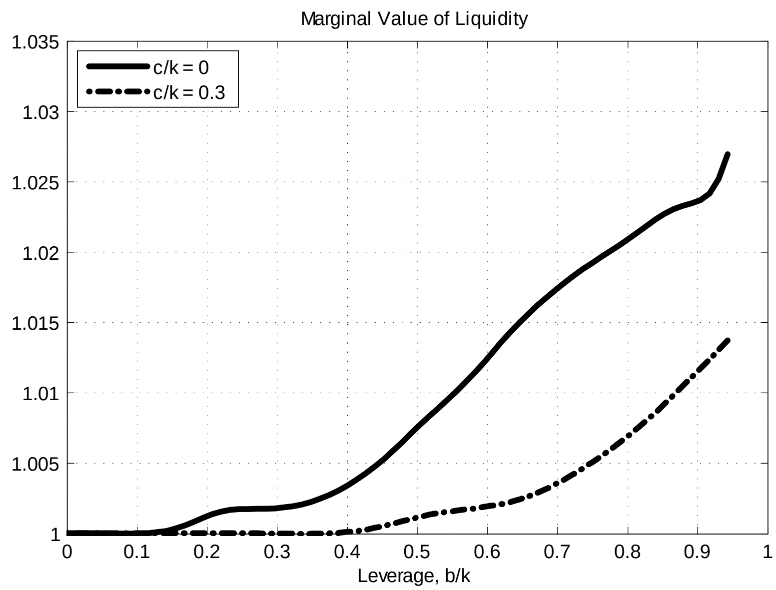
BCW emphasize the marginal value of liquidity as a critical determinant of a firm's dividends, equity financing and liquidity policy. The marginal value of liquidity is a nexus controlling a firm's overall internal and external financing policies, considering all of its close connections to debt servicing costs, equity financing, dividends payout, and cash retention policy.

Figure 2 depicts the effect of the leverage variation on the marginal value of liquidity at the steady state level of capital stock (k^{ss}), and a neutral profitability shock realization ($z = 1$). I plot the marginal value of liquidity for high ($c/k = 0.3$) and low ($c/k = 0$) liquidity states to check the robustness of qualitative predictions.

Most remarkably, Figure 2 points out that a firm with larger debt obligations faces higher debt servicing costs, measured by the marginal value of liquidity. With no liquidity holding, the marginal value of liquidity begins at 1 but increases to 1.025, when the leverage ratio increases from 0 to 0.9. Considering the low risk free rate, 2.5%, of this model, the increase of 2.5% in the marginal value of liquidity is quite material. For the high liquidity holding firm, similarly, the marginal value of liquidity initially stays at 0 but begins to escalate when the leverage ratio grows above 0.4.

The rising debt servicing costs are closely associated with costly capital resale and external financing. With limited cash holding, a firm tends to rely more heavily on capital resale and external financing to service larger debt obligations, as illustrated in Figure 1. Both capital resale and external financing involve increasing marginal costs, which directly raise the marginal value of

Figure 2: Marginal Value of Liquidity

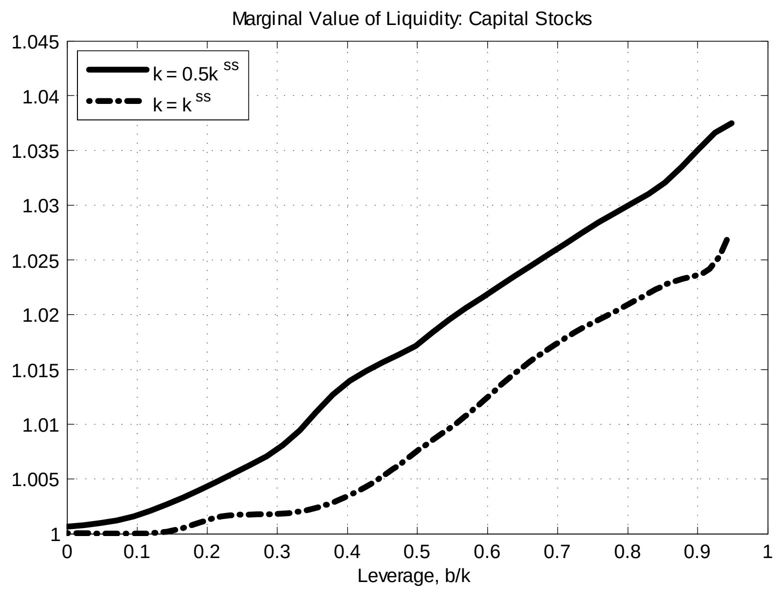


The marginal value of liquidity is plotted at the steady state level of capital stock (k^{ss}) with a neutral profitability shock ($z = 1$). The values from two different levels of cash holding states ($c/k = 0,\ 0.3$) are depicted along with the leverage ratio variation.

liquidity. Moreover, capital resale incurs a loss in the future profit generation capacity and current debt roll-over leads to future debt servicing costs, both of which drive additional inefficiency. The increase in marginal value of liquidity reflects explicit funding costs and inefficiency from asset sales and external financing.

This rising marginal value of liquidity sheds new lights on the debt conservatism puzzle (Graham 2000). Crucially, this finding provides an economic ground for prevailing conservative debt policy. To avoid higher servicing costs from large debt obligations, a firm may exercise conservative debt policy even with large tax benefits and low financial distress costs. Economic factors associated with conservative debt policy, such as growth options to finance, large future acquisition plan, asset intangibility and excess cash holding, all argue for the significance of debt servicing costs in resolving the debt conservatism puzzle. Growth options to fund and a large scale investment plan indicate large funding demands in the future, which increases a firm's precautionary value of liquidity. Asset intangibility is closely related to higher costs of asset sales, which may lead to large costs in servicing debt payments. Excess cash holding with

Figure 3: Marginal Value of Liquidity : Capital Stocks



The marginal value of liquidity is plotted at a neutral profitability shock ($z = 1$) with zero liquidity holding ($c/k = 0$). The liquidity values for the steady state level of capital stock (k^{ss}) and a half of the steady state capital stock ($0.5k^{ss}$) are depicted along with the leverage ratio variation.

conservative debt policy potentially stems from a firm's optimal decision in the face of a large value of liquidity. All of these factors are closely related to large debt servicing costs.

Figure 3 illustrates the effect of firm size on debt servicing costs. The figure plots the marginal value of liquidity along with the leverage variation for two different levels of capital stock, $0.5k^{ss}$ and k^{ss}. All values are evaluated at a neutral profitability shock ($z = 1$) with no liquidity holding state ($c/k = 0$).

Figure 3 clearly indicates that a low capital stock firm faces higher debt servicing costs, captured by the marginal value of liquidity. Compared to the firm with the steady state level of capital stock, the low capital stock firm has a higher value of liquidity for all levels of debt obligations, and its liquidity value arises more steeply in response to growing debt obligations. For instance, the marginal value of liquidity is initially 1.001 but arises to 1.04 for the firm with low capital stock, as the leverage ratio varies from 0 to 0.9. With the same leverage ratio variation, the marginal value of liquidity increases from 1 to 1.025 for the firm with the steady state level of capital stock.

Large current and future investments drive such a large marginal value of liquidity in the low capital stock firm. Due to a decreasing returns to scale profit technology, the low capital stock firm tends to invest more in the current and future periods, and has to create more funds for capital expenditures. Such large funding demands raise the marginal value of liquidity more substantially for the firm with low capital stock, given the same profitability and liquidity holding state.

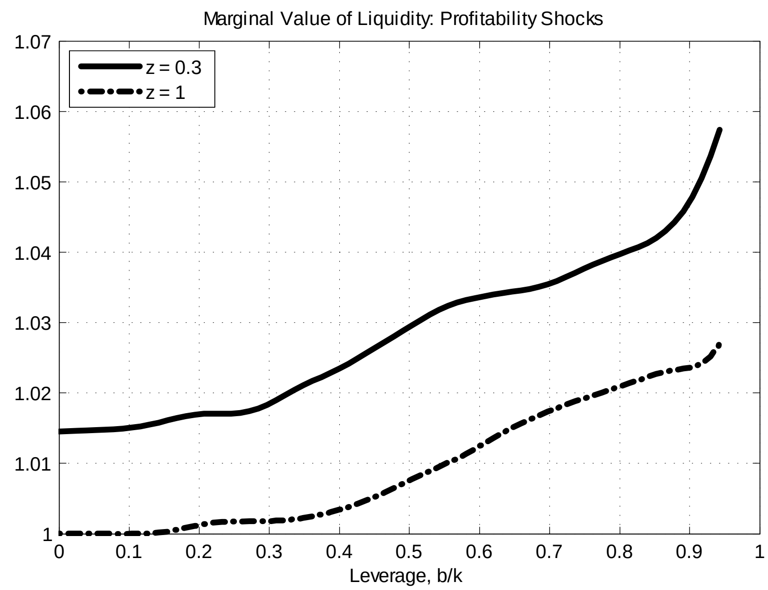
Empirically, large debt servicing costs in the low capital stock firm predict lower leverage ratios in small firms. Prior empirical results support the debt servicing cost prediction between the firm size and debt policy as well as the validity of decreasing returns to scale profit technology. Smaller firms indeed grow faster than large size firms (Hall 1987), which seems to affirm the validity of the decreasing returns to scale profit technology. The book asset size of firm is positively correlated with leverage ratio for a number of different cross-sectional models (Frank and Goyal 2008). Small growth firms tend to maintain low leverage (Frank and Goyal 2003) and large cash flow rich firms heavily rely on debt financing (Shyam-Sunder and Myers 1999), consistent with the debt servicing cost prediction.

The marginal value of liquidity directly connects large investments in smaller firms with low leverage, which differs markedly from the existing literature such as Titman (1988) and DDW. Titman (1988) emphasizes low financing costs or low bankruptcy costs in large firms to explain the relationship between firm size and debt policy. DDW highlight the importance of intertemporal allocation of limited debt capacity in the link between large future investments and a currently low leverage ratio.

Figure 4 investigates how a firm's profitability shock affects debt servicing costs. The figure plots the marginal value of liquidity as a function of leverage ratio for two different profitability shock scenarios, a low profitability shock, $z = 0.3$ and a neutral profitability shock, $z = 1$. The graphs are evaluated at the steady state level of capital stock (k^{ss}) with zero liquidity holding ($c/k = 0$).

Figure 4 indicates that a firm with low profitability shock realization confronts large debt servicing costs. The marginal value of liquidity at the low profitability shock state is initially higher and increases more sharply in response to the increase in leverage ratio, compared to the liquidity value at the neutral profitability shock scenario. For the low profitability shock firm, to be specific, the marginal value of liquidity is 1.014 with no debt obligations and it rises sharply

Figure 4: Marginal Value of Liquidity: Profitability Shocks



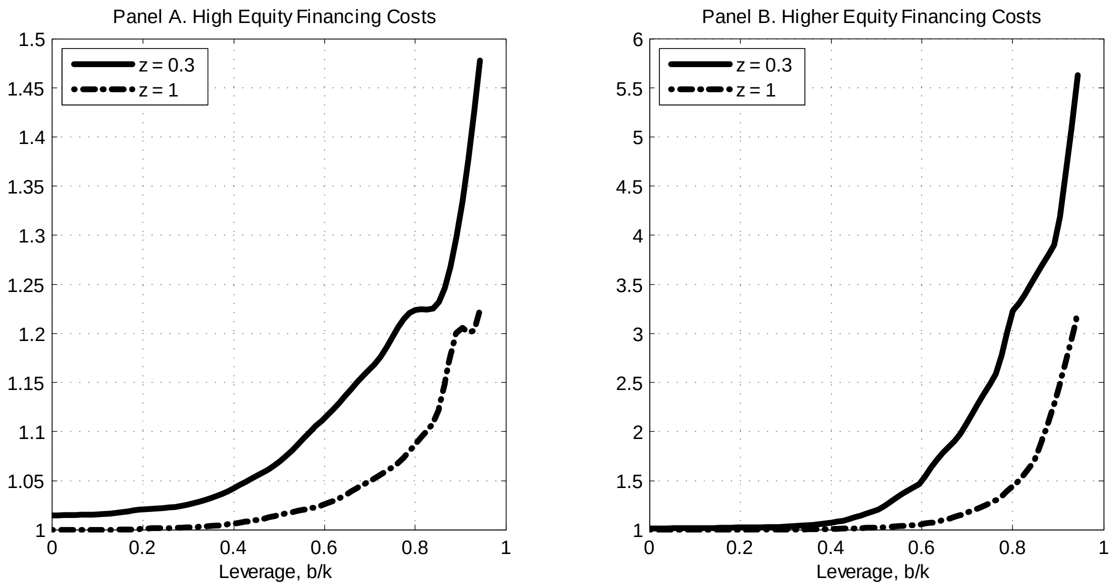
The marginal value of liquidity for two different states of the profitability shock ($z = 0.3,\ 1$) are plotted along with the leverage ratio variation. All values are evaluated at the steady state level of capital stock (k^{ss}) with zero liquidity holding ($c/k = 0$).

to 1.06 when the firm's leverage ratio grows to 0.9. The difference of the marginal value of liquidity in between two different profitability states is initially 1.4% and widens to 3.5% when the leverage ratio reaches to 0.9.

A low profitability shock realization increases the marginal value of liquidity in two ways. First, a low operating profit implies more limited internal funds to service debt payments, given a specific amount of cash stock. Second, a currently low profitability shock predicts low future operating profits in the future, due to the positive serial correlation in a firm's profit generation. The parameter ρ captures this persistency of profitability shock in the model. Low current internal funds and low expected operating profits altogether increase the marginal value of liquidity, in spite of low investment demands implied by a low profitability shock.

Figure 5 analyzes the effect of large external financing costs on the marginal value of liquidity. The figure plots the marginal value of liquidity for a neutral profitability shock ($z = 1$) and a low profitability shock ($z = 0.3$) scenarios at the steady state level of capital stock (k^{ss}) with zero liquidity holding ($c/k = 0$). In Panel A, the fixed and convex equity financing costs are 10

Figure 5: Marginal Value of Liquidity: High Equity Financing Costs



Panel A describes the marginal value of liquidity where fixed and convex equity financing costs are 10 times higher than the baseline estimates. Panel B depicts the marginal value of liquidity where fixed and convex equity financing costs are 100 times higher than the baseline estimates. In both Panels A and B, the marginal value of liquidity for two different states of the profitability shock ($z = 0.3$, 1) are plotted along with the leverage ratio variation. All values are evaluated at the steady state level of capital stock (k^{ss}) with zero liquidity holding ($c/k = 0$).

times higher than the baseline estimates. In Panel B, both equity financing costs are 100 times larger than the baseline costs.

Figure 5 indicates that higher equity financing costs considerably raise debt servicing costs. Both Panels A and B show the soaring marginal value of liquidity in response to growing debt obligations. As expected, the marginal value of liquidity arises more sharply in Panel B where both equity financing costs are far higher than those of Panel A. For instance, the marginal value of liquidity with a low profitability shock ($z = 0.3$) is 1.5 in Panel A and 5.5 in Panel B, when the leverage ratio is 0.9.

Figure 4 and 5 provide new insights on a firm's disaster risk and debt policy. In a disaster period as the recent financial crisis of 2008, a firm's profitability drops sharply and equity financing costs tends to increase considerably. Figure 4 points out that a low profitability shock raises debt servicing costs substantially even in the absence of any financial distress costs. Figure 5

Table 3: Financing and Investment Policies at Equity Issuance

Net Debt Issuance	Positive ($b' > b$)	Zero ($b' = b$)	Negative ($b' < b$)
Variables	Cond. Mean	Cond. Mean	Cond. Mean
Proportion of Regime	0.2241	0.7405	0.0354
Equity Proceeds ($-d/k$)	0.0293	0.0626	0.0702
Current Cash (c/k)	0.0121	0.1997	0.2957
Next Period Cash (c'/k')	0.0000	0.1676	0.2779
Current Investment (I/k)	0.2797	0.1998	-0.0005
Next Period Investment (I'/k')	0.0894	0.1575	0.0849
Current Profit (π/k)	0.1991	0.1273	0.0517
Next Period Profit (π'/k')	0.1922	0.1424	0.0810
Current Leverage (b/k)	0.1984	0.1981	0.2301
Next Period Leverage (b'/k')	0.2493	0.1813	0.1037

This table reports a variety of moment statistics from the baseline model simulation when the firm issues equity. Conditional on the firm's equity issuance, three different net debt issuance regimes-positive, zero and negative are analyzed. The conditional mean of fraction of each regime, equity proceeds, and current and next period cash, investment, operating profits and leverage are documented. All variables are self-explanatory.

verifies the material combined effect of low profitability shocks and high external financing costs on debt servicing costs. A firm may use debt conservatively to avoid massive debt servicing costs in disaster periods, even if the firm has a negligible likelihood of bankruptcy during the disaster periods.

To summarize, debt servicing costs are positively related with large debt obligations, a low level of capital stock, a low current profitability, and large external financing costs. These findings provide new insights on a number of empirical puzzles, such as the debt conservatism puzzle, low leverage in small firms and the relationship between disaster risk and debt policy.

3.4 Equity Financing and Cash Retention

This section analyzes investment and financing policies when a firm uses equity financing, and highlights the cash retention role of equity proceeds.

Table 3 reports a firm's financing and investment policies at equity issuance from the baseline model simulation. To highlight distinctive roles of equity financing, the table documents financing and investment policies according to positive ($b' > b$), zero ($b' = b$), and negative ($b' < b$) net debt issuance cases, conditional on equity financing. The proportion of each net debt issuance category is reported on top of the Table 3. The conditional mean of equity proceeds ($-d/k$), and current and next period cash holding (c/k), investment (I/k), profit (π/k), and leverage ratio (b/k) are documented for three different net debt issuance scenarios.

Noticeably, equity financing in the model is rarely used for retiring debt obligations. Only 3.5% of equity issuance is associated with negative net debt issuance, which points to a minor role of equity financing in retiring debt obligations. This finding is consistent with the infrequent use of proactive equity financing in Denis and McKeon (2012). They document that public firms rarely use equity financing to retire prior surges in debt obligations.

In the majority of cases, a firm's equity proceeds are used for cash retention as well as capital expenditure, especially when it faces large current and future investments. The cash retention role of equity financing is highlighted in the zero net debt issuance case, accounting for more than 74% of total equity financing. Most noticeably, a firm faces large current and future investment demands above average in the zero net debt issuance regime. While large next period investments ($I'/k' = 0.1575$) imply a large value of liquidity, a firm has to drain its cash stocks ($c/k = 0.1997$) to fund currently vast investments ($I/k = 0.1998$). To accumulate a substantial amount of cash stock again, the firm tries to use its current operating profits ($\pi/k = 0.1273$) and equity proceeds ($d/k = 0.0626$). This cash retention role hinges on no servicing cost property of equity financing. A firm can stockpile cash for the future use by issuing equity because current equity financing does not deplete valuable liquidity in the future.

This finding is closely associated with a number of empirical regularities in equity financing. Equity proceeds are largely used for near term cash saving (DeAngelo et al. 2010) and the cash saving propensity of equity proceeds is far higher than that of debt proceeds (McLean 2011). An equity issuance decision is generally concurrent with large current and future investments (Loughran and Ritter 1997; Fama and French 2002). Large current and future investments may also drive frequent equity financing in small growth firms (Frank and Goyal 2003). Large cash flow rich firms can avoid equity financing because these firms can easily use their operating profits for cash saving, which incur neither financing nor servicing costs (Shyam-Sunder and Myers 1999).

The emphasis on the cash retention role of equity issuance differs markedly from prior security choice theories. The dynamic trade-off models with infrequent leverage adjustments focus on the role of equity proceeds in paying down debt obligations (Strebulaev 2007). The pecking-order theory underlines large asymmetric information cost involved in equity financing and emphasizes its inferiority to debt financing (Myers and Majluf 1984). In contrast, the model simulation result highlights the cash retention role of equity financing in the view of servicing costs; equity financing can be used for cash retention because it does not deplete liquidity in the future.

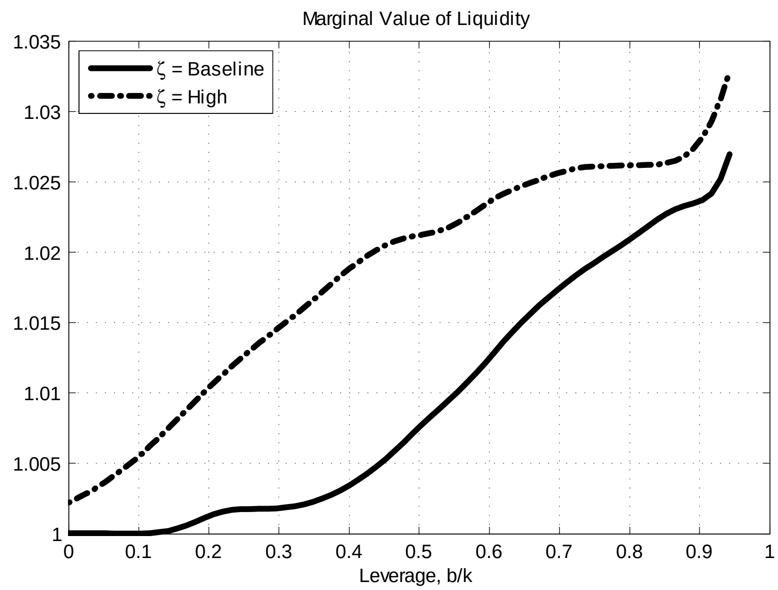
Finally, a firm uses equity proceeds solely for capital expenditure in the case of positive net debt issuance, which takes account of 22% of total equity financing. All operating profits, current cash stocks and equity proceeds are used to finance currently large capital expenditure ($I/k = 0.2797$). High profitability ($\pi'/k' = 0.1922$) and low investment needs ($I'/k' = 0.0894$) in the next period imply a low marginal value of liquidity. As a result, the firm has low incentive to save cash stock from additional equity proceeds and carries no cash for the future use ($c'/k' = 0$). Empirically, this financing role of equity proceeds is particularly significant in human capital intensive firms. Brown, Fazzari and Petersen (2009) document the importance of equity issuance for funding investments in R&D intensive firms during 1990s.

To summarize, in the majority of cases, equity proceeds are used for cash retention as well as capital expenditure, particularly when a firm faces large current and future investments. This finding is consistent with recent empirical studies such as DeAngelo et al. (2010), Loughran and Ritter (1997) and Fama and French (2002). On the other hand, a firm rarely issues equity for retiring debt obligations. This result is consistent with the minor role of proactive equity financing (Denis and McKeon 2012), but contradicts recent dynamic trade-off models with infrequent leverage adjustment (Strebulaev 2007).

4 Comparative Statics

This section investigates how large debt servicing costs affect a firm's capital structure choice. It emphasizes low leverage and frequent equity financing tendencies for a firm with large debt servicing costs. The variations of fixed operating costs and convex capital adjustment costs are considered here to capture the influence of large debt servicing costs on debt and equity financing policies.

Figure 6: Marginal Value of Liquidity: Fixed Operating Cost



The marginal value of liquidity is plotted at the steady state level of capital stock (k^{ss}) with zero liquidity holding ($c = 0$). Two different levels of fixed operating costs are examined ($\zeta = 0.0251$, $\zeta = 0.035$). All values are evaluated along with the leverage ratio variation at a neutral profitability shock ($z = 1$).

4.1 Comparative Statics I: Fixed Operating Cost

A higher fixed operating cost is closely associated with large debt servicing costs. An increase in fixed operating costs decreases a firm's profitability without incurring considerable changes in a firm's investment demands because this adjustment does not affect the marginal profitability of investments. Therefore, a firm with large fixed operating costs tends to confront a higher marginal value of liquidity.

Figure 6 confirms this effect of fixed operating costs on the marginal value of liquidity. The marginal value of liquidity is plotted against the leverage ratio variation for the baseline fixed operating costs, $\zeta = 0.0251$, and for high fixed operating costs, $\zeta = 0.035$, in the case of no liquidity holding ($c = 0$). The marginal value of liquidity is evaluated at the steady state level of capital stock (k^{ss}) with a neutral profitability shock ($z = 1$).

The figure demonstrates that a firm with higher fixed operating costs faces a large marginal value of liquidity. The marginal value of liquidity is initially higher and grows more sharply for the firm with high fixed operating costs. Although the detailed variations are not documented here,

Table 4: Fixed Operating Cost Variation

Fixed Operating Costs	Low				High
Avg. Investment (I/k)	0.1310	0.1310	0.1314	0.1315	0.1320
Var. Investment(I/k)	0.0230	0.0228	0.0239	0.0242	0.0243
Avg. Leverage (b/k)	0.7675	0.3751	0.2271	0.0892	0.0213
Var. Leverage (b/k)	0.0245	0.0103	0.0149	0.0136	0.0031
Avg. Profit (π/k)	0.2199	0.2019	0.1741	0.1648	0.1463
Equity Issuance Freq. ($d < 0$)	0.0195	0.0305	0.1017	0.1193	0.1288
Avg. Equity Financing ($-d/k,\ d < 0$)	0.0354	0.0387	0.0555	0.0579	0.0764
Avg. Cash Holding (c/k)	0.0975	0.0969	0.1150	0.1634	0.4185
Var. Cash Holding (c/k)	0.0130	0.0123	0.0164	0.0321	0.1040

This table reports a variety of financing and investment moments along with fixed operating cost variations. I simulate the model for 102,000 periods and drop first 2000 observations. The representative firm changes its investment and financing policy in response to the series of profitability shock realizations. Each column reports selected financing and investment variables corresponding to different fixed operating cost parameters (ζ) of 0, 0.01, 0.0251, 0.03 and 0.04, respectively. All variables are self-explanatory and other structural parameters are set to the baseline estimates of Table 2.

this qualitative prediction remains unchanged for different levels of capital stock, profitability shock and liquidity holding.

Table 4 shows the effects of fixed operating cost variations on a firm's investment and financing policies. The fixed operating cost parameter ζ varies from 0 to 0.04 and all other economic parameters are fixed at the baseline estimates of Table 2. Table 4 reports the mean and variance of investment (I/k), leverage (b/k), and cash holding (c/k). It also documents the average operating profits (π/k), the frequency of equity financing ($d < 0$), and the amount of equity financing ($-d/k, d < 0$).

As expected, higher fixed operating costs lead to lower average profitability without incurring significant changes in investment demand. An increase in fixed operating costs has negligible effects on investment policy in terms of mean and variance of investments. The average investment (row 1) and the variance of investment (row 2) remain stable for all different levels of fixed operating costs. Yet, the average profitability drops significantly as the fixed operating costs increase. The average profit is initially 0.22 with the low fixed operating cost scenario, $\zeta = 0$, but it decreases to 0.145 when the fixed operating cost parameter ζ becomes 0.04 (row 5).

Table 5: Fixed Operating Cost Variation: Robustness

Variables	Serial Corr.(ρ)		Uncertainty(σ)		DRS(α)	
	Low	High	Low	High	Low	High
Panel A: Low Cost (ζ=0.0)						
Avg. Leverage(b/k)	0.8670	0.3672	0.9326	0.3708	0.9007	0.3982
Equity Freq. ($d < 0$)	0.0302	0.0354	0.0393	0.0091	0.0111	0.0041
Avg. Equity Financing ($-d/k,\ d < 0$)	0.0309	0.0451	0.0265	0.0435	0.1365	0.0167
Panel B: Baseline (ζ=0.0251)						
Avg. Leverage(b/k)	0.2984	0.1190	0.2731	0.0553	0.2350	0.1590
Equity Freq. ($d < 0$)	0.1013	0.1009	0.0810	0.0472	0.0484	0.0448
Avg. Equity Financing ($-d/k,\ d < 0$)	0.0563	0.0710	0.0549	0.0651	0.1983	0.0280

This table reports average leverage(b/k), equity financing frequency($d < 0$) and average equity financing amount ($-d/k$, $d < 0$) based on the model with a low fixed operating cost ($\zeta = 0$, Panel A) and with the baseline fixed cost ($\zeta = 0.0251$, Panel B). The first two columns contrast low and high serial correlation cases in the profitability shock, where $\rho = 0.6$ and $\rho = 0.8$, respectively. The next two columns are for low and high uncertainty cases in the profitability shock where σ is 0.12 and 0.3, respectively. The last two columns are for low and high returns to scale scenarios of the profit function, where $\alpha = 0.6$ and $\alpha = 0.8$, respectively.

Table 4 highlights that a firm with higher fixed operating costs tends to have lower leverage and rely more heavily on equity financing. To be specific, the average leverage decreases by more than 95% and the variance of leverage diminishes by almost 90% as the fixed operating cost parameter ζ increases from 0 to 0.04 (row 3 and 4). Given the same fixed operating cost variation, equity financing frequency increases more than ten times and the amount of equity proceeds becomes more than doubled (row 6 and 7).

The effect of fixed operating costs on cash holding policy is indeterminate. The average cash holding slightly decreases between the first two columns but gradually increases afterwards (row 8). This inconclusive direction may stem from the endogeneity in the joint decisions of liquidity and debt policies. A higher marginal value of liquidity indicates large debt servicing costs given the same amount of debt obligations, ex-ante. Yet, a firm with large debt servicing costs endogenously selects a low leverage ratio, which potentially undermines the firm's cash retention incentives, ex-post. The average liquidity holding ratio reflects these counter-balancing effects from growing debt servicing costs.

Table 5 shows the robustness of the fixed operating cost predictions on the capital structure choice. The firm with low fixed operating costs (Panel A) always relies more heavily on debt financing for high and low uncertainty scenarios of the profitability shock, for high and low serial correlations in operating profits, and for high and low decreasing returns to scale parameters. A firm with low fixed operating costs also uses equity financing less frequently than the firm with the baseline fixed operating costs does, in line with the results of Table 4.

These quantitative predictions are consistent with recent empirical findings on the relationship between operating leverage and external financing policies. Kahl et al. (2012) uniquely analyze the effect of operating leverage on a firm's financing policies. They mainly show that higher operating leverage firms tend to maintain lower leverage and issue equity to a greater extent. Their findings are in line with the quantitative predictions of Table 4 and 5.

Prior dynamic trade-off models without debt financing costs may not successfully generate these quantitative predictions from the fixed operating cost variations. Appendix B reports the comparative statics results from the models of Hennessy and Whited (2005) and DDW. In their model simulations, a high fixed operating cost firm is not closely associated with low leverage and frequent equity financing. These results support the importance of debt servicing costs in obtaining the quantitative predictions on capital structure choice; servicing debt incurs only minor costs in these models because a firm can almost freely roll over its debt obligations.

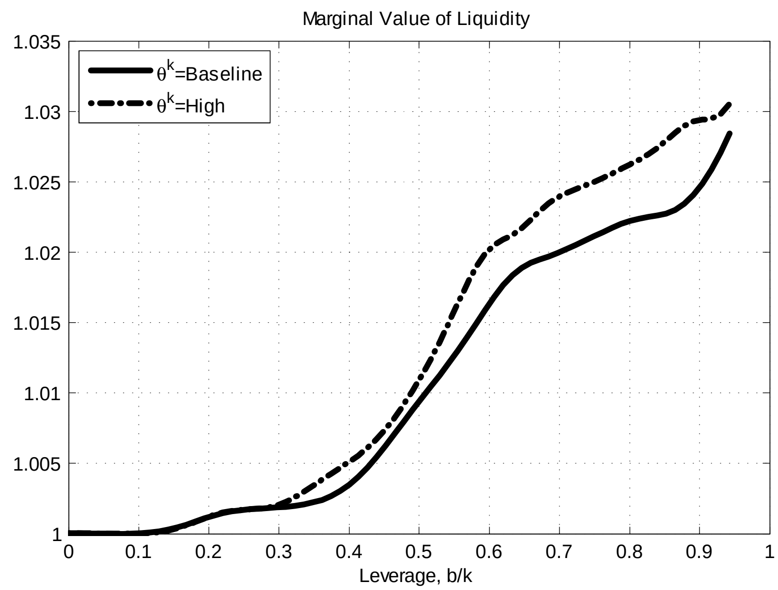
4.2 Comparative Statics II: Convex Capital Adjustment Costs

Capital installation and liquidation incur organizational costs (Hamermesh and Pfann 1997). The accumulation and resale of capital stock lead to the hiring or firing new workers, which may involve training, search, or severance costs. In addition, the extant workers may find their routine disrupted and their tasks reassigned when a firm purchases or sells its capital stock. This reallocation process may lower labor productivity and increase capital adjustment costs.

Higher convex capital adjustment costs lead to slow adjustments of capital stock and large costs of asset sales. A high capital resale cost is especially and closely associated with large debt servicing costs. As depicted in Figure 1, a firm increases its asset sales to service large debt obligations and these asset sales tend to be more costly with higher capital resale costs.

Figure 7 shows the implication of convex capital adjustment cost variations on debt servicing costs. The marginal value of liquidity is plotted for two different levels of convex capital adjust-

Figure 7: Marginal Value of Liquidity : Convex Capital Adjustment Costs



The marginal value of liquidity is plotted at the steady state level of capital stock (k^{ss}) with zero liquidity holding ($c = 0$). Two different levels of convex capital adjustment cost are examined ($\theta^k = 0.1163, \theta^k = 3 \times 0.1163$). All values are evaluated along with the leverage ratio variation with a neutral profitability shock ($z = 1$).

ment costs, the baseline, $\theta^k = 0.1163$, and high cost, $\theta^k = 3 \times 0.1163$, scenarios. The marginal value of liquidity is evaluated along with the leverage ratio at the steady state of capital stock (k^{ss}) with a neutral profitability shock ($z = 1$) and zero liquidity holding ($c = 0$). All other economic parameters are set to the values of Table 2 except the fixed capital adjustment costs: the parameter γ^k is set to zero to isolate the effect of convex capital adjustment costs.

Figure 6 points out that a firm with high convex capital adjustment costs faces large debt servicing costs, especially those with a considerable amount of debt obligations. The baseline and high convex capital adjustment cost firms confront the same marginal value of liquidity until the leverage ratio becomes 0.3. Yet, the high convex capital adjustment cost firm shows a greater marginal value of liquidity than the baseline cost firm does when the leverage ratio is larger than 0.3. This finding is in line with the increasing tendency of asset sales to service additional debt obligations, as illustrated in Figure 1.

Table 6 compares investment and financing policies for different levels of convex capital adjustment costs, which vary from 0.1 to 3 times of the baseline convex capital adjustment cost

TABLE 6: CONVEX CAPITAL ADJUSTMENT COST VARIATION

Convex Capital Adjustment Cost	Low				High
Avg. Investment (I/k)	0.1625	0.1307	0.1248	0.1222	0.1214
Var. Investment(I/k)	0.0885	0.0215	0.0096	0.0044	0.0027
Avg. Leverage (b/k)	0.1952	0.1770	0.1761	0.1655	0.1419
Var. Leverage (b/k)	0.0171	0.0129	0.0084	0.0036	0.0034
Avg. Profit (π/k)	0.1647	0.1681	0.1701	0.1727	0.1743
Equity Issuance Freq. ($d < 0$)	0.0051	0.0095	0.0203	0.0368	0.0373
Avg. Equity Financing ($-d/k,\ d < 0$)	0.0548	0.0719	0.0558	0.0484	0.0548
Avg. Cash Holding (c/k)	0.2957	0.1096	0.0638	0.0370	0.0276
Var. Cash Holding (c/k)	0.1329	0.0260	0.0084	0.0026	0.0023

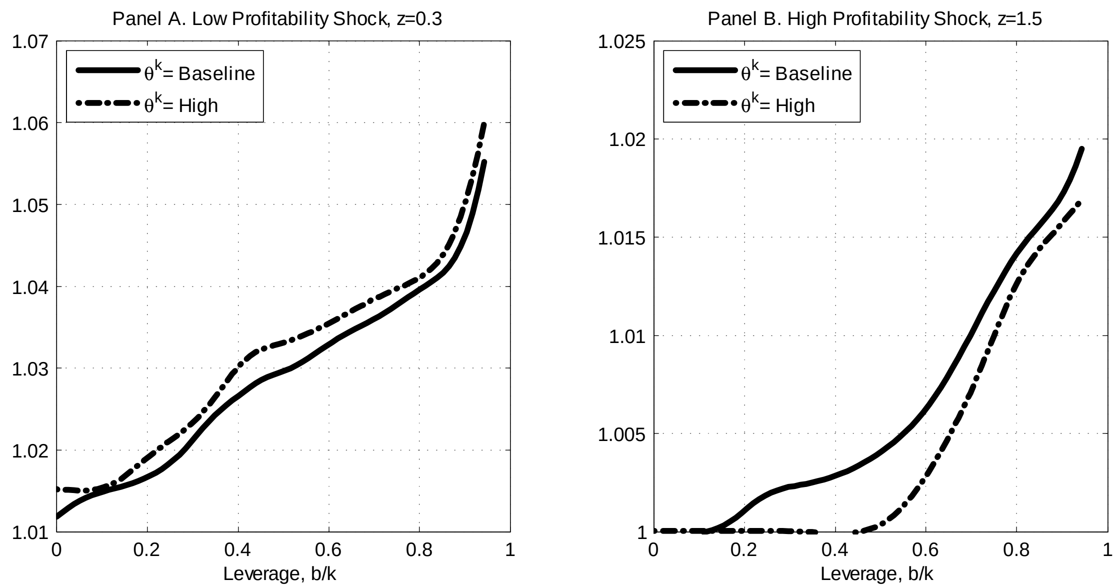
This table reports a variety of financing and investment moments along with fixed operating cost variation. Each column indicates a different level of convex capital adjustment cost; the values are 0.1, 0.5, 1, 2, and 3 times of the baseline convex capital adjustment cost in Table 2. The fixed capital adjustment cost parameter is set to 0 and the other parameter values are from the baseline estimates of Table 2. All variables are self explanatory.

estimate. To focus on the role of convexity in capital adjustment costs, the fixed cost parameter γ^k is set to zero. All other economic parameters are fixed at the baseline estimates in Table 2. Table 6 reports the mean and variance of investment (I/k), leverage (b/k), and cash stock (c/k). It also documents the average operating profits (π/k), the frequency of equity financing ($d < 0$), and the amount of equity proceeds ($-d/k$, $d < 0$).

Table 6 shows that a firm with high convex capital adjustment costs is closely associated with lower leverage and more frequent equity financing. The average leverage ratio drops by almost 25% as convex capital adjustment costs increase. Notice that the leverage ratio is 0.19 in the first column, but decreases to 0.14 in the last column (row 3). The frequency of equity financing also gradually increases from 0.5% to 3% for the same convex capital adjustment costs variation (row 6). The average equity proceeds are stable around 5% of capital stock for all levels of convex capital adjustment costs (row 7). Even with slightly higher profitability (row 5), a higher convexity in capital adjustment costs leads to lower financial leverage and more frequent equity financing.

Interestingly, a higher convex capital adjustment cost firm tends to hold lower cash holding (row 8). This appears inconsistent with a large value of liquidity from a higher convex capital

Figure 8: Marignal Value of Liquidity: Convex Capital Adjustment Costs and Profitability Shock



The marginal value of liquidity is plotted at the steady state level of capital stock (k^{ss}) with zero cash holding. Panel A describes a low profitability shock case (z=0.3) and Panel B describes a high profitability shock case ($z = 1.5$). Two different levels of convex capital adjustment cost are examined ($\theta^k = 0.1163$, $\theta^k = 3 \times 0.1163$). All values are evaluated along with the leverage ratio variation.

adjustment cost in Figure 7. Two economic forces may explain such decline in average cash holding ratio. First, endogenous decisions of leverage and cash holding potentially play an important role, as discussed in the previous section. An economic environment generating large debt servicing costs raises the marginal value of liquidity, given the same amount of debt obligations, ex ante. However, a firm optimally maintains lower leverage, which potentially undermines cash holding incentives, ex post. The latter effects could be more significant in the convex capital adjustment costs variation.

To investigate another potential reason for the diminishing cash holding tendency, Figure 8 examines the relationship between convex capital adjustment costs and the marginal value of liquidity, for two different levels of the profitability shock. The marginal value of liquidity is evaluated for the baseline and high convex capital adjustment costs ($\theta^k = 0.1163$, $\theta^k = 3\times 0.1163$) at the steady state level of capital stock (k^{ss}) with zero cash holding ($c = 0$). Panel A describes

Table 7: Convex Capital Adjustment Costs Variations: Robustness

Variables	Serial Corr.(ρ)		Uncertainty(σ)		DRS(α)	
	Low	High	Low	High	Low	High
Panel A: Baseline						
Avg. Leverage(b/k)	0.2051	0.1132	0.2037	0.0559	0.2045	0.1605
Equity Freq. ($e > 0$)	0.0154	0.1019	0.0077	0.0625	0.0163	0.0386
Avg. Equity Financing (e/k)	0.0579	0.0646	0.0480	0.0594	0.2354	0.0280
Panel B: High Convex Capital Adjustment Cost						
Avg. Leverage(b/k)	0.1293	0.0936	0.1792	0.0165	0.1969	0.1276
Equity Freq. ($e > 0$)	0.0408	0.1330	0.0192	0.0705	0.0215	0.1257
Avg. Equity Financing (e/k)	0.0575	0.0674	0.0425	0.0854	0.2615	0.0306

This table reports average leverage (b/k), equity financing frequency ($d > 0$) and average equity financing amount (d/k) calculated from the simulation of the baseline convex capital adjustment costs ($\theta^k = 0.1163$, Panel A) and high convex capital adjustment cost ($\theta^k = 3\times0.1163$), Panel B. The first two columns contrast low and high serial correlation cases in the profitability shock, where ρ =0.6 and ρ =0.8, respectively. The next two columns are for low and high uncertainty cases in the profitability shock where σ is 0.12 and 0.3, respectively. The last two columns are for low and high returns to scale scenarios of the profit function, where $\alpha = 0.6$ and α =0.8, respectively.

the case with a low profitability shock, $z = 0.3$, whereas Panel B depicts the case with a high profitability shock, $z = 1.5$. All other economic conditions are identical to those explained in Figure 7.

Panels A and B illustrate contrasting patterns of the marginal value of liquidity for the baseline and high convex capital adjustment cost firms, depending on the profitability shock realizations. While the baseline convex capital adjustment cost firm shows a lower marginal value of liquidity in Panel A consistent with Figure 7, the baseline cost firm rather exhibits a higher marginal value of liquidity than the high convex capital adjustment cost firm does in Panel B. This finding is closely associated with the role of low convex capital adjustment costs enabling more rapid accumulation of capital stocks. Given the same high profitability shock realization, the low convex capital adjustment cost firm tries to build up a larger amount of capital stock, which raises the marginal value liquidity more substantially. The decreasing average cash holding ratio may stem from the higher marginal value of liquidity in a lower convex capital adjustment cost firm at high profitability shock states.

Table 7 shows the robustness of the convex capital adjustment cost predictions on the capital structure choice. The external financing policy predictions from large debt servicing costs remain unchanged for high and low uncertainty cases in the profitability shock, for high and low serial correlations in operating profits, and for high and low decreasing returns to scale parameters. Consistent with the result in Table 6, the higher convex capital adjustment cost firm (Panel B) always uses equity financing more frequently and maintains lower leverage than the baseline cost firm does (Panel A).

The frequent equity financing and low leverage in human capital intensive firms are closely associated with the results of Table 6 and 7. Hall (2002) points out the rigidity in wage payments and the firm specificity of human capital stocks as economic forces behind large organizational costs of adjusting R&D expenditures. Consistent with the external financing regularities in R&D intensive firms, my model predicts that a firm with higher convex capital adjustment costs tends to show low leverage and use equity financing more actively.

The debt servicing cost predictions on convex capital adjustment costs differ markedly from DDW. In their model, a firm with high convex capital adjustment costs shows higher leverage, which contrasts the above predictions. With limited debt capacity, a low convex capital adjustment cost firm has an additional incentive to save its debt capacity to prepare for highly volatile investment demands. This incentive of debt capacity preservation drives lower leverage in a firm with low convex capital adjustment costs. Yet, the issuance of debt does not involve any explicit costs in their model, which potentially underestimates the effects of increasing asset sales cost on a firm's debt policy.

5 Empirical Analysis

This section provides empirical evidence supporting the model's quantitative predictions from large debt servicing costs. Leverage ratio, debt conservatism measure (Graham 2000) and equity financing indicators are examined as dependent variables in cross-sectional regression models. I follow Boulin et al. (2011) in their implementation of Graham's (2000) debt conservatism measure. The detailed measure construction is described in Appendix C. A large value of the debt conservatism measure indicates a more conservative debt policy.

5.1 Convex Capital Adjustment Costs

To analyze the implications of convex capital adjustment costs on capital structure choice, I first calculate a firm level convex adjustment cost estimate by using a modified version of Tobin's q regression. Similar to Eberly's (1997) approach, I regress a firm's investment-asset ratio on Tobin's q, operating profits, and the investment good price for each firm, but only when the firm's investment is positive. The operating profit term is introduced to capture the effect of financing constraints, as in Fazzari, Hubbard and Petersen (1988). This inclusion is in line with an important role of external financing costs in my model. To capture non-convexity in capital expenditure, the regression is only conducted for positive investment firm-year observations. The regression model is summarized as follows:

$$\frac{I}{K} = \beta_0 + \beta_1 \text{Tobin's } q + \beta_2 \text{profit} + \beta_3 \text{investment good price} + \varepsilon \text{ for } I > 0. \tag{15}$$

After assignment of the firm level convex capital adjustment cost estimate, I drop firms with negative capital adjustment costs because the quantitative predictions only hold for the positive costs region. Each firm is grouped by its two digit SIC code first, and then it is categorized into convex capital adjustment cost quartiles within its industry group. Since the convex capital adjustment cost is inversely related to β_1, the firms in the first quartile have the highest convex capital adjustment cost estimates and the firms in the fourth quartile have the lowest ones.

Table 8 reports summary statistics for each convex capital adjustment cost quartile category. The table documents the average of leverage ratio, debt conservatism, cash holding, and operating profits. The frequency of equity financing is also reported. The table considers only the firms with at least 12 observations during the sample period, which provides a more reliable convex capital adjustment cost estimate. Appendix E contains the analysis based on the firms with at least 6 firm-year observations. Appendix E confirms that the qualitative predictions remain unchanged in both summary statistics and regression models by the inclusion of younger firms. High-tech and non high-tech sub-categories are introduced to examine whether the overall summary statistics results stem from high-tech industries, which are well known for low leverage and frequent equity financing (Hall 2002).

Table 8 indicates more conservative debt policy and frequent equity financing in high convex

Table 8: Summary Statistics : Convex Capital Adjustment Cost Quartile

	Observations	Equity Freq.	Leverage	Cash	Profit	Conservatism
Panel A: All Firms						
1st Quartile	6415	0.2023	0.2015	0.1817	0.0909	2.9844
2nd Quartile	6303	0.1988	0.2113	0.1668	0.0924	2.6283
3rd Quartile	6268	0.1903	0.2399	0.1415	0.0805	2.05
4th Quartile	5307	0.1577	0.2726	0.1225	0.0873	1.5757
Panel B: Non High-tech Firms						
1st Quartile	4555	0.1488	0.2349	0.1182	0.1204	3.1229
2nd Quartile	4541	0.144	0.2406	0.1059	0.1202	2.6877
3rd Quartile	4658	0.1453	0.2634	0.0951	0.1139	2.2295
4th Quartile	3900	0.1131	0.3052	0.0781	0.1152	1.6128
Panel C:High-tech Firms						
1st Quartile	1860	0.3333	0.1196	0.3373	0.0186	2.6232
2nd Quartile	1762	0.34	0.1356	0.3238	0.0207	2.4677
3rd Quartile	1610	0.3205	0.1718	0.2756	-0.0159	1.5127
4th Quartile	1407	0.2814	0.1823	0.2455	0.0099	1.4689

This table reports a variety of summary statistics for all firms, high-tech firms and non-high-tech firms according to convex capital adjustment cost quartiles. Only the firms with at least 12 firm-year observations are included in the calculations. Firms are included in the high-tech category if their first three digit SIC code is 283, 357, 366, 382, 384, and 737, and all other firms are all in non high-tech category. All values are averaged except the number of observations. The variable construction is illustrated in Appendix D.

capital adjustment cost firms. Even though each category has stable average profitability, high convex capital adjustment cost firms tend to have low leverage ratios and large debt conservatism measures. The average leverage ratio is 0.2015 in the first quartile and rises to 0.2726 in the fourth quartile. Similarly, the debt conservatism measure decreases from 2.98 to 1.58 in response to the same quartile variation. Firms with higher convex capital adjustment costs also use equity financing more frequently. The equity financing frequency is 20% in the first quartile and decreases to 15% in the fourth quartile. The sub-categorization of high-tech and non high-tech industry does not influence the qualitative predictions from convex capital adjustment costs quartile variations.

Table 9 investigates the relationship between convex capital adjustment cost quartile dummies and external financing policies in cross-sectional regression models. The leverage ratio, debt

Table 9: Cross-sectional Analysis : Convex Capital Adjustment Cost Quartile

	Leverage		Conservatism		Equity		
M/B ratio	-0.0141	-0.0116	0.5452	0.5139	0.4062		0.4092
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)
logAsset	0.0133	0.0147	0.4685	0.4530	-0.0471	-0.0551	-0.0460
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Tangibility	0.1679	0.1452	-1.5290	-1.2773	0.3224	0.4326	0.3146
	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.000)	(0.005)
Profitability	-0.2021	-0.2042	6.2191	6.2274	-3.1357	-2.8459	-3.1450
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R&D expenditure	-0.1814	-0.2004	0.3535	0.5980	1.5282	3.9500	1.4838
	(0.000)	(0.000)	(0.307)	(0.081)	(0.000)	(0.000)	(0.000)
R&D dummy	-0.0191	-0.0180	-0.3712	-0.3959	0.1281	0.1585	0.1368
	(0.000)	(0.000)	(0.000)	(0.000)	(0.014)	(0.002)	(0.009)
Med. Industry Leverage	0.2066	0.2452	-3.2308	-3.6798	0.2148	-0.8196	0.2445
	(0.000)	(0.000)	(0.000)	(0.000)	(0.513)	(0.013)	(0.461)
Convex Cost: 1st Quartile		-0.0540		0.5956		0.2938	-0.0350
		(0.000)		(0.000)		(0.000)	(0.591)
Convex Cost: 2nd Quartile		-0.0478		0.4833		0.3188	0.1064
		(0.000)		(0.000)		(0.000)	(0.087)
Convex Cost: 3rd Quartile		-0.0286		0.1277		0.2694	0.1284
		(0.000)		(0.007)		(0.000)	(0.036)
Stock Return(3year)					0.2238	0.3685	0.2234
					(0.000)	(0.000)	(0.000)
Constant	0.1206	0.1434	-0.3888	-0.5595	-2.5248	-2.2340	-2.5928
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	24293	24293	22301	22301	22119	22119	22119
Adjusted R^2	0.1544	0.1634	0.3016	0.3071			
Pseudo R^2					0.1785	0.1429	0.1791

This table reports coefficients, p-values (in parenthesis) and adjusted (pseudo-) R^2 from cross sectional regression and logit models. The leverage ratio, debt conservatism measure, and binary choice of equity issuance (logit) are used as dependent variables. Several control variables and convex capital adjustment cost quartile dummies are used as independent variables. The construction of controlling variables is explained in Appendix D. Only the firms with at least 12 firm-year observations are included in the estimation. The standard errors of the regressions are robust to heteroscedasticity.

conservatism measure, and binary decisions of equity financing are used as the left-hand side variables. On the right hand side, I employ the convex capital adjustment cost quartile dummies and a set of widely used firm characteristics as control variables. The control variables include the logged book asset values, asset tangibility, market to book ratio, R&D expenditure, R&D activity and industry median leverage ratio, as suggested in Frank and Goyal (2008). I also introduce the 3-year stock return in the equity financing analysis to capture the market timing aspect of equity financing. I use the ordinary least squares method in the leverage and debt conservatism measure analysis and adopt a logit model for the binary choice of equity issuance decisions.

As expected, firms with higher convex capital adjustment costs exercise more conservative debt policy. Even after controlling for the firm characteristics, the quartile dummies show a monotonic relation with the leverage ratio and debt conservatism measure. A higher convex capital adjustment cost dummy variable is more negatively correlated with the leverage ratio and positively correlated with the debt conservatism measure.

The logit regression results partially support more frequent equity financing in large convex capital adjustment cost firms. Without inclusion of the market to book ratio, higher convex capital adjustment cost dummies are positively and almost monotonically correlated with equity issuance decisions. Yet, the inclusion of the market to book ratio drastically changes the coefficients of quartile dummies, especially for the firms with the largest convex capital adjustment cost estimates.

The drastic changes of quartile coefficients in the logit model are probably related to the information of the market to book ratio captured in the convex capital adjustment cost dummies. In the estimation of firm level convex capital adjustment costs, I use a firm's Tobin's q value as an independent variable, which is a modification of the market to book ratio. The market to book variation may directly reflect more significant information regarding equity financing decisions.

To summarize, firms with higher convex capital adjustment costs tend to use debt more conservatively and equity financing more frequently, even after considering industry and other firm characteristics. Both of the summary statistics and regression analysis results generally confirm these tendencies. These findings are consistent with the debt servicing cost predictions from the model simulations.

5.2 Future Investments and Capital Structure Choice

This section analyzes how future investment demands influence current external financing policies. Large future investments increase the marginal value of liquidity, after controlling for a firm's operating profits. By similar reasoning, small future investment demands are closely associated with low debt servicing costs.

To analyze the influence of future investments on capital structure choices, I construct indicator variables based on actual future capital expenditure. The use of indicator variables helps relieve a potential measurement error problem stemming from the use of actual future investments as explanatory variables. Unexpectedly great or poor investment opportunities in the next period affect actual future investments and the use of indicator variables partially filters out such unexpected components by covering a wide range of actual investments.

To construct dummy variables indicating large and small future investments, I first calculate the ranking of the investment-asset ratio for each firm-year observation relative to all of the firm' investment-asset ratios in the sample periods. Then I categorize each firm-year observation into a quartile corresponding to its investment-asset ratio ranking. The indicator variable for large future investment takes one if a firm's next period investment-asset ratio is in the fourth quartile, and zero otherwise. Similarly, the small investment dummy takes one if a firm's next period investment-asset ratio is in the first quartile, and zero otherwise

Table 10 documents summary statistics results according to the future investment indicator variables. The table reports the average of leverage ratio, debt conservatism, cash holding, and operating profits. The equity financing frequency is also documented. The summary statistics are calculated for different sub-categories such as high-tech industry, non high-tech industries, young firms and old firms. I introduce the high-tech category to capture the influence of human capital intensive firms, well known for low leverage and frequent equity financing (Hall 2002). The young-old firm categories are also examined because younger firms tend to maintain lower leverage and use equity financing more frequently (Frank and Goyal 2003).

Consistent with debt servicing cost predictions, firms with large future investments are closely associated with low leverage, more conservative debt policy and frequent equity financing despite higher profitability levels. Conversely, firms with small future investments are correlated with higher leverage, less conservative debt policy and infrequent equity financing, in spite of lower

Table 10: Summary Statistics : Future Investments

	Equity	Leverage	Cash	Profit	Conservatism
Panel A : All Firms					
Small Future Investments	0.1995	0.2555	0.174	0.0257	1.8741
Others	0.2404	0.2379	0.1705	0.0416	2.1588
Large Future Investments .	0.2942	0.188	0.197	0.0905	2.8486
Panel B: Old Firm-Year Observation					
Small Future Investments	0.1024	0.259	0.1307	0.0819	2.2973
Others	0.1196	0.2358	0.1286	0.0979	2.5487
Large Future Investments .	0.1606	0.1888	0.1542	0.1321	3.2632
Panel C: Young Firm-Year Observation					
Small Future Investments	0.2843	0.2524	0.2118	-0.0233	1.3488
Others	0.3372	0.2395	0.2041	-0.0036	1.7167
Large Future Investments .	0.4005	0.1874	0.231	0.0573	2.3345
Panel D: Non High-tech Firms					
Small Future Investments	0.1497	0.2969	0.1077	0.0667	1.9137
Others	0.1859	0.2735	0.1094	0.084	2.2437
Large Future Investments .	0.2367	0.221	0.1333	0.126	2.9502
Panel E: High-tech Firms					
Small Future Investments	0.3194	0.1556	0.3336	-0.0731	1.7712
Others	0.3692	0.1539	0.3149	-0.0588	1.9492
Large Future Investments .	0.4326	0.1086	0.3504	0.005	2.595

This table reports a variety of summary statistics for all firms, young-firm year old-firm year, high-tech firms and non-high-tech firms according to future investment dummies. Young firm-year observation indicates all firms that stay less than 12 years in CRSP/Compustat database or the first 12 firm-year observations for the firms that stay more than 12 years in the database. The other descriptions are identical to those of Table 8

profitability levels. For instance, the average leverage ratio is 0.255 for firms with small future investments but 0.188 for firms with large future investments. Equity financing frequency is 29.5% for the firms with large future investments but 20% for the firms with large future investments. The qualitative predictions remain unchanged for the sub-categories of high-tech, non-high-tech, young firms and old firms.

Table 11 investigates the relationship between future investments and current capital structure choice in cross-sectional regression models. All regression and logit model specifications are identical to those of Table 9, except the inclusion of the future investments indicator variables replacing the convex capital adjustment cost dummies. The book asset value in logs, tangibility, market to book ratio, R&D expenditure, R&D activity and industry median leverage ratio are

Table 11: Cross-sectional Analysis : Future Investments

	Leverage		Conservatism		Equity	
M/B ratio	-0.0123	-0.0109	0.5165	0.5021	0.3817	0.3787
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
logAsset	0.0132	0.0128	0.4471	0.4531	-0.0957	-0.0929
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Tangibility	0.1962	0.1960	-1.5715	-1.5768	0.3105	0.3019
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Profitability	-0.1705	-0.1590	4.8101	4.6862	-2.7986	-2.8409
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R&D expenditure	-0.2235	-0.2187	0.3566	0.3005	1.1381	1.1148
	(0.000)	(0.000)	(0.042)	(0.085)	(0.000)	(0.000)
R&D dummy	-0.0357	-0.0359	-0.3048	-0.3045	0.0719	0.0729
	(0.000)	(0.000)	(0.000)	(0.000)	(0.041)	(0.038)
Med. Industry Leverage	0.1909	0.1971	-3.1396	-3.2056	0.3318	0.3110
	(0.000)	(0.000)	(0.000)	(0.000)	(0.121)	(0.146)
Small Future Investments		0.0112		-0.2198		-0.1536
		(0.000)		(0.000)		(0.000)
Large Future Investments		-0.0372		0.2920		0.1026
		(0.000)		(0.000)		(0.005)
Stock Return (3year)					0.2204	0.2124
					(0.000)	(0.000)
Constant	0.1305	0.1322	-0.1542	-0.1265	-2.1701	-2.1362
	(0.000)	(0.000)	(0.001)	(0.005)	(0.000)	(0.000)
N	58143	58143	47481	47481	46914	46914
Adjusted R^2	0.1653	0.1708	0.2972	0.3000		
Pseudo R^2					0.1906	0.1915

This table reports coefficients, p-values (in parenthesis) and adjusted (pseudo-) R^2 from cross sectional regression and logit models. The leverage ratio, debt conservatism measure, and binary choice of equity issuance (logit) are used as dependent variables. Several control variables and the indicator variables for future investment demands are used as independent variables. The construction of controlling variables is explained in Appendix D. The standard errors of the regressions are robust to heteroscedasticity.

still used as control variables. The 3-year stock returns are additionally incorporated in the logit model for equity financing to capture market timing aspects.

The cross-sectional results are consistent with the debt servicing cost predictions from the model simulations. The firms with large future investments are closely associated with low leverage, conservative debt policy and frequent equity financing, even after controlling for other firm characteristics. The small future investments dummy is negatively related with the leverage ratio, and positively related with the debt conservatism measure and equity financing, as expected. All coefficients are highly significant and the signs of these coefficients are in line with the debt servicing cost predictions.

The coefficients of investment dummies in equity financing regression contradict the predictions of the standard trade-off models. The standard trade-off theory predicts less frequent equity financing for firms with conservative debt policy and high profitability. Yet, the firms with large future investments use equity financing more frequently in spite of their conservative use of debt and large operating profits. The firms with small investments are reluctant to issue equity despite low profitability and large debt obligations, which also argues against the standard trade-off theory predictions.

The regression analysis for the leverage ratio provides an interesting result to the puzzling negative correlation between leverage ratio and profitability (Frank and Goyal 2008). The introduction of investment dummy variables slightly weakens the negative correlation between profitability and leverage ($-0.1705 \rightarrow -0.1590$) and the change is statistically significantly at 95% level.[1] The debt conservatism analysis shows a similar change of the profitability coefficient, which suggests the weaker correlation is not a mere coincidence. Debt servicing costs considerations appear to have some explanatory power in resolving the puzzling negative correlation between profitability and leverage ratio.

In summary, the relationship between future investments and current capital choices is consistent with debt servicing cost predictions. Large future investments are closely associated with currently lower leverage and more frequent equity issuance. Equity financing behaviors in both small and large future investment firms contradict the standard trade off theory predictions. The inclusion of investment variables weakens the negative correlation between profitability and leverage ratio.

[1] The p-value is not reported here.

6 Conclusion

I have examined the interdependence between liquidity policy and capital structure choice and shown it to be a key missing link in the existing literature. Debt servicing costs lie at the core of the analysis; servicing debt is costly because it drains a firm's valuable liquidity. To examine the implications of debt servicing costs on a firm's external financing policies, I developed a new dynamic trade-off model with liquidity management and adopted the marginal value of liquidity as a natural measure of debt servicing costs.

My model analysis and following empirical study yielded a number of interesting results. First, a firm with large debt obligations faces a higher cost of debt, even in the absence of financial distress costs. Second, a smaller firm may have lower leverage ratio because its large investment demands increase debt servicing costs. Third, equity financing could be used for cash retention, especially for firms with large current and future investments, because it does not deplete valuable future liquidity. Finally, my comparative statics and empirical analysis show that large debt servicing costs are closely associated with low leverage and frequent equity financing, by investigating the roles of convex capital adjustment costs, fixed operating costs, and future investment demands on capital structure choice.

These findings provide novel insights on a variety of puzzling empirical regularities. Most of all, the debt servicing costs provide an economic explanation for why a firm may exercise conservative debt policy even in the face of low financial costs (Graham 2000). Indeed, many economic factors closely associated with conservative debt policy suggest the potential importance of debt servicing costs in resolving the debt conservatism puzzle. Next, the marginal value of liquidity directly connects large investments with lower leverage in smaller firms (Frank and Goyal 2008), regardless of limited debt capacity considerations (DDW). In fact, equity proceeds are primarily used for cash retention (DeAngelo et al. 2010) and equity financing is generally concurrent with large current and future investments (Loughran and Ritter 1997). This cash retention role of equity proceeds differs markedly from prior theories highlighting large informational costs in equity issuance (Myers and Majluf 1984) or the role of equity proceeds for debt payments (Strebulaev 2007).

My study highlights several lucrative opportunities for future research. Most of all, the risk premium involved in a firm's debt issuance is an important topic. A large risk premium drains a firm's liquidity more substantially, but increases the amount of interest tax shields. The trade-off between large debt servicing costs and growing tax shields provides more precise understanding on a firm's capital structure choice. Incorporating market timing aspect of equity financing is another direction. The market timing consideration of equity financing is empirically important (Baker and Wurgler 2002), but is not well captured in my model. Furthermore, future empirical studies potentially employ more delicate methods for testing the debt servicing costs predictions to overcome endogeneity issues in my cross-sectional models.

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Appendix

A Simulated Method of Moments

The table A.1 report the definition of real and financial variables from the CRSP/Compustat database. The symbols in parenthesis refer to the items in CRSP/Compustat merged database.

Table A.1: Definition of Variables used in the SMM estimation

Variable	Definition
Investment	(Capital Expenditures (CAPX) − Sale of Property, Plant and Equipment (SPPE) +Acquisitions (AQC))/Property, Plant and Equipment − Total (GROSS, PPEGT)
Leverage	Long-Term Debt − Total (DLTT)/ (Assets - Total (AT) − Cash and Short-Term Investments (CHE))
Cash	Cash and Short −Term Investments (CHE) / (Assets - Total (AT) − Cash and Short-Term Investments (CHE))
Dividends(Equity)	(Cash Dividends (DV) + Purchase of Common and Preferred Stock(PRSTKC) − Sale of Common and Preferred Stock (SSTK)) / (Assets - Total (AT) − Cash and Short-Term Investments (CHE))
Tobin's Q	(End of year price (PRCC_F) × Number of Common Shares Outstanding (CSHO) + Long-Term Debt - Total (DLTT) − Cash and Short-Term Investments (CHE)) /Property, Plant and Equipment - Total (GROSS, PPEGT)
Operating Profit	Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA) / (Assets - Total (AT) − Cash and Short-Term Investments (CHE))

Global identification of a simulated moments estimator is achieved if the expected value of the difference between the simulated moments and the data moments equals zero if and only if the structural parameters equal their true values. To find the minimizing parameter values, I employ the simulate annealing method, a global optimization procedure based on parameter simulations.

To correctly identify structural parameters, I pick up the following 13 moments. The identification scheme is similar to the strategy of DDW. Average and variance of investment help to identify the adjustment cost parameters (γ^k, θ^k). A higher convex capital adjustment cost decreases the average and variance of investment and a higher fixed capital adjustment cost raises the variance of investment. Average operating profits helps to identity the curvature of profit function (a) and the fixed operating costs (ζ). As discussed in DDW, a higher α raises average profit ($zk^{\alpha} - \zeta k^{ss}/k$) and a higher operating leverage (ζ) lowers average operating profits. The serial correlation of the profitability shock (ρ) and the fixed operating parameter (ζ) affects the serial correlations in operating profits. A higher fixed operating cost increases the correlations in profit generation. The variance of profit helps to capture the uncertainty parameter of profit evolution (σ). The average dividends and Tobin's q are closely associated with a firm valuation.

The other moment selections pertain to a firm's financing decision. The frequency of equity financing and average amount of equity financing play important roles in the identification of fixed (γ^e) and convex equity issuance cost (θ^e). The average leverage ratio and the variance of leverage helps to pin down the baseline debt financing cost $\left(\psi^b\right)$ and the additional financing cost component $\left(\eta^b\right)$. A higher baseline financing cost lowers the average leverage. A higher additional financing cost decreases the variance of leverage because it provides additional incentive to maintain debt obligations from the option value of debt issuance. The mean and variance of cash holding ratio also help to identify these two debt financing costs. A high debt financing costs $\left(\psi^b\right)$ provides additional incentive to cash retention because it exacerbates a firm's financial frictions. The additional component governs the option value of debt issuance and a higher cost $\left(\eta^b\right)$ implies large incentives to save cash.

The SMM objective function is a weighted sum of squared errors, in which the "errors" are given by the difference between the empirical moments vector and its model counterpart. The vector of empirical moments as $M(x)$, in which x is an i. i.d data sample. The vector of simulated moments is denoted as $m(y;\beta)$, in which y is a simulated data sample. I denote the objective function as $Q(x;y;\beta)$:

$$Q(x, y; \beta) = (M(x) - m(y;\beta))' W (M(x) - m(y;\beta))$$

If I denote J be the ratio of the number of observations in the simulated data set to the number observations in the real data set (N). By choosing the optimal weighting matrix W, the covariance matrix of $\sqrt{N}\left(\hat{\beta} - \beta\right)$ can be written as follows:

$$\sqrt{N}\left(\hat{\beta} - \beta\right) \sim \left(1 + \frac{1}{J}\right)\left(\frac{\partial}{\partial\beta} m(y;\beta)' W \frac{\partial}{\partial\beta} m(y;\beta)\right)^{-1}.$$

The test of the over-identifying restrictions can be denoted as:

$$\frac{NJ}{1+J}Q(x,y,\beta).$$

To achieve a numerical solution of model, I use the value function iteration method, which requires to discretize state spaces for the four state variables. The state variable constructions are very similar to Hennessy and Whited (2005, 2007), and DDW. The space of capital stock lies on the following points:

$$[\bar{k}(1-\delta)^{20},...,\bar{k}(1-\delta)^{1/2},\bar{k}].$$

The boundness of $\bar{k}$ for a decreasing returns to scale profit function α, is discussed in Hennessy and Whited (2005).

The productivity shock (z) is modelled to have 12 points. I transform AR(1) process into a discrete state Markov chain on the interval of $[-4\sigma, 4\sigma]$. Tauchen (1986) argues that 8~9 points are enough to approximate the AR(1) process. The upper bound for debt balance$\left(\bar{b}\right)$ is obtained if I assume the upper bound for cash balance($\bar{c}$) is a half of the upper bound of debt balance $\left(\frac{1}{2}(\bar{b})\right)$, the same as in DDW. I let the debt (b) state have equally spaced 25 points in the interval of $[0,\bar{b}]$ and the cash (b) state have equally spaced 12 points in the interval of $[0,\bar{c}]$.[2]

B Simulations of Prior Models

This section contains simulation results of prior models for different levels of fixed operating costs and convex capital adjustment costs. In Table B.1. and B.2, the first panel is based on the baseline model with very low debt financing costs analogous to DDW. The baseline financing cost is set to 0 and the additional debt financing cost component is set to 0.0002. The second panel is based on the baseline model with a fire sale discount similar to Hennessy and Whited (2005). If a firm's next period debt payment ($b'(1+r)$) is larger than the sum of next period after tax profit ($\pi' - Tax$), liquidity ($c'(1+r)$) and capital stock after depreciation ($k(1-\delta)$), then the firm has to liquidate its capital stock with the resale price of s. I set the resale discount $s = 0.75$ the same value used in the simulation of Hennessy and Whited (2005). The baseline

[2]DDW has net debt space with 29 points covering both cash and debt balance.

and additional financing cost set to 0 and 0.0002 respectively.

In the fixed operating cost analysis of Table B.1 , the model of DDW matches the leverage variation but is unsuccessful in generating equity issuance predictions. Hennessy and Whited (2005) with fire sale discount generates non-monotonic change in leverage contradictory to debt servicing cost predictions.

In the convex capital adjustment cost analysis of Table B.2 , both of the models show monotonically increasing leverage patterns, contrary to the baseline model predictions. This direction in leverage variation is consistent with the limited debt capacity consideration of DDW.

TABLE B.1: SUMMARY STATISTICS FOR DISTINCTIVE OPERATING AND FIXED EQUITY FINANCING COSTS

Fixed Operating Costs	Low				High
Panel A: DDW					
Avg. Investment (I/k)	0.1310	0.1318	0.1312	0.1314	0.1313
Var. Investment(I/k)	0.0229	0.0249	0.0238	0.0241	0.0239
Avg. Leverage (b/k)	1.0544	1.0096	0.4971	0.2970	0.2128
Var. Leverage (b/k)	0.0376	0.0494	0.0248	0.0265	0.0259
Avg. Profit (π/k)	0.2182	0.2013	0.1723	0.1641	0.1480
Equity Issuance Freq. ($d < 0$)	0.0208	0.0272	0.0183	0.0202	0.0398
Avg. Equity Financing ($-d/k,\ d < 0$)	0.0527	0.0693	0.0956	0.1024	0.1015
Avg. Cash Holding (c/k)	0.1754	0.1822	0.1750	0.1945	0.3120
Var. Cash Holding (c/k)	0.0280	0.0373	0.0297	0.0450	0.0692
Panel B : Hennessy and Whited (2005)					
Avg. Investment (I/k)	0.1304	0.1305	0.1309	0.1313	0.1318
Var. Investment(I/k)	0.0216	0.0217	0.0227	0.0236	0.0249
Avg. Leverage (b/k)	0.4084	0.4326	0.3541	0.2830	0.0967
Var. Leverage (b/k)	0.0368	0.0356	0.0223	0.0182	0.0112
Avg. Profit (π/k)	0.2197	0.2016	0.1742	0.1650	0.1465
Equity Issuance Freq. ($d < 0$)	0.0546	0.0546	0.0711	0.0749	0.0820
Avg. Equity Financing ($-d/k,\ d < 0$)	0.0630	0.0632	0.0721	0.0742	0.0825
Avg. Cash Holding (c/k)	0.3619	0.4212	0.4112	0.4054	0.4787
Var. Cash Holding (c/k)	0.0617	0.0665	0.0635	0.0664	0.0885

This table reports a variety of moment statistics along with fixed operating cost variation. Panel A simulates the model of DDW and Panel B simulates the model of Hennessy and Whited (2005), as described in Appendix B. Each column reports selected financing and investment variables corresponding to different fixed operating cost parameters (ζ) of 0, 0.01, 0.0251, 0.030 and 0.04, respectively. All variables are self-explanatory and other structural parameters are set to the baseline estimates.

Table B.2: Summary Statistics for Distinctive Operating and Fixed Equity Financing Costs

Convex Capital Adjustment Costs	Low				High
Panel A: DDW					
Avg. Investment (I/k)	0.1630	0.1316	0.1254	0.1224	0.1215
Var. Investment(I/k)	0.0897	0.0233	0.0108	0.0047	0.0028
Avg. Leverage (b/k)	0.3449	0.4025	0.4079	0.4062	0.4197
Var. Leverage (b/k)	0.0376	0.0201	0.0193	0.0177	0.0190
Avg. Profit (π/k)	0.1646	0.1678	0.1697	0.1724	0.1742
Equity Issuance Freq. ($d < 0$)	0.0219	0.0057	0.0044	0.0082	0.0128
Avg. Equity Financing ($-d/k,\ d < 0$)	0.0477	0.0679	0.0872	0.0876	0.0884
Avg. Cash Holding (c/k)	0.2475	0.1151	0.0947	0.0945	0.1092
Var. Cash Holding (c/k)	0.0956	0.0235	0.0167	0.0142	0.0172
Panel B : Hennessy and Whited (2005)					
Avg. Investment (I/k)	0.1542	0.1297	0.1247	0.1222	0.1214
Var. Investment(I/k)	0.0695	0.0193	0.0094	0.0044	0.0027
Avg. Leverage (b/k)	0.1584	0.2597	0.3073	0.3737	0.3749
Var. Leverage (b/k)	0.0199	0.0191	0.0212	0.0212	0.0197
Avg. Profit (π/k)	0.1654	0.1681	0.1701	0.1725	0.1743
Equity Issuance Freq. ($d < 0$)	0.0773	0.0233	0.0111	0.0052	0.0083
Avg. Equity Financing ($-d/k,\ d < 0$)	0.0772	0.0564	0.0558	0.0803	0.0769
Avg. Cash Holding (c/k)	0.4055	0.3280	0.2876	0.3127	0.3050
Var. Cash Holding (c/k)	0.1077	0.0467	0.0330	0.0274	0.0247

This table reports a variety of moment statistics from the baseline model simulations. Panel A simulates the model of DDW and Panel B simulates the model of Hennessy and Whited (2005), as described in Appendix B. Each column indicates a different level of convex capital adjustment cost; the values are 0.1, 0.5, 1, 2, and 3 times of the baseline convex capital adjustment cost of Table 2, respectively. The fixed capital adjustment cost parameter is set to 0 and the other parameter values are from the baseline estimation. All variables are self explanatory.

C Debt Conservatism Measure Simulation

I follow Bloulin, Core and Guay (2011)'s approach to construct Graham's debt conservatism measure. I define a "kink" as the first interest payment increment at which the firm has a decline in its marginal tax rate (at least 50 basis points). The marginal tax rates (MTR) are estimated by deducting various increments of the current interest payments from the taxable income, and the kink is the increment of interest expense immediately before which results in the computed MTR dropping by at least 50 basis points. I follow the interest deduction schedule of Graham (2000); I add the following increments of current interest payments to before-financing taxable income: 0%; 20%; 40%; 60%; 80%; 100%; 120%; 160%; 200%; 300%; 400%; 500%; 600%; 700%; and 800%. The before taxable income is defined as follows:

EBIT+Special Items(SPI)

- Deferred Tax Expense (TXDC) /maximum statutory tax rate

+Extraordinary Items and Discontinued Operations (XIDO)/(1-maximum statutory tax rate),

where the symbols in parenthesis refer to the items in CRSP/Compustat merged database.

I simulate future interest expenses based on the changes in the interest coverage ratio. So long as income at t is positive, future interest is changed by the ratio of income at t to income at t-1. If income at t is negative, I hold interest expenses constant for that year (i.e., interest expenses at time t = interest expenses at time t-1). In terms of past interest deductions, the interest expenses in historical taxable income is retroactively adjusted. For example, when estimating the MTR at the 50% interest deduction increment at time t, I assume that interest deductions in periods t-n to t-1 are set to 50% of actual.

I do not incorporate the state tax rate and alternative minimum tax rate by following the approach of Bloulin et al. (2011). They mainly pointed out the consistency problem in the application of alternative minium tax rate. I reflect the historical carry backward and forward changes into our simulation as well.

D Data Construction: Empirical Analysis

I introduce several control variables for emprical analyses on capital structure choices, as proposed in Frank and Goyal (2008). Some variables are redefined by following prior literature.

Table D.1: Definition of Variables used in the Empirical Analyses

Variable	Definition
Asset	(Deflated) Assets - Total (AT)
Profitability	Earnings Before Interest (EBITDA) / Assets - Total (AT)
Tangibility	Property, Plant and Equipment - Total (Net, PPENT)/ Assets - Total (AT)
R&D expenditure	Research and Development Expense (XRD)/ Assets - Total (AT)
Market to Book	(End of year price (PRCC_F)×Number of Common Shares Outstanding (CSHO) + Long-Term Debt - Total (DLTT))/Assets - Total (AT)
Investment	(Capital Expenditures (CAPX)-Sale of Property, Plant and Equipment (SPPE) + Research and Development Expense (XRD)/)/ Assets - Total (AT)
Tobin's Q	(End of year price (PRCC_F)×Number of Common Shares Outstanding (CSHO)+ Long-Term Debt - Total (DLTT)– Cash and Short-Term Investments (CHE)) /Assets - Total (AT)
Leverage	Long-Term Debt - Total (DLTT)/ Assets - Total (AT)
Cash	Cash and Short-Term Investments (CHE) /Assets - Total (AT)
Equity Financing	(Cash Dividends (DV) + Purchase of Common and Preferred Stock(PRSTKC) − Sale of Common and Preferred Stock (SSTK)) / (Assets - Total (AT))

E Convex Capital Adjustment Cost Regression (≥6year)

This section provides the cross-sectional model results of convex capital adjustment costs for the firms that stay the CRSP/Compustat database at least six years. The summary statistics and the regression results show similar patterns observed in the baseline models. Table E.1 reports the summary statistics and Table E.2 documents the cross-sectional model results.

Table E.1: Summary Statistics : Convex Capital Adjustment Cost Quartile

	Observations	Equity	Leverage	Cash	Cash Flow	Conservatism
Panel A: All Firms						
1st Quartile	8392	0.2380	0.2045	0.1997	0.0597	2.7815
2nd Quartile	8383	0.2215	0.2175	0.167	0.0686	2.3938
3rd Quartile	8055	0.2303	0.2497	0.1565	0.0557	1.8456
4th Quartile	5979	0.2000	0.2948	0.1337	0.0544	1.2343
Panel B: Non high-tech Firms						
1st Quartile	5802	0.1806	0.2431	0.1286	0.0988	2.8949
2nd Quartile	5992	0.1659	0.248	0.1049	0.107	2.5057
3rd Quartile	5866	0.1742	0.2816	0.1022	0.0997	1.9939
4th Quartile	4378	0.1546	0.3271	0.0852	0.0883	1.2581
Panel C: high-tech Firms						
1st Quartile	2590	0.3664	0.118	0.359	-0.0279	2.5118
2nd Quartile	2391	0.3609	0.1411	0.3226	-0.0278	2.0963
3rd Quartile	2189	0.3805	0.1643	0.302	-0.0623	1.4331
4th Quartile	1601	0.3242	0.2064	0.2665	-0.0381	1.1672

This table reports a variety of summary statistics for all firms, high-tech firms and non-high-tech firms according to convex capital adjustment cost quartiles. Only the firms with at least 6 firm-year observations are included in the calculations. Firms are included in the high-tech category if their first three digit SIC code is 283, 357, 366, 382, 384, and 737, and all other firms are all in non high-tech category. All values are averaged except the number of observations.

Table E.2: Cross-sectional Analysis : Convex Capital Adjustment Cost Quartile

	Leverage		Conservatism		Equity		
M/B ratio	-0.0141	-0.0116	0.5452	0.5139	0.4062		0.4092
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)
logAsset	0.0133	0.0147	0.4685	0.4530	-0.0471	-0.0551	-0.0460
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Tangibility	0.1679	0.1452	-1.5290	-1.2773	0.3224	0.4326	0.3146
	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.000)	(0.005)
Profitability	-0.2021	-0.2042	6.2191	6.2274	-3.1357	-2.8459	-3.1450
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R&D expenditure	-0.1814	-0.2004	0.3535	0.5980	1.5282	3.9500	1.4838
	(0.000)	(0.000)	(0.307)	(0.081)	(0.000)	(0.000)	(0.000)
R&D dummy	-0.0191	-0.0180	-0.3712	-0.3959	0.1281	0.1585	0.1368
	(0.000)	(0.000)	(0.000)	(0.000)	(0.014)	(0.002)	(0.009)
Med. Industry Leverage	0.2066	0.2452	-3.2308	-3.6798	0.2148	-0.8196	0.2445
	(0.000)	(0.000)	(0.000)	(0.000)	(0.513)	(0.013)	(0.461)
Convex Cost: 1st Quartile		-0.0540		0.5956		0.2938	-0.0350
		(0.000)		(0.000)		(0.000)	(0.591)
Convex Cost: 2nd Quartile		-0.0478		0.4833		0.3188	0.1064
		(0.000)		(0.000)		(0.000)	(0.087)
Convex Cost: 3rd Quartile		-0.0286		0.1277		0.2694	0.1284
		(0.000)		(0.007)		(0.000)	(0.036)
Stock Return(3year)					0.2238	0.3685	0.2234
					(0.000)	(0.000)	(0.000)
Constant	0.1206	0.1434	-0.3888	-0.5595	-2.5248	-2.2340	-2.5928
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	24293	24293	22301	22301	22119	22119	22119
Adjusted R^2	0.1544	0.1634	0.3016	0.3071			
Pseudo R^2					0.1785	0.1429	0.1791

This table reports coefficients, p-values (in parenthesis), and adjusted (pseudo-) R^2 from the cross-sectional regression and logit models. The leverage ratio, debt conservatism, and binary choice of equity issuance (logit) are used as dependent variables. Several control variables and convex capital adjustment cost quartile dummies are used as independent variables. Only the firms with at least 6 firm-year observations are included in the estimation. The standard errors of the regressions are robust to heteroscedasticity.