Three Essays in Corporate Finance

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ABSTRACT

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This dissertation consists of three essays on corporate finance. In the first chapter, I investigate how a liquidity cost associated with debt- 'debt servicing cost' affects a firm's capital structure policy. 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, investment, 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. In addition, I quantitatively show that large debt servicing costs are closely associated with low leverage and frequent equity financing by analyzing the role of fixed operating costs and convex capital adjustment costs.

In the second chapter, I empirically support the theoretical debt servicing costs analysis of the previous chapter. I firstly examine the structural estimation method used for the calibration of my model in the first chapter. The statistical property of the simulated method of moments estimator and detailed identification scheme for the calibration are investigated

in the first half of this chapter. Then I cross-sectionally confirm the validity of debt servicing costs predictions on capital structure choices. I study how each firm's convex capital adjustment costs, operating leverage, profit volatility, and future investment needs influence capital structure policies. Consistent with the debt servicing costs predictions, firms with higher convex capital adjustment costs, higher operating leverage, higher profit volatility and larger future investment demands show lower leverage ratios and more frequent equity financing activities. These findings shed new lights on pervasively conservative debt policy in U.S. public firms. A higher profitability observed in large future investment demands firms also suggests the importance of debt servicing costs consideration in resolving the puzzling negative correlation between profitability and leverage ratios.

In the third chapter, I examine how macroeconomic conditions affect the cyclical variations in capital structure policies. As in the financial crisis of 2008, economic contractions affect a firm's profitability, investments and external financing conditions altogether. To address the effects of these simultaneous changes on capital structure dynamics, I develop and estimate a dynamic trade-off model with investment, payouts, and liquidity policies with macroeconomic profitability and financing shocks. Investment dynamics and a higher value of liquidity of economic downturn are pivotal in capital structure dynamics; the former drives the issuance of debt and equity, and the latter leads to active debt retirements and conservative debt issues in upturns. My model yields the following main results: (1) Equity issues are pro-cyclical, and concentrated for small, low profit, and large investment demand firms in earlier stage of economic upturns. (2) Payouts peak in later stages of upturns and co-move positively with equity issues; (3) Debt policies move counter-cyclically, and leverage ratios after debt issuance and retirement are even higher during economic downturns. My comparative static analysis predicts pro-cyclical debt policy for financially constrained firms, and pervasively conservative use of debt for firms expecting financial market shutdowns.

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DEDICATION

To my wife and family members

Chapter 1

Debt Servicing Costs and Capital Structure

1.1 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.

In summary, this chapter 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 concludes.

1.2 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.

1.2.1 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 $\pi(k, z)$:

$$\pi(k, z) = zk^{\alpha} - f \tag{1.1}$$

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

$$\log z' = \rho \log z + \varepsilon \tag{1.2}$$

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:

$$I = k' - (1 - \delta)k, \tag{1.3}$$

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

$$G^k(k, I) = \gamma^k k 1_{I \neq 0} + \frac{\theta^k (I)^2}{k}, \tag{1.4}$$

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.

1.2.2 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:

$$b'(1+r) \leq c'(1+r) + (1-\delta)\,k' + \pi(k', z^{\min}) - Tax(z^{\min}, k', b', c'), \tag{1.5}$$

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:

$$G^b(b^{'}, b) = \psi^b b' + \eta^b\,(b' - b)\,1_{(b'-b)>0}, \tag{1.6}$$

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.

1.2.3 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:

$$g = \pi(k, z) - \delta k - r(b - c). \tag{1.7}$$

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

$$Tax = \tau_c^+ g \mathbf{1}_{g\geq 0} - \tau_c^- g(1 - \mathbf{1}_{g\geq 0}), \tag{1.8}$$

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:

$$e(z, k, b, c) = \pi(k, z) + (b' - c') - (b - c)(1 + r) - I - Tax - G^b(b', b) - G^k(k, I). \tag{1.9}$$

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:

$$G^e(e, k) = \left(\gamma^e k^\alpha + \theta^e e^2\right) 1_{e<0}, \tag{1.10}$$

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:

$$d(z, k, b, c) = (1 - G^{e}(e, k)1_{e<0})e, \tag{1.11}$$

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

$$V_0 = E\left[\sum_{t=0}^{\infty}\left(\frac{1}{1+r(1-\tau_i)}\right)^{t} d_t\right]. \tag{1.12}$$

The Bellman equation for the firm's equity value is

$$V(z, k, b, c) = \max_{k', b', c'} d(z, k, b, c, k', b', c') + \frac{1}{1+r(1-\tau_i)} EV(z', k', b', c'), \tag{1.13}$$

where the firm's optimal policy is subjected to the collateral constraint (1.5). 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.

1.3 Quantitative Analysis

1.3.1 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 1.1 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 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. The next chapter includes detailed information about the model's identification, and SMM procedure.

Table 1.2 reports the baseline economic parameters estimated via the SMM procedure. The estimation results are consistent with the prior estimates. The persistency parameter

Table 1.1: 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.

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

Table 1.2: 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.

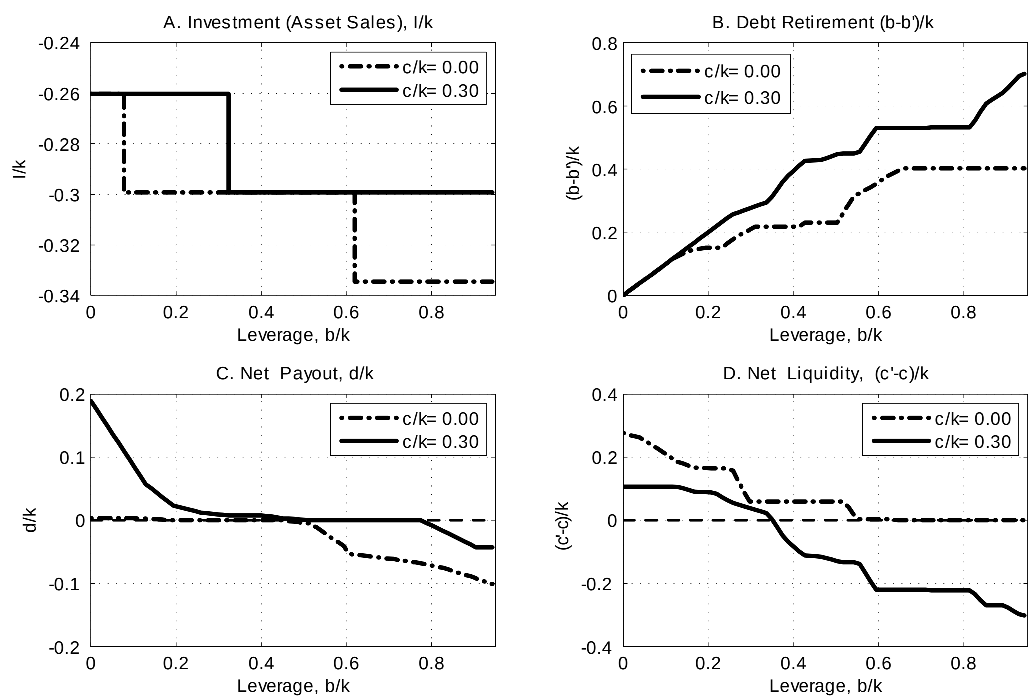
1.3.2 Growing Debt Obligations: Investment and Financing Policies

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

Figure 1.1 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

Figure 1.1: 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.

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 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).

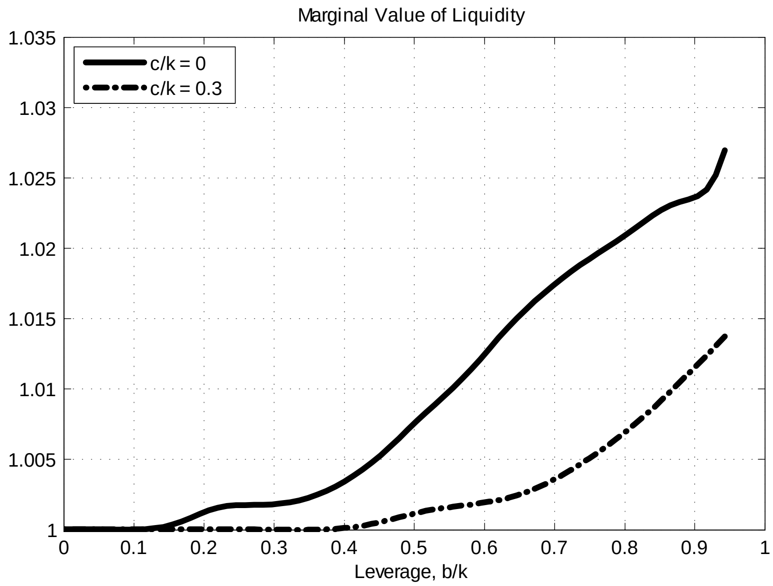
In sum, servicing large debt obligations leads to additional reductions in a firm's valuable cash stocks. A firm with more limited cash holding or with larger debt obligations tends to rely more heavily on costly capital resale or external financing to service debt obligations, which potentially increases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

1.3.3 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:

$$\text{Marginal Value of Liquidity} = \frac{\partial}{\partial c} V(z, k, b, c). \tag{1.14}$$

Figure 1.2: 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.

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.

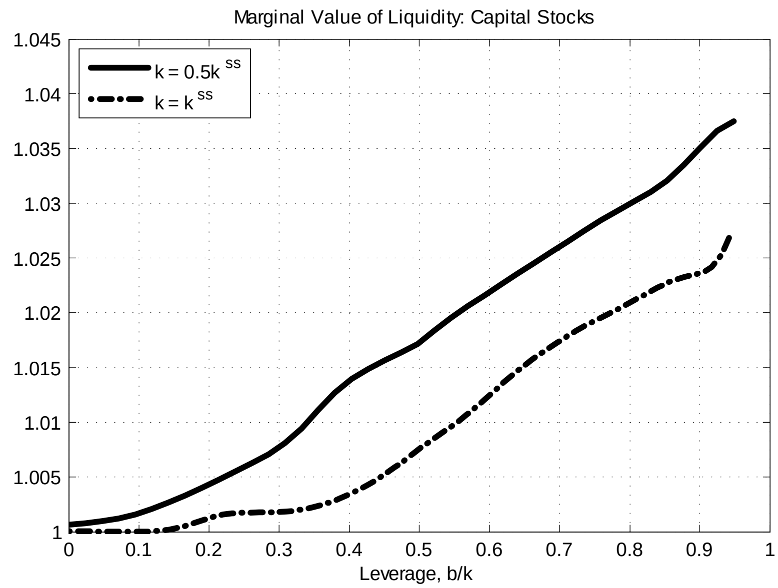
Figure 1.2 depicts the effect of the leverage variation on the marginal value of liquidity at the steady state level of capital stock (k^{ss}), and a neutral profitability shock realization ($z = 1$). I plot the marginal value of liquidity for high ($c/k = 0.3$) and low ($c/k = 0$) liquidity states to check the robustness of qualitative predictions.

Most remarkably, Figure 1.2 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 1.1. Both capital resale and external financing involve increasing marginal costs, which directly raise the marginal value of 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 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 1.3: 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.

Figure 1.3 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 1.3 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.

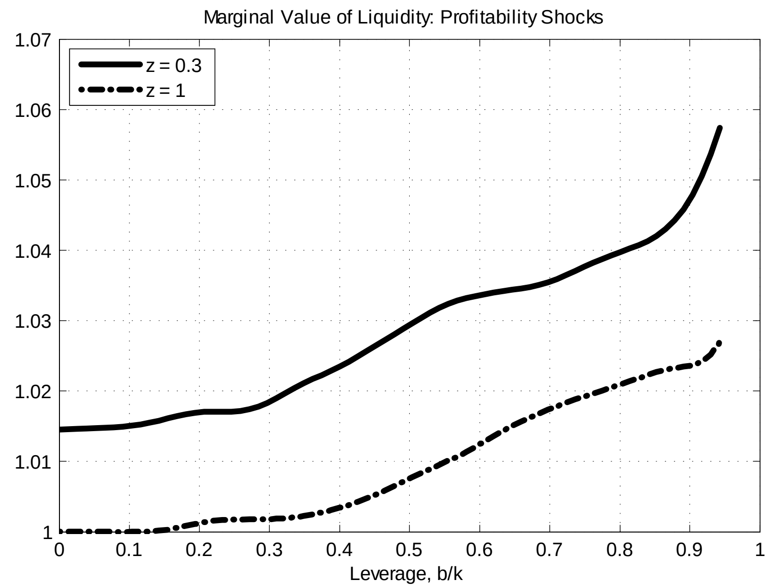
Large current and future investments drive such a large marginal value of liquidity in the low capital stock firm. Due to a decreasing returns to scale profit technology, the low capital stock firm tends to invest more in the current and future periods, and has to create more funds for capital expenditures. 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 1.4 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

Figure 1.4: Marginal Value of Liquidity: Profitability Shocks



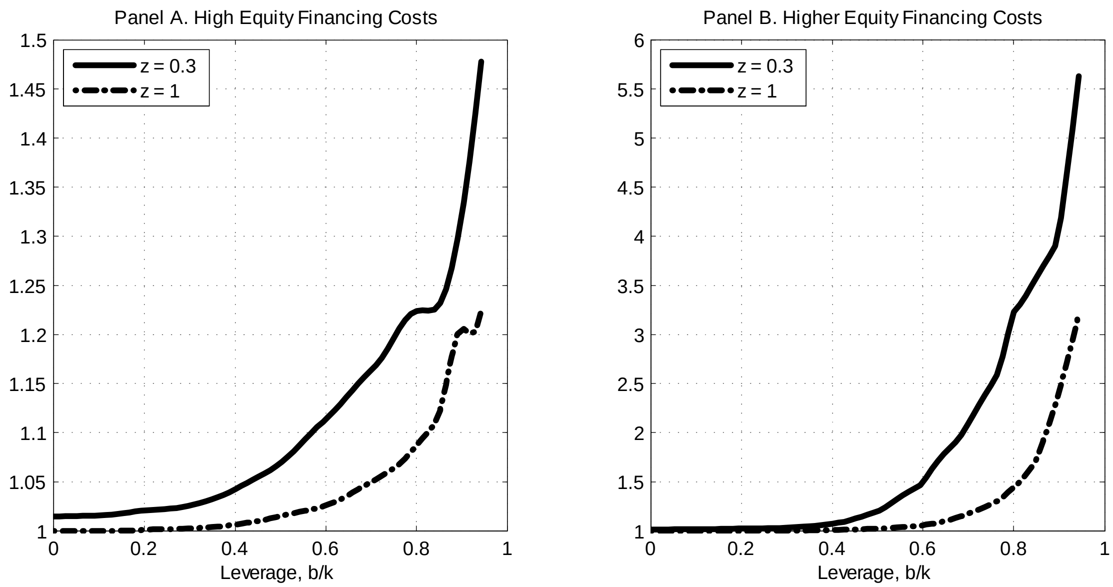
The marginal value of liquidity for two different states of the profitability shock ($z = 0.3,\ 1$) are plotted along with the leverage ratio variation. All values are evaluated at the steady state level of capital stock (k^{ss}) with zero liquidity holding ($c/k = 0$).

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 1.4 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 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.

Figure 1.5: 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 ($c/k = 0$).

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

Figure 1.5 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 1.4 and 1.5 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 1.4 points out that a low profitability shock raises debt servicing costs substantially even in the absence of any financial distress costs. Figure 1.5 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.

Table 1.3: 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.

1.3.4 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 1.3 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 1.3. 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).

1.4 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.

1.4.1 Comparative Statics I: Fixed Operating Cost

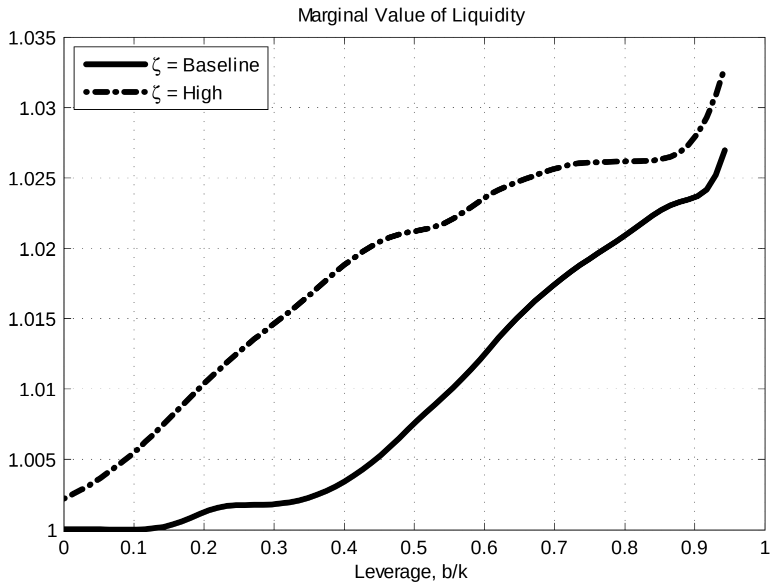
A higher fixed operating cost is closely associated with large debt servicing costs. An increase in fixed operating costs decreases a firm's profitability without incurring considerable changes in a firm's investment demands because this adjustment does not affect the marginal profitability of investments.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

Figure 1.6 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, this qualitative prediction remains unchanged for different levels of capital stock, profitability shock and liquidity holding.

Table 1.4 shows the effects of fixed operating cost variations on a firm's investment and

Figure 1.6: 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 ($z = 1$).

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 1.2. Table 1.4 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

Table 1.4: 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 1.2.

operating cost scenario, $\zeta = 0$, but it decreases to 0.145 when the fixed operating cost parameter ζ becomes 0.04 (row 5).

Table 1.4 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

Table 1.5: 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.

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 1.5 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 1.4.

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 1.4 and 1.5.

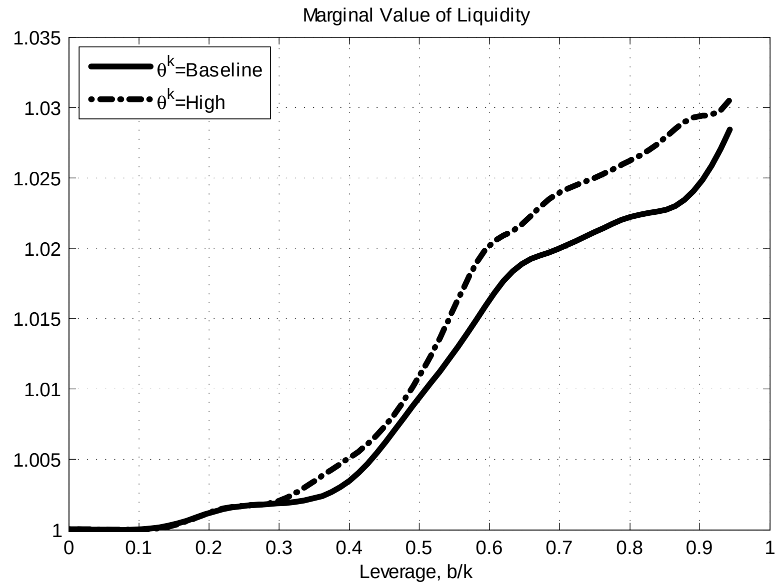
1.4.2 Comparative Statics II: Convex Capital Adjustment Costs

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 1.1, 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 1.7 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 adjustment 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 1.2 except the fixed capital adjustment costs: the parameter γ^k is set to zero to isolate the effect of convex capital

Figure 1.7: 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 ($z = 1$).

adjustment costs.

Figure 1.6 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 1.1.

Table 1.6 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

Table 1.6: 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 1.2. The fixed capital adjustment cost parameter is set to 0 and the other parameter values are from the baseline estimates of Table 1.2. All variables are self explanatory.

cost 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 1.2. Table 1.6 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 ($-d/k$, $d < 0$).

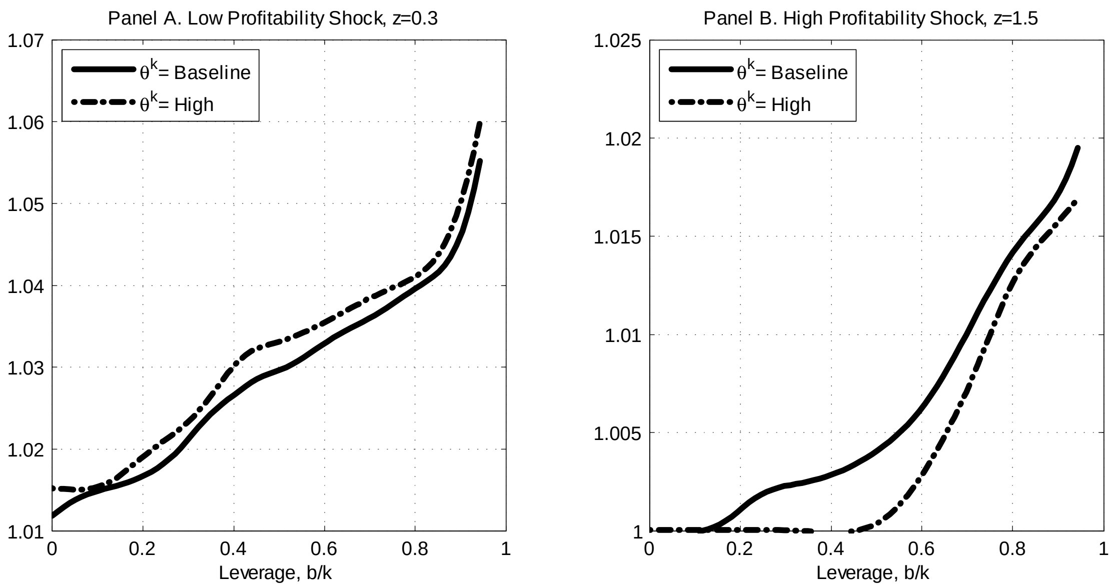
Table 1.6 shows that a firm with high convex capital adjustment costs is closely associated with lower leverage and more frequent equity financing. The average leverage ratio drops by almost 25% as convex capital adjustment costs increase. Notice that the leverage ratio is 0.19 in the first column, but 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 adjustment cost in Figure 1.7. 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 1.8 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 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 1.7.

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 1.7, 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

Figure 1.8: 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.

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 1.7 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 1.6, the higher convex capital

Table 1.7: 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.

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 1.6 and 1.7. 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.

1.5 Concluding Remarks

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 yielded a number of interesting results. Most of all, a firm with large debt obligations faces a higher cost of debt, even in the absence of financial distress costs. Next, a smaller firm may have lower leverage ratio because its large investment demands increase debt servicing costs. Lastly, 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.

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.

Chapter 2

Empirical Analysis on Debt Servicing Costs

2.1 Introduction

This chapter empirically supports the theoretical considerations on debt servicing costs in the previous chapter. For this purpose, I study the simulated method of moments estimation in detail, and cross-sectionally investigate the debt servicing costs predictions on capital structure policies.

I adopted the simulated method of moments (SMM) estimation to obtain important structural parameters of my previous model. The SMM estimation finds a set of structural parameters driving the moments of artificially simulated data from a model as close as possible to the corresponding empirical moments. In my model, this estimation procedure helps ensure close relationships between the model's quantitative predictions and a firm's financing and investment policy in the real world. I investigate the statistical properties of the SMM estimator and demonstrate the identification strategy used for the baseline model calibration in Chapter 1.

In the second half of this chapter, I study the validity of debt servicing costs predictions on capital structure policy. I quantitatively predicted that an economic environment associated with large debt servicing costs leads to lower leverage ratios and frequent equity financing activities. I test these empirical predictions for publicly traded U.S. firms.

For this purpose, I conduct four cross-sectional studies. First, I examine the role of convex capital adjustment costs on a firm's capital structure policies. The previous chapter demonstrated that higher convex capital adjustment costs raise the costs of asset sales that lead to large debt servicing costs. To test the empirical predictions from large debt servicing costs, I calculate each individual firm's convex capital adjustment costs based on Eberly (1997)'s approach, and then introduce quartile dummy variables to indicate high and low adjustment cost firms. Consistent with the debt servicing cost predictions, my empirical analysis confirms more conservative debt policy and frequent equity financing activities for firms with higher convex capital adjustment costs.

Next, I investigate the relationship between fixed operating costs and capital structure choice. My quantitative analysis in the previous chapter predicts lower leverage ratios and frequent equity financing for firms with higher fixed operating costs. To test these quantitative predictions, I build up a measure of fixed operating costs by modifying the estimation method used in Kahl et al. (2012). I obtain each individual firm's fixed operating measure first, which captures the sensitivity of operating cost growths to sales growths. Then I construct quartile indicator variables from individual firm's estimates. In line with the quantitative predictions of Chapter 1, higher fixed operating costs firms maintain lower leverage ratios and issue equity more frequently than lower fixed operating costs firms do.

Moreover, I cross-sectionally study the relationship between a firm's profit volatility and capital structure policies. Provided the same profitability state, a higher volatility in profits indicates a greater likelihood of low profitability state realizations, which results in an expectation of large debt servicing costs. I directly measure the volatility of profits by calculating the variance of operating profits for each individual firm. Then I construct quartile dummy variables to select high and low profit volatility firms and use these indicators as explanatory variables for my cross-sectional analysis. Consistent with the debt servicing cost predictions, firms with highly volatile profits tend to show lower leverage ratios and more frequent equity financing activities.

Finally, I study how future investment demands affect a firm's debt and equity financing policies. Massive operating needs for future investment raise the marginal value of liquidity next period, leading to an expectation of large debt servicing costs in current debt issuance. To obtain the measure of future large investment demands, I firstly assign the relative ranking of investment-asset ratios to each individual firm. I define indicator variables for small and large future investments based on this relative investment-asset ratio quartile. My cross-sectional analysis confirms that firms expecting large future investment demands use debt more conservatively and equity more frequently, in spite of their higher profitability. This finding contradicts the standard trade-off theory predictions on equity financing where a firm avoids equity issuance in the face of large unused tax shields and high profitability. The consideration of investment variables also weakens the puzzling negative correlation between profitability and leverage ratios (Frank and Goyal 2008), which suggests a potential role of debt servicing costs restraining debt issuance during high profitability states.

The first half of this chapter examines the statistical property of the SMM estimator and detailed identification scheme used for my baseline model calibration in the previous chapter. The second half of this chapter confirms the validity of debt servicing costs predictions on capital structure policies. As expected, a firm with higher convex capital adjustment costs, higher fixed operating costs, highly volatile profitability generations, and larger future investment needs is closely associated with lower leverage ratios and more frequent equity financing activities. Especially, my empirical analysis on future investment needs suggests that the debt servicing cost considerations could be potentially related with other empirical puzzles in capital structure literature such as the puzzling negative correlation between profits and leverage ratios.

The next section investigates the SMM estimation procedure in detail. Section 3 cross-sectionally analyzes the debt servicing costs predictions on capital structure policies. Section 4 concludes.

2.2 Calibration: Simulated Method of Moments

2.2.1 Simulated Method of Moments

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 simulation 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 $Q(x;y;\beta)$:

$$Q(x,y;\beta) = (M(x) - m(y;\beta))'W(M(x) - m(y;\beta)), \tag{2.1}$$

where W is a weighting matrix.

I denote J as 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:

$$\sqrt{N}\left(\hat{\beta} - \beta\right) \sim \left(1 + \frac{1}{J}\right)\left(\frac{\partial}{\partial\beta}m(y;\beta)'W\frac{\partial}{\partial\beta}m(y;\beta)\right)^{-1}. \tag{2.2}$$

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

$$\frac{NJ}{1+J}Q(x,y,\beta). \tag{2.3}$$

2.2.2 Identification

As briefly illustrated in the previous chapter, I fix a group of structural parameters at economically reasonable values to efficiently estimate the model parameters. 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).

I estimate the following parameters 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.

The global identification of a SMM 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 correctly identify structural parameters, I pick up the following 13 moments; the first and second moments of investment, cash, leverage and operating profits; the first moment of dividends, Tobins' q, and equity proceeds; the serial correlation of operating profits and the frequency of equity financing. My identification scheme is closely associated with the identification strategy of DDW. The average and variance of investment help identify the capital adjustment cost parameters, γ^k and 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. The average operating profits help identity the curvature of profit function, a and the fixed operating cost parameter, ζ. As discussed in DDW, a higher α raises average profit $(zk^{\alpha} - \zeta k^{ss}/k)$ and a higher fixed operating cost parameter, 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 capture the uncertainty parameter of profit evolution, σ. The average dividends and Tobin's q are closely associated with the value of firm.

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 and convex equity issuance cost parameters, γ^e and θ^e. The average and variance of leverage help pin down the baseline debt financing cost, ψ^b and the additional financing cost component, η^b. 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 an option value of debt issuance. The mean and variance of cash holding ratio also help identify these two debt financing costs. A high debt financing costs, ψ^b provides additional incentive to cash retention because it increases a firm's external financing costs. A higher additional cost parameter, η^b implies large incentives to save cash.

Table 2.1: 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.

2.2.3 Estimation Results

Table 2.1 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.

Table 2.2 reports the baseline economic parameters estimated via the SMM procedure. As explained in the previous chapter, the estimation results are all in line 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 consistent 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, in line with DDW, Cooper and Haltiwanger (2006), and

Table 2.2: 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.

Whited (1992). The convex equity financing cost θ^e is 0.0003, close 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 average debt issuance cost in Altinkihc and Hansen (2000).

2.3 Tests for Debt servicing Costs Predictions

2.3.1 Data Construction

This section illustrates the construction of each measure for my cross-sectional studies.

Debt Conservatism Measure

To strengthen my model's prediction on conservative debt policy, I calculate a direct debt conservatism measure based on the use of interest tax shields. I follow Bloulin, Core and Guay (2011)'s approach to construct Graham (2000)'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). Therefore, a higher debt conservatism measure implies more conservative debt policy. 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 drop 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 income before tax is defined as follows:

EBIT+Special Items(SPI)

- Deferred Tax Expense (TXDC) /max. statutory tax rate

+Extraordinary Items and Discontinued Operations (XIDO)/(1-max. 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 $t=0$ is equal to 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 point out the consistency problem in the application of alternative minium tax rate. I reflect the historical carry backward and forward changes into my simulation as well.

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:

$$\frac{I}{K} = \beta_0 + \beta_1 \text{Tobin's } q + \beta_2 \text{profit} + \beta_3 \text{investment good price} + \varepsilon \text{ for } I > 0. \tag{2.4}$$

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.

Fixed Operating Costs

To construct fixed operating cost measure, I adopt a modified version of the estimation method used in Kahl et al. (2012). For this purpose, I firstly generate ex-ante expectations of sales and operating costs from the geometric growth rate over the previous two years:

$$E(S_{i,t}) = S_{i,t-1}\left(\frac{S_{i,t-2}}{S_{i,t-3}}\right) \text{ and } E(X_{i,t}) = X_{i,t-1}\left(\frac{X_{i,t-2}}{X_{i,t-3}}\right) \tag{2.5}$$

in which $S_{i,t}$ and $X_{i,t}$ indicate an individual firm i's sales and operating costs at time t, respectively. I also calculate the innovations in growth rates as follows:

$$\mu^S_{i,t} = \frac{S_{i,t} - E(S_{i,t})}{S_{i,t-1}} \text{ and } \mu^X_{i,t} = \frac{X_{i,t} - E(X_{i,t})}{X_{i,t-1}} \tag{2.6}$$

where $\mu^S_{i,t}$ and $\mu^X_{i,t}$ point to the innovation of sales growth and operating cost growth, respectively. To obtain a reliable estimate of fixed operating costs, I run the following regression for the firms with at least 12 years of observations in the sample period:

$$\mu^X_{i,t} = FC_i \mu^S_{i,t} + \varepsilon_{i,t} \tag{2.7}$$

where FC_i is an individual firm's fixed operating cost measure. This 12 year restriction potentially relieves outlier problems from a limited horizon of observations. FC_i reflects the sensitivity of operating cost growth to sales growth after taking account of growth trends. Higher proportions of fixed costs to total operating costs will show a lower sensitivity and consequently a lower estimate of FC_i. Conversely, a higher estimate of FC_i indicates more variable costs relative to total costs. Then I introduce dummy variables indicating high and low fixed operating costs firms. The high fixed operating cost dummy variable is one if the cost measure is in the first quartile and zero otherwise. The low fixed operating cost dummy variable takes one if the cost measure is in the fourth quartile and zero, otherwise.

Profit Volatility

To construct a natural measure of profit volatility, I calculate the standard deviation of operating profits for each firm that stays at least 12 years in the sample period. This restriction potentially relieves outlier problems from young firms. Then I generate dummy variables indicating high and low profit volatility firms. The high profit volatility indicator variable takes the value of 1 if the standard deviation is in the fourth quartile. The low profit volatility indicator variable is equal to 1 if the standard deviation is in the first quartile.

Future Investment Demands

For the measurement of expected future investment needs, I construct indicator variables based on actual future capital expenditures. 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 investment demands 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 investment, 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 2.3: 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 A.

2.3.2 Convex Capital Adjustment Costs

This section analyzes the influence of convex capital adjustment costs on a firm's capital structure policies. As shown in Chapter 1, higher convex capital adjustment costs lead to large costs in asset sales, which raise the marginal value of liquidity and debt servicing costs. To investigate the role of convex capital adjustment costs on capital structure policies, I adopt the quartile capital adjustment costs indicator variables, constructed in the previous section. I cross-sectionally investigate the relationship between these indicator variables and capital structure policies.

Table 2.3 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. 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 2.3 indicates more conservative debt policy and frequent equity financing in high convex 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. The 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 2.4 investigates the relationship between convex capital adjustment cost quartile dummies and external financing policies in cross-sectional regression models. The leverage ratio, debt 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

Table 2.4: 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 A. 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.

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. Convex capital adjustment costs are 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 in Chapter 1.

2.3.3 Fixed Operating Costs

This section analyzes the relationship between fixed operating costs and a firm's capital structure policies. In the previous chapter, I quantitatively showed large fixed operating costs are closely associated with low leverage ratios and frequent equity financing activities. Higher fixed operating costs raise the marginal value of liquidity and consequently drive large debt servicing costs. To analyze the implications of higher fixed operating costs on financing policies, I use the indicator variables constructed in the previous section and cross-sectionally analyze the relationship between these dummy variables and capital structure choices.

Table 2.3 reports summary statics results according to the fixed operating costs indicator variables. The table documents the average of leverage ratio, debt conservatism, cash holding, and operating profits. The equity financing frequency is also included. The summary statistics are calculated for different sub-categories such as high-tech industry, non high-tech industries, young firms and old firms. I examine 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 included because younger firms tend to maintain lower leverage and issue equity more frequently (Frank and Goyal 2003).

In line with the debt servicing cost predictions, higher fixed operating costs firms are closely associated with low leverage and frequent equity financing. Conversely, lower fixed operating costs firms show higher leverage ratios and inactive equity issuance activities. For instance, the average leverage ratio for the low fixed operating costs firms is 0.2705 but decreases to 0.1657 for the high fixed operating costs firms. Equity financing frequency is 10% for the low fixed operating costs firms but becomes 28% for the high fixed operating costs firms. These qualitative predictions remain unchanged for the sub-categories of high-tech, non-high-tech, young firms, and old firms.

However, the relationship between fixed operating costs and the debt conservatism mea-

Table 2.5: Summary Statistics : Fixed Operating Costs

	Equity	Leverage	Cash	Profit	Conservatism
Panel A : All Firms					
Low Fixed Operating Costs	0.1157	0.2705	0.0848	0.1407	3.0547
Others	0.148	0.2214	0.1383	0.1139	2.555
High Fixed Operating Costs .	0.3871	0.1657	0.3227	-0.0632	1.1718
Panel B: Old Firm-Year Observation					
Low Fixed Operating Costs	0.0823	0.2788	0.0717	0.1375	3.0597
Others	0.102	0.2217	0.1298	0.1121	2.6731
High Fixed Operating Costs .	0.3021	0.1778	0.2923	-0.0334	1.3962
Panel C: Young Firm-Year Observation					
Low Fixed Operating Costs	0.3021	0.1778	0.2923	-0.0334	1.3962
Others	0.1874	0.2527	0.113	0.1476	3.0418
High Fixed Operating Costs .	0.2302	0.2208	0.1535	0.117	2.2994
Panel D: Non High-tech Firms					
Low Fixed Operating Costs	0.1007	0.289	0.0665	0.1423	2.8906
Others	0.1231	0.2469	0.1049	0.1217	2.5717
High Fixed Operating Costs .	0.3017	0.2105	0.2017	0.008	1.0805
Panel E : High-tech Firms					
Low Fixed Operating Costs	0.2055	0.1599	0.1948	0.1313	4.105
Others	0.2219	0.1454	0.2378	0.0905	2.5045
High Fixed Operating Costs .	0.4484	0.1335	0.4095	-0.1143	1.2388

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 fixed operating costs 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 2.3

sure is not well aligned with the debt servicing cost predictions. Higher fixed operating costs firms rather use debt more aggressively than lower fixed operating costs firms do. For instance, the average debt conservatism measure for the high fixed operating costs firms is 1.17 but increases to 3.0 for the low fixed operating costs firms. This contradictory pattern appears closely associated with the quite low profitability in the high fixed operating cost category firms. Even with low leverage ratios, lower profitability induces a significant drop in debt conservatism measure, which points to more aggressive use of interest tax shields for these firms. This correlation between the fixed operating cost dummy variables and profitability suggests a potential measurement problem in Kahl et al. (2012)'s fixed operating cost estimation.

Table 2.6 analyzes cross-sectional correlations between the fixed operating cost dummy variables and capital structure choice. All regression and logit model specifications are identical to those of Table 2.4, except the inclusion of the fixed operating cost 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 used as control variables in regressions. The logit model incorporates 3-year stock returns to capture market timing aspects of equity financing.

My findings in cross-sectional models are consistent to the summary statics results in Table 2.5. The high fixed operating cost indicator variable is associated with lower leverage ratios and more frequent equity financing activities. Conversely, the low fixed operating cost dummy variable is correlated positively with leverage ratios and negatively with equity financing frequencies. Yet, an increase in fixed operating costs is still negatively related with the measure of debt conservatism, which is inconsistent with the debt servicing cost predictions.

The summary statistics results and regression analyses all confirm the validity of the debt servicing costs predictions in terms of leverage ratios and equity financing frequencies. Higher fixed operating cost firms maintain lower leverage ratios and use equity more frequently. These results are also consistent with the empirical work of Kahl et al. (2012); their fixed operating cost measure is negatively correlated with leverage ratios and positively associated with equity issues. Yet, my results on the debt conservatism measure are not well aligned with the debt servicing cost predictions. The fixed operating measure used in prior literature appears to generate a tendency for selecting lower profitability firms as high fixed operating

Table 2.6: Cross-sectional Analysis : Fixed Operating Costs

	Leverage		Conservatism		Equity	
M/B ratio	-0.0138	-0.0129	0.5549	0.5685	0.3826	0.3602
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
logAsset	0.0144	0.0131	0.4348	0.4160	-0.0751	-0.0538
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Tangibility	0.1830	0.1872	-1.8210	-1.7738	0.3631	0.2592
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)
Profitability	-0.2120	-0.2265	6.7393	6.5343	-3.2067	-2.8903
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R&D expenditure	-0.2586	-0.2289	1.0636	1.4765	1.6668	1.1899
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R&D dummy	-0.0151	-0.0127	-0.4344	-0.4024	0.0786	0.0367
	(0.000)	(0.000)	(0.000)	(0.000)	(0.050)	(0.364)
Med. Industry Leverage	0.1692	0.1612	-2.8942	-3.0239	0.3355	0.4715
	(0.000)	(0.000)	(0.000)	(0.000)	(0.197)	(0.074)
Low Fixed Operating Costs		0.0095		0.1650		-0.1164
		(0.000)		(0.000)		(0.006)
High Fixed Operating Costs		-0.0311		-0.4180		0.4989
		(0.000)		(0.000)		(0.000)
Stock Return (3year)					0.2441	0.2459
					(0.000)	(0.000)
Constant	0.1175	0.1251	-0.2205	-0.1146	-2.4266	-2.5651
	(0.000)	(0.000)	(0.000)	(0.038)	(0.000)	(0.000)
N	41399	41399	38000	38000	37709	37709
Adjusted R^2	0.1726	0.1758	0.3049	0.3074		
Pseudo R^2					0.1746	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 the indicator variables for future investment demands are used as independent variables. The construction of controlling variables is explained in Appendix A. The standard errors of the regressions are robust to heteroscedasticity.

costs ones.

2.3.4 Profit Volatility

This section cross-sectionally investigates how the volatility of profit generation affects a firm's capital structure choice. Given the same profitability state, a highly volatile operating profit implies a greater likelihood of lower profitability states in the future. As analyzed in Chapter 1, such higher likelihoods of lower profitability states indicate a higher marginal value of liquidity in the future, which induces an expectation of large debt servicing costs in current debt issues. To examine the implications of profit volatilities, I use indicator variables for high and low profit volatility firms developed in the previous section.

Table 2.7 shows summary statics results in accordance with the profit volatility indicators. The table describes the average of leverage ratio, debt conservatism, cash holding, and operating profits. The equity financing frequency is also documented. The summary statistics are reported for different sub-categories such as high-tech industry, non high-tech industries, young firms and old firms. I include 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 included because younger firms tend to maintain lower leverage and issue equity more frequently (Frank and Goyal 2003).

Consistent with the debt servicing cost predictions, firms with highly volatile profits are closely associated with low leverage ratios and active equity financing. Conversely, firms with low profit volatility are closely connected with higher leverage ratios and a lower frequency of equity financing. For instance, the average leverage ratio for the low profit volatility firms is 0.2931 but drops to 0.1721 for the high profit volatility firms. The equity financing frequency is 0.0967 but increases to 0.3706 in response to the same firm category changes. These qualitative predictions remain stable for the sub-categories of high-tech, non-high-tech,

Table 2.7: Summary Statistics : Profit Volatility

	Equity	Leverage	Cash	Profit	Conservatism
Panel A : All Firms					
Low Profit Volatility	0.0967	0.2931	0.0634	0.1313	2.8711
Others	0.1385	0.2129	0.1456	0.1315	2.821
High Profit Volatility .	0.3706	0.1721	0.2848	-0.0474	1.1134
Panel B: Old Firm-Year Observation					
Low Profit Volatility	0.0734	0.2962	0.0582	0.1303	2.8959
Others	0.0909	0.2104	0.1354	0.1286	2.9383
High Profit Volatility .	0.3706	0.1721	0.2848	-0.0474	1.1134
Panel C: Young Firm-Year Observation					
Low Profit Volatility	0.1658	0.2839	0.0788	0.1342	2.7812
Others	0.2169	0.2171	0.1623	0.1363	2.5867
High Profit Volatility .	0.4382	0.1633	0.3019	-0.0603	1.047
Panel D: Non High-tech Firms					
Low Profit Volatility	0.0971	0.3032	0.0555	0.1287	2.7336
Others	0.1117	0.2397	0.1064	0.1365	2.7523
High Profit Volatility .	0.2957	0.2104	0.1945	0.0204	1.2212
Panel E : High-tech Firms					
Low Profit Volatility	0.0935	0.1983	0.1375	0.1562	4.177
Others	0.2147	0.1365	0.2571	0.1172	3.0218
High Profit Volatility .	0.4356	0.1389	0.3632	-0.1062	1.0185

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 fixed operating costs 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 2.3

young firms, and old firms.

Yet, the debt conservatism measure shows a distinctive pattern. The firms with highly volatile profits rather use debt more aggressively than the firms with low profit volatility do. For example, the average debt conservatism measure for the firms with highly volatile profits is 1.11 but increases to 2.87 for their low volatility counterparts. Similar to the result of fixed operating costs, this contradictory pattern seems to be closely related with the quite low profitability for the higher profit volatility firms. In spite of lower leverage ratios, lower profitability leads to more aggressive use of tax benefits.

Table 2.8 cross-sectionally investigates how the profit volatility indicator variables are correlated with a firm's capital structure choices. All regression and logit model specifications are identical to those of Table 2.4, except the inclusion of the volatility dummy 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 placed as control variables in regressions. The logit model incorporates 3-year stock returns to capture market timing aspects of equity financing.

The cross-sectional correlations are in line with the summary statics results in Table 2.7. The indicator variable for lower profit volatility shows a positive correlation with leverage ratios and a negative correlation with the frequency of equity financing. This low profit volatility variable is also negatively associated with the debt conservatism measure, consistent with the debt servicing cost predictions. The indicator variable for higher profit volatility is negatively associated with leverage ratios and positively associated with equity financing activities even after controlling for other firm characteristics. Yet, this high volatility variable is negatively correlated with the debt conservatism measure pointing to more aggressive use of tax benefits.

These finding are well aligned with the debt servicing costs predictions on capital structure policies, as proposed in Chapter 1. Low profit volatility firms maintain higher leverage ratios, exercise more aggressive debt policy and issue equity less frequently, consistent with the debt servicing costs predictions. High profit volatility firms show lower leverage ratios and more frequent equity financing activities, as expected in the debt servicing costs analysis. Yet, the debt conservatism measure is negatively related with the indicator variable of highly volatile profits, which argues against the debt servicing cost predictions. A potential association between lower profit generations and higher profit variations may be behind more

Table 2.8: Cross-sectional Analysis : Profit Volatility

	Leverage		Conservatism		Equity	
M/B ratio	-0.0138	-0.0133	0.5549	0.5764	0.3826	0.3470
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
logAsset	0.0144	0.0124	0.4348	0.4082	-0.0751	-0.0156
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.083)
Tangibility	0.1830	0.1795	-1.8210	-1.8596	0.3631	0.4681
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Profitability	-0.2120	-0.2108	6.7393	6.3964	-3.2067	-2.7220
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R&D expenditure	-0.2586	-0.2519	1.0636	1.4608	1.6668	1.2204
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R&D dummy	-0.0151	-0.0141	-0.4344	-0.4292	0.0786	0.0584
	(0.000)	(0.000)	(0.000)	(0.000)	(0.050)	(0.150)
Med. Industry Leverage	0.1692	0.1554	-2.8942	-2.7789	0.3355	0.3788
	(0.000)	(0.000)	(0.000)	(0.000)	(0.197)	(0.150)
Low Profit Volatility		0.0219		-0.1309		-0.1452
		(0.000)		(0.000)		(0.001)
High Profit Volatility		-0.0037		-0.6321		0.7068
		(0.187)		(0.000)		(0.000)
Stock Return (3year)					0.2441	0.2446
					(0.000)	(0.000)
Constant	0.1175	0.1253	-0.2205	0.0714	-2.4266	-2.9100
	(0.000)	(0.000)	(0.000)	(0.226)	(0.000)	(0.000)
N	41399	41399	38000	38000	37709	37709
Adjusted R^2	0.1726	0.1745	0.3049	0.3094		
Pseudo R^2					0.1746	0.1838

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 A. The standard errors of the regressions are robust to heteroscedasticity.

Table 2.9: Summary Statistics : Future Investment Demands

	Equity	Leverage	Cash	Profit	Conservatism
Panel A : All Firms					
Small Future Investment	0.1995	0.2555	0.174	0.0257	1.8741
Others	0.2404	0.2379	0.1705	0.0416	2.1588
Large Future Investment	0.2942	0.188	0.197	0.0905	2.8486
Panel B: Old Firm-Year Observation					
Small Future Investment	0.1024	0.259	0.1307	0.0819	2.2973
Others	0.1196	0.2358	0.1286	0.0979	2.5487
Large Future Investment	0.1606	0.1888	0.1542	0.1321	3.2632
Panel C: Young Firm-Year Observation					
Small Future Investment	0.2843	0.2524	0.2118	-0.0233	1.3488
Others	0.3372	0.2395	0.2041	-0.0036	1.7167
Large Future Investment	0.4005	0.1874	0.231	0.0573	2.3345
Panel D: Non High-tech Firms					
Small Future Investment	0.1497	0.2969	0.1077	0.0667	1.9137
Others	0.1859	0.2735	0.1094	0.084	2.2437
Large Future Investment	0.2367	0.221	0.1333	0.126	2.9502
Panel E : High-tech Firms					
Small Future Investment	0.3194	0.1556	0.3336	-0.0731	1.7712
Others	0.3692	0.1539	0.3149	-0.0588	1.9492
Large Future Investment	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 2.3

aggressive debt policy for the firms with highly volatile profits.

2.3.5 Future Investment Demands

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.

Table 2.9 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 investment are closely associated with low leverage, conservative debt policy and frequent equity financing despite higher profitability levels. Conversely, firms with small future investment are correlated with higher leverage, less conservative debt policy and infrequent equity financing, in spite of lower profitability levels. For instance, the average leverage ratio is 0.255 for firms with small future investment but 0.188 for firms with large future investment. 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 2.10 investigates the relationship between future investment demands and current capital structure choice in cross-sectional regression models. All regression and logit model specifications are identical to those of Table 2.4, except the inclusion of the future investment 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 still used as control variables. The 3-year stock returns are additionally incorporated in the logit model for equity financing to capture market timing

Table 2.10: Cross-sectional Analysis : Future Investment Demands

	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 Investment		0.0112		-0.2198		-0.1536
		(0.000)		(0.000)		(0.000)
Large Future Investment		-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 A. The standard errors of the regressions are robust to heteroscedasticity.

aspects.

The cross-sectional results are consistent with the debt servicing cost predictions developed in the previous chapter. The firms with large future investment are closely associated with low leverage, conservative debt policy and frequent equity financing, even after controlling for other firm characteristics. The small future investment 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 investment use equity financing more frequently in spite of their conservative use of debt and large operating profits. The firms with small investment 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 investment and current capital structure

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

choices is consistent with the debt servicing cost predictions. Large future investment demands 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.

2.4 Concluding Remarks

This chapter empirically supports the theoretical analysis on debt servicing costs in the previous chapter. In the first half of this chapter, I studied the statistical property of the simulated method of moment estimator and investigated a detailed identification procedure used for the calibration of the baseline model in Chapter 1.

In the second half of this chapter, I empirically confirmed the validity of debt servicing costs predictions for public U.S. firms. I proposed that large debt servicing costs are closely associated with low leverage ratios and frequent equity financing activities in the previous chapter. I conducted four cross-sectional studies to test these empirical predictions from large debt servicing costs. The effects of convex capital adjustment costs, fixed operating costs, future investment demands and the volatility of profits on capital structure policies are analyzed in the second half.

All of the four empirical studies argue for the debt servicing cost predictions on capital structure policies. Firms with high convex capital adjustment costs, high fixed operating costs, large future investment needs, and highly volatile profits are all negatively correlated with leverage ratios and positively correlated with equity financing frequencies. These correlations results are all consistent with the debt servicing costs predictions on capital structure policies.

These findings also provide new insights on empirical regularities. Especially, firms expecting large future investment demands use equity frequently, in spite of their higher profitability level and large unused interest tax shields, contradictory to the standard trade-off theory predictions. This correlation between future investment and profitability also weakens the puzzling negative correlation between leverage ratio and profitability (Frank and Goyal 2008). The analysis on convex capital adjustment costs is also closely associated with lower leverage and frequent equity financing activities in human capital intensive firms (Hall 2003). The results from fixed operating costs are consistent with the empirical findings of Kahl et al. (2012) as well.

This cross-sectional analysis also provides lucrative future research directions. Even though my cross-sectional results are all well aligned with the debt servicing cost predictions, other empirical approaches resolving endogeniety issues will strengthen the validity of the debt servicing cost predictions. Furthermore, this analysis on the debt servicing cost predictions could be extended internationally. This liquidity consideration on capital structure policy is quite general to be tested for a different group of countries.

Chapter 3

Macroeconomic Conditions and Capital Structure Dynamics

3.1 Introduction

The financial crisis of 2008 reaffirms that economic contractions critically affect an individual firm's investment needs, profits, and external financing conditions altogether. Practitioners widely recognize these macroeconomic conditions as key determinants in their financing policies. A primary goal of chief financial officers is to maintain financial flexibility, so they do not need to shrink their business in downturns (Graham and Harvey 2001). Financially constrained firms, indeed, cut their investments sharply and had substantial difficulties to access external financing markets in the financial crisis of 2008 (Campello, Graham, and Harvey 2011).

Yet, little theoretical inquiry explores how these simultaneous changes in investment needs, profitability, and external financing conditions shape the cyclical variations of capital structure policies. Indeed, research to date has largely ignored the following related questions: What factors drive empirically observed counter-cyclical debt policy and pro-cyclical equity issues? How do investment dynamics influence the issuance of debt and equity? How does a large value of liquidity in economic downturns change debt policies during economic upturns? What are the implications of stochastic external financing conditions on capital structure dynamics?

I develop and estimate a new dynamic corporate model with macroeconomic conditions to address these questions. My model builds on recent dynamic trade-off models with precautionary cash holding (Lee 2013; Gamba and Triantis 2008), mainly by adding macroeconomic profitability and financing cost shocks. A firm makes investment, cash retention, capital structure, and payout decisions. Both macroeconomic and idiosyncratic profitability shocks affect the firm's profit generations in persistent ways. Macroeconomic conditions also influence the firm's external financing costs, which create the precautionary value of liquidity. Capital accumulation and resale are not perfectly flexible due to the organizational costs involved in investment decisions in my model.

Pro-cyclical profitability, investment dynamics, and stochastic external financing costs are all pivotal in the capital structure dynamics. Lower profitability in downturns contributes to counter-cyclical debt policy in a couple of ways. First, low operating profit generations directly limit the use of internal funds for aggressive debt retirements in economic downturns. Second, such lower profitability raises the marginal value of liquidity in contractions, leading to active debt retirements and restrained debt issues in economic upturns. Servicing debt obligations drains a firm's valuable liquidity and hence creates a liquidity cost associated with debt, i.e., 'debt servicing costs' (Bolton, Chen and Wang 2014; Lee 2013). To avoid large liquidity costs of debt during economic downturns, a manager has strong incentives to retire debt with ample operating profits, and to optimally limit debt issuance during economic upturns.

Next, investment dynamics drive the issuance of external debt and equity. In order to fund larger investment needs, a manager relies more heavily on external debt and equity issuance, ceteris paribus. The joint realization of profits and investment demands critically influences capital structure dynamics, unlike the standard trade-off theory predictions that focus primarily on profitability. This investment demand possibly induces active debt issues during economic downturns, which also contributes to counter-cyclical debt policy.

Counter-cyclical equity financing costs lead to pro-cyclical equity issues, and more counter-cyclical debt financing policy. A higher equity financing cost drives additional debt issues at external financing margins in economic downturns. It also raises the marginal value of liquidity, which, in turn, induces more conservative debt use in economic upturns. Pro-cyclical equity issues critically depend on this cyclical variation of equity financing costs as well; equity issues tend to be counter-cyclical under constant external financing conditions.

My quantitative analysis yields the following main results. First of all, equity issues are pro-cyclical and concentrated for small, low profit, and large investment demand firms in earlier stages of upturns. Lower capital accumulations during economic downturns leave a number of small firms in earlier stage of economic upturns. Even with low current profits, these small firms have large investment needs due to the decreasing returns to scale technology. To finance such endogenously large investment needs, small firms with low profits rely heavily on equity issuance; both large debt servicing costs predicted by currently low profits, and lower equity financing costs in upturns encourage equity financing at these external financing margins. These business cyclical property and firm characteristics of equity financing are consistent with recent empirical findings of Dittmar and Dittmar (2008) and Frank and Goyal (2003).

Second, my model generates a positive correlation between payouts and equity issues, and highlights the importance of stochastic equity financing costs in driving this positive correlation. Payouts move pro-cyclically and peak at later stages of economic expansions due to lower profitability in economic contractions and large investment needs in earlier stages of upturns. Counter-cyclical equity financing costs drive pro-cyclical equity issuance, resulting in a positive correlation with equity issues and payouts. Yet, constant external financing conditions lead to counter-cyclical equity issuance and consequently its negative correlation with payout. This business cyclical property of payout and its positive correlation with equity issuance are all consistent with Dittmar and Dittmar (2008).

Third, and unlike the standard trade-off theory predictions, my model generates counter-cyclical debt policies, and higher leverage ratios after debt issues and retirements during economic downturns. A firm encounters external financing margins frequently to fund operating needs for investment, even during economic downturns. Lower profitability in downturns raises the marginal value of liquidity, leading to active debt retirements and conservative debt issues in upturns. Such low profits limit aggressive debt retirements in downturns as well. These economic forces induce counter-cyclical debt policy, and, higher leverage ratios after debt adjustments in downturns, even under constant external financing conditions. Counter-cyclical equity financing costs strengthen the above counter-cyclical trends in debt policy. My model findings are consistent with the empirical work of Korajczyk and Levy (2003) documenting counter-cyclicality in actual and target leverage ratios.

Fourth, my comparative static analysis points to pro-cyclical debt financing policies for financially constrained firms. The flight-to-quality hypothesis predicts counter-cyclical debt financing costs for lower credit rating or more financially constrained firms. My model directly shows that counter-cyclical variations in debt financing costs drive pro-cyclical leverage ratios and net debt issues. This finding is in line with the empirical works of Eri, Julio, Kim and Weisbach (2011), and Korajczyk and Levy (2003); both studies document pro-cyclical debt policies for financially constrained firms.

Finally, my comparative static analysis also predicts pervasively conservative debt policies for the firms expecting financial market shutdowns, a sharp profitability drop, or a longer stay in economic downturns. All of these factors form an expectation of large debt servicing costs in economic downturns. Such large debt servicing costs endogenously limit debt issues during economic upturns, leading to pervasively conservative debt policy across the whole business cycle (Graham 2000). Furthermore, even a very highly profitable firm in expansions may maintain low leverage ratios due to a sharp drop of profitability in economic downturns; as such, a positive correlation between average profits and leverage ratios may no longer hold. This latter finding also provides a new insight on the puzzling negative correlation between profitability and leverage ratios (Frank and Goyal 2008).

My analysis contributes to the literature in several ways. Most of all, I highlight investment dynamics as a key determinant in the cyclical variations of debt and equity issuance. Lower profitability in economic downturns does not necessarily imply lower leverage ratios if operating needs for investment is considered. Low capital accumulations during economic contractions endogenously create a number of small, low profits and large investment demands firms in early stages of economic expansions, leading to active equity issuance. Next, I emphasize how a large value of liquidity in economic downturns affects corporate debt policies in economic upturns. Large debt servicing costs in contractions encourage debt retirements and discourage debt issues during expansions, which contributes to the counter-cyclical debt policy and pervasively conservative use of debt. Finally, my model stresses the significance of stochastic external financing conditions in a firm's financing policies. On the one hand, counter-cyclical equity financing costs are critical in pro-cyclical equity issuance and its positive correlation with payout. On the other hand, counter-cyclical debt financing costs lead to pro-cyclical debt policies, widely observed in financially constrained firms.

This joint consideration of investment dynamics, the marginal value of liquidity, and stochastic equity financing costs on the cyclicality of capital structure choice differs markedly from prior literature in a number of aspects. Bhamra, Kuehn, and Strebulaev (2010) investigate how infrequent leverage adjustments and macroeconomic risk jointly affect cyclical variations of leverage ratios. Yet, they pay little attention to investment decisions and their implications on the issuance of debt and equity. Bolton, Chen, and Wang (2013), and Eistfeld and Muir (2011) analyze how stochastic external financing costs affect internal and external financing policies but their models ignore the determinants of debt and equity financing. While my model emphasizes the implications of liquidity management on capital structure dynamics, macroeconomic models such as Jermann and Quadrini (2011), Hennessy and Levy (2007), and Covas and Den Haan (2011) stress contractual frictions between economic agents to address cyclical changes in external financing policies.

The next section introduces my model in detail. Section 3 studies the capital structure dynamics in my baseline model. Section 4 conducts comparative static analysis to obtain empirical predictions. Section 5 concludes.

3.2 Model

Macroeconomic shocks affect a representative firm's profitability and external financing costs. A manager decides the 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.

3.2.1 Macroeconomic States

A state variable, s , represents the state of aggregate economy. There are two macroeconomic states, economic expansion, $s = h$ and economic contraction, $s = l$. The transition between expansion and contraction states follows a Markov process. The transition probability matrix is denoted as :

$$\begin{pmatrix} p^{hh} & p^{hl} \\ p^{lh} & p^{ll} \end{pmatrix} \tag{3.1}$$

in which $p^{hh} + p^{hl}$ and $p^{lh} + p^{ll}$ are all equal to 1. p^{hl} points to the transition probability from economic expansions to economic contractions and p^{lh} indicates the transition probability in the other way around.

3.2.2 Profits and Investment

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

$$\pi(z, k; s), = z^s z k^\alpha - f \tag{3.2}$$

where α captures the returns to scale of the profit function. z^h is the realization of macroeconomic profitability shock in economic upturns and z^l represents its counterpart in economic downturns. The idiosyncractic profitability shock, z, follows an AR(1) process in logs:

$$\log z' = \rho \log z + \varepsilon \tag{3.3}$$

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:

$$I = k' - (1 - \delta)k, \tag{3.4}$$

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

$$G^k(k, I) = \gamma^k k 1_{I \neq 0} + \frac{\theta^k (I)^2}{k}, \tag{3.5}$$

where $1_{I \neq 0}$ is an indicator function, the value of which is equal to one if investment is nonzero, and zero otherwise. The capital adjustment cost is non-stochasitic because the source of this cost is mainly an individual firm's organizational capability. 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 DeAngelo, DeAngelo, and Whited (2011, hereafter DDW) for more detailed discussion for this formulation.

3.2.3 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:

$$b'(1+r) \leq c'(1+r) + (1-\delta)\,k' + \pi(z^{\min}, k'; s=l) - Tax(z^{\min}, k', b', c'; s=l), \qquad (3.6)$$

where $z^{\min}$ is the lower bound for the idiosyncratic 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. The minimum after tax profits are evaluated at the state of economic contraction that accompanies a lower aggregate profitability level, z^l.

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

$$G^b(b', b; s) = \psi^s b' + \eta^s\,(b' - b)\,1_{(b'-b)>0}, \qquad (3.7)$$

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^s (ψ^h, ψ^l) captures the magnitude of this baseline debt financing cost, which potentially varies with the macroeconomic state, s. The second term captures additional debt financing costs when a firm increases its net debt obligations $(b' > b)$, and η^s (η^h, η^l) represents the increment of marginal debt financing cost, which may depend on the state of business cycle, s, as well. This cost function reflects the convexity in debt financing costs (Altinkihc and Hansen 2000; Leary and Roberts 2005). See Gamba and Triantis (2008) for detailed discussion about this functional formulation.

3.2.4 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:

$$g = \pi(z, k; s) - \delta k - r(b - c). \tag{3.8}$$

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

$$Tax = \tau_c^+ g \mathbf{1}_{g \geq 0} - \tau_c^- g(1 - \mathbf{1}_{g \geq 0}), \tag{3.9}$$

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:

$$e(z, k, b, c; s) = \pi(z, k; s) + (b' - c') - (b - c)(1 + r) - I - Tax - G^b(b', b; s) - G^k(k, I). \tag{3.10}$$

External equity financing, $e < 0$, incurs time-varying linear flotation costs, $G^e(e; s)$:

$$G^e(e; s) = \phi^s e 1_{e<0}, \tag{3.11}$$

where $1_{e<0}$ is an indicator function that is equal to one if the firm issues equity, and zero otherwise. ϕ^s (ϕ^h, ϕ^l) captures marginal equity financing costs which rely on the realization of macroeconomic states, s. Hennessy and Whited (2005) adopt the linear function for their equity financing costs.

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

$$d(z, k, b, c; s) = (1 - G^e(e; s)1_{e<0})e, \tag{3.12}$$

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

$$V_0 = E\left[\sum_{t=0}^{\infty}\left(\frac{1}{1+r(1-\tau_i)}\right)^t d_t\right]. \tag{3.13}$$

The Bellman equation for the firm's equity value is

$$V(z, k, b, c; s) = \max_{k', b', c'} d(z, k, b, c, k', b', c'; s) + \frac{1}{1+r(1-\tau_i)} EV(z, k', b', c'; s'), \tag{3.14}$$

where the firm's optimal policy is subjected to the collateral constraint (3.6). See Hennessy and Whited (2005) for the contraction mapping property of this Bellman equation.

The model includes the following key elements: interest tax shields, liquidity management, endogenous investment, persistent macroeconomic and indiosyncratic profitability shocks, and capital adjustment costs. Macroeconomic states also affect the supply of credit, which potentially induces stochastic variations in equity and debt financing costs. Contrary to prior models, my model comprehensively incorporates the real and financing side implications of macroeconomic shocks - investment, profitability and external financing costs. For instance, Bharma et al. (2010) ignore the implications on investment dynamics on financing policies. Jermann and Quadrini (2011) pay little attention to the role of stochastic external financing costs. Furthermore, a manager's liquidity management is a key corporate policy in my model, which differs markedly from prior models.

3.3 Quantitative Analysis

3.3.1 Calibration

To precisely investigate quantitative implications of the model, I choose the baseline parameters via the simulated method of moments (SMM) by following DDW and Lee (2013). 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. The parameter ζ governs the size of the fixed operating costs.

In my baseline model, I set the debt financing cost parameters as time invariant ones, $\psi^h = \psi^l = \psi$ and $\eta^h = \eta^l = \eta$. As the flight to quality hypothesis predicts, an individual firm's debt financing cost variations depend on its characteristics such as credit ratings or

Table 3.1: Moments Selection: Acutal and Simulated Values

Variables	Actual Moments	Simulated Moments
Avg. Investment(I/k)	0.1341	0.1324
Avg. Leverage: Contraction $(b/k, s = l)$	0.2321	0.2331
Avg. Leverage: Expansion $(b/k, s = h)$	0.2213	0.2234
Avg. Tobin's q$(V + b - c)/k)$	1.7013	1.715
Avg. Profit (π/k)	0.1731	0.1748
Equity Fin. Freq: Contraction $(d < 0, s = l)$	0.0750	0.0752
Equity Fin. Freq: Expansion $(d < 0, s = h)$	0.1204	0.1244
Avg. Dividends $(d/k, d > 0)$	0.0374	0.0358
Var. Investment(I/k)	0.0225	0.0242
Var. Profit (π/k)	0.0045	0.0036
SerialCor. Profit (π/k)	0.6315	0.6296
Avg. Cash: Contraction (c/k)	0.1247	0.1267
Avg. Cash: Expansion (c/k)	0.1136	0.1152

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.

profit volatilities. For example, high credit rating firms may have lower debt financing costs during economic downturns due to the credit supplier's preference on safer assets. Dittmar and Dittmar (2008) also document relatively smaller cyclical variations in debt financing costs than equity financing costs. Thus, it is quite reasonable to set the representative firm's debt financing cost parameters as time invariant ones. I quantitatively analyze the implications of time varying debt financing costs in later sections.

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. 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 macroeconomic profitability in economic upturns, z^h, and economic downturns, z^l are fixed at 1.09 and 0.91 respectively, to reflect 18% profitability difference in public firms between two macroeconomic states. The transition probability from economic upturns to downturn, p^{hl}, is 0.2 to take account of the average duration of economic boom, 5 years. The transition probability from economic downturn to upturn is 0.5 similar to Bolton, Chen, and Wang (2013).

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 linear equity financing cost in economic expansions ϕ^h, and economic contractions ϕ^l; the constant baseline debt financing cost ψ and the additional debt financing cost η; and the fixed operating cost parameter ζ.

Table 3.1 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 moments consist of the first and second moments of investment and operating profits. The autocorrelation of operating profits, and the average dividends, and Tobin's q values are also included. The average of equity financing frequency, cash and leverage ratios are reported according to the business cyclical variations. This moment selection is closely related to the identification strategy of DDW and Lee (2013). Appendix contains detailed information about the model's identification, numerical solution, and SMM procedure.

Table 3.2 reports the baseline economic parameters estimated via the SMM procedure. The estimation results are consistent with the prior estimates. The persistency parameter ρ is 0.6891, the uncertainty parameter σ is 0.1763, and the returns to scale parameter α is

Table 3.2: Structural Parameter Estimation Results

ρ	σ	α	γ^k	θ^k	ϕ^l	ϕ^h	ψ	η	ζ	J-test (p-value)
0.6891	0.1763	0.7411	0.0088	0.1091	0.0365	0.0461	0.0012	0.0068	0.0273	0.1532

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. ϕ^l and ϕ^h are linear equity financing costs for economic downturns and upturns, respectively. ψ is the baseline debt financing cost and η 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.

0.7411, all of which are in line with DDW and Lee (2013). The fixed capital adjustment cost parameter γ^k is 0.0088 and the convex capital adjustment cost θ^k is 0.1091. Both parameters estimates are within economically reasonable ranges, as in DDW, Cooper and Haltiwanger (2006), and Whited (1992). The linear equity financing cost parameter of economic downturn, ϕ^l is 0.0316 and that of economic upturns, ϕ^h is 0.0465, both of which are smaller than the estimate of Hennessy and Whited (2005). The baseline debt issuance cost ψ^b is 0.12% for all proceeds. The maximum debt financing cost $\left(\psi^b + \eta^b\right)$ is 0.80% of debt proceeds, lower than the average debt issuance cost estimate in Altinkihc and Hansen (2000).

3.3.2 Equity Issues and Payouts

This section studies the cyclical variations of equity financing and payout policies in the baseline economy.

Table 3.3 provides a representative example of equity issuance and payout dynamics by examining a times series evolution of 3,000 firms. The economy starts from an economic contraction period ($t = -1$) and maintains economic expansions afterwards ($t = 0, 1, 2, 3$). The table reports aggregate dividends (payouts), equity proceeds, investments and profits for

Table 3.3: Equity Issue and Payout: An Example

Time Period	-1	0	1	2	3
Econ. State	Contraction	Expansion	Expansion	Expansion	Expansion
Equity Freq ($d_i < 0$)	0.085	0.167	0.165	0.141	0.127
Equity Issue$\left(\sum_i -d_{i,(d_i<0)}\right)$	0.370	1.000	0.936	0.781	0.728
Payout $\left(\sum_i d_{i,(d_i>0)}\right)$	0.565	1.000	0.994	1.013	1.060
Investment ($\sum_i I_i$)	0.806	1.000	0.915	0.913	0.873
Profits ($\sum_i \pi_i$)	0.809	1.000	1.025	1.028	1.033

This table reports aggregate equity issues, payout, investments, and profits for 2005 years simulations of 3000 firms. Initial 2000 years simulations are dropped for stationarity. All of the four variables are normalized by their values at time 0. The table also includes equity financing frequency for each time period. Macroeconomic state is initially contraction at time -1 but remains expansion afterwards.

each time period. All variables are standardized by their values at the beginning of economic expansion ($t = 0$). For instance, the equity issues at period 1 is 93.6% of equity issues at period 0. The table also includes the equity financing frequency for the cross-section of 3,000 firms.

Table 3.3 shows that equity financing activities are concentrated in early stages of economic upturns and that payouts expand over economic upturns. Both equity financing frequency and equity proceeds are quite low at the economic contraction, $t = -1$. (row 1 and 2) These two measures surge at the initial period of the economic upturn ($t = 0$) but decrease monotonically over the economic expansion periods ($t = 1, 2, 3$). For instance, the equity financing frequency of the period 3 drops by more than 25% compared to that of the period 0. The payout stays low at the economic downturn ($t = -1$, row 3). Yet, the payout significantly grows at the beginning of economic expansion ($t = 0$) and gradually increases afterwards ($t = 1, 2, 3$). For example, the payout of the period 3 is 6% larger than that of the period 0.

The patterns of equity issues and payout are closely associated with the joint dynamics

Table 3.4: Equity Financing Firm Characteristics: An Example

Time Period	0	1	2
Econ. State	Expansion	Expansion	Expansion
Rel. Investment (I/k)	1.265	1.446	1.128
Rel. Profits (π/k)	0.884	0.881	0.805
Rel. Cash (c/k)	0.974	1.242	1.668
Rel. Leverage (b/k)	0.622	0.540	0.669
Rel. Size (k)	0.820	0.795	0.746

This table reports the relative size of investments, profits, cash, leverage, and size of equity issuing firms compared to an average firm of each time period. All samples are selected from the simulation of Table 3.3

of investment demands and profits. While aggregate investment decreases over the economic expansion, total profits generally grow over the expansion periods ($t = 0, 1, 2, 3$). With large investment needs and low profits, these firms appear to issue equity frequently in earlier stages of economic expansions. Yet, such large capital accumulations diminish investment needs and realize ample operating profits in later stages of economic upturns. These firms try to payout a significant amount of money as dividends in later stages of upturns.

Table 3.4 documents the characteristics of equity financing firms for the time period of 0, 1, and 2. The table reports the investment, leverage, profits, liquidity, and size of equity financing firms for each time period, from the simulation of Table 3.3. Each firm characteristic is normalized by the cross-sectional average value of all 3,000 firms for each time period. For instance, the relative investment of equity financing firms at period 0 is 1.26, which indicates their investment demands are 26% larger than an average firm's investment at period 0.

Table 3.4 reveals the characteristics of equity issuance firms. The table shows that small, low profitable firms with large investment issue equity frequently. For instance, the investment demands of equity financing firms at period 0 are more than 20% larger than that of the average firm. Yet, their profitability is 12% smaller and their size is 20% smaller than those of the average firm. Even with a relatively low current profitability realization, a small size firm possibly has large investment demands due to the DRS profit technology. Such large investment needs and low profits drive the firm toward external financing margins. Due to the large debt servicing costs and low tax benefits predicted by currently low operating profits, the firm tends to rely substantially on equity issuance.

Lower capital accumulations during economic downturns and counter-cyclical external equity financing costs lead to such concentrations of equity issuance in early stages of upturns. As indicated in Table 3.4, economic downturns involve low capital accumulations, which leaves a number of small firms in early stages of expansions. With lower equity financing costs in upturns, these small firms with low profits tend to use equity financing quite frequently for their investment.

This finding highlights the importance of investment dynamics on equity issuance decisions. To fund large investments with low profits, small firms tend to rely heavily on equity issuance. Relatively low capital accumulations in downturns endogenously create such external financing margins intensively in early stages of economic upturns. This finding is contradictory to the standard trade-off theory predictions, which emphasize lower profitability and large debt obligations as main economic forces behind equity financing.

Table 3.5 compares the cyclicality of equity issues and payouts between the baseline economy and an economy with constant external financing conditions. The table reports equity proceeds, payouts and the frequency of equity financing for economic contractions, economic expansions, and the start and the end of economic expansions. Payouts and equity proceeds are standardized by the average values at the start of economic upturns, as in Table 3.3. This table also documents the correlation between payout and equity issue series.

The baseline model of Table 3.5 yields very similar cyclical variations in equity issuance

Table 3.5: Equity Issue and Payout Dynamics

Panel A. Baseline

Econ State	Contraction	Expansion	Start-Expan.	End-Expan.
Equity Freq ($d_i < 0$)	0.074	0.123	0.141	0.118
Equity $\left(\sum_i -d_{i,(d_i<0)}\right)$	0.516	0.816	1.000	0.765
Payout $\left(\sum_i d_{i,(d_i>0)}\right)$	0.630	1.009	1.000	1.012
Corr(Payout, Equity)		0.426		
Panel B. Constant External Financing				
Equity Freq ($d_i < 0$)	0.090	0.082	0.095	0.079
Equity $\left(\sum_i -d_{i,(d_i<0)}\right)$	1.007	0.842	1.000	0.797
Payout $\left(\sum_i d_{i,(d_i>0)}\right)$	0.575	1.031	1.000	1.041
Corr(Payout, Equity)		-0.555		

This table documents aggregate equity issues, aggregate payout, and equity financing frequency from 5,000 years simulations of 3000 firms. Initial 2000 years simulations are dropped for stationarity These variables are documented according to four phases of business cycle- contraction, expansion, the start of expansion and the end of expansion. Aggregate equity and payout are normalized by those values at the start of expansion. Panel A summarizes the baseline model simulation results and Panel B.

and payout polices as a representative simulation of Table 3.4 does. All of equity financing frequency, equity proceeds and payouts move pro-cyclically. Firms use equity financing most frequently and collect the largest sum of equity proceeds in the earliest stage of economic upturns (row 1, 2). At the end of economic upturns, firms pay out the largest amount of money to shareholders. They also issue less equity than they did in earlier stages of economic upturns. The table points out a positive correlation between payout and equity issuance (0.5455) as well.

Yet, the model with time invariant external financing conditions generate contradicting results. Both of equity financing frequency and equity proceeds move counter-cyclically in contrast to the benchmark economy. The frequency of equity financing in economic downturns is slightly greater and the amount of equity proceeds is 35% greater than their counterparts in economic upturns (row 1, 2). This countercyclical variation in equity proceeds drives a negative correlation between equity issuance and payout under the economy with constant external financing conditions.

This result highlights the importance of counter-cyclical equity financing costs in payout and equity issue dynamics. The counter-cyclical variation drives pro-cyclical equity issues, which leads to a positive correlation between equity issuance and payout. Table 3.5 clearly indicates that equity issues tend to move counter-cyclically under constant external financing conditions, consistent with the standard trade-off theory predictions. Due to large debt servicing costs and lower tax benefits, a firm generally has stronger equity financing incentives in economic downturns, under time invariant external financing conditions.

These findings are all in line with recent empirical findings. Ditmmar and Ditmmar (2008) document that public firms tend to issue equity in early stages of economic boom and increase payouts (share repurchase) in later stages, observations which are exactly consistent with the findings in Table 3.3 and 3.5. They also show that the correlation between aggregate equity issuance and share repurchase is positive, which is also in line with the correlation result of my baseline model. Equity financing is more likely to occur in small growth firms that generate lower operating profits (Frank and Goyal 2003). These firm characteristics are well matched with the findings in Table 3.4.

To sum up, this section presents two interesting findings. First, endogenous investment needs drive active equity issues for small, low profitable, and large investment needs firms in earlier stages of economic upturns. This finding is contradictory to the standard trade-off theory predictions primarily focusing on a firm's profitability. Second, counter-cyclical equity financing costs drive pro-cyclical equity issues, leading to a positive correlation between payout and equity issuance.

Table 3.6: Firm Characteristics: Deb Issuance and Retirement

	Debt Issuance ($b' > b$)		Debt Retirement ($b' < b$)	
Econ State	Contraction	Expansion	Contraction	Expansion
Rel. Investment (I/k)	2.872	2.275	0.000	0.007
Rel. Profits (π/k)	1.465	1.386	0.810	0.779
Rel. Cash (c/k)	0.324	0.225	0.836	1.066
Rel. Leverage (b/k)	0.992	0.965	1.390	1.373
Investment (I/k)	0.324	0.314	0.000	0.001
Profits (π/k)	0.218	0.259	0.121	0.145
Cash (c/k)	0.041	0.027	0.102	0.126
Leverage (b/k)	0.228	0.219	0.319	0.312
Next Period Lev. (b'/k')	0.311	0.271	0.258	0.226

This table reports investments, profits, cash and leverage from 3,000 years simulations of 3000 firms. All values are reported for debt issuance and debt retirements firms according to macroeconomic states. The first four rows document relative ratio between these variables and their counterparts in an average firm. The next four rows summarize the absolute value of each variable. The last row reports next period leverage ratios.

3.3.3 Debt Dynamics

This section analyzes the cyclical variations of debt financing policies in my baseline model.

Before entering the analysis of debt dynamics, Table 3.6 summarizes the characteristics of debt issuance and debt retirement firms in my baseline model simulation of 3,000 firms. The table reports investment, profit, cash and leverage ratios according to the macroeconomic states. The first four rows compare these firm characteristics with their counterparts in an average firm for each cross-section. For instance, debt issuance firms' cash-asset ratio (row 3) is 32.4% of an average firm's cash-asset ratio. The next four rows document absolute values of investment, profit, cash, and leverage ratios for debt issuance and retirement firms. The last row reports next period leverage ratios as well.

Table 3.6 clearly points to the importance of investment dynamics in debt issuance decisions. While the profitability of debt issuance firms is around 40% greater than that of an average firm, their investment demand is 2.5 times of an average firm's investment needs (row 1, 2). Such large investment needs over operating profits endogenously create substantial external financing demands, especially for low cash holding firms (row 3). These firms tend to rely heavily on debt issuance because currently high profitability predicts large future profit generations that accompany large tax benefits, and low liquidity costs of debt, i.e. debt servicing costs.

Table 3.6 also indicates the significant role of investment demands on debt retirement policies. The debt obligations of debt retirement firms are almost 40% larger than that of an average firm (row 4). Yet, they have almost zero investments, which allow an easier use of operating profits and internal funds for retiring debt obligations.

It is also noticeable that the leverage ratios after debt issuance or retirement are higher during economic downturns even with pro-cyclical macroeconomic profitability variations (row 9). For instance, leverage ratio after debt issuance is 0.31 during economic downturn but is 0.27 during economic upturns. To fund quite large operating needs for investment, a firm considerably relies on debt financing even during economic downturns. Relatively low operating profits (row 6) deter aggressive use of internal funds for debt retirements, leading to higher leverage ratios after debt retirement in economic downturns. Counter-cyclical equity financing costs, of course, contribute to more aggressive debt issues during economic downturns. Yet, these aggressive debt policies in downturn still hold for constant external financing condition economy, even though the detailed results are not reported here.

These firm characteristics highlight the importance of investment dynamics on debt issuance and retirement decisions, in contrast to the standard trade-off theory predictions. The standard trade-off theory almost entirely relies on a firm's profitability in the determination of leverage dynamics. Yet, a firm critically relies on debt issuance to fund operating needs for large investment, particularly with low levels of cash. Lower investment demands

Table 3.7: Debt Dynamics

Equity Cost: Contraction	Baseline		$\phi^l = \phi^h$	
Econ State	Contraction	Expansion	Contraction	Expansion
Leverage ($\sum_i b_i / \sum_i k_i$)	0.230	0.227	0.229	0.227
Equity Freq ($d < 0$)	0.074	0.123	0.119	0.112
Debt Issue ($\sum_i b' - b)/(\sum_i I)$, $b' > b$	0.249	0.176	0.238	0.177
Debt Retirement ($\sum_i b' - b)/(\sum_i I)$, $b' < b$	0.224	0.184	0.231	0.179
Net Debt Issue ($\sum_i b' - b)/(\sum_i I)$	0.025	-0.008	0.008	-0.002

This table reports aggregate leverage, debt issues, debt retirement, and net debt issues for the baseline and a constant external financing cost economy ($\phi^l = \phi^h$) from 3,000 years simulations of 3000 firms. It also includes the frequency of equity financing. All values are documented according to the business cyclical states.

also allow flexible use of internal funds to retire debt obligations given the same profitability.

Table 3.7 investigates debt and equity policies across the business cycle for the baseline economy and an economy with constant external financing conditions ($\phi^l = \phi^h$). The table reports aggregate leverage ratio, debt issues, debt retirements and net debt issues. It also documents the frequency of equity financing. All values are evaluated in accordance with the macroeconomic states. The debt issues, retirements, and net debt issues are standardized by the sum of investment for each time period. This standardization reflects the importance of investment dynamics on debt issuance as analyzed in Table 3.6.

Table 3.7 clearly indicates counter-cyclical variations in debt policies. Both leverage ratio and net debt issuance (row 1, 5) show weakly counter-cyclical movements, contradictory to the standard trade-off theory predictions. For example, the aggregate leverage ratio is 0.23 in economic downturns but slightly goes down to 0.227 in economic upturns. The same pattern holds for aggregate net debt issues. Furthermore, the aggregate debt issuance-investment ratio is even larger during economic downturns (row 3), which points to a significant role of debt issuance for funding investments.

This counter-cyclical debt policy is not a mere result of counter-cyclical equity financing costs. The constant external financing cost economy in Table 3.7 still shows weakly counter-

Table 3.8: Debt Dynamics: Low Debt Financing Costs

Equity Cost: Contraction	Baseline		$\phi^l = 0.3$	
Econ State	Contraction	Expansion	Contraction	Expansion
Leverage ($\sum_i b_i / \sum_i k_i$)	0.871	0.864	0.788	0.764
Equity Freq ($d < 0$)	0.229	0.125	0.008	0.160
Debt Issue ($\sum_i b' - b)/(\sum_i I)$, $b' > b$	0.533	0.473	0.676	0.467
Debt Retirement ($\sum_i b' - b)/(\sum_i I)$, $b' < b$	0.672	0.440	0.477	0.547
Net Debt Issue ($\sum_i b' - b)/(\sum_i I)$	-0.139	0.032	0.199	-0.080

This table reports aggregate leverage, debt issues, debt retirement, and net debt issues for the baseline and higher equity financing cost model ($\phi^l = 0.3$) from 3,000 years simulations of 3000 firms. Debt financing costs (ψ, η) are set to $(0.0005, 0.0005)$. It also includes the frequency of equity financing. All values are documented according to the business cyclical states.

cyclical leverage ratios and net debt issuance patterns (row 1, 5). The leverage ratio is slightly higher and the amount of net debt issues is also slightly larger in economic downturns.

Lower profitability and consequently a higher value of liquidity play central roles in this counter-cyclical debt policy. As indicated in Table 3.6, lower profitability in economic downturns limits aggressive debt retirements during economic downturns. Furthermore, a higher value of liquidity or large debt servicing costs in economic downturns induce active debt retirements and conservative debt issues in economic upturns. A manager has strong incentives to retire debt obligations by using ample operating profits in economic upturns, with the expectation of a highly valuable liquidity in downturns. She also limits the issuance debt in anticipation of large debt servicing costs during economic downturns. All of these factors contribute the counter-cyclical movements in debt policies.[1]

Table 3.8 simulates models under an economic environment with low debt financing costs. The marginal equity financing cost in economic downturns is identical to the baseline model in the first scenario, and quite higher in the second scenario. The table documents aggregate leverage ratio, debt issues, debt retirements and net debt issues according to the

[1] I will mainly investigate how debt servicing costs in downturns affect a firm's capital structure dynamics in my comparative static analysis.

macroeconomic states. It also documents the frequency of equity financing. Debt issues, retirements, and net debt issues are standardized by total investments for each time period as in Table 3.7.

Table 3.8 emphasizes the "timing" aspect of debt retirement policies. Debt retirements in economic upturn arise sharply from 0.44 to 0.54 with a substantial increase of equity financing costs in economic downturns. Debt retirements in downturns rather decrease substantially from 0.67 to 0.47, given the same external equity financing cost changes. Low debt financing costs imply relatively lower costs of maintaining debt obligations. A manager could easily “time” debt retirements with such low debt financing costs. A higher external equity financing cost raises the marginal value of liquidity in downturns and accordingly the manager tries to retire debt obligations with ample operating profits in economic upturns.

It is also remarkable that the leverage ratios drop substantially in the higher equity financing cost case. For instance, the leverage ratio of economic downturn in the first scenario is 0.86 but decrease to 0.76 in the second simulation. A higher equity financing cost implies a large marginal value of liquidity and consequently large debt servicing costs in economic downturns. To avoid such large debt servicing costs, a firm optimally maintains lower leverage ratios, as in Lee (2013).

The joint considerations of investment dynamics, pro-cyclical profitability, and stochastic equity financing costs are pivotal in the counter-cyclical debt policies. A firm may have to use external debt issuance frequently to fund its operating needs for investments, even during economic downturns. Lower profitability raises the marginal value of liquidity during economic downturns, which encourages active debt retirements and discourages debt issues during economic upturns. This lower profitability also limits the use of internal funds for retiring debt obligations during economic downturns. Higher equity financing costs induce additional debt issues at such external financing margins, and increase the marginal value of liquidity more significantly in economic downturns.

To summarize, my model highlights investment demand as a main economic force behind debt issuance. It also generates counter-cyclical debt policies, and higher leverage ratios after debt issuance and retirement during economic downturns, contradictory to the standard trade-off theory predictions. Operating needs for investment, pro-cyclical profitability, and counter-cyclical equity financing costs all contribute to these cyclical properties of debt financing policies.

3.4 Quantitative Analysis: Comparative Statics

3.4.1 Counter-cyclical Debt Financing Costs

This section analyzes how counter-cyclical variations of external debt financing costs affect capital structure dynamics.

The flight to quality hypothesis predicts that an individual firm's credit quality is an important determinant in its debt financing cost variation. For instance, Caballelo and Krishmamurthy (2008) argue that investors become more risk averse in poor macroeconomic conditions, which shifts their preference toward safer assets. Hence, the hypothesis predicts that a lower credit rating firm may access the debt financing market very limitedly during economic downturns. Recent survey works of Campello, Graham, and Harvey (2011) indeed document higher external financing costs for financially constrained firms in the financial crisis of 2008.

To examine the implications of limited access to the debt financing market during economic downturns, Table 3.9 simulates an individual firm at three different levels of debt financing costs in economic downturns. The first scenario deals with an economy with pro-cyclical debt financing costs. Debt financing cost parameters change to moderately counter-

Table 3.9: Counter-cyclical Debt Financing Costs

(ψ^l, η^l)	$0.75 \times (\psi^h, \eta^h)$		$1.5 \times (\psi^h, \eta^h)$		$2 \times (\psi^h, \eta^h)$	
Econ State	Contraction	Expansion	Contraction	Expansion	Contraction	Expansion
Leverage (b/k)	0.301	0.278	0.126	0.145	0.076	0.107
Equity Freq $(d < 0)$	0.061	0.132	0.153	0.136	0.163	0.134
Net Debt Issue $((b' - b)/k)$	0.011	-0.003	-0.009	0.005	-0.015	0.008

This table reports leverage ratio, equity financing frequency and net debt issues from 52000 years simulations of a firm, according to macroeconomic states. Initial 2000 years of simulations are dropped for stationarity. The results are evaluated at three different levels of debt financing costs in economic downturns.

cyclical in the second case and become strongly counter-cyclical in the last scenario. An individual firm's leverage ratios, net debt issues, and equity financing frequency are reported according to the macroeconomic states.

Table 3.9 clearly points out that a counter-cyclical debt financing cost leads to more pro-cyclical debt financing policies. As counter-cyclicality of debt financing costs increases, both leverage ratios and net debt issue become more pro-cyclical (row 1, 3). For instance, the leverage ratio is higher in economic downturns for the first scenario. Yet, the other two cases show pro-cyclical leverage ratio variations (row 1).

This pro-cyclical debt policy is consistent with recent empirical findings. Korajyak and Levy (2003) document pro-cyclical target leverage ratios for financially constrained firms. My model successfully shows that counter-cyclical debt financing costs could drive such pro-cyclical leverage ratios. Moreover, Covas and Den Haan (2011) report more pro-cyclical debt issues in smaller size firms. Reflecting the fact that the size of firm is a widely used proxy for financial constraint, my simulation results are well aligned with Covas and Den Haan (2011). Eli, Julio, Kim and Weisbach (2011) also documents counter-cyclical debt issues for financially constrained firms.

This section suggests counter-cyclical debt financing cost variations as a potentialreason behind pro-cyclical debt policies for financially constrained firms. The flight to the qual-

Table 3.10: Financial Market Shutdowns

(ψ^l, η^l) *at* $\phi^l = 0.3$	$0.75 \times (\psi^h, \eta^h)$		$1.5 \times (\psi^h, \eta^h)$		$2 \times (\psi^h, \eta^h)$	
Econ State	Contraction	Expansion	Contraction	Expansion	Contraction	Expansion
Leverage (b/k)	0.311	0.266	0.140	0.140	0.081	0.099
Equity Freq $(d < 0)$	0.000	0.145	0.000	0.150	0.000	0.156
Net Debt Issue $((b' - b)/k)$	0.017	-0.005	-0.003	0.003	-0.008	0.006

This table reports leverage ratio, equity financing frequency and net debt issues from 52000 years simulations of a firm, according to macroeconomic states. Initial 2000 years of simulations are dropped for stationarity. The results are evaluated at three different levels of debt financing costs in economic downturns at $\phi^l = 0.3$.

ity hypothesis predicts more counter-cyclical debt financing cost variations for financially constrained firms due to the shift of credit supply toward safer assets. My model directly generates pro-cyclical debt policies under counter-cyclical variations in debt financing costs.

3.4.2 Financial Market Shutdowns

This section investigates the potential implications of financial market shutdowns in economic downturns on a firm's capital structure choices.

Table 3.10 summarizes the potential effects of financial market shutdowns. While the debt financing costs in each scenario is identical to their counterparts in Table 3.9, I set equity financing costs in downturns as 30% of equity proceeds to induce quite strong counter-cyclicality for equity financing costs. As in Table 3.9, an individual firm's leverage ratios, net debt issues, and equity financing frequency are reported according to the macroeconomic states.

Table 3.10 indicates that the expectation of financial market shutdowns potentially drive a conservative debt policy during economic upturns. As external financing conditions become more deteriorated in economic downturns, leverage ratios decrease substantially (row 1) and equity financing frequency increases slightly during economic upturns (row 2). For instance, the leverage ratio of economic upturns is initially 0.266 but drops significantly to 0.099 in the third case (row 1). Furthermore, all of the leverage ratios during economic upturns slightly lower than their counterparts in Table 3.9. Financial market shutdowns imply large debt servicing costs in economic downturns, leading to more conservative debt issues in economic upturns.

This finding is closely associated with the debt conservatism puzzle (Graham 2000). The considerations of financial market shutdowns during economic downturns limit the use of debt financing in economic upturns. Therefore, a firm may appear to use debt conservatively across the whole period of business cycle.

To sum up, the expectation of financial market shutdowns in economic downturns leads to conservative debt policy during economic upturns, which potentially drives a pervasively conservative debt policy. The expectation of large debt servicing costs plays the central role here.

3.4.3 Deeper Economic Downturns

This section studies the role of deeper economic downturns on capital structure dynamics. For this purpose, I conduct two comparative static analyses. First, I increase the macroeconomic profitability difference between economic expansion and contraction states. Second, I extend the duration of economic downturns.

Table 3.11 summarizes the financing and investment policies for two different scales of macroeconomic profitability shock variations. The macroeconomic profitability of economic upturns, z^h, is 1.05 and that of downturns, z^l, is 0.95 in the first economy. These values are 1.2 and 0.8 respectively in the second scenario. Table 3.11 reports the average leverage ratio and profitability over the whole business cycle. It also documents investment, operating profits, cash, leverage and equity financing frequency in accordance with the macroeconomic states.

Table 3.11: A Sharper Difference in Aggregate Profitability

(z^l, z^h)	Small: (0.95,1.05)		Large: (0.8,1.2)	
Profits (π/k)	0.173		0.188	
Leverage (b/k)	0.278		0.142	
Econ State	Contraction	Expansion	Contraction	Expansion
Investment (I/k)	0.120	0.136	0.071	0.156
Profits (π/k)	0.158	0.179	0.107	0.220
Cash (c/k)	0.114	0.111	0.119	0.104
Leverage (b/k)	0.280	0.278	0.142	0.142
Equity Freq ($d < 0$)	0.076	0.188	0.107	0.077

This table reports financing and investment variables from 52000 years simulations of a firm, for two different magnitude of aggregate profitability differences. Initial 2000 years of simulations are dropped for stationarity. First two rows report operating profits and leverage ratio over the whole business cycle. Investments, operating profits, cash, leverage and equity financing frequency are separately documented for economic contraction and expansion periods.

Table 3.11 points out that a sharp drop in profitability during economic downturn could drive a conservative debt policy over the whole business cycle. Even though the average profitability increases by 10% (0.173 $\rightarrow$ 0.188), the average leverage ratio decreases sharply (0.278 $\rightarrow$ 0.142). It is also remarkable that firms expecting a sharp drop in profitability maintain lower leverage ratios (0.278 $\rightarrow$ 0.142) during economic upturns even with a substantial increase in their average profitability (0.179 $\rightarrow$ 0.220). Lower profitability generates large debt servicing costs in economic contractions, which restrains debt issuance during economic upturns as well as downturns.

Table 3.12 documents the financing and investment policies for two different durations of economic downturns. The transition probability from downturns to upturns, p^{lh}, is 0.4 and the duration of economic downturn is 1.67 years (1/0.6) in the first scenario. The probability and duration become 0.2 and 5 years (1/0.2) respectively in the second model simulation. Table 3.12 reports the average leverage ratio and profitability over the whole business. It also documents investment, operating profits, cash, leverage and equity financing frequency

Table 3.12: A Longer Duration of Economic Contraction

Transition Probability	p^{lh}= 0.4		p^{lh}= 0.8	
Profits (π/k)	0.177		0.169	
Leverage (b/k)	0.260		0.151	
Econ State	Contraction	Expansion	Contraction	Expansion
Investment (I/k)	0.121	0.135	0.105	0.159
Profits (π/k)	0.149	0.186	0.150	0.188
Cash (c/k)	0.123	0.121	0.147	0.107
Leverage (b/k)	0.262	0.259	0.145	0.156
Equity Freq ($d < 0$)	0.065	0.113	0.172	0.183

This table reports financing and investment variables from 52000 years simulations of a firm, for two different durations of economic downturns. Initial 2000 years of simulations are dropped for stationarity. First two rows report operating profits and leverage ratio over the whole business cycle. Investments, operating profits, cash, leverage and equity financing frequency are separately documented for economic contraction and expansion periods.

according to the macroeconomic states.

Table 3.12 also suggests that the expectation of deeper economic downturns limits the use of debt over the whole business cycle. The average leverage ratio drops substantially ($0.260 \rightarrow 0.151$) in spite of a moderate drop in average profitability between two simulations ($0.177 \rightarrow 0.169$). Similar to the results of Table 3.8, a firm with a longer duration of economic downturns maintains lower leverage ratios even during economic upturns ($0.259 \rightarrow 0.156$). These firms rather rely more heavily on equity issuance even during economic upturns, compared to their counterparts in the first scenario ($0.113 \rightarrow 0.183$).

These findings provide new insights on the debt conservatism (Graham 2000) and the puzzling negative correlation between profitability and leverage ratios (Frank and Goyal 2008). A manager may exercise pervasively conservative debt policy across the business cycle due to large debt servicing costs from a sharp profit drop or a longer stay in economic downturns. Moreover, even a very highly profitable firm in economic expansions possibly maintains lower leverages because of a sharp profitability drop and large debt servicing costs in economic contraction. Therefore, a firm's profitability does not necessarily move positively with leverage ratios, unlike the standard trade-off theory predictions. With the expectation of large debt servicing costs, a manager also relies more substantially on equity financing as expected in Lee (2013).

To sum up, my model shows the expectation of deeper economic downturns leads to more conservative debt policy over the whole business cycle. Lower profitability in economic downturns predicts more conservative debt policy during economic upturns, even with a higher average profitability. A longer duration of economic downturn also drives more conservative debt policy and frequent equity financing activities during economic upturns. These macroeconomic considerations possibly lead to pervasively conservative debt policy (Graham 2000) and a negative correlation between profitability and leverage ratios (Frank and Goyal 2008).

3.5 Concluding Remarks

Macroeconomic conditions affect a firm's investment demands, profitability, and external financing conditions altogether. I studied how these simultaneous changes impact cyclical variations in capital structure policies. Lower profitability in downturns, investment dynamics, counter-cyclical equity financing costs are all pivotal in the capital structure dynamics. Lower profitability increases the marginal value of liquidity in downturns leading to active debt retirements and limited debt issues in upturns. Investment demands drive active debt issues even during economic downturns. Counter-cyclical equity financing costs induce pro-cyclical equity issues and intensify counter-cyclical movements in debt policies.

In line with recent empirical findings, my baseline model generates counter-cyclical debt policy and pro-cyclical patterns of equity issues and payout. In particular, equity issues are concentrated for small, low profitable, large investment demand firm in early stages of upturns. Low capital accumulations in downturns lead to this business cyclical property. Payouts peak in later stages of economic upturns due to the lower profitability in downturn and large investment demands in early stages of upturns. Leverage ratios after debt issues and retirements are even higher in economic downturns, unlike the standard trade-off theory predictions. These business cycle properties in debt, equity and payout policies are all consistent with empirical works of Dittmar and Dittmar (2008) and Korajczyk and Levy (2003).

My comparative static analysis also predicts pro-cyclical debt policies for financially constrained firms and pervasively conservative debt policies for firms expecting financial market shutdowns, a sharp profitability drop and a longer stay in economic downturns. The flight to quality hypothesis expects more counter-cyclical debt financing cost variations for financially constrained firms, which leads to pro-cyclical debt policies in my model. Financial market shutdowns, a sharp profitability drop, and a longer stay in economic downturns all indicate large debt servicing costs, leading to pervasively conservative debt policy across the whole business cycle. These findings provides new insights on the pro-cyclical debt policy in financially constrained firms Korajczyk and Levy (2003), and Covas and Den Haan (2011) , debt conservatism (Graham 2000), and puzzling negative correlation between profitability and leverage ratios (Frank and Goyal 2008).

My study provides several fruitful opportunities for future research. The endogenous determination of risk premium is an important topic. Counter-cyclical credit spread variations are widely recognized in empirical studies but largely unexamined in this study. The examination of an individual firm's market timing aspect is another direction. I mainly consider stochastic variation of external financing conditions according to the business cyclical states. Yet, my model does not incorporate potential market timing opportunities relying on an individual firm's valuation. The combinational effects of macroeconomic and individidual market timing aspects may have substantial implications on a firm's capital structure dynamics.

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Appendix A

Data Description

A.1 Data Description: Structural Estimation

Table A.1.1: 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))

The table A.1.1 reports 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.

The business cyclical categorization in Chapter 3 is based on US Business Cycle Expansions and Contractions.

A.2 Data Description: Cross-sectional Analysis

I introduce several control variables for empirical analyses on capital structure choices, as proposed in Frank and Goyal (2008). Some variables are redefined by following prior literature. Table A.1.2 reports the detailed variable constructions.

Table A.2.1: 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))

Appendix B

Numerical Solutions

B.1 Numerical Solutions: Chapter 1

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 profitability 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$(\bar{b})$ 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 $[0, \bar{c}]$.[1]

B.2 Numerical Solutions: Chapter 3

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 individual profitability shock (z) is modelled to have 8 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. There are two macroeconomic states z^h and z^l as well with the transition probability defined in the main body. The upper bound for debt balance$(\bar{b})$ 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 $[0, \bar{c}]$.

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

Appendix C

Identification: Chapter 3

The global identification of a SMM 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 correctly identify structural parameters, I pick up the following 13 moments; these moments consist of the first and second moments of investment and operating profits. The autocorrelation of operating profits, and the average dividends, and Tobin's q values are also included. The average of equity financing frequency, cash and leverage ratios are reported according to the business cyclical variations. My identification scheme is closely associated with the identification strategy of DDW because I fix the macroeconomic transition probability and profitability realizations. The average and variance of investment help identify the capital adjustment cost parameters, γ^k and 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 cost parameter, ζ. A higher α raises average profit $(zk^\alpha - \zeta k^{ss}/k)$ and a higher fixed operating cost parameter, 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 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 over the macroeconomic states help the identification of time-varying equity financing costs, ϕ^h and ϕ^l. The leverage ratios in economic upturns and downturns help pin down the baseline debt financing cost, ψ and the additional financing cost component, η. A large ψ decreases leverage ratios in economic downturn more substantially due to the lower interest tax shields in economic downturns. A large η conversely provides substantial incentives to maintain higher leverage ratios in economic downturns. The business cyclical variations of cash holding also assist the identification of two debt financing cost parameters by a similar reasoning.