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Innovative Applications of O.R.

Investment timing, debt structure, and financing constraints

Takashi Shibata [a,*], Michi Nishihara [b,c]

[a] Graduate School of Social Sciences, Tokyo Metropolitan University, 1-1 Minami-osawa, Hachioji, Tokyo 192-0397, Japan
[b] Graduate School of Economics, Osaka University, 1-7 Machikaneyama, Toyonaka, Osaka 560-0043, Japan
[c] Swiss Finance Institute, École Polytechnique Fédérale de Lausanne, 1015 Lausanne, Switzerland

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ABSTRACT

We introduce debt issuance limit constraints along with market debt and bank debt to consider how financial frictions affect investment, financing, and debt structure strategies. Our model provides four important results. First, a firm is more likely to issue market debt than bank debt when its debt issuance limit increases. Second, investment strategies are nonmonotonic with respect to debt issuance limits. Third, debt issuance limits distort the relationship between a firm's equity value and investment strategy. Finally, debt issuance limit constraints lead to debt holders experiencing low risk and low returns. That is, the more severe the debt issuance limits are, the lower are the credit spreads and default probabilities. Our theoretical results are consistent with stylized facts and empirical results.

1. Introduction

In the frictionless financial markets of Modigliani and Miller (1958), investment and financing decisions are completely separable. However, when we introduce financial frictions such as corporate taxes, bankruptcy costs, and financing constraints, there is no longer separability between a firm's investment and financing strategies. Since their seminal study, the corporate finance literature has highlighted the role of financial frictions between investment and financing decisions.[1]

Brennan and Schwartz (1984) and Mauer and Triantis (1994) examine the interaction between investment and financing decisions in contingent claim models. These models have two major limitations. First, there are no financial frictions. Second, the firm is financed by a single type of debt, not various debt structures. The drawback of treating corporate debt as uniform is highlighted by the fact that different types of debt instruments have quite different effects on investment strategies (see Bolton & Freixas, 2000; Hackbarth, Hennessy, & Leland, 2007; Rauh & Sufi, 2010).

Several recent studies have already begun the task of incorporating either financing frictions or various debt structures separately into investment timing decision (real options) models. Boyle and Guthrie (2003), Hirth and Uhrig-Homburg (2010), and Nishihara and Shibata (2013) examine investment timing decisions under internal financing constraints. Nishihara and Shibata (2010) and Shibata and Nishihara (2012) investigate investment timing strategies under debt financing constraints.[2] An interesting result among these earlier papers is that investment strategies are nonmonotonic with respect to financial frictions.[3] Alternatively, most models consider a firm with only market debt (a single type of debt), assuming that dispersion of creditors prevents debt reorganization during financial distress. In practice, a leveraged firm in financial distress can try to restructure its outstanding debt into a more affordable form. A model allowing for debt restructuring approximates a firm with bank debt (i.e., nonmarket debt).[4] Sundaresan and Wang (2007) derive investment strategies under various debt structures by considering debt reorganization strategies for a firm under financial distress. However, these strategies are derived independently of financing frictions.

In this paper, we assume that a firm can issue two classes of debt: bank and market debt. Following Bulow and Shoven (1978), Gertner and Scharfstein (1991), and Hackbarth et al. (2007), the only difference between bank and market debt is the bankruptcy procedure.[5]

* Corresponding author. Tel.: +81 42 677 2310; fax: +81 42 677 2298.
E-mail addresses: tshibata@tmu.ac.jp (T. Shibata), nishihara@econ.osaka-u.ac.jp (M. Nishihara).

[1] A partial list includes Fazzari, Hubbard, and Petersen (1988), Hoshi, Kashyap, and Scharfstein (1991), Kaplan and Zingales (1997), Hennessy and Whited (2007), and Livdan, Sapriza, and Zhang (2009).

[2] See, e.g., Stiglitz and Weiss (1981), Gale and Hellwig (1985), and Greenwald and Stiglitz (1993) for static models of the investment decision under a financing constraint.

[3] See Boyle and Guthrie (2003), Hirth and Uhrig-Homburg (2010), and Shibata and Nishihara (2012) for theoretical analyses. See Cleary, Povel, and Raith (2007) for an empirical analysis.

[4] A partial list of structural models with bank debt includes Mella-Barral and Perraudin (1997), Fan and Sundaresan (2000), Broadie, Chernov, and Sundaresan (2007), and Hackbarth et al. (2007). None of these papers considers investment strategies.

[5] They assume that payments to market lenders cannot be changed outside the formal bankruptcy process and that the new owners can recapitalize optimally, although costs are incurred.

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Bank loan renegotiations are generally easier than bond restructuring, as suggested in Lummer and McConnell (1989) and Gilson, John, and Lang (1990). In addition, we assume that firms face issuance limits for debt. It is widely observed that firms face debt issuance limits in financing investment. Debt issuance limit constraints are typically needed to rule out corporate default by mitigating risk shifting from equity holders to debt holders (see Jensen & Meckling, 1976). Thus, imposing debt issuance limit constraints in economic models can thus capture an important feature of reality.

We introduce debt issuance limit constraints along with market debt and bank debt to consider how financial frictions affect investment, financing, and debt structure strategies. Our model endogenously determines investment timing, coupon payment level, and debt structure (either bank or market debt issuance) in the presence of financial frictions. To be more precise, our model is solved as follows. Given a debt structure, we derive the optimal investment and coupon payment strategies under debt issuance limit constraints. We then choose the optimal debt structure by comparing equity value under bank debt with that under market debt.

Our model builds primarily on three papers: McDonald and Siegel (1986), Sundaresan and Wang (2007), and Shibata and Nishihara (2012).[6] Our model becomes an all-equity financing model when the firm cannot issue any type of debt (i.e., McDonald & Siegel, 1986). Our model is a nonconstrained model under various debt structures when the firm can issue bank and market debt without issuance constraints (i.e., Sundaresan & Wang, 2007). Our model becomes a constrained model under a market debt structure when a firm can issue only market debt with an issuance bound constraint (i.e., Shibata & Nishihara, 2012). Our model can be regarded as a natural extension of these three papers, and yields several additional important implications.

Our model provides four important results. The first result is that the type of debt that is issued at the time of investment depends largely on three parameters (debt issuance limit, volatility, and firm's bargaining power during financial distress). The firm is more likely to issue market debt than bank debt when the debt issuance limit is increased.[7] In practice, the firms with higher (lower) debt issuance bounds are regarded as large/mature (small/young) corporations. Based on this definition, our results show that large/mature (small/young) corporations are more likely to choose market (bank) debt. Thus, this segmentation is broadly consistent with the stylized facts. In addition, we consider the effects of volatility and bargaining power. When volatility is sufficiently high, the firm prefers bank debt financing irrespective of bargaining power. When volatility is high and the firm's bargaining power is low, the firm prefers bank debt financing. The reason is that higher volatility is more likely to lead to default, and a lower firm's bargaining power is more likely to lead to bank debt issuance. When volatility is low and the firm's bargaining power is high, the firm prefers market debt financing. This is because lower volatility is less likely to result in default, and a higher firm's bargaining power causes less bank debt issuance. These findings fit well with the empirical findings of Blackwell and Kidwell (1988) and Denis and Mihov (2003).

The second result is that the investment strategies (one of two solutions) are nonmonotonic with respect to the debt issuance constraints, while the coupon payments (the other solution) are monotonic with respect to the debt issuance constraints. Given a debt structure, the investment thresholds have a U-shaped relationship with the debt issuance constraints. The U-shaped relationship under bank debt financing is a new result, although the U-shaped relationship under market debt financing has already been established in Shibata and Nishihara (2012). The nonmonotonicity between investment and frictions is similar to that in previous related papers (see, e.g., Boyle & Guthrie, 2003; Cleary et al., 2007; Hirth & Uhrig-Homburg, 2010). Given a debt structure, the coupon payments are monotonically increasing with respect to the debt issuance constraints. These results imply that the optimal investment thresholds of the constrained levered firm are not in between those of the unconstrained levered firm and unlevered firm, while the optimal coupon payments of the constrained levered firm are in between those of the unconstrained levered firm and unlevered firm. Thus, it is less costly to distort investment thresholds than to distort coupon payments. Moreover, if the optimal debt structure strategies are changed from bank debt to market debt by increasing the debt issuance bound, the investment thresholds and coupon payments have a discontinuous curved relationship with respect to the debt issuance limit. In particular, the investment thresholds may have a discontinuous W-shaped relationship with the debt issuance limit.

The third result is about the relationship between equity option values and its investment thresholds. Suppose, as a benchmark, there is no debt issuance limit constraint. Then, if the firm prefers bank debt financing, the investment thresholds under bank debt financing are lower than those under market debt financing. We call this a "symmetric relationship." This implies that having the opportunity to choose the debt structure always hastens corporate investment (decreases the investment threshold) and increases its equity options value. Suppose, by contrast, the firm is financially constrained by its debt issuance limit. Then we show that there is not always a symmetric relationship between them. To be more precise, the investment thresholds under bank debt financing are not always lower than those under market debt financing, even when the firm prefers bank debt. This implies that having the opportunity to choose a debt structure does not always hasten corporate investment although its equity option value is increased. Thus, we show that financing constraints cause a distortion to the symmetric relationship between investment and its equity value.

The final result is that debt issuance constraints create a low-risk and low-return outcome for debt holders. In our model, return and risk for debt holders can be measured by the credit spreads and default probabilities, respectively. We show that, the more severe the debt issuance bounds are, the lower are the credit spreads and default probabilities. Thus, we shed light on the determinants of the debt issuance limits for debt holders. Moreover, we show that the credit spreads and default probabilities for bank debt are higher than those for market debt. These imply that bank debt is high risk and high return compared with market debt. These results are consistent with the empirical results of Davydenko and Strebulaev (2007).

The remainder of the paper is organized as follows. Section 2 describes the model and derives the value functions. Section 3 provides the solution of our model and considers its properties. Section 4 discusses the model's implications. Section 5 concludes.

2. Model

In this section, we begin with a description of the model. We then provide the value functions for the firms financed by bank debt and by market debt. Then, we formulate our model as an investment optimization problem for the firms financed by bank debt and by market debt with issuance limit constraints. As a benchmark, we derive the solutions to the two extreme cases in our model. One is the solution for an unlevered (all-equity financed) firm when the debt issuance limit constraints are strict (i.e., the model developed by McDonald & Siegel, 1986). The other is the solution for a firm financed by bank debt and market debt when the debt issuance limit constraints are immaterial (i.e., a model similar to that of Sundaresan & Wang, 2007).

[6] We incorporate the investment decision into a financing decision model having the choice of debt structure developed by Hackbarth et al. (2007).

[7] This result is similar to that of Hackbarth et al. (2007) who do not consider investment strategies.

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