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The Research on the Impact of Institutional Environment on Debt Maturity Structure

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As an important part of the debt financing decision, the choice of debt maturity structure will not only affect investment and financing cost, corporate governance and liquidity risk, but also be directly related to the distribution of interests between the creditor and debtor. In fact, debt maturity structure can be regarded as an endogenous result of one social economic system in a particular development stage. Therefore, it owns important theoretical significance and application value to study the effect of institutional environments on debt maturity structure. Using theoretical analysis, this paper introduces institutional environments into the standard debt maturity model established by Holmstrom and Tirole (1998, 2000). And then, this paper constructs a theoretical model under this situation and examines the influence of institutional environment on debt maturity structure, through solving the mathematical model, theoretical derivation, comparative static analysis and numerical simulation. The theoretical research results show that, debt maturity structure is shortened with the improvement of institutional environment.

1. Introduction

Debt financing has always been the most important channel for the enterprise's funding. As one of the most important content of debt financing decisions, the corporate choice for debt maturity structure is destined to become a hot academic issue. So it is particularly important to study the various factors influencing debt maturity structure, based on its nature. Foreign scholars have studied the debt maturity structure from the perspective of the enterprise's internal microscopic features since the 1990s, and some representative theories were formed, such as the matching principle hypothesis (Lopes and Caetano (2015)), agency cost theory (Brockman and Unlu (2009)), tax hypothesis (Blouin et al. (2010)) and information asymmetry hypothesis(Cheng and Milbradt (2012)). However, financing contract signing is not only the enterprise's own behavior, to a great extent; it would be led by the institutional environments.

From a macro perspective, the enterprise's debt maturity structure and its institutional environment would be bound together in a common cause. Through the empirical research, lots of scholars find that all sorts of institutional environment would affect the corporate choice for debt maturity (Fan et al. (2012), Zheng et al. (2012), Diamond and He (2014)). Liu et al. (2015) accurately demonstrate the debt maturity is negatively related to the degree of institution developing and perfecting. Ben-Nasr (2015) believed that short-term debt is positively related to labor protection. Taking Chinese listed companies as samples, Tu (2014) finds that debt maturity structure is negatively related to institutional environment. However, few scholars explain the relationship using theoretical research.

Holmstrom and Tirole (1998, 2000) examine the influence of the enterprise's own factors on debt maturity through the theoretical analysis. And they assume that the investors' claims on long-term income can be fully implemented. But considering the reality in China, the imperfect institutional environment will surely affect this kind of right of investors. When analyzing the importance of property rights system, Acemoglu et al. (2005) point out that difference in institutional environment will change creditor's claims on final income. And both of Frieden (2015) and Holmstrom and Tirole (2011) use the similar assumption in their theoretical analysis.

Now that, the hypothesis that the institutional environment could affect investors' claims on income has strong practical significance and theoretical basis. Then, how will the change of institutional environment affect the

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debt contract? Will the change of institutional environment influence debt maturity structure? If it is, what kind of relationship would be between them? This article will further expand the benchmark model of debt maturity structure built by Holmstrom and Tirole (1998, 2000), and then answer these questions one by one.

2. Assumption

This paper introduces institutional environments into the standard debt maturity model, in the contest of the variable-investment framework. The basic assumptions are as follows:

• Participants: an entrepreneur and investors.

• Three periods: date 0, date 1 and date 2. At date 0, the entrepreneur has a project requiring variable investment I. He initially has "assets" A and needs to borrow $I-A$ from investors.

• At date 1, the investment yields deterministic and verifiable income rI; at the same time, the firm meets a new investment chance requiring an amount ρI, where ρ is ex ante unknown and has cumulative distribution function $F(\rho)$ with density $f(\rho)$ on $\rho \in [0,\infty)$. The realization of ρ is learned at date 1.

• If the entrepreneur would not get enough money for reinvestment, he will face bankruptcy liquidation, and liquidation value LI belongs to outside investors.

• If the firm reinvests ρI, then it yields, at date 2, RI with probability p and 0 with probability $1-p$.

• Influenced by institutional environment factors, such as laws and regulations, transparency of market, protection of small and medium-sized investors, effectiveness of the court, and so on, investors cannot get all earnings of the claims on final profits. That is, the investors recoup the profit with probability e at date 2. Where e means how well the institutional environments, in fact increasing of e shows that institutional environment improves.

• The probability of success p is affected by the effort degree of the entrepreneur which is unobservable. Behaving yields probability $p = p_H$ of success, and misbehaving results in probability $p = p_L < p_H$ of success and private benefit $BI > 0$. Let $\Delta p = p_H - p_L > 0$.

• The project has positive NPV if the entrepreneur behaves, but negative NPV, even if one includes the borrower's private benefit, if she does not. Let $(1-e)R \geq B/\Delta p$.

• Both the entrepreneur and investors are risk neutral. The entrepreneur is protected by limited liability, and the riskless rate is taken to be 0. Investors behave competitively in the sense that the loan, if any, makes zero profit. We summarize the timing in figure 1:

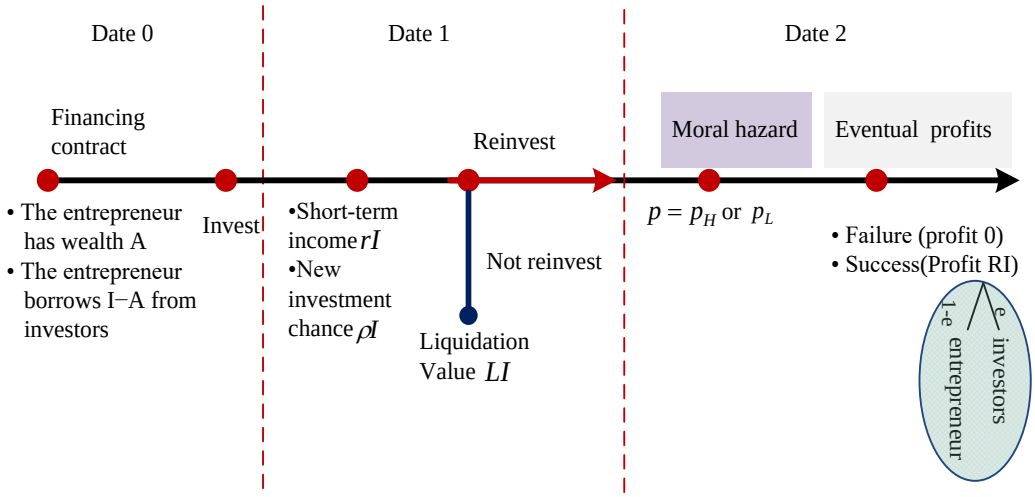

Figure 1: Figure of the timing

3. Optimal Model

Suppose that the financing contract takes the following state-contingent form:

$$\{I;\rho^c;(0,R_b,0);(rI,RI-R_b,0)\}$$

The contract specifies investment level I, and ρ^c is a cutoff of reinvestment. Only if $\rho \le \rho^c$, the firm reinvests. The entrepreneur gets nothing at date 1, and, If the project success, the entrepreneur and investors get R_b and $RI-R_b$ respectively; if the project fail, both of them get 0. The outside investors can only get $RI-R_b$ with probability e; the entrepreneur can get R_b with probability e and R_b with probability $1-e$.

According to the contract, the probability of reinvestment is $\Pr ob\{\rho \le \rho^c\} = F(\rho^c)$. So the optimization problem becomes

$$\begin{cases} \max\limits_{R_b,\rho^c,I} F(\rho^c)p_H[eR_b+(1-\mathrm{e})\mathrm{RI}]-A \\ s.t.\ (a1)\ F(\rho^c)p_H[eR_b+(1-e)RI] \ge F(\rho^c)\{p_L[eR_b+(1-e)RI]+BI\} \\ \quad (b1)\ rI+F(\rho^c)p_He(RI-R_b)+[1\text{-}F(\rho^c)]LI \ge I+\int_0^{\rho^c}\rho If(\rho)d\rho-A \end{cases} \tag{1}$$

Where the objective function is the entrepreneur's utility; (a1) is the entrepreneur's incentive-compatibility constraint, and it could be simplified as

$$eR_b+(1-e)RI \ge BI/\Delta p \tag{2}$$

and because $(1-e)R \ge B/\Delta p$, equation (2) must be established; (b1) is the investors' individual-rationality constraint, and it could be simplified as

$$\frac{F(\rho_c)(p_HeR-L)-[1+\int_0^{\rho^c}\rho f(\rho)d\rho-L-r]}{F(\rho_c)p_He}I+\frac{A}{F(\rho_c)p_He} \ge R_b \tag{3}$$

So the optimal model (1) will be simplified as

$$\begin{cases} \max\limits_{R_b,\rho^c,I} rI+F(\rho^c)(p_HR-L)I+LI-[I+\int_0^{\rho^c}\rho If(\rho)d\rho] \\ s.t.\quad rI+F(\rho^c)[p_He(RI-R_b)-LI]+LI \ge [I+\int_0^{\rho^c}\rho If(\rho)d\rho]-A \end{cases} \tag{4}$$

4. Optimal Contract

Next, the model (4) could be solved in three steps.

Step one: Solve R_b^* for a given ρ^c and I. In fact, the model (4) can be simplified further as

$$\begin{cases} \max\limits_{R_b,\rho^c,I} m(\rho^c)I \\ s.t.\ (a1)\ rI+F(\rho^c)p_He(RI-R_b)+[1-F(\rho^c)]LI \ge [I+\int_0^{\rho^c}\rho If(\rho)d\rho]-A \end{cases} \tag{5}$$

Where $m(\rho^c)=F(\rho^c)(p_HR-L)-1-\int_0^{\rho^c}\rho f(\rho)d\rho+L+r$ is the margin per unit of investment. And it could be easy to get that $R_b^*=0$.

Step two: Find the optimal I^* for a given ρ^c. Actually, take $R_b^* = 0$ into the problem (5). And as investors makes zero profit, (a1) in (5) holds with equality. And then it could be get that

$$I^*(\rho^c) = k(\rho^c)A; \qquad U_b^*(\rho^c) = m(\rho^c)k(\rho^c)A \quad ;$$

$$k(\rho^c) = [1+\int_0^{\rho^c} \rho f(\rho)d\rho - L - r + F(\rho^c)p_H(R-L)]^{-1} > 0$$

Step Three: Consider the optimal ρ^{c*}.

Corollary 1: If the threshold liquidity shock ρ_c^* is equal to the expected unit cost of effective investment, the entrepreneur's welfare reaches its maximum, and ρ_c^* lies between the expected pledgeable income and the expected income, that is: $c(\rho^{c*}) = \rho^{c*};\ \rho_0 < \rho^{c*} < \rho_1$, where

$$c(\rho^c) = [1+\int_0^{\rho^c} \rho f(\rho)d\rho - L - r]/F(\rho^c).$$

Proof: In fact

$$U_b(\rho^c) = \frac{F(\rho^c)\rho_1 - [1+\int_0^{\rho^c} \rho f(\rho)d\rho - L - r]}{1+\int_0^{\rho^c} \rho f(\rho)d\rho - L - r - F(\rho^c)\rho_0} A = \frac{\rho_1 - c(\rho^c)}{c(\rho^c) - \rho_0} A$$

So $\max_{\rho^c} U_b(\rho^c) \Leftrightarrow \min_{\rho^c} c(\rho^c)$. The first-order condition is

$$\frac{\rho^c f(\rho^c)F(\rho^c) - f(\rho^c)[1+\int_0^{\rho^c} \rho f(\rho)d\rho - L - r]}{[F(\rho^c)]^2} = 0$$

that is: $\int_0^{\rho^c} F(\rho)d\rho + L + r = 1$ (6)

then from (6) it can be got that

$$c(\rho^{c*}) = \frac{1+\int_0^{\rho^{c*}} \rho f(\rho)d\rho - L - r}{F(\rho^{c*})} = \frac{1+\rho^{c*}F(\rho^{c*}) - \int_0^{\rho^{c*}} F(\rho)d\rho - L - r}{F(\rho^{c*})} = \rho^{c*} \quad (7)$$

Because of $U_b^* = \frac{\rho_1 - \rho^{c*}}{\rho^{c*} - \rho_0} A$, It may be achieved that: $\rho_0 < \rho^{c*} < \rho_1$.

Corollary 2: The "first-best cutoff" of reinvestment ρ^{c*} has nothing to do with e, that is

$$\partial\rho^{c*} / \partial e = 0$$

The expression of ρ^{c*} is (7), so it is very easy to get that ρ^{c*} has nothing to do with e.

Corollary 3: The optimum investment scale I^* is increasing with the improvement of institutional environment, that is $\partial I^* / \partial e > 0$.

Proof: To simplify the proof process, set

$$M^*(\rho^{c*}) = 1 + \int_0^{\rho^{c*}} \rho f(\rho) d\rho - L - r - F(\rho^{c*})(p_H eR - L) \quad (8)$$

taking partial derivative on both sides and combine with (8), it can be got that $\partial M^*(\rho^{c*}) / \partial e = -F(\rho^{c*}) p_H R < 0$. And because $I^*(\rho^{c*}) = k(\rho^{c*})A = \frac{A}{M^*(\rho^{c*})}$, easy to draw that

$$\frac{\partial I^*(\rho^{c*})}{\partial e} = -\frac{A}{[M^*(\rho^{c*})]^2} \cdot \frac{\partial M^*(\rho^{c*})}{\partial e} = \frac{A}{[M^*(\rho^{c*})]^2} F(\rho^{c*}) \rho_1 > 0$$

5. Comparative Analysis

Definition 1: The debt maturity structure can be measured by the ratio of long-term debt to total debt, namely: $DM = LD / (LD + SD)$, where $SD = (r + \rho_0 - \rho^{c*}) I^*; \quad LD = RI^* - R_b^* - \rho_0 I^*$.

Proposition 1: The short-term debt increase with improvement of institutional environment, that is $\partial SD / \partial e > 0$.

Proof: The short-term debt is $SD = (r + \rho_0 - \rho^{c*}) I^*$, where $\rho_0 = p_H eR - L$, so

$$\frac{\partial SD}{\partial e} = (r + \rho_0 - \rho^{c*}) \frac{\partial I^*}{\partial e} + \rho_1 I^*$$

From corollary 3, it can be got that $\partial I^* / \partial e > 0$, and SD is positive means $r + \rho_0 - \rho^{c*} > 0$, so

$$\partial SD / \partial e > 0^*$$

Proposition 2: The long-term debt increase with improvement of institutional environment, that is $\partial LD / \partial e > 0$.

Proof: The long-term debt is $LD = RI^* - R_b^* - \rho_0 I^*$, and $R_b^* = 0$, so

$$LD = RI^* - \rho_0 I^* = [R - (p_H eR - L)] k(\rho^{c*}) A = \frac{(R - p_H eR + L)}{M^*(\rho^{c*})} A$$

And because $\partial M^*(\rho^{c*}) / \partial e = -F(\rho^{c*}) p_H R$, it can be got that

$$\frac{\partial LD}{\partial e} = \frac{p_H R\{RF(\rho^{c*}) - [1 + \int_0^{\rho^{c*}} \rho f(\rho) d\rho - L - r]\}}{[M^*(\rho^{c*})]^2} A > 0$$

Proposition 3: The debt maturity structure reduce with improvement of institutional environment, that is $\partial DM / \partial e < 0$.

Proof: The debt maturity structure,

$$DM = \frac{LD}{LD + SD} = \frac{(R - \rho_0) I^*}{[(R - \rho_0) + (r + \rho_0 - \rho^{c*})] I^*} = \frac{R - p_H eR + L}{R + r - \rho^{c*}}$$

ρ^{c*} has nothing to do with e from corollary 3, so DM is decreasing with the increase of e.

5. Conclusions

Signing of financing contract is not just kind of the enterprise's independent behavior; it will be led by the institutional environment to a great extent. As an important content of corporate debt financing, the choice of debt maturity structure is bound to affect by the institutional environment.

This paper analyzes the impacting process and influencing result of institutional environment on debt maturity, by constructing theoretical model. And finally get that, as the improvement of the institutional environment, the short-term debt and long-term debt will increase; meanwhile, the debt maturity structure will become shorter.

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