Collateral registrations and debt/equity finance*

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Abstract

This paper investigates the capital structure under the different collateral registration systems. This paper incorporates one of the characteristic on collateral of Uniform Commercial Code, where the future assets can be collateralized, into a corporate finance model and considers the effect of the collateralization on the incentive of innovation. We show the importance of the collateral institution for innovation through the corporate finance. The incentive for high value product under the institution that allows to register the future assets as well as the existing assets is higher than that under the institution that can register only the existing assets through the complementary effect.

1 Introduction

Innovation is an important driving force to promote economic growth and development. The innovative entrepreneurs try to develop new products or technology. External finance helps to promote innovation through entrepreneurship. Institutions regarding collateral are one of the fundamental property rights to support corporate finance, although intellectual property

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law is important to promote innovation. This paper shows that the legal institution on inside collateral can encourage innovation through corporate finance.

What assets can be collateralized is decided by the law outside the private contract, that is, it is determined as property rights, and the parties cannot decide it. The contents of legal institutions regarding collateral have a great influence on the parties' activities through the credit contract.

Some authors study inside collateral (Niinimaki (2009) and Wang (2010)), but most of the research on collateral are related to the analysis of outside collateral (Besley, Burchardi and Ghatak (2012), Manove, Padilla and Pagano (2001) and Niinimaki (2009)). We are considering the effect of inside collateral on incentives of the entrepreneurs and investors. As far as we know, there is little studies where explicitly analyze collateralizing of the future assets, although the US institution, Uniform Commercial Code (UCC), permits to collateralize the future assets.

In reality, there is legal difference on (inside) collateral among the countries. One is the institution that not to permit securitization of the future assets, and the other is to permit. We examine the effects of legal difference with regard to collateral on R&D or development of intellectual property.

2 The basic model

We study contracting between entrepreneurs (business owners) and funders (investors), and use a standard agency model that is often used to analyze corporate finance, where the entrepreneur's effort is not verifiable and is a source of moral hazard. In order to focus on inside collateral, it is assumed that the entrepreneur has no wealth for simplicity and cannot pledge her own assets as outside collateral. The entrepreneur has a unique idea for the

business and takes R&D to achieve the idea. She needs external credit from funder(s) because of no wealth. The funders have money but no idea for business.

The borrower tries to develop a new product or intellectual property z and need investment of R&D for z. She has no her own wealth and his company has no cash to invest, thus he needs lenders. The borrower makes an effort a, where $0 \leq a \leq \bar{a}$, and at probability a a new intellectual property z is developed. The effort a is unobservable for the lender and unverifiable, therefore is not contractable on a. The effort a needs the cost $d(a)$ for her, where $d(a)$ is increasing and convex function of a.

The borrower has asset x as his company asset, which exists at the time of the contract. This is used as (inside) collateral. If the entrepreneur develops a new intellectual property or new product z successfully and the business is in success, and then she can receive y_z as the cash flow of the successful business. This cash flow includes business sales by using both x and z. If she fails to develop z but the business is still successful and generates cash flow, he gets y as the cash flow by using only x. That is, there can be in failure of the business even when the R&D is successful, and there can be in success of the business even when the R&D fails.

There are two type of investors; the one is the lender for debt finance D and the other is the the investor for equity finance E. The total amount of investment I for R&D is the sum of debt and equity finance; $I = D + E$. The marginal cost of investment for the investors is assumed to be γ both for debt and equity finance. The investment I makes effect on the value of the new product z; thus the cash flow $y_z(I)$ and the value of collateral $v_z(I)$ depend on the investment I. $y_z(I)$ and $v_z(I)$ are increasing and concave functions of I.

Assume that the entrepreneur makes a take-it-or-leave-it offer to the funders. The timeline of the model is the following.

1. The borrower and funders sign up credit contracts; debt contract and/or equity contract. Debt contract consists of (R, D, C), where R is the repayment for debt, C is the secured assets for the lender in case of default. Equity contract consists of (R_s, R_f, E), where R_s is dividend in case of success of both R&D and business and R_f is the stock value in case of failure of R&D and success of business.

2. The entrepreneur makes effort a to develop a new product z.

3. The entrepreneur acquires a new product z if the R&D is successful or do business by using the existing assets x if the R&D is failed.

4. It is verifiable whether the business is successful (the entrepreneur obtains the cash flow) or failed (the entrepreneur obtains no cash flow). Given the success of business, she obtains cash flow $y_z + y$ in success of $R\&D$, and obtains cash flow y in failure of $R\&D$. The entrepreneur pays R and/or (R_s, R_f), which depends on the state. In case of failure of the business, The lender collects assets C as collateral.

In this paper, we focus on the effect of the payment conditions between debt and credit financing. We assume that debt and credit finance in this paper as follows:

Debt the payment of debt depends on whether the cash flow is generated or not (the business is in success or failure). If the entrepreneur obtains the cash flow from the business, then the lender acquires the payment R. If the business is in default, then the lender acquires the collateral C that was set at the contract. Note that the content of collateral C depends on the collateral registration system: $C \in \{z + x, x\}$.

Equity the payment of equity depends on whether the new product z is generated or not (the R&D is in success or failure). Given the success of business, the investor obtains $R_s + R_f$ as dividend and capital gain when R&D is successful, and obtains only R_f when R&D is in failure. Therefore, R_s is additional value in successful R&D. When the business is in default, no payment go to the investor of equity.

We summarize the payment or transfers of debt and equity finance in Table1.

Tab. 1: payments or transfers (as debt or equity)

R&D / business	success	failure
success	$(R,\ R_s)$	$(C,\ 0)$
failure	$(R,\ R_f)$	$(C,\ 0)$

Let us consider the generic registration first, where the future assets are allowed as collateral; $C = x+z$. In Comparison between the registrations, we examine the specific registration, where only the existing assets are allowed as collateral; $C = x$.

The payoff of the entrepreneur is defined as:

$$\begin{aligned}\pi &= p \times [a \times \{y_z(I) + y - R_s - R_f - R\} + (1-a) \times \{y - R_f - R\}] - d(a) \\ &= p[a\{y_z(I) - R_s\} + y - R_f - R] - d(a), \end{aligned} \tag{1}$$

where p is the probability of success of business.

From the first order condition of (1), incentive compatibility constraint (ICC) is as:

$$p[y_z - R_s] = d'(a) \tag{2}$$

We see that this condition does not depend on the repayment R of debt

finance.

In the case of that each investor provides debt finance and equity finance, the Non-Profit Constraints (NPCs) are

$$p \times [a \times R_s + (1 - a) \times R_f] - \gamma E = 0$$

for equity finance and

$$p \times R + (1 - p) \times [a \times (v_z + v) + (1 - a) \times v] - \gamma D = 0$$

for debt finance, respectively. We assume that the opportunity costs for both equity and debt finance have the same value γ, for simplicity.

Before proceeding the analysis, we make the three assumptions; assumptions about other institutions, inside collateral, and legal difference on collateral registration. We focus on the difference in the ways of registration of collateral. It is assumed firstly that other legal institutions, such as foreclosure, reorganization, or liquidation, and the level of enforcement are given, though theses institutions also influence on corporate finance. Therefore, other (institutional) things being equal, we provide comparative analysis on institution of collateral registration.

Secondly, to make the analysis of inside collateral meaningful, we assume that a creditor shares the claim with "other creditors" related for the business in default when there are not enough assets to satisfy all of the debt, and then the creditor can fully collect debt if she registers the firm assets as collateral, although any business-related creditors have the right to acquire the firm's remaining assets to collect the debt in the case of default. By this assumption, the entrepreneur pledges the full inside (business) assets as collateral as much as possible because such full collateralization makes her

better off.

Finally, we mention two types of legal registration on collateral; "generic" approach and "specific" one. Although there are other different characteristics between the generic and specific approaches[1], this paper focuses on whether the future assets can be collateralized or not. On the one hand, a legal institution requires that the corporate assets must be registered "specifically." This kind of rule is closely related to the civil law countries such as Germany and Japan.[2] In such countries, they can register only "specified" asset as collateral. Specific registration in this paper indicates that the assets must be specified to be registered as collateral. That is, it is impossible to collateralize the future corporate assets, which are not specified at the time of contract, as collateral under the specific approach. On the other hand, in the generic registration, we keep Article 9 of UCC in mind. We can "generically" register the corporate assets under this institution. Generic registration in this paper means that it is possible to registrar the future assets as collateral as well as the existing asset.

In addition, we assume the following technical assumptions as the second order conditions in the second best:

$$d''(a) + \theta d'''(a) > 0 \text{ and} \tag{3}$$

$$(-d''(a)) \times (p\{ay_z''(I)\} + (1-p)\{av_z''(I)\}) - (py_z'(I) + (1-p)v_z'(I))^2 > 0, \tag{4}$$

where θ is the Lagrange multiplier for the ICC.

[1] See Armour (2008).

[2] In the specific registration, we keep civil law countries such as Germany and Japan in mind. In such countries, they employs the following as fundamental principles: the principles of Specificity, certainty and public disclosure. See Reimann and Zekoll (2005) and Foster and Sule (2010) in German law, and .... in Japanese law.

2.1 Benchmark

We shall examine the first best outcome as benchmark in this subsection. Social welfare which summarizes the payoffs of the entrepreneur and funders in this model is as:

$$\begin{aligned} & p\times[a \times (y_z + y) + (1-a) \times y] - d(a) \\ & \quad + (1-p)[a \times (v_z + v) + (1-a) \times v] - \gamma I \end{aligned} \tag{5}$$

We get the first best conditions as first order conditions of (5) regarding (a, I):

$$p y_z + (1-p) v_z = d'(a) \tag{6}$$

$$p[a v_z'(I)] + (1-p)[a v_z'(I)] = \gamma \tag{7}$$

The level of R&D effort and investment satisfying both (6) and (7) is defined as (a^F, I^F). (a^F, I^F) are complementary inputs in this setting.

Now we consider the hypothetical situation where the one investor can provide the continent claims (R_z, R_x, C), where R_z and R_x are contingent claims when z occurs or not, respectively, and C is claim in default, that is collateral.

The problem of the entrepreneur in the one investor case is as:

$$\begin{aligned} & \max_{R_z, R_x, a, I} \pi \\ & \text{subject to} \qquad \text{NPC and ICC} \end{aligned}$$

the NPC under contingent claims is defined as:

$$p[a(R_z) + (1-a)R_x] \\ + (1-p)[a(v_z + v) + (1-a)v] - \gamma I = 0,$$

where γ is the opportunity cost of investment.

The ICC under contingent claims is defined as:

$$p(y_z - R_z + R_x) = d'(a)$$

By substituting the NPC into π, we obtain the modified optimal contracting problem:

$$\max_{a,I} p[ay_z(I) + y] + (1-p)[av_z(I) + v] - d(a) - \gamma I$$

subject to ICC.

The first order conditions is as:

$$py_z + (1-p)v_z = d'(a) \tag{8}$$

$$p[av'_z(I) + v'(I)] + (1-p)[av'_z(I) + v'(I)] = \gamma \tag{9}$$

(a, I) satisfying the above equations is the same as (a^F, I^F). Therefore, if we allow that one investor can provide the contingent claims, the first best outcome is achieved.

2.2 Debt/Equity finance

Now let us consider the case where the one funder provides debt finance and the other funder provides equity finance. When the entrepreneur use two class of financing including debt and equity finance, the entrepreneur's problem is

$$\begin{aligned}
&\max_{R_s,R_f,R,D,E,a} \pi \\
&\text{subject to} \quad \text{NPC for debt, NPC for equity, ICC,} \\
&y - R - R_f \geq 0 \\
&\text{and} \quad I = D + E,
\end{aligned}$$

where the condition $y - R - R_f \geq 0$ is feasibility constraint (FC) when R&D is in failure but cash flow is still generated.

We classify two cases: one is the equilibrium only with debt finance, and the other is the equilibrium with both debt and equity finance depending on the project value. We have the optimal contract as the following:

Proposition 1. *Suppose that the project value is sufficiently small. Then the entrepreneur uses only debt finance as external finance; $I^* = D^*, E^* = 0$. The Feasibility constraint (FC) is not binding; $y - R^* > 0$.*

The R&D effort a^* and investment $I^* = D^*$ satisfy the following equations:

$$py_z(I) + (1-p)v_z(I) = d'(a^*) + \theta d''(a^*) \tag{10}$$

$$p(ay'_z(I)) + (1-p)(av'_z(I)) + \theta py'_z(I) = \gamma. \tag{11}$$

Proposition 1 indicates that if the entrepreneur can access both debt and credit finance, she uses debt finance first. This is because Marginal

cost of equity finance $\lambda_2^*\gamma$ is higher than Marginal cost (MC) of debt finance γ, where $\lambda_2^* > 1$ is the Lagrange multiplier for the non-profit constraint of the equity finance. That is, debt finance is more cost effective as external finance than equity finance when the FC is not binding.

As the project value increases, the amount of debt finance increases to the point that the FC is binding, i.e., $y = R^*$. At this point, the additional debt finance cannot be used more. Then, the entrepreneur requires equity finance as further fund. Given the D at the point, the use of equity E leads to the total amount of investment I because of $I = D + E$, and results in that the entrepreneur can reduce the payment R to satisfy the NPC for debt and can increase the amount of debt further. Therefore, the maximum amount of debt is relaxed by the introduction of equity finance. Because of $y = R^*$, $R_f^* = 0$ when the equity finance is used.

The following result is the equilibrium with both debt and credit finance.

Proposition 2. *Suppose that the project value is sufficiently large. Then the entrepreneur uses equity finance in addition to debt finance; $I^* = D^* + E^*$. The Feasibility constraint is binding; $y = R^*$, and $R_f^* = 0$.*

The R&D effort a^*, debt D^* and equity E^* satisfies the following equations:

$$py_z(I^*) + \lambda_1^*(1-p)v_z(I^*) = d'(a^*) + \theta^* d''(a^*), \tag{12}$$

$$py + (1-p)\{av_z(I^*) + v\} = \gamma D^*, \qquad \textit{and} \tag{13}$$

$$pay_z'(I^*) + \lambda_1(1-p)av_z'(I^*) + \theta py_z'(I^*) = \lambda_2\gamma, \tag{14}$$

where $I^* = D^* + E^*$, $\lambda_1^* > 1$ and $\theta^* > 0$.

3 Comparison

So far, we have analyzed given the generic registration. This section compare the specific registration with the generic registration, and considers the effect of each registration on debt and equity finance.

Under the specific registration, only the existing asset is collateralized, i.e., $C = x$. As is the case with the generic registration in the preceding section, the case is divided into the two equilibria depending on the project value, that is, one is the equilibrium only with debt finance and the other is the equilibrium with both debt and equity finance. We summarize that as the proposition:

Proposition 3. *i) Suppose that the project value is sufficiently small. Then the entrepreneur uses only debt finance as external finance;* $I^* = D^*, E^* = 0$. *The Feasibility constraint (FC) is not binding;* $y - R^* > 0$.

The R&D effort a^* *and investment* $I^* = D^*$ *satisfy the following equations:*

$$py_z(I) = d'(a^*) + \theta d''(a^*) \tag{15}$$

$$p(ay'_z(I)) + \theta p y'_z(I) = \gamma. \tag{16}$$

ii) Suppose that the project value is sufficiently large. Then the entrepreneur uses equity finance in addition to debt finance; $I^* = D^* + E^*$. *The Feasibility constraint is binding;* $y = R^*$, *and* $R^*_f = 0$.

The R&D effort a^*, *debt* D^* *and equity* E^* *satisfies the following equa-*

tions:

$$py_z(I^*) = d'(a^*) + \theta^* d''(a^*), \tag{17}$$

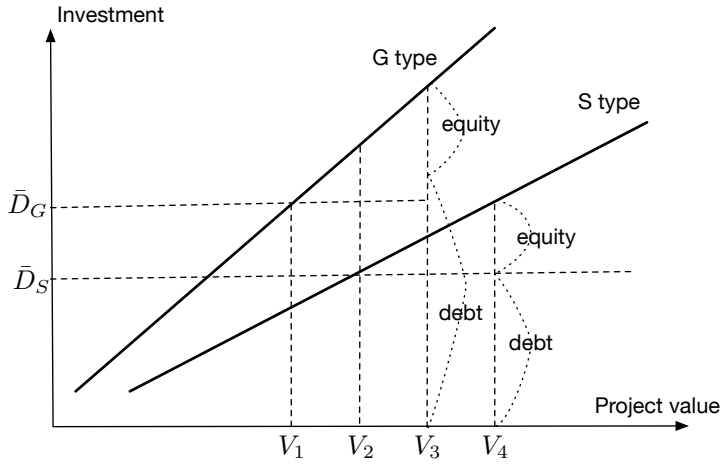
$$py + (1-p)v = \gamma D^*, \qquad and \tag{18}$$

$$pay'_z(I^*) + \theta py'_z(I^*) = \lambda_2 \gamma, \tag{19}$$

where $I^* = D^* + E^*$, λ_2 *and* $\theta^* > 0$.

We summarize the relationship between the project value and capital structure under each registration.

Fig. 1: **project value and capital structure**



4 Concluding remarks

We compare the inside collateral institutions between the specific and generic registrations, and examine the effect of the legal difference on incentives through the credit contracts. The specific registration, which allows the creditors to secure only the existing asset of the business, provides relatively little incentive to develop new product, and this problem deteriorates espe-

cially in the potential high value project. The generic registration, which allows the creditors to secure the future assets as well as the existing asset, gives the entrepreneur relatively high incentive for R&D through the complementary effect.

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