DISCUSSION PAPER SERIES

**Discussion paper No.45**

# The Effects of Corporate Finance on Firm Risk-taking and Performance: Theory and Evidence

Toshihiro Okada
Kwansei Gakuin University

Kohei Daido
Kwansei Gakuin University

May 2009

MASTERY FOR SERVICE

SCHOOL OF ECONOMICS

KWANSEI GAKUIN UNIVERSITY

1-155 Uegahara Ichiban-cho
Nishinomiya 662-8501, Japan

# The Effects of Corporate Finance on Firm Risk-taking and Performance: Theory and Evidence*

Toshihiro Okada†
Kwansei Gakuin University

Kohei Daido‡
Kwansei Gakuin University

**Abstract**

Some firms may exhibit better operating performance than others because they undertake riskier projects: risk-return tradeoff. We develop a model to examine the effects of financial contracts on a firm's choice between *safer* (*lower risk*, *lower return*) and *riskier* (*higher risk*, *higher return*) projects. The model shows that, assuming a competitive capital market (i.e., financiers with no monopoly power), three types of financial contracts can each be an equilibrium contract, depending on conditions. We show that firms undertake "safer" projects when using rollover loans (i.e., short-term loans with a possible rollover option), while firms undertake "riskier" projects when using non-rollover loans (i.e., long-term loans) or new share issues. The model emphasizes the role of rollover loans (with passive monitoring) as a potential disciplinary device to suppress a firm's risk-taking. The model generates several predictions about the determinants of a firm's risk-taking and its performance. One key prediction of the model is that (risk-neutral) firms with closer bank relationships are more likely to use rollover loans and undertake "safer" projects, even with a contestable capital market. We find novel empirical support for the model's predictions.

JEL Classification: G32

Key Words: corporate finance, corporate governance, firm risk-taking, firm performance, loan rollover

†. toshihiro.okada@kwansei.ac.jp ‡. daido@kwansei.ac.jp

*We would like to especially thank Yoshiko Sato, whose help and advise have been invaluable to us. We would also like to thank Yuichi Abiko, Atsuo Fukuda, Ryoji Odoi, Hiroshi Osano, Ken Tabata, Yoshiro Tsutsui, Hirofumi Uchida, Kazuhiro Yamamoto, Noriyuki Yanagawa, and the seminar participants at Kobe University, Kwansei Gakuin Universitry, Osaka Prefecture University, and Osaka University for their useful comments and suggestions.

# 1 Introduction

To explain the operating performance of a firm, we usually consider its efficiency. A more efficient firm obtains more from a given amount of resources. Many studies have looked at firm performance through this lens. Researchers have considered various factors (e.g., inadequate production technologies, insufficient managerial efforts, perks, and under- and over-investment) to be a potential source of firm inefficiency and have investigated what mechanisms might help reduce these inefficiencies.[1]

Apart from efficiency, a firm's risk-taking behavior can also be an important determinant of its operating performance.[2] Some firms may exhibit better performance than others simply because they undertake riskier business operations: risk-return tradeoff.[3] In general, a firm has many different product lines and departments. A firm's business operation can thus be viewed as a collection of many different individual activities with their own risk-return characteristics. Then, by applying the well-known theory of portfolio selection in finance, we can say that by diversification a firm faces a set of business operations on the efficient frontier—the frontier is, in the present context, the set of risk-return choices from the business operation opportunity set where for a given variance (risk) no other business operation opportunity offers a higher expected return, and the frontier is monotonically increasing in the (variance, expected return) space. This means that a firm gets higher expected returns by choosing a riskier business operation. Conditions and events that change a firm's risk-taking behavior can therefore alter its performance. In this paper, we focus on this risk-taking channel to study firm operating performance. In other words, we consider movement along the efficiency frontier rather than a shift in the frontier.[4]

Although various factors affect the risk-taking channel, corporate governance is probably one of the most important. Suppose that a firm has two projects (two business operations): the "safe" project and the "risky" project. The safe project has the lower expected returns and the fewer risks, and the risky project has the higher expected returns and the more risks. If the firm's financier prefers the safe project and the corporate

[1] See, for example, Jensen and Meckling (1976) on perks and over-investment, Myers (1977) on under-investment, Myers and Majluf (1984) on under-investment, Jensen (1986) on free cash flows, Stultz (1990) on over- and under-investment, and Aghion and Bolton (1992) on perks.

[2] By "risk-taking", we mean the extent to which a firm is willing to engage in conduct with an uncertain outcome for the firm.

[3] Gilley, Walters, and Olson (2002) investigate the influence of the risk-taking propensity of top management teams on firm performance. They show that managerial risk-taking has a strong positive influence on firm performance. The recent study reported by John, Litov, and Yeung (2008) examines managerial incentives to take value-enhancing risks in relation to the investor protection environment. They find that better investor protection leads to higher firm risk-taking and, consequently, greater growth.

[4] Our paper differs from "under-investment" and "over-investment" stories, which focus on *efficiency*. In addition, while the over-investment (asset substitution effects) story of Jensen and Meckling (1976) and the under-investment (debt overhang) story of Myers (1997) are about the agency cost of debt financing, we stress the benefit of debt financing to investors.

governance works well, the firm is disciplined to take the safe project even if it is risk neutral and thus prefers the risky project.

Considering the impact of corporate governance on the risk-taking channel, it is not hard to imagine that a financial contract plays a crucial role in determining a firm's risk-taking behavior. A key aspect of corporate governance is how a firm's financiers obtain a return on their investment. The first step to assure this return is to deliberately design a financial contract. A well-designed financial contract can establish effective corporate governance, and thus have an impact on a firm's choice between *safer* (*lower risk*, *lower return*) and *riskier* (*higher risk*, *higher return*) business operations. This paper examines the effects of a financial contract on a firm's risk-taking, which in turn affects its performance.

We develop a model to study the effects of a financial contract on a firm's choice between *safer* (*lower variance*, *lower expected return*) and *riskier* (*higher variance*, *higher expected return*) projects. The model assumes, for simplicity, that a risk-neutral firm has two projects: the "safe" project and the "risky" project, where the former has the lower expected return and the lower variance while the latter has the higher expected return and the higher variance. We consider a situation in which the firm requires financing from a risk-neutral competitive investor (competition exists between multiple principals: multiple bank investors and equity investors). In the model, (in which the firm's action is unverifiable,) the firm prefers the risky project, but the bank investor wants the firm to choose the safe project; i.e., an agency problem exists between the firm and the bank investor (in contrast, no agency problem exist between the firm and the equity investor). The model shows that three types of (exclusive) financial contracts can each be an equilibrium contract, depending on various conditions. The three contracts are: (i) a bank loan contract with an unconditional early loan demand option (i.e., an unconditional early liquidation option), (ii) a bank loan contract without the early demand option, and (iii) an equity contract. The second and third contracts are considered a long-term (normal) loan and a new share issue, respectively. The first contract is considered a short-term loan with a possible loan rollover. Rollover loans are commonly found in banking.

We argue that, while a firm undertakes a project with higher expected returns and more risks when choosing a normal (non-rollover) loan or a new share issue, it undertakes a project with lower expected returns and fewer risks when choosing a rollover loan. The loan contract with the early loan demand option (the early liquidation option) in the model preserves the most important feature of a rollover loan; i.e., a bank's total control over continuation of the project implemented by the borrowing firm. In reality, a bank often refuses to roll-over maturing short-term loans.[5] In the model, the early loan demand option is not contingent on the firm's action (playing it safe or risky) because the action

[5] The rollover condition is very often not written in a contract, but a bank and its borrower both know that the loan will be rolled over if nothing happens.

is unverifiable. The bank holding the contract can thus liquidate the project early *at will.*

At first glance, it seems hard for the loan contract with the early demand option to be the equilibrium contract of the model because: (i) the agency problem exists between the firm and the bank investor (but not between the firm and the equity investor), (ii) the firm chooses any of the three competitive contracts, and (iii) the bank with the demandable loan contract can liquidate the project early *at will.* We will show, however, that under certain conditions the firm selects the early demandable loan contract in equilibrium.

There are three crucial and necessary reasons why, under certain conditions, the loan contract with the early demand (at will) option becomes an equilibrium contract and the risk-neutral firm chooses the "safe" project with this contract. The first reason is concerned with the credibility of the contract. The model shows that the loan contract with the early demand option (which is offered by a bank investor) can be credible to the firm in two ways. It can be credible in the sense that the firm knows that the bank investor will liquidate the project if the firm chooses the risky project. It can also be credible in the sense that the firm knows that the bank will not liquidate the project (i.e., the bank will let the business go) as long as the firm chooses the safe project. The first form of credibility works as a disciplinary device to constrain the firm's risk-taking, and the latter form of credibility makes the contract acceptable to the firm even though it gives the bank total control over the firm's operation. The second reason why the early demandable loan contract can be an equilibrium contract relates to the cost of liquidating firm assets. Firm assets include intangible assets like firm-specific knowledge and know-how, so that the firm assets become much less valuable if they are taken over by the bank investor (i.e., the debt holder) upon default due to project failure. In the model of our paper, this leads the bank to *strongly* prefer the "safe" project to the "risky" project. The bank may thus have an incentive to offer an interest rate low enough for the firm to choose the early demandable loan contract, knowing that with this interest rate the contract is credible in the ways described above. The third reason is concerned with the dilution of manager shareholdings. In the model, the manager of the firm owns part of the firm's shares. The new share issue dilutes the manager's shareholdings and thus may lead the manager to prefer the bank loan to the new share issue.

Close analysis of the model reveals the relationship between a firm's risk-taking (and thus its performance) and three key variables of the model. The three variables are: the firm's relationship with banks, the number of the firm's outstanding shares and the firm's scale of production. The model predicts that, holding all other factors fixed, the extent of a firm's risk-taking, and thus its operating performance, is negatively related to the closeness of its relationship with banks and the scale of its production and positively related to the number of its outstanding shares.

One key prediction of the model is that (risk-neutral) firms with closer bank relationships are more likely to use rollover loans and undertake "safer" business operations, even with a contestable capital market. This prediction is partially attributed to heterogeneous monitoring costs: in our model, bank investors having closer relationships with its client firms have informational advantages in *passive* monitoring (i.e., collecting information about firms) and the early liquidation by bank investors requires *passive* monitoring. If the prediction is correct, our model could explain an interesting fact about the distribution of firm ROA across countries. Kameda and Takagawa (2003) compare the distribution of ROA for Japanese firms with those observed for other countries, and find that the ROA distribution for Japanese firms has a much lower variance and mean than those observed for firms in other countries. This is consistent with the prediction that the closer relationship a firm has with banks, the safer and less profitable project the firm is likely to undertake. In fact, many Japanese firms are affiliated with a "main bank" and thus probably have a much closer relationship with banks than firms in other countries.

Using a panel of data obtained for Japanese firms, we find empirical support for the model's predictions. Our empirical method has some new features. We show that although it is not possible to observe how much risk a firm has actually taken, a reasonable assumption about firm risk-taking and our newly proposed measure of performance uncertainty can together provide a reliable test of the model. We do not employ commonly used variables, such as the ex post variance of firm performance, in order to measure ex ante uncertainty of firm performance (i.e., ex ante risk). Using the ex post variance as a good proxy for ex ante uncertainty of firm performance requires a reasonable number of time-series observations of firm performance. This severely limits the number of usable observations for a regression, since usually only a short time-series of panel data on firm performance is available. The proposed method does not require many time-series observations of firm performance to measure the uncertainty, so that the regressions can use a much lager number of time-series observations. In addition, we show that our method can provide a more accurate measure of the uncertainty. These features allow us to, in testing our model, reliably carry out a panel regression to control for a firm-specific effect, a time effect and a heterogeneous linear time trend (i.e., to control for unobserved firm efficiency), and thus mitigate the problem of omitted variable bias.

The most closely related work is a paper by Weinstein and Yafeh (1998). Using data on Japanese firms, they provide indirect evidence that banks exert pressure on their client firms and influence the firms to forgo high-risk, high-expected-return projects according to the bank's preference.[6] They argue that underdeveloped capital markets provide banks with monopoly power, and Japanese main banks have taken advantage of this situation and have suppressed a firm's risk-taking behavior. Our study is complementary to their

[6] They find the lack of a significant advantage in growth rates for firms under main bank influence and interpret this as evidence that main banks induce their client firms to take less risky projects which lead to lower growth rates.

work. The model of our paper shows that a bank may affect a client firm's risk-taking behavior even though a capital market is competitive, and the empirical test provides direct evidence of the effect of bank-firm relationships on firm risk-taking and performance.

Our study is related to the literature emphasizing the disciplinary role of debt in an incomplete contract setting. The literature includes Dewatripont and Tirole (1994), Berglof and von Thadden (1994), Zwiebel (1996), and Grinstein (2006), among many others.[7] The paper differs from previous studies in a few important ways. First, our paper shows that the firm exhibits worse operating performance if it chooses a bank loan (debt) contract with disciplinary power over the firm. This result is different from that of other studies in which the debt contract disciplines the manager to work *efficiently*, and has a positive effect on firm performance. Second, the present paper differs in terms of allocation of control rights. In other studies, the debt holder is given control rights contingent on the verifiable outcome of default. In contrast, in our model the bank (the debt holder) can liquidate the project of its borrowing firm to demand an early loan payment *at will*. That is, the bank has non-contingent control rights.

The paper is also related to the work of Repullo and Suarez (1998) and Gordon and Kahn (2000). They also consider the disciplinary role of a loan contract with the option for a bank to liquidate its loan *at will*.[8] Their treatment of the liquidation option differs from ours. In Repullo and Suarez (1998), the option is exogenously included in a loan contract. In our paper, the option is endogenously included; i.e., the bank has a choice between including the option or not, and it decides by considering what other bank investors (and equity investors) would do. In Gordon and Kahn (2000), the liquidation is contingent on verifiable events. They assume that a bank loan contract includes a large number of covenants, such that a small change in the state of a borrowing firm will violate at least one covenant. This assumption makes it possible for a bank to execute its liquidation option at will at any time. In contrast, in our model, the execution of the option is not contingent on anything.

The outline of the paper is as follows: Section 2 presents a model of firm risk-taking and financial contracting, Section 3 discusses the empirical method and presents the results, and Section 4 concludes the paper.

---

[7] Earlier literature stressing the benefit of debt financing in mitigating an agency problem includes Jensen and Meckling (1976) and Jensen (1986).

[8] Tirole (2006, Chapter 8.4) also studies the role of demandable loan contracts and bank monitoring.

# 2 A Model of Firm Risk-taking and Financial Contracting

## 2.1 Environment

Consider a firm run by a risk-neutral manager who owns a fraction of the firm's shares (henceforth the "manager" and the "firm" are used interchangeably). Risk-neutral outside investors own the remainder of the shares. The manager faces two projects, and both projects require the same set-up cost, $I$. For simplicity, we assume that the set-up cost is sunk. The two projects, project $S$ and project $R$, are expected to be profitable and differ both in terms of riskiness and expected cash flow.

Project $S$ and project $R$ both generate three possible cash flow scenarios: 0 (fail), $X_L$ (success) and $X_H$ (big success). We make the following assumption:

**Assumption 1** $X_H > X_L > I > 0.$

Table 1 shows the payoffs of the two projects. The manager is assumed to work *efficiently*, and the success probability $p_v$ in Table 1 is exogenously determined. According to Table 1, the expected cash flows from project $S$ and that from project $R$ are given by

$$E(Y_v) = (1 - p_v)\ X_H/2 + p_v\ X_L, \quad v = S \text{ and } R. \tag{1}$$

The variances of the cash flows from the two projects are given by

$$var(Y_v) = \frac{1}{4}\left[(1-p_v)((1+p_v)X_H^2 - 4p_vX_HX_L + 4p_vX_L^2)\right], \quad v = S \text{ and } R. \tag{2}$$

We also make the following two assumptions

**Assumption 2** $p_S > p_R,$

**Assumption 3** $X_H - 2X_L > 0.$

Assumptions 2 and 3 give $var(Y_R) > var(Y_S)$ and $E(Y_R) > E(Y_S)$; i.e., project $R$ is riskier but generates a higher expected cash flow than project $S$.[9] Projects $R$ and $S$ are considered to represent any pair of business operations on the efficiency frontier, which is the set of risk-return choices from the possible business operation opportunity set where, for a given variance (expected return), no other business operation opportunity offers a higher expected return (lower variance). The efficiency frontier is located in a different

[9] From (2) we can obtain $var(Y_R) - var(Y_S) = \frac{1}{4}(p_S - p_R)\left[(p_S + p_R)(X_H - 2X_L)^2 + 4(X_H - X_L)X_L\right]$. Furthermore, from (1) we can obtain $E(Y_R) - E(Y_S) = (p_S - p_R)(\frac{1}{2}X_H - X_L)$.

position if the exogenous variables take on different values. In other words, the firm's efficiency level is exogenously given by $I$, $p_v$, $X_L$, and $X_H$.

For convenience, we assume that the firm has no liabilities, has assets, $A_0$, and requires $A_0$ to undertake its projects. The firm's assets, $A_0$, include intangible assets, factories, machines, and land. To simplify the analysis, we disregard other kinds of assets such as cash on hand and marketable securities, so that the set-up cost, $I$, needs to be fully financed by outside investors. We also assume

**Assumption 4** $A_0 < I$ *and* $1 < \underline{A}_0 \leq A_0$

where $\underline{A}_0$ is the minimum amount of $A_0$ for a firm to be in operation. Assumption 4 indicates that the investors face a risk of losing their investment.

The manager chooses either project $S$ or project $R$. The manager either borrows from a single bank investor or issues shares to new outside investors in order to finance the project (i.e., the bank loan and equity contracts are exclusive). We assume that the investors are competitive.

## 2.2 Preliminary Model

We first present the preliminary model in which the loan contracts do not posses an early demandable loan option. Studying this simple model will facilitate a clearer understanding of the model later presented.

### 2.2.1 Model timing and contract types

Figure 1 describes the timing of the preliminary model. The time line is divided into three stages: stage 0, stage 1 and stage 2.

(Stage 0) The contract is made and the firm receives funding.[10] The manager then chooses between project $S$ and project $R$. We assume that the manager's project choice is unverifiable. Thus, a contract contingent on project choice (e.g., a contract that reads "if the firm does not undertake project $S$, the firm faces a large penalty") cannot be made.

(Stage 1) The investor chooses whether to monitor the firm at cost $M$ (>0). The monitoring cost, $M$, differs among the investors. The manager can observe this monitoring activity at no cost. The equity investor carries out *active* monitoring and the bank investor performs *passive* monitoring. That is, the equity investor can directly interfere with the management of the firm and correct the course of action taken by the manager (if the investor owns a large proportion of the shares), while the bank investor can only

[10]Before this stage, the manager asks multiple banks for a loan and at the same time considers issuing shares.

collect information about the firm's activities (the information includes whether the firm is pursuing project $S$ or project $R$). We assume that although the monitoring reveals the firm's action (whether it is pursuing project $S$ or project $R$) to the bank investor, the action is still unverifiable. This implies that the bank investor cannot write a contract contingent on the firm's project choice. Therefore, the monitoring is useless to the bank investor in the present setting; i.e., the bank investor has no incentive to monitor the firm. However, a bank's *passive* monitoring plays an important role in the model later presented: the model in which the loan contracts can posses an early demandable loan (at will) option. We also assume that in stage 1 the firm can change the project at no cost after observing whether the bank investor has chosen to monitor or not.

(Stage 2) The verifiable cash flows are realized. Since the cash flows are verifiable, to place the manager in an optimal incentive scheme, the bank investors can, in principle, write a contract contingent on the project cash flows. We assume, however, that the bank investors do not want to write the contingent contract because writing such a contract is too costly. That is, the cost associated with verifying the firm's outcome (realized cash flow in the model) at the end of the period is assumed to be much higher than the cost of writing a simple loan contract without costly verification. The bank loan contracts hereafter do not require any verification of the firm's outcome. Note also that verifiability of cash flow is necessary because an equity contract is included in the model. Equity contracting is not possible without verifiability of cash flow.

The equity contract, $\mathbb{C}_E$, and the loan contract, $\mathbb{C}_D$, are defined as

$$\mathbb{C}_E = \mathbb{C}_E(\theta),\ \mathbb{C}_D = \mathbb{C}_D(r),$$

where $\theta$ is the manager's shareholding ratio after new shares of the firm are issued and $r$ is the interest rate. The bank investor with $\mathbb{C}_D$ has the right to seize the firm's assets upon default of the firm. The equity investor, on the other hand, does not have this right.

We first consider equity contracting. We assume that there are a number of homogenous equity investors, and that the investor cannot finance the project alone. If the manager decides to issue new shares (i.e., the manager decides to obtain funds from the equity investors), he has the following expected net return by undertaking project $v$

$$\begin{aligned} \pi_M(\theta{:}v) &= \theta[p_v\ (A_0 + X_L) + \tfrac{1-p_v}{2}(A_0 + X_H) + \tfrac{1-p_v}{2}A_0]\ - \theta_0 A_0 \\ &= \theta(A_0 + E(Y_v)) - \theta_0 A_0, \qquad v\ = S \text{ and } R, \end{aligned} \tag{3}$$

where $\theta_0$ is an initial shareholding ratio of the manager (the manager's shareholding ratio before new shares of the firm are issued). The term in [ ] shows the expected value of the firm. The term $\theta_0 A_0$ represents the value that the manager obtains if project $v$ is not undertaken; i.e., $\theta_0 A_0$ is the manager's reservation level of utility.

On the other hand, by purchasing the firm's shares, the representative equity investor obtains the following expected return (if he does not monitor the firm, i.e., if he does not pay $M$)

$$\begin{aligned}\pi_{EI}(\theta{:}v) = &\tfrac{1}{q}[p_v\ (1-(\theta+\widetilde{\theta}))(A_0+X_L)\\ &+\tfrac{1-p_v}{2}(1-(\theta+\widetilde{\theta}))(A_0+X_H)+\tfrac{1-p_v}{2}(1-(\theta+\widetilde{\theta}))(A_0)]\\ &-\tfrac{I}{q},\qquad v\ = S \text{ and } R,\end{aligned} \tag{4}$$

where $q$ is the number of homogeneous equity investors, and $\widetilde{\theta}$ is a shareholding ratio for the initially existing equity investors after new shares of the firm are issued. The term $\widetilde{\theta}$ can thus be written as a function of $\theta$ and $\theta_0$, i.e., $\widetilde{\theta}=\widetilde{\theta}(\theta,\theta_0)$. The term in [ ] represents the expected value of the firm if project $v$ is undertaken, and $\frac{I}{q}$ represents the amount of investment made by the investor. Notice here that how many shares of the firm the representative equity investor offers to purchase by paying $\frac{I}{q}$ is the same thing as $\mathbb{C}_E(\theta)$ being offered to the manager by the homogeneous equity investors as a whole.

Equations (3) and (4) give

$$\pi_M(\theta{:}R)-\pi_M(\theta{:}S)=\frac{(p_S-p_R)\ \theta}{2}\ (X_H-2X_L), \tag{5}$$

$$\pi_{EI}(\theta{:}R)-\pi_{EI}(\theta{:}S)=\frac{(p_S-p_R)(1-\theta)}{2}(X_H-2X_L). \tag{6}$$

From Assumptions 2 and 3, $\pi_M(\theta{:}R)-\pi_M(\theta{:}S)>0$ and $\pi_{EI}(\theta{:}R)-\pi_{EI}(\theta{:}S)>0$; i.e., the equity investor and the manager both prefer project $R$ to project $S$. Thus, an agency problem does not arise in this case and the equity investor has no incentive to monitor the firm.

Next, consider bank loan contracting. If the bank investor makes a loan to the firm, the bank has the following expected return[11]

$$\pi_{BI}(r{:}v)=p_v\ rI+\frac{1-p_v}{2}rI+\frac{1-p_v}{2}\ (A_0-I-{A_0}^w),\quad v=S \text{ and } R, \tag{7}$$

where

$$0<w<1, \tag{8}$$

$$rI\leq X_L-I. \tag{9}$$

The term $(A_0-I-{A_0}^w)$ in (7) shows what the investor obtains if the project fails (i.e., if the project cash flow is zero). The term ${A_0}^w$ represents the cost of liquidating firm assets. Since assets $A_0$ include intangible assets like firm-specific knowledge and know-how, the assets becomes much less valuable if they are taken over by the bank investor upon default due to failure of the project. The term ${A_0}^w$ captures this wedge between the bank investor and the manager in the valuation of $A_0$ . It can also include the transaction

[11] Note also that if $rI>X_L-I$, then, $\pi_{BI}$ is, in some cases, not defined by (7). However, we can safely ignore the case of $rI>X_L-I$, because competitive investors are assumed.

cost of liquidating $A_0$, e.g., the cost of selling assets to third parties. This type of cost can also be quite large.[12]

If the firm borrows from the bank investor, the manager has the following expected net return by undertaking project $v$

$$\begin{aligned}\pi_M(r{:}v) = \theta_0[p_v(A_0 + X_L - (1+r)I) + \tfrac{1-p_v}{2}(A_0 + X_H - (1+r)I)] \\ - \theta_0 A_0, \quad v = S \text{ and } R.\end{aligned} \tag{10}$$

As in the case of equity contracting, the term in [ ] and $\theta_0 A_0$ show the expected value of the firm and the manager's reservation level of utility, respectively.

Equations (7) and (10) give

$$\pi_M(r{:}R) - \pi_M(r{:}S) = \frac{p_S - p_R}{2}\theta_0 \ [X_H - 2X_L + \ (1+r)I - A_0] \ ,$$

$$\pi_{BI}(r{:}R) - \pi_{BI}(r{:}S) = -\frac{p_S - p_R}{2} \ [(1+r)I - A_0 + {A_0}^w] \ .$$

From Assumptions 2, 3, and 4, $\pi_M(r{:}R) - \pi_M(r{:}S) > 0$ and $\pi_{BI}(r{:}R) - \pi_{BI}(r{:}S) < 0$. This means that, although the bank investor wants the manager to choose project $S$, the manager has an incentive to choose project $R$. An agency problem thus arises in the case of bank loan contracting. The important point here is the role of ${A_0}^w$. Although the existence of the agency problem does not hinge on the wedge ${A_0}^w$ (i.e., the agency problem arises even if ${A_0}^w = 0$), the bank's preference for project $S$ over project $R$ is *stronger* with ${A_0}^w$. This point will be very important when we later analyze the model with the early loan demand option.

### 2.2.2 Equilibrium contracts

We now analyze the preliminary model and demonstrate the equilibrium contracts. First, we consider the loan contract, $\mathbb{C}_D$. Since the manager has an incentive to choose project $R$ in the loan contract and the bank investor figures this out, the bank investor knows that $\pi_{BI}$ $(r{:}R)$ is the only possible return. Thus, for the bank investor to have an incentive to offer the loan contract, the following constraint must hold

$$\pi_{BI}(r{:}R) \geq a, \tag{11}$$

where $a$ is the net return on investing $I$ on risk-free assets and $E(Y_v) - I > a$.[13] From (7) and (11), we obtain

$$r \geq \frac{1}{1+p_R}[\frac{2a}{I} + (1-p_R) - \frac{1-p_R}{I}(A_0 - {A_0}^w)] \ . \tag{12}$$

[12] See Tirole (2006, pp. 164-171) for more concrete arguement of this kind of costs.

[13] Since $a$ is the net return on risk-free assets, it is natural to assume $E(Y_v) - I > a$.

Under investor competition, the bank investor needs to offer the $\mathbb{C}_D$ which maximizes the manager's expected profits, in order for the contract to be accepted. Thus, we can obtain the following lemma

**Lemma 1** *The contract which the bank investor offers is given by*

$$\mathbb{C}_D^* = \mathbb{C}_D(\underline{r}), \tag{13}$$

*where*

$$\underline{r} = \frac{1}{1+p_R}[\frac{2a}{I} + (1-p_R) - \frac{1-p_R}{I}(A_0 - {A_0}^w)], \tag{14}$$

$$\pi_{BI}(\underline{r}{:}R) = a, \tag{15}$$

$$\pi_M(\underline{r}{:}R) = \theta_0[E(Y_R) - \frac{1-p_R}{2}{A_0}^w - I - a]. \tag{16}$$

**Proof.** Proof in the text. ■

$\mathbb{C}_D^*$ is a *feasible* contract, assuming that $\pi_M(\underline{r}{:}R) \geq 0$ holds. The term "*feasible* contract" means that by signing such a contract, the manager and investor both obtain the expected profits which are greater than or equal to their reservation levels. The contract is not feasible if either the manager or the investor gets (knows that he gets) less than the reservation level by signing it. The interest rate $\underline{r}$ is greater than zero based on Assumption 4.

Next, consider the equity contract $\mathbb{C}_E$. For the equity investor to have an incentive to invest $\frac{I}{q}$, the following constraint must hold

$$\pi_{EI}(\theta{:}R) \geq \frac{a}{q}. \tag{17}$$

From (4) and (17), we can then get

$$\frac{I+a}{A_0 + E(Y_R)} \leq 1 - [\theta + \widetilde{\theta}(\theta, \theta_0)]. \tag{18}$$

The term $1 - [\theta + \widetilde{\theta}(\theta, \theta_0)]$ shows a shareholding ratio for the new equity investors. Since the firm must issue at least one share to each of the homogeneous equity investors, the following inequality must also hold

$$\frac{q}{N_0 + q} \leq 1 - [\theta + \widetilde{\theta}(\theta, \theta_0)], \tag{19}$$

where $N_0$ is the number of shares initially issued (the number of shares outstanding before the contract).

Under investor competition, $\theta$ must take the highest possible value. Using (18) and (19), the contract which the equity investor offers is thus given by

$$\mathbb{C}_E^* = \mathbb{C}_E(\overline{\theta}),$$

where

$$1 - [\overline{\theta} + \widetilde{\theta}(\overline{\theta}, \theta_0)] = \frac{I+a}{A_0 + E(Y_R)} \text{ if } \frac{q}{N_0 + q} < \frac{I+a}{A_0 + E(Y_R)}\ , \tag{20}$$

$$1 - [\overline{\theta} + \widetilde{\theta}(\overline{\theta}, \theta_0)] = \frac{q}{N_0 + q} \text{ if } \frac{q}{N_0 + q} > \frac{I+a}{A_0 + E(Y_R)}\ . \tag{21}$$

Now denote $\overline{\theta}'$ as the $\overline{\theta}$ in (20). Using (3), we can then obtain

$$\pi_M(\overline{\theta}':R) = \ (A_0 + E(Y_R))\ \overline{\theta}' - \theta_0 A_0. \tag{22}$$

Appendix A shows that $\overline{\theta}'$ is given by

$$\overline{\theta}' = \theta_0 \frac{A_0 + E(Y_R) - (I+a)}{A_0 + E(Y_R)}. \tag{23}$$

Substituting (23) into (22) for $\overline{\theta}'$ yields

$$\pi_M(\overline{\theta}':R) = \theta_0[E(Y_R) - (I+a)].$$

This result is as expected since the new equity investor receives just the reservation level. Consequently, we can establish that

**Lemma 2** *If* $\frac{q}{N_0+q} < \frac{I+a}{A_0+E(Y_R)}$, *the contract which the equity investor offers is given by*

$$\mathbb{C}_E^* = \mathbb{C}_E(\overline{\theta}'),$$

*where*

$$\overline{\theta}' = \theta_0 \frac{A_0 + E(Y_R) - (I+a)}{A_0 + E(Y_R)},$$

$$\pi_M(\overline{\theta}':R) = \theta_0[E(Y_R) - (I+a)],$$

$$\pi_{EI}(\overline{\theta}':R) = \frac{a}{q}.$$

**Proof.** Proof in the text. ■

The contract $\mathbb{C}^E(\overline{\theta}')$ in Lemma 2 is a feasible contract since $\pi_{M,EI}(\overline{\theta}':R) > 0$ and $\pi_{EI}(\overline{\theta}':R) = \frac{a}{q}$.

Similar to the analysis above, we denote $\overline{\theta}''$ as the $\overline{\theta}$ in (21). We then can obtain the following lemma.

**Lemma 3** *If* $\frac{q}{N_0+q} > \frac{I+a}{A_0+E(Y_R)}$*, the contract which the equity investor offers is given by*

$$\mathbb{C}_E^* = \mathbb{C}_E(\overline{\theta}''),$$

*where*

$$\overline{\theta}'' = \frac{F_0}{N_0+q},$$

$$\pi_M(\overline{\theta}'':R) = \theta_0 \frac{1}{N_0+q}\left[N_0 E(Y_R) - qA_0\right] \ ,$$

$$\pi_{EI}(\overline{\theta}'':R) = \frac{1}{q}\left[\frac{q}{N_0+q}(A_0+E(Y_R)) - I\right] \ .$$

*Here,* $F_0$ *is the number of the shares which the manager owns.*

**Proof.** Proof in Appendix B. ■

In Lemma 3, $\pi_{EI}(\overline{\theta}'':R) > \frac{a}{q}$, since $\frac{q}{N_0+q} > \frac{I+a}{A_0+E(Y_R)}$. That is, the equity investor obtains more than the reservation level even under competition. Assuming that $q$ is not large (i.e., $q < N_0\frac{E(Y_R)}{A_0}$, where $\frac{E(Y_R)}{A_0} > 1$), $\pi_M(\overline{\theta}'':R) > 0$.[14] Thus, $\mathbb{C}_E(\overline{\theta}'')$ is a feasible contract.

We are now in a position to examine the equilibrium contracts of the model.

**Proposition 1** *(i) If* $\frac{q}{N_0+q} < \frac{I+a}{A_0+E(Y_R)}$*,* $\mathbb{C}_E(\overline{\theta}')$ *is the equilibrium contract. (ii) If* $\frac{q}{N_0+q} > \frac{I+a}{A_0+E(Y_R)}$ *and* $\frac{1-p_R}{2}{A_0}^w + (a+I) - \frac{q}{N_0+q}(A_0+E(Y_R)) > 0$*,* $\mathbb{C}_E(\overline{\theta}'')$ *is the equilibrium contract. (iii) If* $\frac{q}{N_0+q} > \frac{I+a}{A_0+E(Y_R)}$ *and* $\frac{1-p_R}{2}{A_0}^w + (a+I) - \frac{q}{N_0+q}(A_0+E(Y_R)) < 0$*,* $\mathbb{C}_D(\underline{r})$ *is the equilibrium contract.*

**Proof.** (i) From Lemma 2, if $\frac{q}{N_0+q} < \frac{I+a}{A_0+E(Y_R)}$, $\mathbb{C}_E(\overline{\theta}')$ is the contract offered by the equity investor. As already shown, $\mathbb{C}_D(\underline{r})$ and $\mathbb{C}_E(\overline{\theta}')$ are feasible contracts. From Lemmas 1 and 2, we can obtain

$$\pi_M(\overline{\theta}':R) - \pi_M(\underline{r}:R) = \theta_0\frac{1-p_R}{2}{A_0}^w.$$

This is greater than 0. Thus, the manager prefers $\mathbb{C}_E(\overline{\theta}')$ to $\mathbb{C}_D(\underline{r})$.

(ii) and (iii) From Lemma 3, if $\frac{q}{N_0+q} > \frac{I+a}{A_0+E(Y_R)}$, $\mathbb{C}_E(\overline{\theta}'')$ is the contract offered by the equity investor. As already shown, $\mathbb{C}_D(\underline{r})$ and $\mathbb{C}_E(\overline{\theta}'')$ are feasible contracts. From Lemmas 1 and 3, we can obtain

$$\pi_M(\overline{\theta}'':R) - \pi_M(\underline{r}:R) = \theta_0\left[\frac{1-p_R}{2}{A_0}^w + (a+I) - \frac{q}{N_0+q}(A_0+E(Y_R))\right].$$

This can be negative or positive. Since $\theta_0 > 0$, $\pi_M(\overline{\theta}'':R) - \pi_M(\underline{r}:R) > 0$ ($< 0$) if $\frac{1-p_R}{2}{A_0}^w + (a+I) - \frac{q}{N_0+q}(A_0+E(Y_R)) > 0$ ($< 0$). Thus, the manager prefers $\mathbb{C}_E(\overline{\theta}'')$ to

[14] Together with $\frac{q}{N_0+q} > \frac{I+a}{A_0+E(Y_R)}$, we thus assume $\frac{N_0\ E(Y_R)}{A_0} > q > \frac{N_0\ (I+a)}{A_0+E(Y_R)-I-a}$, where $\frac{E(Y_R)}{A_0} > \frac{I+a}{A_0+E(Y_R)-I-a}$ holds according to the assumptions.

$\mathbb{C}_D(\underline{r})$ if $\frac{1-p_R}{2}{A_0}^w + (a+I) - \frac{q}{N_0+q}(A_0 + E(Y_R)) > 0$, and the manager prefers $\mathbb{C}_D(\underline{r})$ to $\mathbb{C}_E(\overline{\theta}'')$ if $\frac{1-p_R}{2}{A_0}^w + (a+I) - \frac{q}{N_0+q}(A_0 + E(Y_R)) < 0$. ■

Proposition 1 is visualized as in Figure 2. In the figure, the straight line (L1) at the top is given by

$$N_0 = \frac{q}{a+I}(A_0 + E(Y_R)) - q, \quad \left(\Leftrightarrow \frac{q}{N_0+q} = \frac{I+a}{A_0 + E(Y_R)}\right). \tag{24}$$

Another line (L2) is given by

$$\begin{aligned} N_0 &= \frac{q}{\frac{1-P_R}{2}{A_0}^{\,w} + a + I}(A_0 + E(Y_R)) - q, \\ &\left(\Leftrightarrow \frac{1-p_R}{2}{A_0}^{\,w} + (a+I) - \frac{q}{N_0+q}(A_0 + E(Y_R)) = 0\right). \end{aligned} \tag{25}$$

L1 and L2 never cross, and L2 is below L1 for $\underline{A}_0 \le A_0 < I$.[15] Figure 2 shows that $\mathbb{C}_D(\underline{r})$ is the equilibrium contract when $N_0$ is small, such that $\frac{q}{N_0+q} > \frac{I+a}{A_0+E(Y_R)}$ and $\frac{1-p_R}{2}{A_0}^w + (a+I) - \frac{q}{N_0+q}(A_0 + E(Y_R)) < 0$. This is because dilution of the manager's shareholdings by issuing new shares is large if $N_0$ is low (i.e., $\theta_0 - \theta$ is large if $N_0$ is low), so that the manager prefers $\mathbb{C}_D(\underline{r})$ to $\mathbb{C}_E$. However, when the manager realizes the dilution is large, such that $\pi_M(\overline{\theta}'' : R) - \pi_M(\underline{r} : R) < 0$, he can, in principle, split the shares first and then issue new shares. This procedure can provide the manager with $\pi_M(\overline{\theta}' : R)$ because splitting the shares allows manager to drive down $\pi_{EI}(\overline{\theta} : R)$ to the equity investor's reservation level $\frac{a}{q}$ without affecting the manager's shareholding ratio. This ends up being the case of $\frac{q}{N_0+q} < \frac{I+a}{A_0+E(Y_R)}$, because splitting the existing shares before issuing the new shares implies an increase in $N_0$: the equilibrium contract will then be $\mathbb{C}_E(\overline{\theta}')$. We assume that there is a cost to share-splits, and this hinders the manager from splitting the shares. Appendix C shows the effect of the costs in detail. It shows that if the costs are higher than $\theta_0((1-p_R)/2)I^w$, the manager does not consider splitting the shares.[16]

---

[15] At $A_0 = 0$, the two lines intersects with each other. $\left[\partial\left(q\left(\frac{1-P_R}{2}{A_0}^w + a + I\right)^{-1}(A_0 + E(Y_R)) - q\right)/\partial A_0\right]\left(\frac{q}{a+I}\right)^{-1} - 1 = \left\{-{A_0}^w(1-p_R)\left[2aA_0 + {A_0}^{1+w}(1-p_R) + 2A_0 I + 2awA_0 + 2wA_0 I + 2awE(Y_R) + 2wE(Y_R)I\right]\right\} / \left[2(a+I) + {A_0}^w(1-p_R)\right]^2$. The right hand side of this equation is less than zero. Thus, $\left[\partial\left(q\left(\frac{1-P_R}{2}{A_0}^w + a + I\right)^{-1}(A_0 + E(Y_R)) - q\right) / \partial A_0\right] < \frac{q}{a+I}$. Note here that $\left[\partial\left(q\left(\frac{1-P_R}{2}{A_0}^w + a + I\right)^{-1}(A_0 + E(Y_R)) - q\right) / \partial A_0\right]$ can be negative or positive. Line L2 in Figure 2 represents the case of $\left[\partial\left(q\left(\frac{1-P_R}{2}{A_0}^w + a + I\right)^{-1}(A_0 + E(Y_R)) - q\right) / \partial A_0\right] > 0$.

[16] McGough (1993) and Angel (1997) argue that the costs of splitting shares (e.g., administrative costs, transfer tax, and printing costs) can be substantial. Bebartzi, Michaely, and Weld (2007) report that firms almost never split their shares in Japan.

## 2.3 The Model

We have shown that the loan contract and the equity contract can each be an equilibrium contract, but that the contract type does not matter in the manager's project choice. The manager always plays it risky (chooses project $R$). In this subsection, we show that the manager, in some cases, plays it safe (chooses project $S$) by selecting the loan contract.

Remember that the bank investor faces an agency problem. To overcome the problem, he devises a way to discipline (threaten) the manager. Otherwise, the manager will never play it safe (i.e., never choose project $S$). To discipline the manager, the bank investor must provide a credible threat to the manager by including some sort of option in the loan contract.

Since the firm's action—to make "safe" or "risky" choices—is not verifiable, and the bank never wants to write a contract contingent on the project outcome (because it is too costly), the option must be a non-contingent one. Although the option could take any form, it is reasonable to suppose that the bank investor thinks of including a non-contingent early loan demand option in the contract; i.e., an option for the investor to liquidate the project early *at will*. This loan contract can be interpreted as a short-term loan with a possible rollover, which is common in banking. Most commercial bank loans are, in fact, of the short-term type, and banks often refuse to roll over maturing short-term loans. The contract with the early loan demand option preserves the most important feature of a rollover loan; i.e., a bank's total control over continuation of the project implemented by its borrowing firm.

At first glance, it seems hard for the loan contract with the early demand option to be an equilibrium contract because: (i) the agency problem exists between the firm and the bank investor (but not between the firm and the equity investor), (ii) the firm chooses any of the three competitive contracts, and (iii) the bank with the demandable loan contract can liquidate the project early at will. We will show, however, that under certain conditions, the firm selects the loan contract with the early demand option and plays it safe in equilibrium.

### 2.3.1 Model timing and contract types

Model timing is slightly changed from the preliminary model, as shown in Figure 3. In contrast to the preliminary model, early loan demand is now possible during stage 1 if the option is written in the contract and *passive* monitoring is implemented. If the project is liquidated in stage 1, the firm receives no cash flow. Here we assume that the liquidation requires monitoring because the bank investor must know about the firm (e.g., it must know where the assets are placed) in order to intervene and seize the assets. In other words, *passive* monitoring makes it possible for the bank investor to liquidate the project early.[17]

The equity contract is the same as the one shown in the preliminary model. The loan contract is now defined by

$$\mathbb{C}_D = \mathbb{C}_D(r, L, Z) \ ,$$

where $L$ denotes the early liquidation option ($L = 1$ if the option is included and $L = 0$ otherwise), and $Z$ is the payment received by the bank from the firm in liquidation of the project. $Z$ may include collateral. If $L = 0$, $Z = 0$, and $Z > 0$ if $L = 1$. Note here that the firm never wants its project to be liquidated because, if the project is liquidated early, it receives no cash flow and must pay $Z > 0$. For analytical convenience, we divide $\mathbb{C}_D$ into two types: a type $A$ loan contract and a type $B$ loan contract. The type $A$ contract, $\mathbb{C}_{D_A}$, has $L = 0$, and the type $B$ contract, $\mathbb{C}_{D_B}$, has $L = 1$. Thus, they can be written as

$$\mathbb{C}_{D_A} = \mathbb{C}_{D_A}(r) \text{ and } \mathbb{C}_{D_B} = \mathbb{C}_{D_B}(r, Z).$$

$\mathbb{C}_{D_A}$ is identical to the loan contact studied in the preliminary model. Thus, an immediate corollary arises from Lemma 1:

**Corollary 1** *If the bank investor does not include the early loan demand option, the contract which the bank investor offers is given by*

$$\mathbb{C}^*_{D_A} = \mathbb{C}_{D_A}(\underline{r}),$$

*where*

$$\underline{r} = \frac{1}{1+p_R}[\frac{2a}{I} + (1-p_R) - \frac{1-p_R}{I}(A_0 - {A_0}^w)],$$

$$\pi_{BI}(\underline{r}{:}R) = a,$$

$$\pi_M(\underline{r}{:}R) = \theta_0[E(Y_R) - \frac{1-p_R}{2}{A_0}^w - I - a],$$

*and* $\mathbb{C}^*_{D_A}$ *is a feasible contract.*

Consider next $\mathbb{C}_{D_B}$. The bank investor with $\mathbb{C}_{D_B}$ has three possible returns: $\pi_{BI}(r{:}R)$, $\pi_{BI}(r{:}R) - M$, and $\pi_{BI}(r{:}S) - M$. Return $\pi_{BI}(r{:}S)$ is not possible because: (i) the manager knows that the bank needs to monitor the firm in order to liquidate the project early, (ii) the manager can switch the project after observing whether the bank is monitoring or not, and (iii) the manager, with a given interest rate, prefers project $R$ to project $S$.[18] With a given interest rate, $\pi_{BI}(r{:}R)$, $\pi_{BI}(r{:}R) - M$, and $\pi_{BI}(r{:}S) - M$ are ordered

[17] As we will show later, this gives the bank investor an incentive to monitor the firm. In contrast, in the preliminary model, the bank does not have an incentive to monitor and thus no monitoring occurs.

[18] In fact, (ii) with (i) is the same as assuming that the bank can (contractually) commit to monitor the firm because the contractual commitment also makes it impossible for the bank to obtain $\pi_{BI}(r{:}S)$. Condition (ii) is an important assumption of the model. Without it, costly monitoring conducted by the

according to either

$$\begin{cases} \pi_{BI}(r{:}R) - M < \pi_{BI}(r{:}R) < \pi_{BI}(r{:}S) - M \\ \text{or} \\ \pi_{BI}(r{:}R) - M < \pi_{BI}(r{:}S) - M < \pi_{BI}(r{:}R). \end{cases} \tag{26}$$

In the following, we examine the *feasibility* of $\mathbb{C}_{D_B}$, using (26) in relation to the bank investor's reservation level of utility, $a$.

Before examining the feasibility of $\mathbb{C}_{D_B}$, we rule out the cases which clearly lead to non-equilibrium $\mathbb{C}_{D_B}$, in order to simplify our analysis of the model. With $\pi_{BI}(r{:}R) \geq a$, Corollary 1 gives

$$\pi_M(r{:}S) < \pi_M(r{:}R) \leq \pi_M(\underline{r}{:}R) \ . \tag{27}$$

Expression (27) tells that the manager prefers $\mathbb{C}^*_{D_A}$ to $\mathbb{C}_{D_B}(r, Z)$ with $\{(r, Z) \mid \pi_{BI}(r{:}R) \geq a\}$.[19] Thus, under investor competition where any bank can offer $\mathbb{C}^*_{D_A}$, $\mathbb{C}_{D_B}(r, Z)$ with $\{(r, Z) \mid \pi_{BI}(r{:}R) \geq a\}$ cannot be the equilibrium contract of the model, even if it is a feasible contract. In the following analysis, we can thus safely ignore the case of $\pi_{BI}(r{:}R) \geq a$.

To analyze the feasibility of $\mathbb{C}_{D_B}$, we first consider $\mathbb{C}_{D_B}(r, Z)$ with $\{(r,Z) \mid \pi_{BI}(r{:}R) < a$ and $\pi_{BI}(r{:}S)$ - $M < a\}$. With this contract, (26) can be rewritten as

$$\begin{cases} \pi_{BI}(r{:}R) < \pi_{BI}(r{:}S) - M < a. \\ \text{or} \\ \pi_{BI}(r{:}S) - M < \pi_{BI}(r{:}R) < a. \end{cases} \tag{28}$$

Expression (28) indicates that the bank has no incentive to offer $\mathbb{C}_{D_B}(r, Z)$ with $\{(r,Z) \mid \pi_{BI}(r{:}R) < a$ and $\pi_{BI}(r{:}S)$ - $M < a\}$ unless $a \leq Z - M$. From (28), the $\mathbb{C}_{D_B}(r, Z)$ with $a \leq Z - M$ implies that the investor liquidates the project regardless of whether the manager plays it safe or risky. Therefore, since the liquidation provides the manager with return less than his reservation level, then $\mathbb{C}_{D_B}$ with $\{(r,Z) \mid \pi_{BI}(r{:}R) < a$ and $\pi_{BI}(r{:}S)$ - $M < a\}$ cannot be a feasible contract.

Next, consider $\mathbb{C}_{D_B}(r, Z)$ with $\{(r,Z) \mid \pi_{BI}(r{:}R) < a$ and $\pi_{BI}(r{:}S)$ - $M \geq a\}$. For

bank cannot be credible under any circumstances because, from an *ex post* perspective, the bank investor has no incentive to monitor the firm. This leads to the result that $\mathbb{C}_{D_B}$ cannot be the equilibrium contract of the model. Khalil (1997) and Khalil and Parigi (1998) study this kind of commitment problem and analyze a mixed-strategy equilibrium. In order to keep the model simple, we have decided not to follow this approach. Many studies, e.g., Diamond (1991), Rajan (1992) and Repullo and Suarez (1998), make the assumption that the bank can commit to monitor.

[19] To be precise, this arguement is not exactly correct. $C^*_{D_A}$ and the $C_{D_B}$ which gives the manager the same level of return as $C^*_{D_A}$ are indifferent for the manager in terms of his expected monetary return. We assume herein that the option somehow results in a negative impact on the manager's choice of contract.

this contract, (26) can be rewritten as

$$\pi_{BI}(r{:}R) - M < \pi_{BI}(r{:}R) < a \leq \pi_{BI}(r{:}S) - M \ . \tag{29}$$

Considering (29), we can establish the following lemma

**Lemma 4** *$\mathbb{C}_{D_B}(r, Z)$ (excluding $\mathbb{C}_{D_B}(r, Z)$ with $\{(r, Z) \mid \pi_{BI}(r{:}R) \geq a\}$) is a feasible contract only if it is with*

$$\{(r, Z) \mid \pi_{BI}(r{:}R) < a \ \leq \pi_{BI}(r{:}S) - M, \ \ \pi_{BI}(r{:}R) < Z < \pi_{BI}(r{:}S)\} \ , \tag{30}$$

*and, if the manager ever accepts feasible $\mathbb{C}_{D_B}(r, Z)$, he or she undertakes project $S$.*

**Proof.** To examine the feasibility of $\mathbb{C}_{D_B}(r, Z)$ with $\{(r, Z) \mid \pi_{BI}(r{:}R) < a \leq \pi_{BI}(r{:}S)$ - $M$ $\}$, we consider (i) $Z \leq \pi_{BI}(r{:}R)$, (ii) $Z \geq \pi_{BI}(r{:}S)$ and (iii) $\pi_{BI}(r{:}R) < Z < \pi_{BI}(r{:}S)$ in turn (note that these three cases cover every possibility, since $\pi_{BI}(r{:}R) < \pi_{BI}(r{:}S)$).

First, consider the case of $Z \leq \pi_{BI}(r{:}R)$. If $Z \leq \pi_{BI}(r{:}R)$, $Z - M \leq \pi_{BI}(r{:}R) - M$. From (29), we then obtain

$$Z - M \leq \pi_{BI}(r{:}R) - M < \pi_{BI}(r{:}R) < a \leq \pi_{BI}(r{:}S) - M \ .$$

This expression indicates that the bank investor has no incentive to liquidate the project because doing so results in the lowest return $(Z - M)$. With this knowledge, the manager plays it risky if he accepts the contract. The investor thus gets $\pi_{BI}(r{:}R) - M < a$. Therefore, the $\mathbb{C}_{D_B}$ with $Z \leq \pi_{BI}(r{:}R)$ is not a feasible contract (knowing that he receives $\pi_{BI}(r{:}R) - M < a$, the bank investor never offers this contract).

Second, consider the case of $Z \geq \pi_{BI}(r{:}S)$. If $Z \geq \pi_{BI}(r{:}S)$, $Z - M \geq \pi_{BI}(r{:}S) - M$. From (29), we then obtain

$$\pi_{BI}(r{:}R) - M < \pi_{BI}(r{:}R) < a \leq \pi_{BI}(r{:}S) - M \leq Z - M \ .$$

This expression implies that the bank investor liquidates the project regardless of what the manager does. Since the liquidation of the project gives the manager a return less than his reservation level, then the $\mathbb{C}_{D_B}(r, Z)$ with $Z \geq \pi_{BI}(r{:}S)$ is not a feasible contract.

Finally, consider the case of $\pi_{BI}(r{:}R) < Z < \pi_{BI}(r{:}S)$. If $\pi_{BI}(r{:}R) < Z < \pi_{BI}(r{:}S)$,

$$\pi_{BI}(r{:}R) - M < Z - M < \pi_{BI}(r{:}S) - M \ . \tag{31}$$

With this contract, the bank investor's best choice of action is to monitor the firm, and the liquidation threat becomes credible. The reasoning is as follows. If the bank does not monitor, it gets a return less than the reservation level ($\pi_{BI}(r{:}R) < a$ from expression 29). If the bank monitors, the bank is better to liquidate the project in the case that the manager plays it risky, according to (31): $\pi_{BI}(r{:}R) - M < Z - M$. Since the manager never wants to be liquidated, *observing that the bank is monitoring and thus knowing that the bank is ready to liquidate the project*, he does not play it risky.[20] According to (31), the bank then gets $\pi_{BI}(r{:}S) - M \geq a$, which is the highest possible return in this case. This leads the bank and the manager to believe that the bank's best choice of action is to monitor the firm, and thus the threat of liquidation becomes credible.[21] As a result, the manager plays it safe, and the bank obtains $\pi_{BI}(r{:}S) - M \geq a$ if the contract is signed.

This contract also provides another form of credibility. According to (31): $Z - M < \pi_{BI}(r{:}S) - M$, the bank has no incentive to liquidate as long as the manager plays it safe (bank monitoring reveals whether the manager is playing it safe or risky). In other words, the level of $Z$ given by (30) makes the manager believe that the bank will not execute the liquidation option if the manager plays it safe. This makes the contract acceptable to the manager. $\mathbb{C}_{D_B}$ with (30) is thus a feasible contract ($a \leq \pi_{BI}(r{:}S) - M$ in (30) holds if $M$ is not too large).

According to the previous analyses, $\mathbb{C}_{D_B}(r, Z)$ with $\{(r,Z) \mid \pi_{BI}(r{:}R) < a$ and $\pi_{BI}(r{:}S)$ - $M < a\}$ is not a feasible contract. $\mathbb{C}_{D_B}(r, Z)$ (excluding $\mathbb{C}_{D_B}(r, Z)$ with $\{(r,Z) \mid \pi_{BI}(r{:}R)$ $\geq a\}$) is thus a feasible contract only if it is with $\{(r,Z) \mid \pi_{BI}(r{:}R) < a \leq \pi_{BI}(r{:}S)$ - $M$, $\pi_{BI}(r{:}R) < Z < \pi_{BI}(r{:}S)\}$, and the manager plays it safe if he accepts feasible $\mathbb{C}_{D_B}$. ■

The important point in Lemma 4 and its proof is that a feasible type $B$ loan contract is "credible" to the manager in two ways. First, it is credible in the sense that the manager knows that the bank investor will liquidate the project if the manager plays it risky. Second, the contract is credible in the sense that the manager knows that the bank investor will not liquidate the project (i.e., the bank will let the business go) as long as the manager plays it safe. The first form of credibility works as a disciplinary device for the manager, and the second form of credibility makes the contract acceptable to the manager, even though the contract gives the bank total control over the firm's operation. By setting $r$ and $Z$ given by Lemma 4, $\mathbb{C}_{D_B}(r, Z)$ gains these two forms of credibility at once. For example, with a given $Z$, $\mathbb{C}_{D_B}(r, Z)$ having a value of $r$ that is too high or too low neither disciplines the manager nor represents a feasible contract. Interestingly, with a given $r$, $Z$ works as not only as a threatening device, but also as a relieving device for the manager by making the manager believe that the bank will not execute the liquidation option as long as he plays it safe.

Other important points are that, as mentioned in the proof of Lemma 4, $a \leq \pi_{BI}(r{:}S) - M$ in (30) cannot hold if $M$ is too large, and that the bank (weakly) prefers feasible $\mathbb{C}_{D_B}(r, Z)$ to $\mathbb{C}_{D_A}(\underline{r})$ (see Corollary 1 and Lemma 4).

[20] Note that the manager's observation of bank monitoring is important. The manager observes bank monitoring, and this makes the manager believe that the bank is ready to liquidate the project if the manager does not behave himself (remember that monitoring is required for liquidation).

[21] This is not possible without the assumption that the manager can switch the project after observing bank monitoring. See note 18.

### 2.3.2 Different $M$

We have not yet considered bank competition in offering $\mathbb{C}_{D_B}(r, Z)$, although monitoring cost $M$ is assumed to differ among the investors. Consider the effects of such competition in the following.

There are many possible candidates that cause $M$ to vary across banks. The most important factor is probably the bank's relationship with the firm. We assume that the bank more closely tied to the firm has a lower level of $M$ because the closer relationship leads to an informational advantage. For example, in Japan, it is common for banks to temporarily (typically for several years) transfer their executives to client firms as senior executives (sometimes even as board members), and also for client firms to hire the retired executives of their banks. Banks that send their executives to client firms are likely to pay lower monitoring costs than banks with no close connection with their client firms.

We define bank 1 as the bank with the closest relationship to the firm and bank 2 as the second closest one. We denote $\eta$ as closeness, where a bank with a lower level of $\eta$ is more closely tied to the firm. We then have

$$0 < \eta_1 < \eta_2 \ , \tag{32}$$

where the subscript indicates bank 1 or bank 2. To simplify the analysis, we also assume

$$M = \eta \ . \tag{33}$$

By defining $\underline{r}_B$ as the interest rate that satisfies $\pi_{BI}(\underline{r}_B{:}S) - M = a$ and using (7) and (33), we can obtain

$$\underline{r}_B(\eta) = \frac{1}{(1+p_S)I}[(1-p_S)(I - A_0 + {A_0}^w) + 2(a+\eta)] \ . \tag{34}$$

Since feasible $\mathbb{C}_{D_B}$ requires $\pi_{BI}(r{:}S) - M \geq a$ according to Lemma 4, $\underline{r}_B$ shows the lower bound on $r$ of feasible $\mathbb{C}_{D_B}$ for a given $Z$: as already shown by using (28), with $r < \underline{r}_B$ the bank liquidates the project early regardless of what the manager does. Equations (32) and (34) then provide the following inequality

$$\underline{r}_B(\eta_1) < \underline{r}_B(\eta_2) \ . \tag{35}$$

Now suppose bank 2 offers feasible $\mathbb{C}_{D_B}(r_2, Z_2)$, where $r_2 = \underline{r}_B(\eta_2)$, that is, in offering the contract, bank 2 sets the interest rate at the lowest possible level. By accepting this contract, the firm gets $\pi_M(r_2{:}S)$ (remember from Lemma 4 that the manager chooses project $S$ by accepting feasible $\mathbb{C}_{D_B}$). However, bank 1 can offer an even better deal to the manager. For example, bank 1 can offer feasible $\mathbb{C}_{D_B}(r_1, Z_1)$, such that:

$$\underline{r}_B(\eta_1) \leq r_1 < r_2 = \underline{r}_B(\eta_2) \text{ and } Z_1 = Z_2 \ .$$

The manager prefers the $\mathbb{C}_{D_B}(r_1, Z_1)$ to the $\mathbb{C}_{D_B}(r_2, Z_2)$, since $\pi_M(r_2{:}S) < \pi_M(r_1{:}S)$.[22] Note here that the levels of $Z_1$ and $Z_2$ are irrelevant to the firm's return as long as $Z_1$ and $Z_2$ satisfy $\pi_{BI}(r{:}R) < Z < \pi_{BI}(r{:}S)$ in (30) of Lemma 4 (i.e., as long as the contracts are feasible). This is because if the manager accepts feasible $\mathbb{C}_{D_B}$, he undertakes project $S$ and knows that the bank will not liquidate the project as long as he behaves himself (so that $Z$ is not in his return function). We can thus establish that

**Lemma 5** *Bank 1 can offer feasible $\mathbb{C}_{D_B}$ which dominates any feasible $\mathbb{C}_{D_B}$ of bank 2.*

**Proof.** Proof in the text. ■

An immediate corollary from Lemmas 4 and 5 is

**Corollary 2** *If $\mathbb{C}_{D_B}$ is ever signed, the contract is always the one offered by bank 1.*

Bank 1 can offer feasible $\mathbb{C}_{D_B}(r_1, Z_1)$ if its monitoring cost ($M_1 = \eta_1$) is not large. Bank 1 can obtain more than its reservation level if its feasible $\mathbb{C}_{D_B}$ is accepted by the manager. In addition, bank 1 prefers feasible $\mathbb{C}_{D_B}(r_1, Z_1)$ to $\mathbb{C}^*_{D_A}$ because $\mathbb{C}^*_{D_A}$ gives bank 1 just the reservation level.

### 2.3.3 Equilibrium contracts

We can now examine the model's equilibrium contracts. Since we are interested in knowing under what circumstances the manager undertakes project $S$, we focus on finding the conditions for which feasible $\mathbb{C}_{D_B}(r_1, Z_1)$ becomes the equilibrium contract of the model.

To find the equilibrium conditions, we start by comparing feasible $\mathbb{C}_{D_B}(r_1, Z_1)$ with the feasible $\mathbb{C}_{D_A}$, $\mathbb{C}^*_{D_A} = \mathbb{C}_{D_A}(\underline{r})$. Let us first define $\overline{r}_B$, such that

$$\pi_M(\underline{r}{:}R) = \pi_M(\overline{r}_B{:}S).$$

As Corollary 1 shows, $\underline{r}$ is the interest rate of $\mathbb{C}^*_{D_A}$. Solving the equation for $\overline{r}_B$ yields

$$\overline{r}_B = \frac{1}{(1+p_S)I}[(1-p_R)A_0{}^w + (1-p_S)(I - A_0) + 2a + (p_S - p_R)(2X_L - X_H)] \ . \quad (36)$$

Only if feasible $\mathbb{C}_{D_B}(r_1, Z_1)$ has an interest rate less than $\overline{r}_B$, the manager prefers it to $\mathbb{C}_{D_A}(\underline{r})$. Remember that $\underline{r}_B(\eta_1)$ is the lower bound on $r_1$ of feasible $\mathbb{C}_{D_B}(r_1, Z_1)$. Thus,

[22] Although not directly comparable, this result and the implication of (35) seem to be consistent with the findings of Petersen and Rajan (1994) and Berger and Udell (1995). They find that firms with closer bank relations are charged a lower interest rate.

for feasible $\mathbb{C}_{D_B}(r_1, Z_1)$ to be an equilibrium contract, it must have $r_1$ , such that

$$\underline{r}_B(\eta_1) < r_1 < \overline{r}_B \ . \tag{37}$$

Bank 1 sets $r_1$ in the range given by (37). The level of $r_1$ selected from this range depends on $\eta_2$ and the upper bound on $r_1$ of feasible $\mathbb{C}_{D_B}(r_1, Z_1)$.[23]

Considering (37) and using (34) and (36), we can get the following necessary condition for equilibrium $\mathbb{C}_{D_B}(r_1, Z_1)$.

$$\overline{r}_B - \underline{r}_B(\eta_1) = \frac{1}{(1+p_S)I}\left[(p_S - p_R)(A_0{}^w - (X_H - 2X_L) - 2\eta_1\right] > 0. \tag{38}$$

The term $\overline{r}_B - \underline{r}_B(\eta_1)$ cannot be positive without the wedge $A_0{}^w$. In other words, the equilibrium condition cannot be met without $A_0{}^w$. This is because the bank's preference for project $S$ over project $R$ cannot be strong enough without $A_0{}^w$, and thus bank 1 has no incentive to offer a type $B$ contract with an $r_1$ low enough to attract the manager.

To obtain the equilibrium conditions, we also need to compare feasible $\mathbb{C}_{D_B}(r_1, Z_1)$ with feasible $\mathbb{C}_E$. Let us define $r'_E$ and $r''_E$, such that

$$\pi_M(\overline{\theta}'{:}R) = \pi_M(r'_E{:}S), \tag{39}$$

$$\pi_M(\overline{\theta}''{:}R) = \pi_M(r''_E{:}S) \tag{40}$$

where $\overline{\theta}'$ and $\overline{\theta}''$ are given by Lemma 1 and Lemma 2, respectively. Solving equations (39) and (40) gives

$$r'_E = \frac{1}{(1+p_S)I}\left[\begin{array}{c} 2(p_S - p_R)X_L - (p_S - p_R)X_H \\ +(1-p_S)(I - A_0) + 2a \end{array}\right], \tag{41}$$

$$r''_E = \frac{1}{(1+p_S)I}\left[\begin{array}{c} E(Y_S) - \frac{N_0}{N_0+q}E(Y_R) + \left(\frac{1+p_S}{2} - \frac{N_0}{N_0+q}\right)A_0 \\ -\left(\frac{1+p_S}{2}\right)I \end{array}\right]. \tag{42}$$

Remember from the analysis of the preliminary model that: (i) if $\frac{q}{N_0+q} < \frac{I+a}{A_0+E(Y_R)}$, the equity investor offers $\mathbb{C}_E\,(\overline{\theta}')$, and (ii) if $\frac{q}{N_0+q} > \frac{I+a}{A_0+E(Y_R)}$, the equity investor offers $\mathbb{C}_E(\overline{\theta}'')$. ($\mathbb{C}_E(\overline{\theta}')$ and $\mathbb{C}_E(\overline{\theta}'')$ are feasible contracts.) Thus, since $\underline{r}_B(\eta_1)$ is the lower bound on $r_1$ of feasible $\mathbb{C}_{D_B}(r_1, Z_1)$, in order for feasible $\mathbb{C}_{D_B}(r_1, Z_1)$ to be an equilibrium contract, it must have $r_1$ , such that

$$\begin{array}{l} \underline{r}_B(\eta_1) < r_1 < r'_E \quad \text{if } \frac{q}{N_0+q} < \frac{I+a}{A_0+E(Y_R)}, \\ \underline{r}_B(\eta_1) < r_1 < r''_E \quad \text{if } \frac{q}{N_0+q} > \frac{I+a}{A_0+E(Y_R)}. \end{array} \tag{43}$$

[23] We can derive the upper bound on $r_1$ of feasible $\mathbb{C}_{D_B}(r_1, Z_1)$ from Lemma 4.

From (34), (41) and (42), we can obtain

$$r'_E - \underline{r}_B(\eta_1) = \frac{1}{(1+p_S)I}\begin{bmatrix} (p_S - p_R)(2X_L - X_H) \\ -(1-p_S){A_0}^w - 2\eta_1 \end{bmatrix}, \tag{44}$$

$$r''_E - \underline{r}_B(\eta_1) = \frac{1}{(1+p_S)I}\begin{bmatrix} 2\left(E(Y_S) - \frac{N_0}{N_0+q}E(Y_R)\right) + \frac{2q}{N_0+q}A_0 \\ -(1-p_S){A_0}^w - 2(I+a+\eta_1) \end{bmatrix}. \tag{45}$$

The values for $r'_E - \underline{r}_B(\eta_1)$ in (44) cannot be positive, since $p_S - p_R > 0$ from Assumption 2, $2X_L - X_H < 0$ from Assumption 3 and $\eta_1 > 0$. Therefore, according to (43), $\mathbb{C}_{D_B}(r_1, Z_1)$ cannot be an equilibrium contract if $\frac{q}{N_0+q} < \frac{I+a}{A_0+E(Y_R)}$. Thus, the following necessary conditions for equilibrium $\mathbb{C}_{D_B}(r_1, Z_1)$ are obtained

$$r''_E - \underline{r}_B(\eta_1) = \frac{1}{(1+p_S)I}\begin{bmatrix} 2\left(E(Y_S) - \frac{N_0}{N_0+q}E(Y_R)\right) \\ +\frac{2q}{N_0+q}A_0 - (1-p_S){A_0}^w \\ -2(I+a+\eta_1) \end{bmatrix} > 0, \tag{46}$$

$$\frac{q}{N_0+q} > \frac{I+a}{A_0+E(Y_R)}. \tag{47}$$

In sum, we can establish that

**Proposition 2** *The conditions for equilibrium $\mathbb{C}_{D_B}(r_1, Z_1)$ are (all of the following inequalities must be met)*

$$[(p_S - p_R)({A_0}^w - (X_H - 2X_L) - 2\eta_1] > 0, \tag{48}$$

$$\begin{bmatrix} 2\left(E(Y_S) - \frac{N_0}{N_0+q}E(Y_R)\right) + \frac{2q}{N_0+q}A_0 \\ -(1-p_S){A_0}^w - 2(I+a+\eta_1) \end{bmatrix} > 0, \tag{49}$$

$$\frac{q}{N_0+q} - \frac{I+a}{A_0+E(Y_R)} > 0. \tag{50}$$

*If $\mathbb{C}_{D_B}(r_1, Z_1)$ is the equilibrium contract, the manager undertakes project $S$.*

**Proof.** Proof in the text. ■

The left hand sides of (48), (49) and (50) can be positive or negative. From the condition in Proposition 2, we can obtain the following set of equations.

$$\begin{aligned} \frac{\partial CD'}{\partial \eta_1} &= \frac{\partial CD''}{\partial \eta_1} = -2 \quad (<0), \\ \frac{\partial CD''}{\partial N_0} &= -\frac{q}{(N_0+q)^2}\left[A_0 + E(Y_R)\right] \quad (<0), \\ \frac{\partial CD'''}{\partial N_0} &= -\frac{q}{(N_0+q)^2} \quad (<0), \\ \frac{\partial CD'}{\partial A_0} &= w{A_0}^{w-1} \quad (>0), \\ \frac{\partial CD''}{\partial A_0} &= \frac{2q}{N_0+q} - w(1-p_S){A_0}^{w-1}, \\ \frac{\partial CD'''}{\partial A_0} &= \frac{a+I}{(A_0+E(Y_R))^2} \quad (>0), \end{aligned} \tag{51}$$

where $CD'$, $CD''$ and $CD'''$ are the left hand sides of (48), (49), and (50), respectively. The signs of the values in (51) are shown in parentheses. Apart from $\frac{\partial CD''}{\partial A_0}$, all of the signs are singly determined, as shown in (51).

### 2.3.4 From the model to the empirical test

To test the model empirically, we make the following assumptions.

**Assumption 5** *For any given $\eta_1$, $A_0$, and $N_0$, the probability that firm i has $CD' > 0$, $CD'' > 0$, and $CD''' > 0$ at time t is nonzero.*

**Assumption 6** *$\eta_1$, $A_0$, and $N_0$ are not correlated with the other variables.*

Assumption 6 implies that $\eta_1$, $A_0$, and $N_0$ are not correlated with the productivity (efficiency) of the firm because $p_v$, $X_L$, $X_H$, and $I$ together reflect the productivity. Since this may not be true in reality, using a panel of data for Japanese firms, our empirical tests attempt to control for differences in firm productivity by including a firm-specific effect, a time effect and a heterogeneous linear time trend.

Since (51) shows that $\frac{\partial CD'}{\partial \eta_1}$, $\frac{\partial CD''}{\partial \eta_1}$, $\frac{\partial CD''}{\partial N_0}$, and $\frac{\partial CD'''}{\partial N_0}$ are all negative, assumptions 5 and 6 lead to the following corollary

**Corollary 3** *(i) Holding $N_0$ and $A_0$ fixed, the lower the level of $\eta_1$, the more likely firm i is to undertake project S at time t, and (ii) holding $\eta_1$ and $A_0$ fixed, the lower the level of $N_0$, the more likely firm i is to undertake project S at time t.*

Although (51) shows $\frac{\partial CD'}{\partial A_0} > 0$ and $\frac{\partial CD'''}{\partial A_0} > 0$, the effect of $A_0$ on the firm's project choice is not clear: $\frac{\partial CD''}{\partial A_0}$ can be negative or positive. We assume that $\frac{\partial CD''}{\partial A_0} > 0$ holds because our empirical test employs the data for firms with relatively large $\frac{A_0}{N_0}$ (relatively high share prices) and, if $\frac{A_0}{N_0}$ is large, $\frac{\partial CD''}{\partial A_0}$ is positive according to (51). The model then implies that holding $N_0$ and $\eta_1$ fixed, the higher the level of $A_0$, the more likely firm $i$ is to undertake project $S$ at time $t$. We would like to empirically test this together with Corollary 3.

Above all, we make the following testable hypotheses for the model:

**Hypothesis 1** *Holding all other factors constant, the closer relationship firm i has with banks, the safer but less profitable project firm i undertakes at time t,*

**Hypothesis 2** *Holding all other factors constant, the lower the number of firm i's outstanding shares, the safer but less profitable project firm i undertakes at time t,*

**Hypothesis 3** *Holding all other factors constant, the lager the scale of firm i's production, the safer but less profitable project firm i undertakes at time t.*

When making these hypotheses, we interpret $\eta_1$ as a firm's relationship with its banks in general rather than with a single bank (we will show how this is measured later). This is because: (i) although in the model $\eta_1$ is the firm's relationship with bank 1 (the most closely related bank), in reality it is often difficult to correctly identify which bank has the closest tie with the firm, and (ii) more importantly, firms, generally, borrow from several banks. Concerning $N_0$ and $A_0$, $N_0$ is simply the number of outstanding shares of a firm, and $A_0$ represents the scale of a firm's production since $A_0$ is the assets required to undertake the project (including both tangible and intangible assets).

# 3 Empirical Testing of the Model

In this section, we empirically test Hypotheses 1, 2, and 3. The testing consists of two parts. The first regression test considers firm $i$'s risk taking behavior (henceforth $FRT_i$). The hypotheses suggest that $FRT_i$ is influenced by firm $i$'s relationship with its banks, the number of firm $i$'s outstanding shares, and the scale of its production. The second regression test considers firm $i$'s operating profitability ($ROA_i$: return on assets). The hypotheses suggest that the three variables (firm $i$'s relationship with banks, the number of firm $i$'s outstanding shares, and the scale of its production) influence $ROA_i$ through their effect on $FRT_i$. As we will later show, the testing is an interactive two-step procedure in which the first and second regression tests complement each other.

## 3.1 Specification of FRT regressions

We will now derive the regression specification for the first test. According to the hypotheses, $FRT_i$ at time $t$ can be given by

$$FRT_{i,t} = c^{FRT} + \zeta_i^{FRT} + \lambda_t^{FRT} + \alpha_1\ BR_{i,t} + \alpha_2\ NS_{i,t} + \ \alpha_3\ SC_{i,t}, \tag{52}$$

where $c^{FRT}$ is a constant effect across time and firms, $\zeta_i^{FRT}$ is a firm-specific effect, $\lambda_t^{FRT}$ is a time effect, $BR_{i,t}$ is firm $i$'s relationship with its banks at time $t$, $NS_{i,t}$ is the number of outstanding shares of firm $i$ at time $t$, and $SC_{i,t}$ is the scale of production for firm $i$ at time $t$. An increase in $FRT_{i,t}$ means that firm $i$ takes more risks. An increase in $BR_{i,t}$ indicates that firm $i$ has a closer relationship with its banks (measured by a decrease in $\eta_{1,i}$ in the model). The hypotheses tell that $\alpha_1 < 0$, $\alpha_2 > 0$, and $\alpha_3 < 0$. We want to estimate $\alpha_1$, $\alpha_2$, and $\alpha_3$, but $FRT_{i,t}$ is unobservable (we cannot observe how much risk a firm has actually taken). We demonstrate a strategy to overcome this problem.

Assume that the following relationship exists

$$E_{i,t}\left[\phi_{i,t+1}\right] = c^{EF} + \zeta_i^{EF} + E_{i,t}[\lambda_{t+1}^{EF}] + \alpha_4\ FRT_{i,t}, \quad \alpha_4 > 0, \tag{53}$$

where $E_{i,t}$ is an expectation operator, $\phi_{i,t+1}$ is the uncertainty of firm $i$'s profitability at time $t+1$ (i.e., the degree of deviation of $ROA_{i,t+1}$ from $E_{i,t}\left[ROA_{i,t+1}\right]$), $c^{EF}$ is a constant effect across time and firms, $\zeta_i^{EF}$ is a firm-specific effect, and $\lambda_{t+1}^{EF}$ is a time effect. $E_{i,t}\left[\phi_{i,t+1}\right]$ is the value of $\phi_{i,t+1}$ that firm $i$ expects at time $t$ and $E_{i,t}[\lambda_{t+1}^{EF}]$ is the value of $\lambda_{t+1}^{EF}$ expected at time $t$. We believe that the assumed relationship of (53) is reasonable. With $\alpha_4 > 0$, (53) shows that $E_{i,t}\left[\phi_{i,t+1}\right]$ is positively related to $FRT_{i,t}$: taking more risks at time $t$, firm $i$ expects that the uncertainty of its profitability will increase at time $t+1$.

Next, by substituting (52) into (53) for $FRT_{i,t}$, we obtain

$$\phi_{i,t+1} = c^F + \zeta_i^F + \lambda_t^F + \alpha_4\alpha_1\ BR_{i,t} + \alpha_4\alpha_2\ NS_{i,t} + \ \alpha_4\alpha_3\ SC_{i,t} + \varepsilon_{i,t+1}^F, \qquad (54)$$

where

$$\begin{aligned} c^F &= \alpha_4 c^{FRT} + c^{EF}, \\ \zeta_i^F &= \alpha_4 \zeta_i^{FRT} + \zeta_i^{EF}, \\ \lambda_t^F &= \alpha_4 \lambda_t^{FRT} + \lambda_{t+1}^{EF}, \\ \varepsilon_{i,t+1}^F &= (\phi_{i,t+1} - E_{i,t}\left[\phi_{i,t+1}\right]) + (\lambda_{t+1}^{EF} - E_{i,t}[\lambda_{t+1}^{EF}]). \end{aligned} \qquad (55)$$

Equation (54) is our basic regression specification to test the hypotheses (we will later show how to measure $\phi_{i,t+1}$).[24] As (55) shows, the term $\varepsilon_{i,t+1}^F$ in (54) is the sum of firm $i$'s expectation error for $\phi_{i,t+1}$ and that for $\lambda_{t+1}^{EF}$. Thus, treating $\varepsilon_{i,t+1}^F$ as an error term, we can obtain unbiased coefficient estimates from the regression.

Estimating the coefficients of (54), we can test the relationship shown in (52). To test whether $\alpha_1 < 0$, $\alpha_2 > 0$, and $\alpha_3 < 0$ hold, we need only to check the estimates of $\alpha_4\alpha_1$, $\alpha_4\alpha_2$, and $\alpha_4\alpha_3$ since we know $\alpha_4 > 0$. If the estimates for $\alpha_4\alpha_1$ and $\alpha_4\alpha_3$ are negative and significant, and the estimate for $\alpha_4\alpha_2$ is positive and significant, partial evidence for the model' validity is obtained.

## 3.2 Specification of the firm profitability regressions

We next show the regression specification for the second test. In the first regression test, we examine whether $BR_{i,t}$, $NS_{i,t}$, and $SC_{i,t}$ have an effect on $FRT_{i,t}$, as the model predicts. However, this is not enough to prove the validity of the model. The model shows that $BR_i$, $NS_i$, and $SC_i$ influence $ROA_i$ through their effect on $FRT_i$, i.e., through the risk-taking channel.

[24] Some of the coefficients in (54) vary across firms and time because the values in (51) are not constant, except $\frac{\partial CD'}{\partial \eta_1}$ and $\frac{\partial CD''}{\partial \eta_1}$. Since it is a formidable task to allow the coefficients to differ as shown by (51), we restrict the coefficients to be constant.

According to the hypotheses, we can obtain the following expression

$$E_{i,t}\left[ROA_{i,t+1}\right] = c^{ROAE} + \zeta_i^{ROAE} + E_{i,t}[\lambda_{t+1}^{ROAE}] + \beta_1\ FRT_{i,t}, \tag{56}$$

where $ROA_{i,t+1}$ is firm $i$'s return on assets at time $t+1$, $c^{ROAE}$ is a constant effect across time and firms, $\zeta_i^{ROAE}$ is a firm-specific effect, and $\lambda_{t+1}^{ROAE}$ is a time effect.[25] $E_{i,t}[ROA_{i,t+1}]$ is the value of $ROA_{i,t+1}$ that firm $i$ expects at time $t$, and $E_{i,t}[\lambda_{t+1}^{ROAE}]$ is the value of $\lambda_{t+1}^{ROAE}$ expected at time $t$.

Using (52) and (56), we can get

$$ROA_{i,t+1} = c^{ROA} + \zeta_i^{ROA} + \lambda_{t+1}^{ROA} + \beta_1\ \widehat{FRT}_{i,t} + \varepsilon_{i,t+1}^{ROA}, \tag{57}$$

where

$$\begin{aligned}
\widehat{FRT}_{i,t} &= \widehat{\alpha_4\alpha_1}\ BR_{i,t} + \widehat{\alpha_4\alpha_2}\ NS_{i,t} + \widehat{\alpha_4\alpha_3}\ SC_{i,t} \\
c^{ROA} &= c^{ROAE} + \delta c^{RTA}, \\
\zeta_i^{ROA} &= \zeta_i^{ROAE} + \delta\zeta_i^{RTA}, \\
\lambda_t^{ROA} &= \lambda_{t+1}^{ROAE} + \delta\lambda_t^{RTA}, \\
\varepsilon_{i,t+1}^{ROA} &= \left(ROA_{i,t+1} - E_{i,t}\left[ROA_{i,t+1}\right]\right) + \left(\lambda_{t+1}^{ROAE} - E_{i,t}[\lambda_{t+1}^{ROAE}]\right).
\end{aligned} \tag{58}$$

Equation (57) is our basic regression specification. The values of $\widehat{\alpha_4\alpha_1}$, $\widehat{\alpha_4\alpha_2}$, and $\widehat{\alpha_4\alpha_3}$ are the coefficient estimates from the first regression, and thus $\widehat{FRT}_{i,t}$ reflects the part of $FRT_{i,t}$ explained (predicted) by $BR_{i,t}$, $NS_{i,t}$, and $SC_{i,t}$.[26] If the hypotheses are valid, we should find that $\beta_1 > 0$. The term $\varepsilon_{i,t+1}^{ROA}$ in (57) is the sum of the two expectation errors, as shown by (58). As before, treating $\varepsilon_{i,t+1}^{ROA}$ as an error term, we can thus obtain unbiased coefficient estimates.

The test is thus an interactive two-step procedure. First, we do the $FRT$ regression and estimates the coefficients. Then, using the predicted value $\widehat{FRT}$, we estimate $\beta_1$.[27] We need support from both tests in order to verify the validity of the model.

[25] As shown in the data appendix, $ROA_{t+1}$ is measured by (operating profits at $t+1$)/(total assets at time $t$).

[26] Although $\widehat{FRT}_{i,t}$ is $\alpha_4$ times the part of $FRT$ predicted by the three variables, it does not matter for the test of $\beta_1$ in terms of sign and significance. This is because $\alpha_4$ only scales up the predicted part of $FRT$.

[27] We could also directly include $BR$, $NS$ and $SC$ in the second regression test. However, this approach would not correctly identify the effect of $FRT$ on $ROA$, since these variables might influence $ROA$ in other ways; e.g., $SC$ might affect $ROA$ through an economy of scale (the efficiency channel) rather than the risk-taking channel.

### 3.3 The measurement of $\phi_{i,t+1}$

An important variable in our empirical test is $\phi_{i,t+1}$, and measurement of this variable using a new approach is explained in detail in this subsection.[28]

The variable $\phi_{i,t+1}$ represents the uncertainty of firm $i$'s outcome. It represents the degree of deviation of $ROA_{i,t+1}$ from $E_{i,t}\left[ROA_{i,t+1}\right]$. We can easily obtain $ROA_{i,t+1}$, but not $E_{i,t}\left[ROA_{i,t+1}\right]$. While firms usually make their expected $ROA$ available to the public, it is very difficult to obtain their 'true' expected $ROA$. For example, firms frequently disguise the fact that their business is not going well. We show below how to obtain the 'true' expected $ROA$.

First, by assuming that firms are rational, we can get the following equations

$$ROA_{i,t+1} - E_{i,t}[ROA_{i,t+1}] = e_{i,t+1}, \tag{59}$$

$$E_{i,t}[e_{i,t+1}] = 0. \tag{60}$$

Note here that the 'true' expected ROA, $E_{i,t}[ROA_{i,t+1}]$, cannot be observed.

Denote ${}_tROA^P_{i,t+1}$ as the expected value of $ROA_{i,t+1}$, which is publicly announced by firm $i$ at time $t$. We assume that ${}_tROA^P_{i,t+1}$ takes the following form

$${}_tROA^P_{i,t+1} = c^P + \zeta^P_i + \lambda^P_t + \mu E_{i,t}[ROA_{i,t+1}], \tag{61}$$

where $c^P$ is a constant effect across time and firms, $\zeta^P_i$ is a firm-specific effect, and $\lambda^P_t$ is a time effect (i.e., a macroeconomic effect). Equation (61) states that firm $i$ publicly announces its expected $ROA$ by incorporating the true expected value of ROA to some extent $\mu$ as well as the firm-specific and macroeconomic effects.

Substituting (61) into (59) for $E_{i,t}[ROA_{i,t+1}]$ yields

$$ROA_{i,t+1} = c^* + \zeta^*_i + \lambda^*_{t+1} + \frac{1}{\mu}({}_tROA^P_{i,t+1}) + e_{i,t+1} \tag{62}$$

where

$$c^* = \frac{1}{\mu}c^P,$$

$$\zeta^*_i = \frac{1}{\mu}\zeta^P_i,$$

$$\lambda^*_{t+1} = \frac{1}{\mu}\lambda^P_{t+1}.$$

We can thus obtain $E_{i,t}[ROA_{i,t+1}]$ $(= ROA_{i,t+1} - e_{i,t+1})$ by running the panel regression based on (62) and getting the predicted values of $e_{i,t+1}$ (we treat $e_{i,t+1}$ as an error term in the regression).

[28]The measure is originally due to Okada and Sato (2005).

Using the obtained value of $E_{i,t}[ROA_{i,t+1}]$, we calculate $\phi_{i,t+1}$ as

$$\phi_{i,t+1} = \ln\left(\left|\frac{ROA_{i,t+1} - E_{i,t}[ROA_{i,t+1}]}{E_{i,t}[ROA_{i,t+1}]}\right| + 1\right). \tag{63}$$

The reason for using logarithmic value is to reduce the effect of outliers. When the mean of $ROA_{i,t+1} - E_{i,t}[ROA_{i,t+1}]$ is zero and $ROA_{i,t+1} - E_{i,t}[ROA_{i,t+1}]$ is normally distributed, $\left|\frac{ROA_{i,t+1}-E_{i,t}[ROA_{i,t+1}]}{E_{i,t}[ROA_{i,t+1}]}\right|$ is skewed greatly to the right. In this case, the effect of outliers can be reduced by applying the following methods: (i) taking the squares of $\frac{ROA_{i,t+1}-E_{i,t}[ROA_{i,t+1}]}{E_{i,t}[ROA_{i,t+1}]}$ if many of the outliers are in the left tail of the distribution, or (ii) taking the logs of $\frac{ROA_{i,t+1}-E_{i,t}[ROA_{i,t+1}]}{E_{i,t}[ROA_{i,t+1}]}$ if many of the outliers are in the right tail of the distribution. Since the distribution is skewed to the right, the outliers are more likely to be in the right tail of the distribution. Thus, logs are used. The reason for adding add 1 to $\left|\frac{ROA_{i,t+1}-E_{i,t}[ROA_{i,t+1}]}{E_{i,t}[ROA_{i,t+1}]}\right|$ before taking the logs in (63) is that $\ln\left(\left|\frac{ROA_{i,t+1}-E_{i,t}[ROA_{i,t+1}]}{E_{i,t}[ROA_{i,t+1}]}\right|\right)$ approaches $-\infty$ when $\left|\frac{ROA_{i,t+1}-E_{i,t}[ROA_{i,t+1}]}{E_{i,t}[ROA_{i,t+1}]}\right|$ get close to zero.[29]

We believe that using the above measurement as $\phi_i$ and then estimating (54) by treating $\phi_i - E_i[\phi_i]$ as an error term (an expectation error) can serve as a much more reliable test of the model, compared with estimating (53) by using the ex post variance of $ROA_i$ as a proxy for the ex ante uncertainty, $E_i[\phi_i]$.[30] This is because it is difficult (or impossible) for the ex post variance of $ROA_i$ to correctly incorporate changes in $E_{i,t}[ROA_{i,t+1}]$ when $E_{i,t}[ROA_{i,t+1}]$ changes frequently and dramatically over time. Also, when using the ex post variance as a proxy for the ex ante uncertainty, $E_i[\phi_i]$, measurement error on $E_i[\phi_i]$ is absorbed in the disturbance of the regression, which may be highly correlated with the dependent variables, e.g., the firm-specific and time (macroeconomic) effects. Furthermore, since $\phi_i$ is obtainable at an annual frequency, we can acquire a much larger number of usable time-series observations for a regression than can be obtained using the ex post variance. These points allow us to reliably carry out panel regressions to control for a firm-specific effect, a time effect, and a heterogeneous linear time trend (i.e., to control for unobserved firm efficiency), and thus mitigate the problem of omitted variable bias.

## 3.4 Data and variables

The empirical work presented in this section uses two databases. We have obtained data on company' profit forecasts from Toyo Keizai Shinposha's Kaisha Yosou database, and other data from the Development Bank of Japan's corporate finance database.

Our sample includes non-financial Japanese companies listed on the Tokyo Stock Market, the Osaka Stock Market, and the Nagoya Stock Market (both the 1st and 2nd

[29] However, this does not significantly change our results.

[30] See equations (54) and (55) for our treatment of $\phi_i - E_i[\phi_i]$.

sections). The sample period spans from 1981 to 2002 (the panel is unbalanced).

We next explain some of the variables used for the tests (the data appendix shows the details of all variables used). As for $BR_{i,t}$, it is difficult to find a variable that measures the relationship of firm $i$ with banks in a panel format (preferably at an annual frequency, since $\phi_{i,t+1}$ is annual). We use the shareholding ratio of the top three bank shareholders.[31] We assume that the firm issuing a larger number of shares to banks has a closer bank relationship because banks frequently hold their client firms' shares in order to access important information about the firms. Note that in Japan, the Banking Law and the Fair Trade and Anti-Trust Laws prohibit bank ownership of more than five percent of a firm's outstanding shares, so that a bank is more likely to hold a firm's shares for an informational advantage and/or other purposes, rather than for investment purposes. To proxy the scale of production of a firm, $SC_{i,t}$, we use the log of total sales.[32] In the model, the firm's production scale largely depends on its intangible assets like brand, firm-specific knowledge and know-how, and human capital. Thus, total sales rather than total assets are more appropriate.

### 3.5 Results

We first show the results from simple cross-sectional regressions. We average all of the variables over the sample period and run OLS regressions with industry dummy variables (47 industry categories). The results are shown in Table 2, and they seem to support the model's predictions. All of the coefficient estimates have the signs predicted by the model. Although $\widehat{FRT}_{i,t}$ does not enter significantly in the profitability regression, all variables in the $FRT$ regression enter significantly.

The cross-sectional regressions may severely suffer from an omitted variable bias since we do not include a variable which measures firm efficiency (the efficiency can be correlated with $BR$, $NS$, and $SC$). To mitigate the problem, we run the panel regressions with firm-specific and time effects as shown by (54) and (57).

Several points should be noted. First, we construct $BR$, $NS$, and $SC$ by taking an average of one to three (or four) year lagged values. This is because it most likely takes several years before a firm's risk-taking behavior has an effect on its outcome.[33] Second, to account for the firm-specific effect, we use a first differencing transformation of (54) and (57). When making the transformation, we use a four (or five) year interval

[31] Related to the measure of bank-firm relationship, to measure bank control, Morck, Nakamura, and Shivdasani (2000) use a percentage of main bank ownership of outstanding shares, and Hoshi, Kashyap, and Scharfstein (2000) use a main bank loan share. We do not use main bank-related data to measure bank-firm relationships because we consider a firm's relationship with multiple banks rather than a powerful single bank.

[32] Many other studies use the log of sales as a proxy for the production scale, e.g., Morck, Nakamura, and Shivdasani (2000) and Weinstein and Yafeh (1998).

[33] In addition, concerning $SC$, averaging "total sales" over several years reduces the demand effect on "total sales."

for the first differencing. This is because noise will account for a large proportion of the variations in the first differenced variables if the interval is not long enough. Third, apart from the time and firm-specific effects, we also allow a heterogeneous linear time trend. Together with the time and firm-specific effects, the heterogeneous time trend can give us more power to control unobserved variables, such as firm productivity. To estimate the model with the heterogeneous time trend, we use a within-group estimation after taking the first difference.

Tables 3 and 4 give the results using the first-differencing interval of four and five years, respectively.[34] $FRT$ regressions (1) and (3) are conducted with the homogeneous trend, and $FRT$ regressions (2) and (4) are conducted with the heterogeneous trend. The $\widehat{FRT}$ of profitability regressions (1)-a and (1)-b is calculated by using the coefficient estimates of $FRT$ regression (1), and the $\widehat{FRT}$ of the other profitability regressions is calculated in a similar way.

The results, generally, support the model's predictions. As for the $FRT$ regressions, (i) all of the coefficient estimates of $BR$ show a correct sign and are significant, (ii) most of the coefficient estimates of $SC$ show a correct sign and are significant, and (iii) although none of the coefficient estimates of $NS$ are significant, most of them (except one) show the sign predicted by the model. As for the profitability regressions, excluding case (4)-b in Table 3, the coefficient estimates with the heterogeneous time trend have a correct sign, and most of them are significant. Although (4)-a and (4)-b in Table 3 show that the estimates have a wrong sign and are significant, the $\widehat{FRT}$ of these regressions is calculated by using the wrong-signed coefficient estimate of $SC$ shown by (4) in Table 3.

# 4 Conclusion

This paper examines the effects of financial contracts on a firm's choice between *safer* and *riskier* projects. Assuming that a firm requires financing from a competitive investor, we show that three types of contracts can each be an equilibrium contract, depending on various conditions. The three contracts are: (i) a bank loan contract with an (unconditional) early loan demand option, (ii) a bank loan contract without the demand option, and (iii) an equity contract. The first contract is considered to be a rollover loan. It preserves the most important feature of a rollover loan; i.e., a bank's total control over continuation of the borrowing firm's project. We show that firms undertake a "safer" ("riskier") project, when using rollover loans (non-rollover loans or new share issues). The model emphasizes the role of a rollover loan as a disciplinary device to suppress a firm's risk-taking. One key prediction of the model is that (risk-neutral) firms with closer bank relationships are more likely to use rollover loans and undertake a "safer" project, even with a competitive

[34] The standard errors are heteroscedasticity and serial correlation consistent standard errors (Arrelano,1987).

capital market. The model provides testable hypotheses, and the empirical tests do not reject the hypotheses. The paper also proposes a new measure of the uncertainty for firm performance that results in more reliable empirical tests.

We focus on the disciplinary role of bank loans by stressing the effect of the unconditional early loan demand option. When considering firms with relatively healthy and large assets, our approach has perhaps more practical relevance than studies emphasizing bank control rights that are contingent on firm default. This is because such firms usually have a relatively low probability of bankruptcy, and a shift in control rights upon default would not have a very large impact on disciplining the firms.

# 5 Appendix A: the derivation of $\overline{\theta}'$

The term $\overline{\theta}' + \widetilde{\theta}(\overline{\theta}', \theta_0)$ is shown by

$$\overline{\theta}' + \widetilde{\theta}(\overline{\theta}', \theta_0) = \frac{F_0}{N_0 + \overline{F}'} + \frac{N_0 - F_0}{N_0 + \overline{F}'} = \frac{N_0}{N_0 + \overline{F}'} \ , \tag{A1}$$

where $F_0$ is the number of the shares owned by the manager, and $\overline{F}'$ is the number of newly issued shares if $\frac{q}{N_0+q} \leq \frac{I+a}{A_0+E(Y_R)}$. Since $1 - [\overline{\theta}' + \widetilde{\theta}(\overline{\theta}', \theta_0)] = \frac{I+a}{A_0+E(Y_R)}$ if $\frac{q}{N_0+q} \leq \frac{I+a}{A_0+E(Y_R)}$, from (A1), we can obtain

$$N_0 + \ \overline{F}' = N_0 \frac{A_0 + E(Y_R)}{A_0 + E(Y_R) - (I + a)}. \tag{A2}$$

Using $\overline{\theta}' = \frac{F_0}{N_0 + \overline{F}'}$ , $\theta_0 = \frac{F_0}{N_0}$ and (A2), we can then obtain

$$\overline{\theta}' = \theta_0 \frac{A_0 + E(Y_R) - (I + a)}{A_0 + E(Y_R)}.$$

# Appendix B: proof of lemma 3

From (21), if $\frac{q}{N_0+q} > \frac{I+a}{A_0+E(Y_R)} \frac{q}{N_0+q}$

$$1 - [\overline{\theta}'' + \widetilde{\theta}(\overline{\theta}'', \theta_0)] = \frac{q}{N_0 + q}. \tag{A3}$$

In (A3), $q$ is equal to the number of newly issued shares. Thus, $\overline{\theta}''$ is given by

$$\overline{\theta}'' = \frac{F_0}{N_0 + q}, \tag{A4}$$

where $F_0$ is the number of the shares which the manager owns. From (3) and (A4), we obtain

$$\pi_M(\overline{\theta}'':R) = \frac{F_0}{N_0+q}(A_0 + E(Y_R)) - \theta_0 A_0.$$

Since $\frac{X_0}{N_0+q} = \theta_0 \frac{N_0}{N_0+q}$, this equation can be rewritten as

$$\pi_M(\overline{\theta}'':R) = \theta_0 \frac{N_0}{N_0+q}(A_0 + E(Y_R)) - \theta_0 A_0 = \theta_0 \frac{1}{N_0+q}\left[N_0 E(Y_R) - qA_0\right].$$

Using (A3) and (4), we obtain

$$\pi_{EI}(\overline{\theta}'':R) = \frac{1}{q}\left[\frac{q}{N_0+q}(A_0 + E(Y_R)) - I\right].$$

# Appendix C: the cost of splitting shares

If the manager thinks that the dilution is large; i.e., $\pi_M(\overline{\theta}'':R) - \pi_M(\underline{r}:R) < 0$, he or she splits the shares first and then issues new shares. As explained in the text, this procedure will give the manager $\pi_M(\overline{\theta}':R)$ if there is no cost to a share split. We assume that there are fixed share-splitting costs of $G$. The manager then does not consider splitting the shares if $\pi_M(\overline{\theta}':R) - G < \pi_M(\underline{r}:R)$ holds. Using Lemmas 1 and 2, the inequality $\pi_M(\overline{\theta}':R) - G < \pi_M(\underline{r}:R)$ can be rewritten as

$$G > \theta_0 \frac{1-p_R}{2} {A_0}^w \quad . \tag{A5}$$

Since $A_0 < I$, the manager never considers splitting the shares if $G > \theta_0 \frac{1-p_R}{2} I^w$.

# Data appendix

- $ROA_{i,t}$: (operating profits at time $t$) / (total assets at time $t-1$).
- ${}_tROA^P_{i,t+1}$ (the expected value of ROA which firm $i$ makes available to the public at time $t$ ): (predicted operating profits at time t+1 which is publicly announced at time $t$) / (total assets at time $t$).
- $\phi_{t+1}$: $\ln\left(\left|\frac{ROA_{t+1} - E_t[ROA_{t+1}]}{E_t[ROA_{t+1}]}\right| + 1\right)$.
- $BR_{i,t}$ (a shareholding ratio of top three bank shareholders of firm $i$ at time $t$): (the number of firm $i$'s shares held by the top three bank shareholders at time $t$) / (the total number of firm $i$'s shares at time $t$).
- $NS_{i,t}$ (the number of firm $i$'s outstanding shares at time $t$): the log of the number of firm $i$'s outstanding shares at time $t$.

- $SC_{i,t}$ (firm $i$'s production scale at time $t$): the log of firm $i$'s total sales at time $t$.

# References

Angel, J.J. (1997), "Tick Size, Share Prices and Stock Splits," *Journal of Finance*, 52(2), pp.655-681.

Aghion, P., and P. Bolton (1992), "An Incomplete Contracts Approach to Financial Contracting," *Review of Economic Studies,* 64, pp.473-494.

Arellano, M. (1987), "Computing Robust Standard Errors for Within-Groups Estimators," *Oxford Bulletin of Economics and Statistics,* 49, pp.431-434.

Benartzi, S., R. Michaely, R.H. Thaler, and W.C. Weld (2007), "The Nominal Prize Puzzle," American Finance Association 2007 Chicago Meetings Paper.

Berger, A.N., and G.F. Udell (1995), "Relationship Lending and Lines of Credit in Small Firm Finance," *Journal of Business,* 68(3), pp.351-381.

Berglof, E., and E.L. von Thadden (1994), "Short-Term Versus Long-Term Interests: Capital Structure with Multiple Investors," *Quarterly Journal of Economics,* 109, pp.1055-1084.

Dewatripont, M., and J. Tirole (1994), "A Theory of Debt and Equity, Diversity of Securities and Manager-Shareholder Congruence," *Quarterly Journal of Economics,* 109, pp.1027-1054.

Diamond, D. (1991), "Monitoring and Reputation: The Choice between Bank Loans and Directly Placed Debt," *Journal of Political Economy,* 99, pp.688-721.

Gilley, K.M., B.A. Walters, and B.J. Olson (2002), "Top Management Team Risk Taking Propensities and Firm Performance: Direct and Moderating Effects," *Journal of Business Strategies*, 19(2), pp.95-114.

Gorton, G., and J. Kahn (2000), "The Design of Bank Loan Contracts," *Review of Financial Studies,* 13(2), pp.331-364.

Grinstein, Y. (2006), "The Disciplinary Role of Debt and Equity Contracts: Theory and Tests," *Journal of Financial Intermediation,* 15(4), pp.419-443.

Hart, O. (2001), “Financial Contracting,” *Journal of Economic Literature* 39, no.4. pp.1079-1100.

Hoshi, T., A. Kashap, and D. Scharfstein (1990), "The Role of Banks in Reducing the Costs of Financial Distress in Japan," *Journal of Financial Economics,* 27, pp.67-88.

Jensen. M. (1986), "Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers," *American Economic Review,* 76(2), pp.323-329.

Jensen. M., and W. Meckling (1976), "Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure," *Journal of Financial Economics,* 3, pp.305-360.

John, K., L. Litov, and B. Yeung (2008), "Corporate Governance and Risk-Taking," *Journal of Finance*, 63(4), pp.1679-1728.

Kameda, S, and I. Takagawa (2003), "ROA no Kokusai Hikaku—Wagakuni Kigyo no Sihonshuekiritsu no Teimei ni Kansuru Kosatsu [International Comparison of ROA—A Study on Sluggish Return on Assets of Japanese Companies]," Bank of Japan Research and Statistics Department Working Paper No. 3-11.

Khalil, F. (1997), "Auditing Without Commitment," *Rand Journal of Economics*, 28(4), pp.629-640.

Khalil, F., and B.M. Parigi (1998), "Loan Size as a Commitment Device," *International Economic Review*, 39(1), pp.135-150.

McGough, E.F. (1993), "Anatomy of a Stock Split," *Management Accounting*, 75, September, pp.58-61.

Morck, E.R., M. Nakamura, and A. Shivdasani (2000), "Banks, Ownership Structure, and Firm Value in Japan," *Journal of Business,* 73(4), pp.539-567.

Myers S. (1977), "Determinants of Corporate Borrowing," *Journal of Financial Economics,* 5, pp.147-175.

Okada, T., and Y. Sato (2005) "Ginkou no Gabanansu, Kigyou no Risukuteikukoudou to Pafoumansu [Bank Governance, Firm Risk Taking and Performance]," Bank of Japan Working Paper Series 05-J4.

Petersen M.A., and R.G. Rajan (1994), "The Benefits of Lending Relationships: Evidence from Small Business Data," *Journal of Finance,* 49(1), pp.3-37.

Rajan, R.G. (1992), "Insiders and Outsiders: The Choice Between Informed and Arm's Length Debt," *Journal of Finance,* 50, pp.1113-1146.

Repullo, R., J. Suarez (1998), "Monitoring, Liquidation, and Security Design," *Review of Financial Studies,* 11(1), pp.163-187.

Stulz, R.M. (1990), "Managerial discretion and optimal financing policies," *Journal of Financial Economics,* 25, pp.3-27.

Tirole, J. (2006), "The Theory of Corporate Finance," Princeton University Press.

Weinstein, D.E., and Y. Yafeh (1998), "On the Costs of a Bank-Centered Financial System: Evidence from the Changing Main Bank Relations in Japan," *Journal of Finance,* 53(2), pp.635-672.

Zwiebel, J. (1996), "Dynamic Capital Structure under Managerial Entrenchment," *American Economic Review,* 86(5), pp.1197-1215.

Table 1: Project payoffs

| | Cash flow: **Y** | | |
|---|---|---|---|
| | 0 | $X_L$ | $X_H$ |
| project *S* | $probability = \frac{1-p_S}{2}$ | $probability = p_S$ | $probability = \frac{1-p_S}{2}$ |
| project *R* | $probability = \frac{1-p_R}{2}$ | $probability = p_R$ | $probability = \frac{1-p_R}{2}$ |

Table 2: The cross-sectional regression results

| **FRT regression** | |
|---|---|
| The dependent variable: $\phi$ | |
| $BR$ | -0.0086*** |
| | (0.0023) |
| $NS$ | 0.0026** |
| | (0.0011) |
| $SC$ | -0.0053*** |
| | (0.0010) |
| # of obs. | 1934 |
| $R^2$ | 0.15 |
| **Profitability regression** | |
| The dependent variable: ROA | |
| $\widehat{FRT}$ | 0.47 |
| | (0.95) |
| # of obs. | 1985 |
| $R^2$ | 0.013 |

Notes:

1. Robust standard erros are in parenteses.
2. * siginificant at 10% level, ** significant at 5% level and *** siginificant at 1% level.

Table 3: The panel regression results with the differencing interval of 4 years

**FRT regression** (the dependent variable: $\phi_t$)

| | independent variables: avg of 1 to 3 years lagged values | | independent variables: avg of 1 to 4 years lagged values | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | Homogeneous time trend | Heterogeneous time trend | Homogeneous time trend | Heterogeneous time trend |
| $BR_{t-1}$ | −0.0012*** | −0.0017*** | −0.00094* | −0.0014* |
| | (0.00044) | (0.00059) | (0.00056) | (0.00079) |
| $NS_{t-1}$ | 0.0043 | 0.0072 | 0.00054 | 0.0025 |
| | (0.0038) | (0.0050) | (0.0039) | (0.0054) |
| $SC_{t-1}$ | −0.019*** | −0.0063 | −0.010* | 0.012 |
| | (0.0048) | (0.0077) | (0.0059) | (0.0097) |
| # of obs. | 8835 | 8835 | 7557 | 7557 |
| $R^2$ | 0.044 | 0.042 | 0.040 | 0.0368 |

**Profitability regression** (the dependent variable: $ROA_t$)

| | (1)−a | (1)−b | (2)−a | (2)−b | (3)−a | (3)−b | (4)−a | (4)−b |
|---|---|---|---|---|---|---|---|---|
| | Homogeneous time trend | Heterogeneous time trend | Homogeneous time trend | Heterogeneous time trend | Homogeneous time trend | Heterogeneous time trend | Homogeneous time trend | Heterogeneous time trend |
| $\widehat{FRT}_{t-1}$ | 0.24** | 0.81*** | 0.056 | 0.35** | 1.45*** | 2.87*** | −0.83*** | −1.30*** |
| | (0.12) | (0.15) | (0.14) | (0.17) | (0.22) | (0.30) | (0.19) | (0.24) |
| # of obs. | 13873 | 13873 | 13873 | 13873 | 12355 | 12355 | 12355 | 12355 |
| $R^2$ | 0.083 | 0.079 | 0.082 | 0.081 | 0.096 | 0.089 | 0.091 | 0.089 |

Notes:
1. Heteroscedasticity and serial correlation consistent standard erros are in parentheses.
2. * siginificant at 10% level, ** siginificant at 5% level and *** siginificant at 1% level.
3. "Heterogeneous time trend" indicates that the specification includes a linear heterogenous time trend. To estimate the model with the heterogenous time trend, we perform a fixed effect (within growup) estimation after taking the first− differecing.
4. All of the regressions include time dummies.

Table 4: The panel regression results with the differencing interval of 5 years

**FRT regression** (the dependent variable: $\phi_t$)

| | independent variables: avg of 1 to 3 years lagged values | | independent variables: avg of 1 to 4 years lagged values | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | Homogeneous time trend | Heterogeneous time trend | Homogeneous time trend | Heterogeneous time trend |
| $BR_{t-1}$ | −0.0011** | −0.0012* | −0.00097* | −0.0014* |
| | (0.00045) | (0.00064) | (0.00055) | (0.00083) |
| $NS_{t-1}$ | 0.0016 | 0.0051 | −0.0022 | 0.0060 |
| | (0.0044) | (0.0061) | (0.0048) | (0.0075) |
| $SC_{t-1}$ | −0.022*** | −0.021*** | −0.016*** | −0.0071 |
| | (0.0044) | (0.069) | (0.0054) | (0.0095) |
| # of obs. | 8428 | 8428 | 6983 | 6986 |
| $R^2$ | 0.037 | 0.036 | 0.034 | 0.033 |

**Profitability regression** (the dependent variable: $ROA_t$)

| | (1)–a | (1)–b | (2)–a | (2)–b | (3)–a | (3)–b | (4)–a | (4)–b |
|---|---|---|---|---|---|---|---|---|
| | Homogeneous time trend | Heterogeneous time trend | Homogeneous time trend | Heterogeneous time trend | Homogeneous time trend | Heterogeneous time trend | Homogeneous time trend | Heterogeneous time trend |
| $\widehat{FRT}_{t-1}$ | −0.031 | 0.26** | −0.10 | 0.12 | 0.64*** | 1.60*** | 0.31* | 0.76*** |
| | (0.10) | (0.13) | (0.32) | (0.13) | (0.16) | (0.21) | (0.19) | (0.24) |
| # of obs. | 12747 | 12747 | 12747 | 12747 | 11039 | 11039 | 11039 | 11039 |
| $R^2$ | 0.075 | 0.073 | 0.075 | 0.074 | 0.085 | 0.077 | 0.081 | 0.080 |

Notes: see the notes in table 3.

Figure 1: Timing of events in the preliminary model

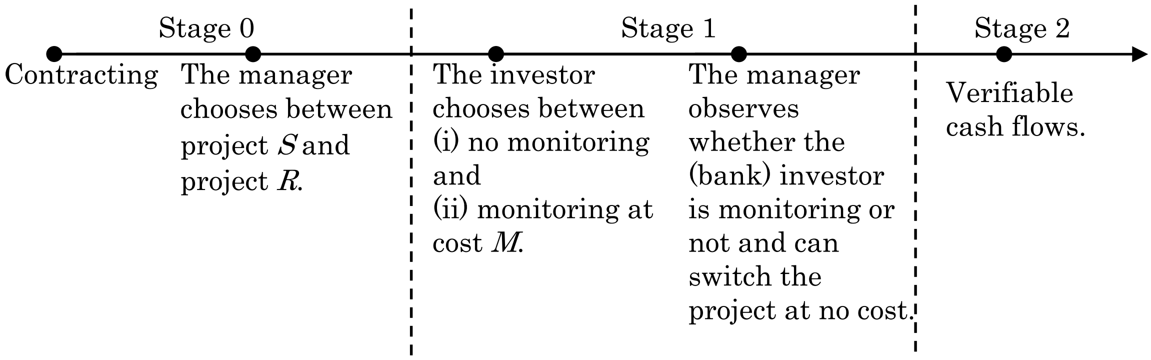


Figure 2: The equilibrium contract

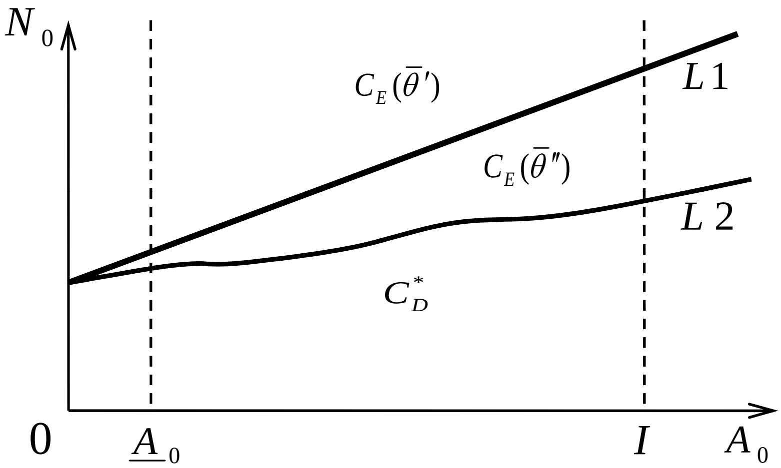


Figure 3: Timing of events in the model