行政院國家科學委員會補助專題研究計畫成果報告

債權結構與監督機制之研究

計畫類別：□個別型計畫　□整合型計畫

計畫編號：NSC 89－2416－H－002－017

執行期間：88 年 8 月 1 日至 90 年 1 月 31 日

計畫主持人：陳業寧

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一、中文摘要

本計畫探討債權結構與債權人監督誘因間的關係。本計畫發現，當負責監督之債權人的資金成本較其他債權人高時，其持有的債的求償順位應低且不受擔保品的保障。這個結論支持 Fama(1990)的看法。本計畫也發現，為使債權人有動機監督，債務人會保留部份資產不設定抵押。本文的結果可用來解釋為何 trade credit 的求償順位較低。

關鍵詞：債權結構、擔保品、信用交易、監督

Abstract

This paper investigates the relationship between debt seniority structure and the lenders' incentives to monitor borrowers. It shows that the monitoring creditor should hold a junior and unsecured claim if she requires a higher rate of return for her capital. This result supports the view of Fama (1990) that junior debtholders have more incentive to monitor. It is also found that to induce monitoring, borrowers will keep some assets not collateralized. This paper has implications on trade credit. It offers an explanation for why trade credits are junior.

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Keywords: Debt Seniority Structure, Collateral, Trade Credit, Monitoring

二、計畫緣由、目的及主要結果（以下摘自附件的第一節。有關本計畫的更詳細的結果與討論，請參考附件）

It is well acknowledged in the finance literature that debt contracts may cause moral hazard problems on the borrowers' side. A borrower can transfer debtholders' wealth to himself through various ways, such as pursuing a highly risky project, trading with companies he owns, or distributing handsome cash dividends to shareholders including himself. One way of deterring this moral hazard problem is to induce some debtholders to monitor the borrower. This issue has been investigated in several papers. For example, Park (2000) proposes that the monitoring creditor should hold senior debt. Rajan and Winton (1995) demonstrate how covenants and collateral can be used to increase the lenders' incentive to monitor. Rajan (1992) suggests that bank debt should be junior to prevent banks from abusing their information monopoly power.

Complementing to this literature, our paper studies the relationship between debt seniority structure and the lenders' incentives to monitor borrowers. In contrast to Park (2000), we find that the monitoring creditor

should hold junior short-term debt if she requires a higher rate of return for her capital. The intuition of this result can be explained as follows. Consider an entrepreneur who borrows money to invest. After the investment project is undertaken, new information about the project will be revealed. Depending on the intermediate information, sometimes it is more efficient to liquidate the project before it matures. However, the entrepreneur does not have the incentive to do so, so the debtholder with the lowest monitoring cost should be induced to monitor the project.

Because monitoring is costly, the monitoring creditor's claim on the project has to be large enough so that it is worthwhile for her to monitor. This implies that, compared with other creditors, the monitoring creditor need lend more to the entrepreneur. Since the marginal cost of capital should be increasing in the amount of the capital required, it is natural to assume that the monitoring creditor asks a higher rate of return for lending than other creditors. Because of this assumption, the entrepreneur would like to minimize the amount of money he borrows from the monitoring debtholder. It will be shown that a debtholder has more incentive to monitor if she receives more when the project succeeds and receives less when the project fails. Therefore, to achieve efficient monitoring and to minimize the monitoring creditor's claim, the monitoring creditor should not receive anything when the project fails. This implies that her claim should be junior and not secured by collateral. This result supports the view of Fama (1990) that junior debtholders will have a stronger incentive to monitor borrowers.

At first look, holding a junior and unsecured claim may reduce a creditor's incentive to monitor. This is because most of the liquidation value will go to senior or secured creditors when the project is liquidated. Knowing this, a junior debtholder with an unsecured claim will have no incentive to monitor and trigger liquidation unless she can get paid before liquidation occurs. Therefore, to induce monitoring, the monitoring creditor's claim must be short-term and the entrepreneur has to keep some assets not collateralized to serve as the source of repaying the short-term debt. When the monitoring creditor finds something wrong, before the project is liquidated she can refuse to roll over the short-term debt and get paid from assets that have not been collateralized. The opportunity to get money back before liquidation happens gives the monitoring creditor an incentive to monitor.

It is interesting to compare the results in this paper with those in Rajan and Winton (1995). In both papers, leaving some assets not collateralized can facilitate monitoring. In Rajan and Winton, when some assets are not collateralized, the bank can acquire more collateral on its claim if it monitors and finds that the project is likely to fail. This action increases the effective priority of its debt. In our paper, non-collateralized assets allow the monitoring creditor to get her money back earlier if she monitors and finds something wrong with the project. Another similarity between the two papers is that the monitoring debtholder's claim is junior in both papers. However, the optimal contracts are different in the two papers. In Rajan and Winton, the

bank debt is long-term and will be secured if bad information is revealed. In contrast, in our paper the monitoring creditor's claim is short-term and is not secured throughout the whole lending relationship.

This paper provides an explanation for why trade credits are junior. Trade creditors are similar to the monitoring creditor in our model. First, because they trade with customers frequently, trade creditors know their customers well, so they should have lower monitoring costs than other creditors. Second, since trade creditors are not financial institutions, they have higher costs of capital than creditors such as banks. Because of these similarities, the results in this paper can be applied to explain certain features of trade credit. There has been a long literature exploiting why trade creditors provide financing services even if they have high costs of capital than banks. Biais and Gollier (1997) propose that trade credits improve efficiency because the information that trade creditors have about their customers is different from banks' information. Wilner (2000) shows that, since trade creditors are more willing to yield in debt renegotiation, they will require higher interest rates when they lend. The main contribution of our paper is to point out that, to induce trade creditors to monitor, trade credits should be junior and unsecured. As far as we know, this feature of trade credit has not been much explained in the literature.

三、計畫成果自評

本計畫探討債權結構與債權人監督誘因間的關係。本計畫之研究成果與當初提出計畫時的預期相當一致。本計畫的結果有兩個特色。第一是對探討債權結構的文獻有一定貢獻。本文的主要結論（負責監督之債權人的求償順位應較低）與 Park (2000) 中的結論不同，形成有趣對比，故在文獻上有貢獻。本計畫的第二個特色是解釋了為何 trade credits 通常求償順位較低。這個結論不但合乎實際世界的觀察，對於探討 trade credit 的相關文獻也有貢獻。本計畫的研究成果預計將可發表於國外的學術期刊。

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Debt Structure and Monitoring

Yehning Chen*

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Abstract

This paper investigates the relationship between debt seniority structure and the lenders' incentives to monitor borrowers. It shows that the monitoring creditor should hold a junior and unsecured claim if she requires a higher rate of return for her capital. This result supports the view of Fama (1990) that junior debtholders have more incentive to monitor. It is also found that to induce monitoring, borrowers will keep some assets not collateralized. This paper has implications on trade credit. It offers an explanation for why trade credits are junior.

Keywords: debt seniority structure, collateral, trade credit, monitoring

*Department of Finance, National Taiwan University, 50 Lane 144, Keelung Road, Section 4, Taipei 106, Taiwan, R.O.C. E-mail: ynchen@ccms.ntu.edu.tw. Financial support by the National Science Council of Taiwan, R.O.C. is gratefully acknowledged.

1 Introduction

It is well acknowledged in the finance literature that debt contracts may cause moral hazard problems on the borrowers' side. A borrower can transfer debtholders' wealth to himself through various ways, such as pursuing a highly risky project, trading with companies he owns, or distributing handsome cash dividends to shareholders including himself. One way of deterring this moral hazard problem is to induce some debtholders to monitor the borrower. This issue has been investigated in several papers. For example, Park (2000) proposes that the monitoring creditor should hold senior debt. Rajan and Winton (1995) demonstrate how covenants and collateral can be used to increase the lenders' incentive to monitor. Rajan (1992) suggests that bank debt should be junior to prevent banks from abusing their information monopoly power.

Complementing to this literature, our paper studies the relationship between debt seniority structure and the lenders' incentives to monitor borrowers. In contrast to Park (2000), we find that the monitoring creditor should hold junior short-term debt if she requires a higher rate of return for her capital. The intuition of this result can be explained as follows. Consider an entrepreneur who borrows money to invest. After the investment project is undertaken, new information about the project will be revealed. Depending on the intermediate information, sometimes it is more efficient to liquidate the project before it matures. However, the entrepreneur does not have the incentive to do so, so the debtholder with the lowest monitoring cost should be induced to monitor the project.

Because monitoring is costly, the monitoring creditor's claim on the project has to be large enough so that it is worthwhile for her to monitor. This implies that, compared with other creditors, the monitoring creditor need lend more to the entrepreneur. Since the marginal cost of capital should be increasing in the amount of the capital required, it is natural to assume that the monitoring creditor asks a higher rate of return for lending than other creditors. Because of this assumption, the entrepreneur would like to minimize the amount of money he borrows from the monitoring debtholder. It will be shown that a debtholder has more incentive to monitor if she receives more when the project succeeds and receives less when the project fails. Therefore, to achieve efficient monitoring and to minimize the monitoring creditor's claim, the monitoring creditor

should not receive anything when the project fails. This implies that her claim should be junior and not secured by collateral. This result supports the view of Fama (1990) that junior debtholders will have a stronger incentive to monitor borrowers.

At first look, holding a junior and unsecured claim may reduce a creditor's incentive to monitor. This is because most of the liquidation value will go to senior or secured creditors when the project is liquidated. Knowing this, a junior debtholder with an unsecured claim will have no incentive to monitor and trigger liquidation unless she can get paid before liquidation occurs. Therefore, to induce monitoring, the monitoring creditor's claim must be short-term and the entrepreneur has to keep some assets not collateralized to serve as the source of repaying the short-term debt. When the monitoring creditor finds something wrong, before the project is liquidated she can refuse to roll over the short-term debt and get paid from assets that have not been collateralized. The opportunity to get money back before liquidation happens gives the monitoring creditor an incentive to monitor.

It is interesting to compare the results in this paper with those in Rajan and Winton (1995). In both papers, leaving some assets not collateralized can facilitate monitoring. In Rajan and Winton, when some assets are not collateralized, the bank can acquire more collateral on its claim if it monitors and finds that the project is likely to fail. This action increases the effective priority of its debt. In our paper, non-collateralized assets allow the monitoring creditor to get her money back earlier if she monitors and finds something wrong with the project. Another similarity between the two papers is that the monitoring debtholder's claim is junior in both papers. However, the optimal contracts are different in the two papers. In Rajan and Winton, the bank debt is long-term and will be secured if bad information is revealed. In contrast, in our paper the monitoring creditor's claim is short-term and is not secured throughout the whole lending relationship.

This paper provides an explanation for why trade credits are junior. Trade creditors are similar to the monitoring creditor in our model. First, because they trade with customers frequently, trade creditors know their customers well, so they should have lower monitoring costs than other creditors. Second, since trade creditors are not financial institutions, they have higher costs of capital than creditors such as banks. Because of these similarities, the results in this paper can be applied to explain certain features of

trade credit. There has been a long literature exploiting why trade creditors provide financing services even if they have high costs of capital than banks. Biais and Gollier (1997) propose that trade credits improve efficiency because the information that trade creditors have about their customers is different from banks' information. Wilner (2000) shows that, since trade creditors are more willing to yield in debt renegotiation, they will require higher interest rates when they lend. The main contribution of our paper is to point out that, to induce trade creditors to monitor, trade credits should be junior and unsecured. As far as we know, this feature of trade credit has not been much explained in the literature.

The rest of the paper is organized as follows. Section 2 is the model. Section 3 studies the optimal debt contracts under the assumption that contracts can be contingent on the realized states of the world. Section 4 shows that the optimal contracts in Section 3 can be enforced even if contracts cannot be contingent on states. Section 5 contains concluding remarks.

2 The Model

This is a three-period model (dates 0, 1, and 2). At date 0, a risk neutral entrepreneur has an investment project. This project requires one dollar invested at date 0, and will mature at date 2. The project either succeeds or fails. The project's date 2 value will be $R + K$ if it succeeds and will be K if it fails, where R is the cash flow generated by the project and K is the value of the project's fixed assets. At date 0, the probability that the project will succeed is p_0.

At date 1, the project's probability of success is updated. Let p denote the date 1 probability that the project will succeed, where p is a random variable. The probability density and cumulative functions of p are $f(p)$ and $F(p)$, respectively. The project can be liquidated at date 1 and the liquidation value is $Y + K$, where Y is the value of the project's liquid assets. The R, K, and Y are positive constants with $R + K > 1$ and $0 < Y + K < 1$. From the above description, it is obvious that the project should be liquidated at date 1 if p is low.

At date 0, the entrepreneur has no money and has to borrow from investors to make the investment. There is one informed investor and numerous uninformed investors in

the market. Both informed and uninformed investors are risk neutral. The two types of investor differ in two ways. First, uninformed investors can never learn the value of p, while the informed investor can learn p at a monitoring cost c. Second, the two types of investor require different returns for their capitals. The uninformed investors will lend if the rate of return for lending is non-negative. In contrast, the informed investor will not lend unless the rate of return for lending two periods (dates 0 to 2) is no lower than $r > 0$.

The assumption that the informed investor requires a higher rate of return is crucial and deserves an explanation. To induce monitoring, the entrepreneur must require the informed investor to hold a large claim on the project so that it is worthwhile for her to monitor. This implies that, compared with other investors, the informed investor need lend more to the entrepreneur. For an individual investor, the marginal cost of capital should be increasing in the amount of capital required. Therefore, the informed investor should require a higher rate of return than others.

At date 1, the entrepreneur also learns the value of p. However, he will never voluntarily liquidate the project. Therefore, inducing the informed investor to monitor is the only way to liquidate the project when p is low.

The contract between the entrepreneur and the informed investor is a debt contract. For simplicity, assume that the face value of the debt can be contingent on the realized states of the world, and no renegotiation is allowed at date 1. This is a strong assumption. In Section 4 we shall show that the results of this paper still hold when this assumption is relaxed. The contract can be represented by $(\alpha \quad D_1,\ D_2,\ x)$. At date 0, the informed investor lends α to the entrepreneur. At date 1, if the informed investor refuses to roll over the debt, she gets D_1 and the project is liquidated. If the informed investor rolls over the debt, at date 2 she will receive D_2 if the project succeeds and will receive x if the project fails.

The contract between the uninformed investors and the entrepreneur is also a debt contract. Since uninformed investors cannot monitor, they hold long-term debt due at date 2. At date 0, the entrepreneur borrows $1-\alpha+\beta$ from uninformed investors, and the face value of the debt is D_u.[1] Note that the entrepreneur borrows more than one dollar

[1]The fact that the face value of the debt is D_u does not mean the uninformed investors always receive D_u. For more detail, please see Sections 3 and 4.

from investors when $\beta > 0$. As will be shown in Section 4, allowing the entrepreneur to borrow more than one dollar gives the entrepreneur more flexibility in designing the optimal debt contracts.

In addition, we assume that D_1, D_2, x, and β satisfy the following constraints.

$$0 \leq D_1 \leq K + Y + \beta.$$

$$0 \leq D_2 \leq K + R + \beta.$$

$$0 \leq x \leq K + \beta.$$

These constraints say that what the informed investor receives should not exceed what is available from the project plus the extra cash β.

The sequence of moves can be summarized as follows.

(1) At date 0, the entrepreneur borrows from investors and makes the investment.
(2) At date 1, the entrepreneur learns the value of p. The informed investor decides whether to monitor. If she does, she learns p at a cost c. Having made the monitoring decision, the informed investor decides whether to roll over the debt. The project continues if she rolls over the debt, and is liquidated if she refuses to roll over the debt.
(3) At date 2, the project matures if the short-term debt is rolled over at date 1. The entrepreneur pays back investors according to the debt contracts.

3 The Case When the Contracts Can Be Contingent on the States

In this section, we assume that contracts can be contingent on the realized states of the world. The case where contracts cannot be contingent on states will be analyzed in the next section. The game is solved backwards. We shall first study the informed investor's monitoring decision, and then find the optimal debt contracts for the entrepreneur. Because this paper focuses on how to induce the informed investor to monitor, we shall put more attention on the contract between the entrepreneur and the informed investor.

As to the contract between the entrepreneur and uninformed investors, in Section 4 we shall verify that the uninformed investors are willing to lend at date 0 when the contract $(1-\alpha+\beta,\ D_u)$ is offered.

To facilitate our discussion on the informed investor's monitoring decision, we denote $\hat{p}$ as the p that satisfies

$$D_1 \ = \ p\ D_2 \ + \ (1-p)\ x. \tag{1}$$

If the informed investor monitors and learns the value of p, she will roll over the debt when $p \geq \hat{p}$ and will liquidate the project when $p < \hat{p}$. The following lemma states the condition under which the informed investor will monitor. The proofs of all lemmas and propositions are in the Appendix.

Lemma 1. Suppose that the informed investor lends money to the entrepreneur.
(a) When $\hat{p} \leq p_0 = \int_{p=0}^{1} p\ dF(p)$, the informed investor monitors at date 1 if and only if

$$c \ \leq \ (D_2 - x) \int_{p=0}^{\hat{p}} (\hat{p} - p) dF(p). \tag{2}$$

(b) When $\hat{p} > p_0$, the informed investor monitors if and only if

$$c \ \leq \ (D_2 - x) \int_{p=\hat{p}}^{1} (p - \hat{p}) dF(p). \tag{3}$$

In addition to the intuitive result that the informed investor will monitor when c is small, Lemma 1 also shows that the informed investor has a stronger incentive to monitor when $(D_2 - x)$ is large. Since this result is important for deriving the optimal debt contracts, we now explain it in more detail. If the informed investor monitors, she will roll over the debt when $p \geq \hat{p}$ and will liquidate the project when $p < \hat{p}$. If she does not monitor, then it is shown in the proof that she will roll over the debt if $\hat{p} \leq p_0$ and will liquidate the project if $\hat{p} > p_0$. In case $\hat{p} \leq p_0$, for the informed investor the difference in payoff between monitoring and not monitoring is

$$-c + \int_{p=0}^{\hat{p}} [D_1 - (pD_2 + (1-p)x)] dF(p).$$

From the facts that $D_1 = \hat{p}D_2 + (1-\hat{p})x$ and that $p < \hat{p}$ when $p \in (0, \hat{p})$, we know that given a $\hat{p}$ monitoring is more effective when the difference between D_2 and x increases.

On the other hand, if $\hat{p} > p_0$, then for the entrepreneur the difference in payoff between monitoring and not monitoring becomes

$$-c + \int_{p=\hat{p}}^{1} [(pD_2 + (1-p)x) - D_1] dF(p).$$

Again, from the facts that $D_1 = \hat{p}D_2 + (1-\hat{p})x$ and that $p > \hat{p}$ when $p \in (\hat{p}, 1)$, we know that given a $\hat{p}$ monitoring is more effective when the difference between D_2 and x increases.

Having analyzed the informed investor's monitoring decision, we can now investigate the optimal debt contracts. At date 0, given a $\hat{p}$ the informed investor is willing to lend if and only if[2]

$$c + (1+r)\alpha \;\leq\; F(\hat{p})D_1 + \int_{p=\hat{p}}^{1} [pD_2 + (1-p)x] dF(p). \tag{4}$$

To keep the tractability of the model, in the rest of the paper we shall assume that $F(p) = p$. This assumption greatly simplifies the analysis. Given this assumption, (4) can be written as

$$c + (1+r)\alpha \;\leq\; \frac{1+\hat{p}^2}{2} D_2 \;+\; \frac{1-\hat{p}^2}{2} x. \tag{5}$$

Using (2), (3), and (5), we can write the optimal (α, D_1, D_2, x) as functions of $\hat{p}$. Proposition 1 states this result.

Proposition 1. Suppose that the informed investor lends at date 0, and the entrepreneur induces the informed investor to monitor at date 1. Given a $\hat{p} \in (0,1)$, the optimal D_2 is

$$D_2^* \;\equiv\; \max\{\frac{2c}{\hat{p}^2},\; \frac{2c}{(1-\hat{p})^2}\}. \tag{6}$$

The optimal D_1 is $\hat{p}D_2^*$ and the optimal x is 0. The entrepreneur will borrow α^* from the informed investor, where

[2]Note that in (4), it is assumed that even if the informed investor may get D_1 back at date 1 rather than date 2, the informed investor still require $(1+r)$ for each dollar she lends at date 0. This assumption is not critical. The main results of this paper will not change if this assumption is eliminated.

$$\alpha^* \equiv \max\{\frac{c}{\hat{p}^2(1+r)}, \frac{2\,\hat{p}\,c}{(1-\hat{p})^2(1+r)}\}. \tag{7}$$

To see the intuition of Proposition 1, note that since the informed investor requires a higher rate of return for her capital, given a $\hat{p}$ the entrepreneur will minimize α. From (5), to reduce α either D_2 or x should be decreased. From (2) and (3), to induce the informed investor to monitor the difference between D_2 and x has to be large enough. As a result, the entrepreneur will set x to be 0. From (1), (2), (3), (5), and the fact $x = 0$, we can get the optimal D_1, D_2, and α.

Proposition 1 has important implications. It means that, when the informed investor's capital is costly, the most efficient way to induce her to monitor is to reduce her payoff in the bad state and to increase her payoff in the good state. As will be shown in Section 4, this result implies that the informed investor's debt should be junior.

The above analysis assumes that $\hat{p}$ is given. We next solve the optimal $\hat{p}$ for the entrepreneur. At date 0, to maximize his expected payoff, the entrepreneur minimizes the sum of $\alpha^* r$, the extra return he has to compensate the informed investor, and investment inefficiency. Denote

$$\bar{p} \equiv \frac{Y}{R}. \tag{8}$$

The date 1 liquidation decision is not efficient if $\hat{p} \neq \bar{p}$. The next proposition shows that the optimal $\hat{p}$ is always between $\bar{p}$ and 0.5, which means that either over- or under-liquidation may occur in equilibrium.

Proposition 2. Let $\hat{p}^*$ denote the optimal $\hat{p}$ for the entrepreneur.
(a) If $\bar{p} < 0.5$, then $\hat{p}^*$ satisfies $\bar{p} < \hat{p}^* \leq 0.5$.
(b) If $\bar{p} > 0.5$, then $\hat{p}^*$ satisfies $0.5 \leq \hat{p}^* < \bar{p}$.
(c) If $\bar{p} = 0.5$, then $\hat{p}^* = 0.5$.

Proposition 2 states that the entrepreneur will choose a $\hat{p}$ to balance between the extra return he pays to the informed investor and investment inefficiency. From (7), α^* is concave in $\hat{p}$. Moreover, it is decreasing in $\hat{p}$ when $\hat{p} < 0.5$, and is increasing in $\hat{p}$

when $\hat{p} > 0.5$. On the other hand, investment inefficiency is increasing in the distance between $\bar{p}$ and $\hat{p}$. As a result, when $\bar{p} < 0.5$, the entrepreneur will never set $\hat{p}$ lower than $\bar{p}$ or higher than 0.5. For the same reason, when $\bar{p} > 0.5$, the entrepreneur will never set $\hat{p}$ lower than 0.5 or higher than $\bar{p}$. Therefore, the optimal $\hat{p}$ will fall between $\bar{p}$ and 0.5. Proposition 2 shows that the entrepreneur may tolerate inefficient liquidation in equilibrium.

At date 0, when the entrepreneur designs the debt contract, he has to decide whether to induce the informed investor to monitor. If he does not, then obviously $\alpha = 0$ and the project is never liquidated at date 1. Since $p_0 = 0.5$, in this case the project can be financed if and only if

$$\pi_n \equiv K + 0.5R - 1 \geq 0. \tag{9}$$

On the other hand, if the entrepreneur induces the informed investor to monitor, the project can be financed if and only if

$$\pi_m \equiv K + \hat{p}^* Y + \frac{(1-\hat{p}^*)^2}{2} R - 1 - c - \alpha^* r \geq 0. \tag{10}$$

In (10), $\hat{p}^*$ is the probability that the project will be liquidated, $\frac{(1-\hat{p}^*)^2}{2}$ is the probability that the project will succeed, and $c + \alpha^* r$ is the return the entrepreneur has to compensate the informed investor. From (9) and (10), the financing decision can be summarized in Proposition 3.[3]

Proposition 3.

(a) The project will be financed at date 0 if $\max\{\pi_n, \pi_m\} \geq 0$.

(b) When the project is financed at date 0, the entrepreneur will induce the informed investor to monitor if and only if $\pi_m \geq \pi_n$.

[3]Because Proposition 3 is obvious from (9) and (10), it is not proved in the Appendix.

4 The Case When the Contracts Cannot Be Contingent on the States

In the last section, we demonstrate how the entrepreneur can induce the informed investor to monitor. A major assumption in the last section is that the contracts can be contingent on the states and renegotiation is not allowed at date 1. In this section, we shall relax this assumption and show that the results obtained in the last section still hold.

Assume that, if the informed investor learns p, she can make a take-it-or-leave-it offer D_R to the entrepreneur at date 1. If the entrepreneur accepts, the debt is rolled over and the new face value is D_R (rather than D_2). If the entrepreneur rejects, the informed investor either liquidates the project or rolls over the debt with face value D_2.

Our major concern here is whether the contracts stated in Propositions 1 and 2 will still hold after assumptions are modified. The following proposition claims that the answer is yes if D_2 and α are not too large.

Proposition 4. Suppose that the optimal (α, D_1, D_2, x) is $(\alpha_a, D_{1a}, D_{2a}, 0)$ under the assumptions stated in Section 2, where $D_{2a} \leq R$ and $0 < \alpha_a \leq 1$. Now modify the assumptions: assume that contracts cannot be contingent on states and that the informed investor can make a take-it-or-leave-it offer at date 1. The following contracts enforce $(\alpha_a, D_{1a}, D_{2a}, 0)$.

(1) Uninformed investors hold long-term debt due at date 2 with face value D_u. The informed investor holds short-term debt due at date 1 with face value D_{1a}. At the same time, the entrepreneur gives himself a long-term debt claim due at date 2 with face value D_e.

(2) In terms of seniority, debt held by the uninformed investors is senior to that held by the entrepreneur; the debt held by the entrepreneur is senior to that held by the informed investor.

(3) D_u, D_e, and β are chosen to satisfy the following requirements.

(i) The expected payoff for holding the uninformed investors' claim is $1 - \alpha_a + \beta$.

(ii) The expected payoff for holding the entrepreneur's claim is π_m.

(iii)

$$D_{2a} + D_e + D_u = K + R + \beta. \tag{11}$$

(iv)

$$D_{1a} \leq Y + \beta. \tag{12}$$

Several points related to Proposition 4 are worth mentioning. First, it shows that the claim of the monitoring creditor should be junior. Second, from the fact $D_{2a} \leq R$ and (11), $D_e + D_u > K + \beta$, so the informed investor receives nothing when the project fails, which implies that $x = 0$. Third, from (12), the informed investor can always receive D_{1a} if she refuses to roll over the debt. In fact, it is the opportunity to withdraw money earlier that makes the informed investor to have the incentive to monitor. Because of this assumption, our result is different form that of Park (2000). In Park's paper, a junior debt holder receives nothing if she triggers liquidation, so junior debtholders will not monitor. In comparison, in our paper, if the junior short-term creditor monitors, she can get money back before the project is liquidated. Therefore, she has a strong incentive to monitor.

5 Concluding Remarks

This paper shows that under certain circumstances, the creditor with the lowest monitoring costs will monitor and hold junior and unsecured debt. This result is consistent with the argument of Fama (1990) that junior debtholders have stronger incentives to monitor borrowers.

This paper can be extended in at least two directions. First, because this paper is not directly designed to model trade credits, the optimal contracts in this paper do not contain certain important features of trade credits. A natural extension of this paper is to develop a model to explain more features of trade credits. Second, in this paper we assume that the informed investor requires a higher return for her capital. This assumption is critical to our result. It is interesting to see how the results will change if this assumption is relaxed. Since banks usually monitor and have a lower cost of

capital than other creditors, investigating this case will allow us to learn more about the differences between bank debt and trade credit.

Appendix

Proof of Lemma 1. The informed investor's incentive to monitor will be affected by what she would do if she does not monitor. When the informed investor does not monitor, she will roll over the debt if and only if

$$\int_{p=0}^{1}[pD_2+(1-p)x]dF(p) \;\geq\; D_1 \;=\; \hat{p}D_2+(1-\hat{p})x. \tag{13}$$

The left-hand side of (13) is the informed investor s payoff for rolling over the loan, while the right-hand side is her payoff for liquidating the project. It can be shown that (13) is equivalent to

$$[p_0-\hat{p}](D_2-x) \;\geq\; 0.$$

Suppose that $\hat{p} \leq p_0$ so that the informed investor will roll over the debt when she does not monitor. In this case, monitoring will make her better off if and only if

$$-c+F(\hat{p})D_1+\int_{p=\hat{p}}^{1}[pD_2+(1-p)x]dF(p) > \int_{p=0}^{1}[pD_2+(1-p)x]dF(p).$$

It can be shown that this expression is equivalent to (2). On the other hand, if $\hat{p} > p_0$, the informed investor will liquidate the project when she does not monitor. In this case, she monitors if and only if

$$-c+F(\hat{p})D_1+\int_{p=\hat{p}}^{1}[pD_2+(1-p)x]dF(p) > D_1.$$

It can be shown that this expression is equivalent to (3). This completes the proof of Lemma 1. **Q.E.D.**

Proof of Proposition 1. First consider the case of $\hat{p} \leq 0.5$. Note that given the assumption that $F(p)=p$, (2) can be written as

$$c \;\leq\; (D_2-x)\,\frac{\hat{p}^2}{2}. \tag{14}$$

Since the informed investor requires a higher rate of return than uninformed investors, at date 0 the entrepreneur will minimize α. From (14) and (5), α can be minimized by choosing the smallest x and D_2 that can satisfy (14). Therefore, $x=0$, $D_2=2c/\hat{p}^2$, and $\alpha=\frac{c}{\hat{p}^2(1+r)}$.

The case of $\hat{p} > 0.5$ can be shown using the same logic. Given the assumption that $F(p) = p$, (3) can be written as

$$c \leq (D_2 - x)\frac{(1-\hat{p})^2}{2}. \tag{15}$$

To minimize α, the entrepreneur will set $x = 0$ and D_2 equal to $2c/(1-\hat{p})^2$. The optimal α becomes $\frac{2\hat{p}c}{(1-\hat{p})^2(1+r)}$. Combining the above results, we can get Proposition 1. **Q.E.D.**

Proof of Proposition 2. From (7), α^* is decreasing in $\hat{p}$ if $\hat{p} \leq 0.5$, and is increasing in $\hat{p}$ if $\hat{p} > 0.5$. Moreover, it is concave in $\hat{p}$. Since (i) the entrepreneur minimizes the sum of $\alpha^* r$ and investment inefficiency, and (ii) investment inefficiency is increasing in the distance between $\bar{p}$ and $\hat{p}$, we know that $\hat{p}^*$ will fall between 0.5 and $\bar{p}$. **Q.E.D.**

Proof of Proposition 4. From the fact that $\pi_{rn} > 0$, there exist D_u, D_e, and β that can satisfy conditions stated in the proposition. At the renegotiation stage, from (11), the informed investor will set the face value of the new debt to be D_{2a}. From (11) and the fact that $D_{2a} \leq R$, we know that

$$D_u + D_e > K + \beta,$$

which implies that the informed investor gets nothing when the project fails. Finally, (11) guarantees that the informed investor receives D_{1a} if she refuses to roll over the debt. This completes the proof of the proposition. **Q.E.D.**

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