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How Large Creditors Affect Corporate Bond Prices through Creditor Coordination

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Abstract

We investigate the role of large creditors such as Japanese main banks in determining the prices of corporate bonds when creditors face coordination problems. We present a model in which a single large creditor and a group of small creditors independently decide whether to continue lending to a borrowing company without common knowledge of the company's fundamentals. Our numerical calculations in the model show that when these fundamentals are good enough, corporate bond values fall as the information available to the large creditor deteriorates. However, when the fundamentals are bad enough, corporate bond values rise as the information available to the large creditor deteriorates. These results suggest that, for both the borrowing company and its bond holders, whether a better informed large creditor is beneficial or detrimental crucially depends on the strength of the company's fundamentals.

1. Introduction

1) Transitions in Bank-Firm Relationships in Japan

Since the end of World War II, banks have become a key component of the Japanese financial system called the "main-bank system," where bank-firm relationships are long-term and multi-dimensional.[1] Japanese listed companies usually hold business relationships with multiple banks. Among them, those known as the "main banks" are generally the largest creditors as well as the largest shareholders. The main banks even occupy a special place, which often allows them to dispatch executives to companies and generally gain more information than other creditors regarding a company's financial situation. Moreover, the main banks occasionally offer relief for financially distressed borrowers. Many listed companies in financial trouble have supported, have solved their problems, and have recovered because of the relief efforts of the main banks, which backed them up financially and arbitrated conflicts arising among interested parties.

In general, if a company suffers from a temporary funding problem but is expected to recover from the crisis and realize high profits in the future, creditors can gain profits in the

[1] There is enormous discussion on the functions of the main-bank system in Japan. A summary on this issue is provided in Aoki and Patrick (1995).

future by offering relief to the company. However, if creditors take preventive action to recover debts owing to them ahead of time for fear of the company going bankrupt, even though it is fair to expect that the company will recover, this will result in a dead end for funding and could result in bankruptcy. To avoid such a situation and to offer relief to a company, it is critical for creditors to take action in coordination with each other and to be prudent about the preventive recovery of their credits. The relief efforts of the main banks, by providing financial support and by arbitrating the interests of involved parties, are effective in helping other creditors to act in coordination and to prevent financially distressed companies from being pushed into further difficulties due to a withdrawal of funding. In other words, relationships with the main banks play an important role both in easing the financial constraints on companies that have temporarily suffered a deterioration in their funding situation and in avoiding inefficient company liquidation.[2]

However, after Japan's economic bubble burst, banks ended up with massive bad loans, which seriously undermined the banks' financial standing. Subsequently, from 1997 to 1998, when anxiety about the banks' bad loan problems reached its peak, a financial crisis occurred in Japan, in which large banks collapsed one after another. This crisis made the Japanese government recognize the need to settle the bad loans problem quickly in order to help Japan's economy recover. In a change from dealing with bad loan problems in an ad hoc manner, the government proceeded with a systematic framework for a full-scale settlement of bad bank loans through an injection of public funds. During this period, the main banks, on the alert for any sign of more bad loans, began increasingly to hold off relief efforts for any troubled companies that did not have clear prospects for a recovery. As a result, troubled companies for which the main banks discontinued support went bankrupt.

2) Development of the Corporate Bond Market in Japan

For a long time after the end of World War II, companies depended on bank loans for most of their funding. Raising money through bonds was a method of funding that was limited to certain large reputable companies, since the amount and conditions of issuance of domestic straight corporate bonds were severely regulated until 1996, when the qualification standard for bond issuance was eliminated and restrictive financial covenants became liberalized. Also, until the regulations on trustee banks were eliminated and the installation of commission banks generally became obligatory, trustee banks conventionally re-purchased defaulted corporate bonds at par value. In this way, corporate bond holders could impose the credit risks of corporate bonds onto the trustee banks, so that investors did not understand that the credit risk premiums of the issuing companies were an important factor that could affect corporate bond prices.

As a result of the early 1990's deregulation, which included the elimination of the qualification standard for bond issuance, large companies improved their funding situation with unsecured straight corporate bonds in the domestic corporate bond market. Consequently, for an increasing number of companies, which had been depending on bank loans for most of their external funding, corporate bonds became an important funding instrument. However, some of the large companies went bankrupt due to financial problems after they had issued

[2] Please refer to Hoshi *et al*. (1990, 1991), Rajan (1992), and Detragiache (1994) regarding relief efforts by the main banks for financially distressed companies.

corporate bonds, having been affected by the decline in asset prices and by economic stagnation in the economy. For the first time in Japan's post-war history, Yaohan Japan defaulted on domestic convertible bonds after a public offering in 1997, and JDC Corporation defaulted on domestic straight bonds after a public offering in 1998. These events made bond holders who had purchased domestic corporate bonds in a public offering realize that they might suffer real losses from a default. After this, institutional investors began to recognize that the credit risk premiums of the issuing companies are an important factor that affects corporate bond prices in the domestic corporate bond market. In addition, Mycal Corporation, which had obtained an investment-grade rating from a Japanese rating institute at the time of issuance, defaulted on straight corporate bonds for individual investors. Many individual investors suffered losses because of this, and this resulted in considerable public concern. Based on these experiences, in order to develop the Japanese corporate bond market in the future, it is necessary to improve the framework for making an appropriate assessment of the credit risk premiums of corporate bonds with regard to the unique situation of the Japanese credit market characterized by the dominant main banks.

3) Problems in Creditor Coordination and the Role of Large Creditors

Many recent theoretical studies on debt contracts have focused on problems in negotiation or coordination between financially distressed companies and their creditors. Most of them assume the creditor is a single economic agent, so they neglect the problems of conflicts of interest among multiple creditors. Corporate funding problems from multiple creditors have been actively studied in recent years in terms of the moral hazard problems of borrowing companies, which include the problems of strategic defaults and hold-ups.

First, with regard to strategic defaults, Bolton and Scharfstein (1996) indicated that if a company raises funds from multiple creditors, re-negotiation between the company and its creditors may become more difficult, which might reduce the risk of a strategic default by the company. On the other hand, they also indicated that multiple creditors could increase the risk of a default due to insufficient liquidity by making re-negotiation difficult. Berglöf *et al*. (2000), using the incomplete contract theory, also pointed out that multiple creditors reduce the risks of strategic defaults.

Regarding hold-up problems, Rajan (1992) explained that borrowings from multiple creditors can limit the monopoly power that arises from borrowing from a single creditor, and can ease hold-up problems. However, these studies on the moral hazard of borrowing companies mainly focused on the effects of multiple creditors on negotiation problems between borrowers and creditors. There has been no explicit discussion about creditor coordination problems.

It is only recently that theoretical research has actively focused on the creditor coordination problems discussed in this article. There are two pioneering pieces of research. Hubert and Schäfer (2002) indicated that if advantages in eliminating the monopoly power of a single creditor exceed the disadvantages in increasing the risks of failure of creditor coordination, it is desirable for borrowing companies to borrow from multiple creditors. Morris and Shin (2004) discussed how a company's risk of bankruptcy due to failure in creditor coordination

affects debt prices.[3]

If the main banks do not play an active and leading role in offering relief to companies in financial crisis, each creditor can attempt to recover their credits early in order to maintain their value. This individually rational action could cause bankruptcy due to a rapid deterioration in the company's funding situation, even if the company is fundamentally sound. Such a bankruptcy is the result of a failure in creditor coordination. Morris and Shin (2004) call these risks "coordination risks," which are to be distinguished from the usual credit risks.

If a coordination system cannot be established for a group of creditors through the leadership of the main banks, how can creditor coordination problems affect both the risks of a company going bankrupt and the corporate bond prices? Could the main bank play a regulatory role against creditor coordination failures, even if they do not take action to cooperate with the other creditors? These important issues emerged in Japan for the first time after the financial crisis in which the main banks displayed negative behavior in offering relief for troubled companies. Therefore, in this article, we would like to develop a theoretical model to analyze creditors' actions in a situation that could cause coordination failure among the creditors of a company in danger of bankruptcy. By doing so, we will attempt to provide some clues to the solution for these problems.

4) Analytical Framework

In this article, we develop a theoretical model that focuses on creditor coordination problems based on the method of global games to analyze how the proportion of credits held by the large creditor and informational accuracy affect corporate bond prices. Global games, pioneered by Carlsson and van Damme (1993), are games with incomplete information, whose type space is determined by the players each observing a private noisy signal of the underlying state.[4] Global games method shows how a slight departure from the common knowledge of the state can generate a unique equilibrium even in those games that typically have multiple equilibria under common knowledge. Morris and Shin (2004) proposed a theoretical framework for debt pricing considering the coordination risks by applying global games methodology to coordination problems among creditors. Their model indicated that debt prices could be uniquely determined in an equilibrium that was derived from interaction between a debtor's fundamentals and self-fulfilling beliefs.

Takeda (2003) introduced a model for analyzing the role of large creditors in the coordination of creditors by extending the model of Morris and Shin (2004). He examined the role of large creditors in coordination games that were played by a single large creditor and many small creditors based on the premise of the uniform prior distribution of the fundamentals. Furthermore, Takeda and Takeda (2005a) assumed normal distribution for the prior distribution of the fundamentals, extending a model of Takeda (2003), and proposed a model for analyzing the influence of the large creditor on debt prices. In this article, we analyzed how private and public information that is related to the fundamentals affects debt prices. On the basis of the model presented in Takeda and Takeda (2005a), we propose a framework to analyze the

[3] Please refer to Detragiache *et al*. (2000), Ongena and Smith (2000), and Elsas (2005) for empirical studies on creditor coordination.

[4] Please refer to Morris and Shin (2002a) for details on global games.

influence of creditor coordination problems on corporate bond prices, and discuss the role of large creditors and the influence of private and public information.

This article proposes a theoretical model that employs players of multiple sizes, following a strand of recent studies related to global games.[5] Corsetti *et al*. (2002, 2004), Takeda (2004), Taketa (2004), and Bannier (2005a) studied asymmetric global games assuming the existence of both large and small players as a method to analyze the influence of large speculators on a currency crisis. Only recently have creditor coordination problems been investigated using a method of asymmetric global games by Takeda (2003), Elsas *et al*. (2004), Bannier (2005b), Takeda and Takeda (2005a, b), Schüle and Stadler (2005), and Schüle (2007). In this article, a framework of asymmetrical global games is applied to the valuation of corporate bonds, and we introduce a model to analyze the influence of large creditors on corporate bond prices.[6]

This article presents a model in which corporate bond prices are uniquely determined under a circumstance in which creditors are only able to obtain noisy information related to a company's fundamentals. Numerical calculations proved that improvements in the accuracy of the information available to large creditors raise corporate bond prices if the fundamentals are good. However, if the fundamentals are bad, such improvements in the accuracy of the information available to large creditors lower corporate bond prices.

This article is organized as follows. Section 2 proposes creditor coordination games, Section 3 derives a unique equilibrium, Section 4 presents a numerical simulation of corporate bond prices based on the model, and Section 5 concludes the discussion.

2. Creditor Coordination Games – A Basic Model

This model assumes an economy composed of three periods, such as $t = 0$, 1, and 2, in which a single large creditor and multiple small creditors lend for a company's investment project. Let us assume that this company owns no capital, therefore the project will only be financed by debts. On this assumption, the company raises investment funds from creditors in the following ratio: $\lambda \in (0,1)$ from the large creditor and $1-\lambda$ from the small creditors. It is also assumed that all creditors are rational and their rationality is common knowledge.

This investment project is assumed to be completed in Period 2 and yields a return. The return in Period 2 is denoted by ν, whose value is uncertain in Period 0 since it depends on creditors' actions in Period 1. The company promises the repayment of its debts at the end of Period 2 to the amount of $L>0$ to its creditors. If Project 2 yields a return ν exceeding the fixed amount of the repayment L, the creditors can receive the repayment as promised.

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[5] Frankel *et al*. (2003) present detailed discussion on the determination of equilibrium in global games that contain players of multiple sizes.

[6] Besides Morris and Shin (2004), Bruche (2003) has applied the method of global games to the valuation of corporate bonds. Bruche (2003) extended the work of Morris and Shin (2004) and related it to the continuous-time structural model for pricing corporate bonds à la Merton (1974). However, the model by Bruche (2003) only deals with small creditors of a homogeneous size in the same way as Morris and Shin (2004). This article presents a model that is different from Bruche's model and it enables us to consider the role of large creditors. In addition, public debts including government bonds, were analyzed using global games methods in research by Chui *et al.* (2002), Haldane *et al*. (2004), Hattori (2004), and Tanaka (2005).

It is assumed that at Period 1 each creditor simultaneously decides whether he/she should continue or discontinue lending until the completion of the project. The basic model in this section assumes that the debts are collateralized. A case in which the debts include non-collateralized corporate bonds will be explained in Section 4. The liquidation values of the collaterals are $K^* \in (0, L)$ if the creditors collect and liquidate the collaterals after they discontinue lending in Period 1. If the creditors collect and liquidate the collaterals because they cannot receive the amount promised as repayment, the liquidation values of the collaterals fall to $K_* \in [0, K^*)$.

If the creditors decide to continue lending in Period 1, they receive a pay-off depending on the realized return ν from the project. The value of ν depends on two factors: fundamentals θ, which are randomly determined, and the severity of the disruption $z > 0$ to the project in the case of liquidation before the completion of the project due to a discontinuation in the provision of funds by creditors in Period 1. Using ℓ to denote the proportion of creditors who stop lending at Period 1, if θ is larger than $z\ell$, the project succeeds; while, if θ is smaller than, the project fails. Under this assumption, the realized return ν from this project is

$$\nu(\theta, \ell) = \begin{cases} V \ \ if & z\ell < \theta, \\ K_* \ if & z\ell \geq \theta, \end{cases}$$

where $V > L$ represents the realized return if the project succeeds. To simplify this discussion, let us normalize the pay-off so that L=1 and K_*= 0. In this case, the amount collected from the liquidated collaterals, if the creditors decide to discontinue lending in Period 1, is represented as $\kappa^* \equiv (K^* - K)/(L - K_*)$; here $K_* < K^* < L$, thereby $0 < \kappa < 1$. Under this condition, the pay-offs to the creditors are given in **Table 1**. To simplify the discussion, we assume that if continuing the lending yields the same expected pay-off as discontinuing the lending, the creditors will discontinue their lending.

Table 1. The Pay-offs to Creditors

	Project succeeds ($z\ell < \theta$)	Project fails ($z\ell \geq \theta$)
Continue lending	1	0
Discontinue lending	κ	κ

Although the creditors do not know the realized value of the fundamentals θ until Period 2, they do receive private information about θ. The large creditor receives a signal $x_L = \theta + \eta$ with noise η, in accordance with a normal distribution in which the average is 0 and the variance is $1/\gamma$ ($\gamma > 0$ represents a constant for the precision of the signal received by the large creditor); while a small creditor i receives a signal $x_i = \theta + \varepsilon_i$ with noise ε_i in accordance with a normal distribution of which the average is 0 and the variance is $1/\beta$ ($\beta > 0$ represents a constant for the precision of the signal received by the small creditor). ε_i is independent and identically distributed across the creditors and each one is independent of η and θ. Distributions of η and ε_i are assumed to be common knowledge among the creditors.

The realized value of θ is drawn from a normal distribution whose average is y and vari-

[7] This specification follows Morris and Shin (2004) and Bannier (2005a). On the other hand, Corsetti *et al*. (2002, 2004), Takeda (2003), and Takeda (2004), for simplification purposes, assume a uniform distribution.

ance is $1/\alpha$ ($\alpha > 0$ represents a constant for the precision of public information.[7] Both y and α are common knowledge and are exogenously given. In other words, y can be considered as the creditors' prior expected value of the fundamentals based only on public information. Each creditor receives a signal and develops beliefs concerning the value of θ based on public information and the private signal. In addition, he/she also develops beliefs concerning the distribution of signals received by the other creditors, as well as their estimates of θ.[8] The other creditors also develop individual beliefs based on public information and the signals they receive.

The following is a summary of this model in accordance with time progression:

- Period 0
  - The company raises funds from the large creditor and small creditors in a ratio of λ:1-λ.
  - The company invests the funds in a project.
  - The fundamentals θ are determined.
- Period 1
  - Creditors receive private signals about θ.
  - Creditors decide whether to continue or discontinue lending.
  - Creditors who decide to discontinue lending liquidate collaterals and receive a payoff κ.
- Period 2
  - θ becomes common knowledge and a return ν on the company's project is realized.
  - The creditors who continued lending receive a pay-off of "1" if the project succeeds; they receive a pay-off of "0" if the project fails.

3. Equilibrium Analysis of the Creditor Coordination Game

1) Case of Complete Information

Before investigating the equilibrium of the basic model, let us consider what kinds of choices would be optimal for the creditors if all of them know the precise value of θ at the time of decision-making, and discuss whether they should continue or discontinue lending.

If $\theta > z$, regardless of the other creditors' choices, each creditor's optimal choice is to continue lending because the project will succeed, even if all the other creditors discontinue lending. Conversely, if $\theta \leq 0$, regardless of the other creditors' choices, each creditor's optimal choice is to discontinue lending because the project will fail, even if all the other creditors continue lending.

What is interesting is the condition of $\theta \in (0, z]$, in which creditor coordination problems occur. In this situation, if the proportion of creditors who continue lending is high enough to forecast success for the project, continuation of the lending is the best choice for the creditors.

[8] Beliefs about other players' beliefs are generally called "higher order beliefs." Recent studies on this issue explain that in various cases these beliefs play an important role in determining equilibria in incomplete information games. Please refer to the survey by Kaiji and Morris (1997) regarding higher order beliefs.

Conversely, if the proportion of creditors who discontinue lending is high enough to predict failure for the project, discontinuation of the lending is the best choice for the creditors. Such problems of creditor coordination are similar to those that can occur among creditors in a model of bank runs proposed by Diamond and Dybvig (1983). In this situation, in the case of a complete information game in which the fundamentals are common knowledge, as Diamond and Dybvig (1983) articulated, multiple equilibria exist and they cannot be uniquely determined. In our case, continuing lending and discontinuing lending are both pure strategy Nash equilibria. The creditors face uncertainty of beliefs, as expected pay-offs calculated by subjective probability, based on Bayes' theorem, cannot be allocated to each strategy. Therefore they cannot narrow down the number of strategies to a single optimal strategy.

2) Case of Incomplete Information

Let us derive a Bayesian equilibrium for the situation in which each creditor considers the following simple switching strategy. If the creditors receive signals that are less than a certain critical value, they will discontinue lending; and if the creditors receive signals that are more than a certain critical value, they will continue lending.[9] Hereafter, the critical values of signals are called "critical signals."

There are four critical values that characterize the unique equilibrium of this article's model. Two out of the four values are critical signals for small creditors x^* and large creditors x^*_L. The other two are the following two critical values for the fundamentals θ, which exceed the critical value, allowing the project to always succeed (hereafter, this critical value of fundamentals is called "critical fundamentals"). One value is denoted as $\overline{\theta}$ under a condition in which the large creditor discontinues lending, and the other value is denoted as $\underline{\theta}$ under a condition in which the large creditor continues lending. We derive four equilibrium conditions that determine the above-mentioned critical values.

When a small creditor i receives a signal x_i, a posterior distribution of θ is normally distributed with mean $\xi_i \equiv (\alpha y + \beta x_i)/(\alpha + \beta)$ and variance $1/(\alpha + \beta)$. When a small creditor i follows a switching strategy, he/she has a critical value ξ^* for his/her switching strategy, and continues lending if and only if the private signal x_i exceeds $x^*(\xi^*, y)$. Likewise, when the large creditor receives a signal x_L, a posterior distribution of θ is normally distributed with mean $\xi_L \equiv (\alpha y + \gamma x_L)/(\alpha + \gamma)$ and variance $1/(\alpha + \gamma)$. When the large creditor follows a switching strategy, he/she has a critical value ξ^*_L for their switching strategy, and continues lending if and only if the private signal x_L exceeds $x^*_L(\xi^*_L, y)$.

Now, let us consider a certain value of critical fundamentals $\overline{\theta}$ under a condition in which the large creditor discontinues lending. When fundamentals exceed the value $\overline{\theta}$, even if only small creditors continue lending, the project succeeds. $\overline{\theta}$ can be calculated with the following equation:

$$\overline{\theta} = z(1 - (1 - \lambda)\Phi(\sqrt{\beta}(\overline{\theta} - x^*))), \tag{1}$$

where Φ expresses a cumulative standard normal distribution. If θ exceeds $\overline{\theta}$, regardless of any actions by the large creditor, the project always succeeds. Note that $\overline{\theta}$ lies between $z\lambda$ and z.

[9] We can prove that the switching strategy is the only equilibrium, and generality will not be lost, even though we narrow our discussions down to the switching strategy alone.

Next, we consider another value for the critical fundamentals $\underline{\theta}$ under a condition in which the large creditor continues lending. When the fundamentals exceed $\underline{\theta}$, the project succeeds if and only if the small creditors and the large creditor jointly continue lending. $\underline{\theta}$ can be calculated with the following equation:

$$\underline{\theta} = z(1 - \lambda - (1 - \lambda)\Phi(\sqrt{\beta}(\underline{\theta} - x^*))) \tag{2}$$

Note that $\underline{\theta}$ lies between o and z (1-λ).

These values of $\overline{\theta}$ and $\underline{\theta}$ are functions of a critical signal x^* for small creditors. However, x^* depends on the large creditor's critical signal x^*_L. Therefore, to calculate the equilibrium, the creditors' optimization problems regarding the two critical fundamentals $\overline{\theta}$ and $\underline{\theta}$ should be solved simultaneously.

First, let us consider the large creditor's problems. The probability that fundamentals θ exceed the critical fundamentals $\underline{\theta}$ conditional on x_L is $\Pr(\theta > \underline{\theta} \mid x_L) = \Phi(\sqrt{\alpha + \gamma}(\xi_L - \underline{\theta}))$. Therefore, the expected pay-off when lending is continued by the large creditor who observed the signal x_L is $\Phi(\sqrt{\alpha + \gamma}(\xi_L - \underline{\theta}))$. Unless an expected pay-off for continued lending exceeds a pay-off for discontinued lending κ, the large creditor will discontinue lending. When lending is continued by the large creditor who receives a critical value for signals x^*_L, the expected pay-off should be the same value as the pay-off from an early redemption κ. Therefore, the large creditor's critical signal $x^*_L(\xi^*_L, y)$ should meet the following condition:

$$\Phi(\sqrt{\alpha + \gamma}(\xi^*_L - \underline{\theta})) = \kappa. \tag{3}$$

Next, let us consider the problems of the small creditors. If $\theta > \overline{\theta}$, the project succeeds regardless of any actions taken by the large creditor. If $\underline{\theta} < \theta \leq \overline{\theta}$, then if and only if the large creditor also continues lending and if the small creditors continue lending, the project succeeds. If $\theta \leq \overline{\theta}$, even though the small creditors continue lending, the project always fails.

Since the optimal strategy for the small creditors is to continue lending if and only if the expected pay-offs from continued lending exceed the pay-offs κ from discontinuing the lending, a small creditors' critical signal $x^*(\xi^*, y)$ should fulfill the following condition:

$$\int_{\underline{\theta}}^{\overline{\theta}} \Phi(\sqrt{\alpha + \beta}(\theta - \xi^*))\Phi\left(\sqrt{\gamma}(\theta - x^*_L)\right) d\theta + \int_{\overline{\theta}}^{\infty} \phi(\sqrt{\alpha + \beta}(\theta - \xi^*)) d\theta = \kappa, \tag{4}$$

where ϕ expresses a standard normal distribution. To simplify equation (4), variables are converted as follows:

$$\begin{cases} s \equiv \sqrt{\alpha + \beta}(\theta - \xi^*), \\ \underline{\delta} \equiv \sqrt{\alpha + \beta}(\underline{\theta} - \xi^*), \\ \overline{\delta} \equiv \sqrt{\alpha + \beta}(\overline{\theta} - \xi^*), \end{cases}$$

Employing these variables, equation (4) can be rewritten as

$$\int_{\underline{\delta}}^{\overline{\delta}} \phi(s)\Phi(A)\, ds + \int_{\overline{\delta}}^{\infty} \phi(s) ds - \kappa = O, \tag{5}$$

where

$$A = \sqrt{\frac{\gamma}{\alpha + \beta}}\left(s - \frac{\alpha + \gamma}{\gamma}\underline{\delta}\right) - \frac{\alpha}{\sqrt{\gamma}}\xi^* - \sqrt{\frac{\alpha + \gamma}{\gamma}}\Phi^{-1}(\kappa) + \frac{\alpha}{\sqrt{\gamma}}y, \tag{6}$$

As Takeda and Takeda (2005a) have shown, by the iterative elimination of strictly dominated strategies, the switching strategy can be shown to be the only equilibrium strategy. Our results on the uniqueness of the equilibrium are summarized as follows:

Proposition (Takeda and Takeda (2005a)): If $z(1-\lambda)/\sqrt{2\pi} \leq (\alpha+\beta)/(\alpha\sqrt{\alpha+\beta})-1/\sqrt{\beta}$, then there is a unique equilibrium in which the large creditor employs its switching strategy with a critical signal x^*_L and the small creditors employ their switching strategy with a critical signal x^*.

The proposition above indicates that if the accuracy of the private signals is sufficiently high for a given degree of accuracy in public information, the equilibrium is uniquely determined. The unique equilibrium is determined by equations (1), (2), (3), and (5), which jointly determine the critical fundamentals $\overline{\theta}$ and $\underline{\theta}$, and the critical signals x^* and x^*_L.

4) Simulation of Coordination Risk Assessment for Corporate Bonds

In this section, the basic model explained in the preceding section is modified to examine a case in which debts are partially composed of corporate bonds, and we consider the prices of corporate bonds with coordination risk premiums. The following variables' influences on corporate bonds are analyzed in detail: (i) the prior expected value of the fundamentals y, (ii) the accuracy of the private information available to the large creditor γ, and (iii) the accuracy of the public information α.

Let us begin with a modification of the assumptions in the basic model and the introduction of the unsecured corporate bonds.[10] Corporate bonds usually constitute a small portion of the total debts of the companies that actually issue corporate bonds and usually the larger portion is made up of secured bank loans with collaterals. For this reason, corporate bonds are assumed in this section to be a small portion of the total debts that are mostly secured debts as in the basic case. To simplify the discussion, the portion of corporate bonds is assumed to be negligible. The creditors for the corporate bonds are considered to own unsecured corporate bonds of face value 1, which is due in Period 2. They receive face value 1 as pay-offs if the project succeeds when due in Period 2, and they receive 0 pay-off if the project fails and are not able to gain a pay-off κ as creditors of secured debts by discontinuing lending in Period 1, because the corporate bonds are not secured with collaterals. If prior expected fundamentals y are given, a prior value for unsecured corporate bonds W, as explained above, is calculated by the following equation:

$$W(y) = \int_{\underline{\theta}}^{\overline{\theta}} \phi(\sqrt{\alpha}(\theta - y))\Phi(\sqrt{\gamma}(\theta - x^*_L))d\theta + \int_{\overline{\theta}}^{\infty} \phi(\sqrt{\alpha}(\theta - y))d\theta. \quad (7)$$

It should be noted that a liquidation value κ for the collaterals that the creditors obtain by discontinuing lending is included in equation (7), which expresses the prices of unsecured corporate bonds, not because unsecured corporate bond creditors can gain a pay-off κ by discontinuing lending, but because the creditors of secured debts, which are the majority of the total debts, have equilibrium strategies in coordination games that affect the prices of unsecured

[10] Straight corporate bonds through a public offering in Japan in recent years are generally unsecured. Therefore, only unsecured corporate bonds are considered in this article.

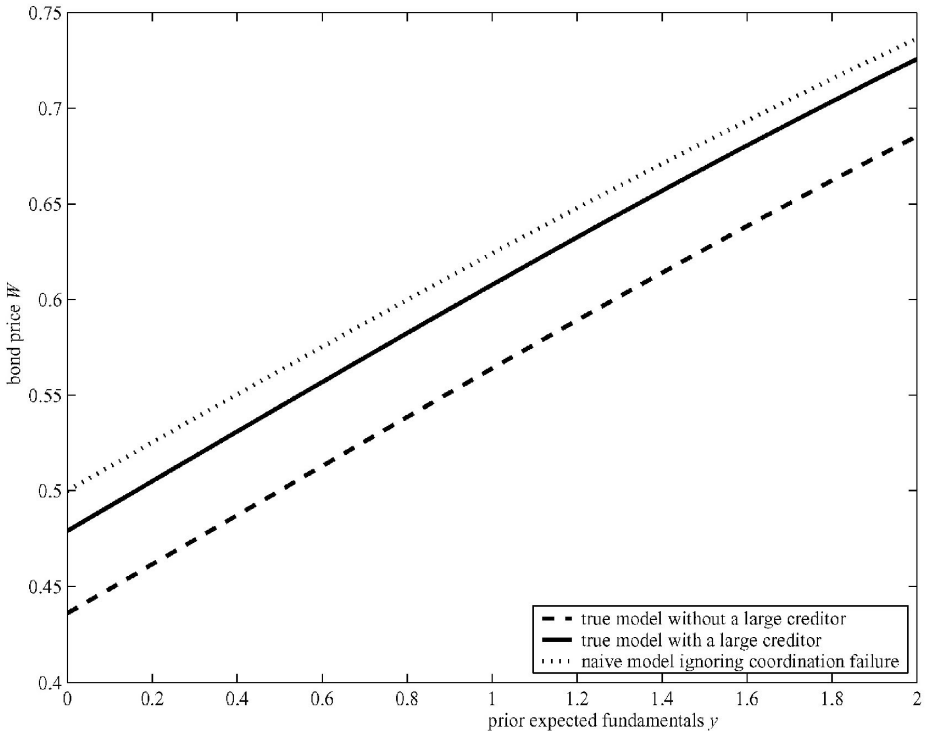
corporate bonds through coordination risk premiums. In other words, unsecured corporate bond creditors have no influence over creditor coordination problems or corporate bond prices; however, their bond prices are passively influenced by secured debt creditors' strategic actions in equilibrium.

In our model, because it is difficult to obtain simple results for comparative statics with analytical methods in terms of general parameter values, the following analysis employs a numerical simulation. In detail, based on corporate bond prices calculated with equation (7), we examine how various factors affect corporate bond prices. For numerical calculation, as a benchmark case, the following set of variables is used:

$\alpha = 0.1,\ \beta = 5,\ \gamma = 5,\ z = 1,\ \kappa = 0.5,\ \lambda = 0.4,\ y = 1.6$

More specifically, we carry out numerical simulations to illustrate the effect of a change in a particular variable on corporate bond prices, maintaining the other variables in the benchmark case. In all numerical simulations, we keep the variables within a range in which the uniqueness of the equilibrium is guaranteed.

Figure 1. The Effect of Prior Expected Fundamentals y on the Bond Price

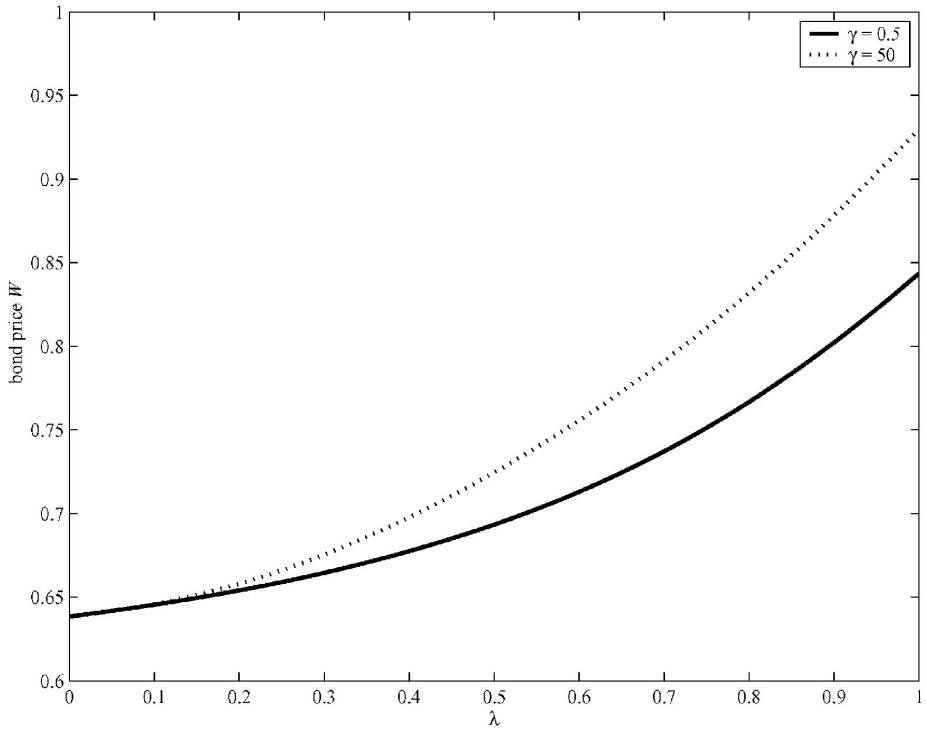


Our analysis will start with a consideration of how changes in prior expected fundamentals y affect corporate bond prices. Figure 1 indicates that corporate bond prices increase along with an increase in y. In other words, the higher the prior expected fundamentals become, the higher the corporate bond prices. Figure 1 also depicts corporate bond prices in the naïve model that does not take risks from failure in creditor coordination into account.[11] It

[11] In this case, only fundamental risk matters in determining bond prices in the absence of coordination risk. This applies to the case studied by Merton (1974) in his model of valuation for corporate bonds.

is evident that the naïve model that neglects coordination risks overestimates corporate bond prices compared to the model that considers coordination risks. The degree of over-estimation is equivalent to the coordination risk premiums. Figure 1 shows that in the assessment of corporate bond prices with credit risks, it is important to consider the coordination risk premiums. This observation is consistent with that presented by Morris and Shin (2004).

Figure 2. The Effect of the Accuracy of the Large Creditor's Private Information γ on the Bond Price



Subsequently, we analyze how the accuracy of the private information available to the large creditor γ affects corporate bond prices. Figure 2 depicts a relationship between the large creditor's share λ and corporate bond prices in these two cases: $\gamma = 0.5$ and $\gamma = 50$, while keeping β constant. A case ($\gamma = 50$) in which γ is large and the accuracy of the information available to the large creditor is high shows higher corporate bond prices than a case ($\gamma = 0.5$) in which γ is small and the accuracy of the information available to the large creditor is low. In other words, the more accurate the private information available to the large creditor becomes, the greater the probability that the project will succeed and the higher the corporate bond prices rise.

To explain how the accuracy of the private information available to the large creditor affects corporate bond prices, it should be noted that changes in the accuracy of the private information available to the large creditor directly affect creditor coordination, unlike public information. This is because, although each creditor uses both public and private information in decision-making, each creditor's information is different and complete coordination is disturbed because of the noise of the private information, which makes realized values vary depending on the creditor. Therefore, the smaller the noise of the private information

becomes, the less each creditor's information varies, making it easy for creditors to coordinate with each other.

Considering the direct coordination effects of private information, we shall intuitively explain the meaning of the influence of the large creditor's private information on corporate bond prices as follows. Even if the fundamentals are not so good, creditors know that if a sufficient number of creditors continue to lend, the project can succeed. Therefore, even if the expected fundamentals are not so good, the large creditor is motivated by the prospect of high pay-offs to coordinate with the small creditors to continue lending and make the project succeed. For this reason, once creditor coordination becomes easy by increasing the accuracy of the private information available to the large creditor, the large creditor becomes more positive about continuing its lending. This is because the large creditor prioritizes the continuation of its lending when coordinating with small creditors to make the project succeed and to obtain high pay-offs. Since small creditors also know about the increasing accuracy of the private information available to the large creditor, they also become more positive about continuing their lending as they coordinate with the large creditor through higher beliefs. This intensity of conformity among the creditors is the reason why increasing the accuracy of the private information available to the large creditor heightens the probability of the project's success and raises the prices of the company's corporate bonds.

Figure 3. The Effect of the Accuracy of Public Information α on the Bond Price (y=1.6)

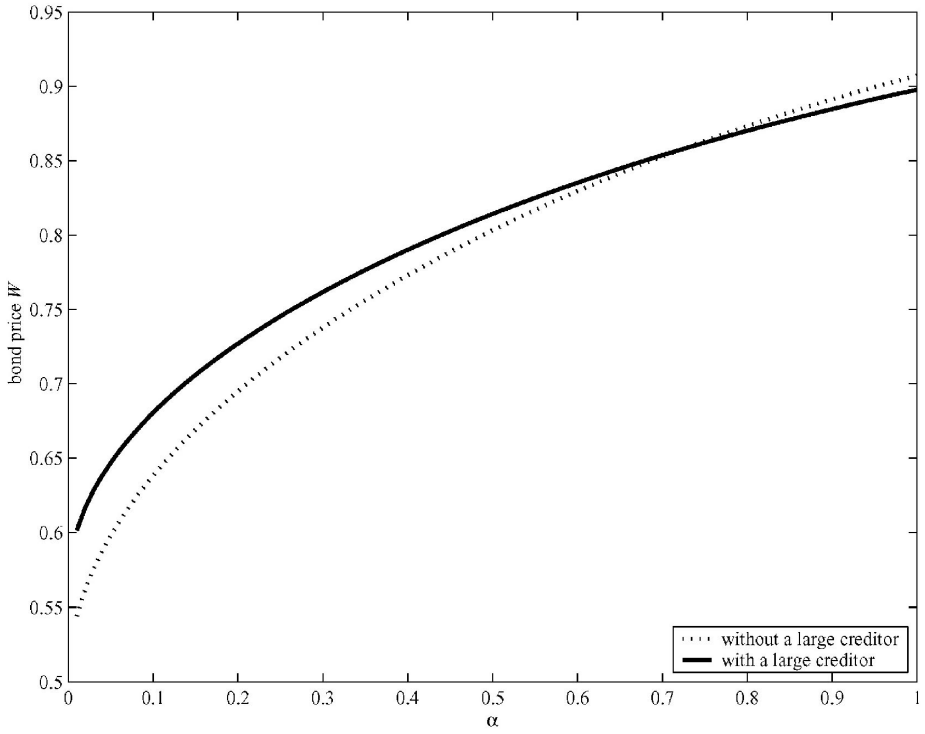
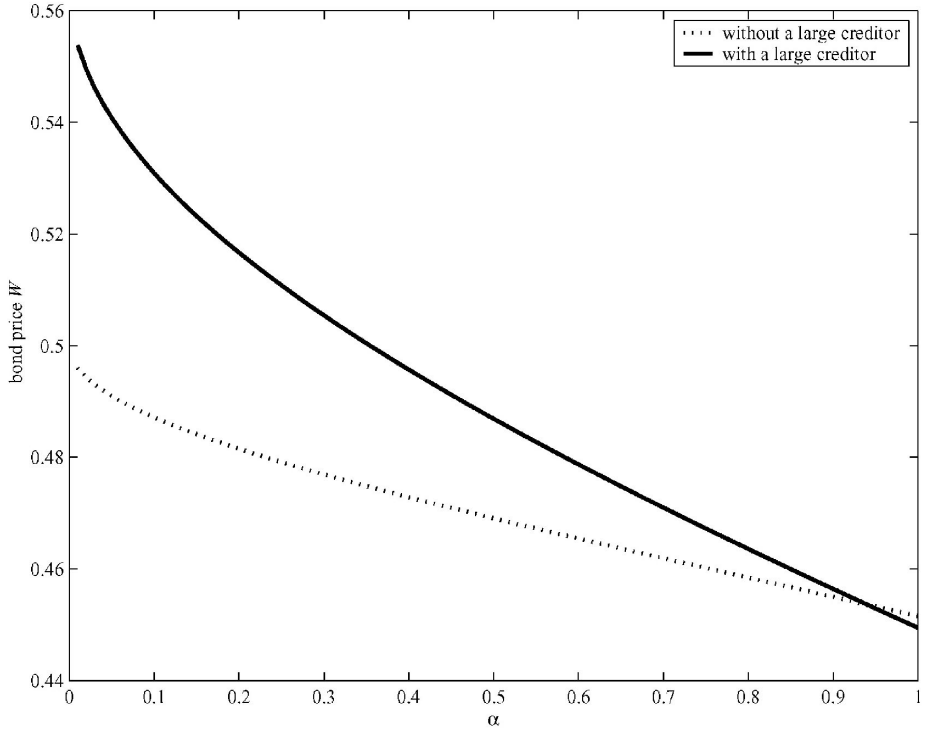


Figure 4. The Effect of the Accuracy of Public Information α on the Bond Price (y=0.4)



Next, we would like to analyze the effects of the degree of accuracy of the public information α. Figure 3 explains a case of y =1.6 and Figure 4 explains a case of y = 0.4. These figures illustrate relationships between α and corporate bond prices. Figure 3 shows that if y is large, the corporate bond prices rise as α rises; Figure 4 shows that if y is small, corporate bond prices fall as α rises. In other words, if the fundamentals are good enough, improving the accuracy of the public information raises corporate bond prices. On the other hand, if the fundamentals are bad enough, improving the accuracy of the public information lowers corporate bond prices.

It should be noted, when explaining the influence of public information on corporate bond prices, that, unlike private information, while public information does not directly affect creditor coordination, it does indirectly affect such coordination. This is because as the accuracy of the public information improves, and each creditor increasingly tends to regard the public information as important when he/she develops posterior beliefs about the fundamentals, the importance for the creditors of their private information diminishes. Consequently, the noise of the private information is less likely to be passed onto their posterior beliefs, and any variance in the posterior beliefs of the creditors also diminishes, which facilitates creditor coordination.

Considering the indirect effects of public information on coordination, we shall intuitively explain the meaning of the influence of public information on corporate bond prices as follows. Creditors use public information to develop posterior beliefs concerning fundamentals. If the fundamentals are good and the accuracy of the public information improves, creditors

will increasingly tend to continue lending based on the following two factors. One factor is the fundamental effect of public information. Under a condition in which the fundamentals are good, creditors know that the project will succeed even if there are fewer creditors who continue lending. Therefore, if the fundamentals are good enough and the accuracy of the public information improves, creditors have a better understanding of the good condition of the fundamentals. This strengthens the creditors' tendency to continue lending; therefore, corporate bond prices rise.

The second factor is the indirect effect of public information on coordination. As public information becomes more accurate, each creditor puts more weight on public information to develop posterior beliefs concerning fundamentals, therefore he/she reduces the weight of their private information. Consequently, the noise of the private information becomes less likely to be passed onto posterior beliefs and this reduces the variance in posterior beliefs among the creditors. In this situation, if the fundamentals are good enough, they strengthen the creditors' tendency to coordinate their actions to continue their lending, therefore the corporate bond prices rise. The reverse can occur if the fundamentals are bad. These conditions suggest that if a company enjoys good financial conditions, the disclosure of company information can bring favorable results for the company and its creditors, such as a reduction in coordination risks and a rise in the company's corporate bond prices. If a company is in a bad financial situation, the disclosure of company information has unfavorable consequences for the company and its creditors, such as an increase in coordination risks and a fall in the company's corporate bond prices.[12]

5) Concluding Remarks

In this article, the coordination problems that a group of creditors face in the recovery of credits with companies that might default are analyzed theoretically. Thus, the influence of the large creditor on creditor coordination was explained and price changes in corporate bonds were shown under various conditions. Generally, in coordination games in which self-fulfilling beliefs significantly affect the determination of equilibrium, equilibrium cannot be uniquely determined with complete information. In this article, a condition with incomplete information in which creditors can only use noisy information about fundamentals is assumed in the calculation of a unique Bayesian equilibrium based on global games, and corporate bond prices in the equilibrium were examined.

Since analytical methods do not produce clear conclusions, we used numerical calculations and derived several important conclusions that indicate the characteristics of the equilibrium. Most of all, it was interesting that if the fundamentals are good enough and there is an improvement in the accuracy of the information available to the large creditor, the probability of the project's success increases as does the value of the company's corporate bonds. On the other hand, if the fundamentals are bad and the accuracy of the information available to the large creditor deteriorates, the probability of the project's success declines and the value of the company's corporate bonds falls. This conclusion suggests that it is a sensitive question as to whether or not it is desirable, from the point of view of either the borrowing company or that company's corporate bond holders, for the large creditor to hold precise private information,

[12] Related topics on the roles of public information are discussed by Hellwig (2002), Morris and Shin (2002a, b), Bannier (2005a), and Bannier and Heinemann (2005).

since that desirability depends on the strength of the company's fundamentals.

In this article, we tried to minimize the complication of our model structures as much as possible by expressing basic ideas to simplify our explanation of the large creditor's influence on corporate bond prices in equilibrium in a situation in which the consequences of creditor coordination affect the equilibrium. Therefore, although important conclusions were obtained in a relatively simple form, to develop this model and use actual data and apply quantitative market analysis, each abstract component of this model needs to be modified and changed into a more practical form, and many elements that were omitted for simplification should be considered.

In Japan and neighboring East Asian countries, the use of corporate bonds by companies as a funding method could become advanced, and corporate bond markets could expand significantly if there is support for future development of, one, market infrastructure, including legal systems, two, information and telecommunications infrastructure, and, three, financial technology. However, in Japan, only a few years have passed since the elimination of the qualification standard for bond issuance caused real losses to corporate bond creditors due to defaults in corporate bonds. Thus, even though it is increasingly important to establish methods to assess corporate bond credit risks, and considering how Japan's corporate bond markets differ from those in the United States and Europe, both theoretical and empirical studies are scarce, and research about the large creditor's influence on corporate bond prices has only just got started. The results of this article's analysis suggest that large creditors such as main banks could significantly affect corporate bond prices through their influence on creditor coordination. We expect that the importance of a large creditor's influence on corporate bond prices will be recognized; this issue will be further discussed as an extension of this article or from a different perspective, and such discussions will contribute to the fruitful development of corporate bond markets in Asia and other regions.

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