Contagion of a Liquidity Crisis Between Two Firms

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Contagion of a Liquidity Crisis Between Two Firms

This paper presents a model in which the contagion of a liquidity crisis between two nonfinancial institutions occurs because of learning activity within a common creditor pool. After creditors observe what occurs in a rollover game for a firm, they conjecture one another's "type" or attitude toward the risk associated with the firm's investment project. Creditors' inference about one another's type then influences their decision to lend to the next firm. By providing an analysis of the "incidence of failure" (the threshold for a liquidity crisis) for each firm, this paper demonstrates that the risk of contagion increases sharply if it originates ex ante from a firm facing a low probability of failure. In addition, the paper proposes some policy measures for mitigating the severity of contagion during a liquidity crisis.

Key Words : Contagion; Liquidity Crisis; Global Game; Learning; Coordination Failure; Collateral; Government Bailout; Information Structure; Financial Disclosure

JEL Classification : G33, G38, D82, D83

I. Introduction

Financial contagion refers to the spread of solvency problems of a single institution to other institutions and is one of the most striking features of any financial crisis because it can spread a crisis across countries and institutions. In the late 1990s, most East Asian countries suffered severe financial crises via contagion across countries (the so-called "Asian *Flu*"). When South Korea (hereafter "Korea") caught the Asian *Flu*, the liquidity crisis spread from one firm to another, even though they represented different business areas. For example, in January 1997, Hanbo Steel Group (the country's fourteenth largest conglomerate) declared bankruptcy, and within several months, Jinro (the largest liquor group in Korea) also failed. Of course, these two firms were exposed to the same aggregate demand shock in the same country, but the noteworthy connection they had was common creditors.[1] This raises the question of why serial (contagious) failures of nonfinancial firms in unrelated business areas occur.

In this regard, this paper presents a model in which the contagion of a liquidity crisis between two unrelated nonfinancial institutions occurs because co-creditors learn about one another's "type" or attitude toward the risk associated with a firm's investment project. A number of studies have addressed the contagion of financial crises among financial institutions and/or international financial markets based on their interlinkages and changes in asset prices.[2] However, few studies have focused on the contagion of liquidity crises among nonfinancial institutions whose businesses are not directly linked to each other.[3] In this regard, the present study provides a better understanding of the

1 This 1997 financial crisis in Korea is explained more specifically in Section 5.

2 Rochet [2004] provides a survey of explanations about the contagion of financial crises.

contagion phenomenon by considering nonfinancial institutions in unrelated business sectors and subscribing to the idea that the mechanism triggering contagion is the learning within a common creditor pool. Specifically, this study suggests that when co-creditors learn about one another's "type," contagion is triggered.

This study focuses on "self-fulfilling crises," those crises that arise just because creditors believe that they are going to occur. This self-fulfilling nature is important because a firm's liquidity crisis is often viewed as a result of a coordination failure among creditors. However, considering a crisis to be self-fulfilling tends to produce multiple equilibrium outcomes, making it difficult to demonstrate the contagion effect.[4] Therefore, to obtain a unique equilibrium outcome, this study employs the global game method introduced by Carlsson and van Damme [1993]. This method allows for unique equilibrium outcomes for each firm and thus the determination of the contagion effect, which refers to an adverse effect of one firm's liquidity crisis on the likelihood of another firm's liquidity crisis.

Specifically, the global game setting of firms and that of creditors are similar to those in Morris and Shin [2004], who analyze the coordination game in the debt market by using global game tools and suggest that a distressed borrower's creditors face a coordination problem (a rollover game among creditors). Further, they demonstrate that, without common knowledge of the fundamentals of the distressed borrower, the probability of failure is uniquely

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3 Note that in the contagion of a financial crisis among financial institutions and/or countries, the crisis generally spreads through a direct linkage. A contagion phenomenon from capital links between financial institutions is examined by Allen and Gale [2000], Cifuentes, Ferrucci, and Shin [2005], and Dasgupta [2004]. Gerlach and Smets [1995] provide a contagion mechanism based on the trade linkage among countries.

4 Models with multiple equilibria cannot capture the contagion effect in which a firm's liquidity crisis affects the likelihood of another firm having a liquidity crisis because such models do not predict the likelihood of each particular equilibrium.

determined, given that the creditors' private information on the fundamentals is precise enough.[5] However, they address the rollover game for only one firm among creditors of the same type and do not investigate the contagion of a liquidity crisis between firms, which is the present study's central topic of interest. In this regard, the present study extends Morris and Shin's [2004] model to the case of two firms with two different types of creditors. In doing so, this study provides a better understanding of the phenomenon of contagion between two firms.

For the contagion setting, this study generally refers to Goldstein and Pauzner [2004], who use the global game method to explain the phenomenon of contagion between two countries. They examine two countries having independent fundamentals but sharing the same group of investors. In their model, a crisis in one country reduces agents' wealth, which makes them more averse to the strategic risk associated with the unknown behavior of other agents in the other country. This increases agents' incentive to withdraw their investments in the latter. That is, the mechanism that triggers contagion in their model originates in the wealth effect. However, the present paper focuses on the case in which creditors learn about one another's type, which serves as the contagion mechanism. In a coordination game setting, such a learning process is critical because it can directly explain the creditors' strategic behavior, which in turn can influence the probability of a firm having a liquidity crisis.

Angeletos, Hellwig, and Pavan [2007] examine how learning about the underlying fundamentals influences the dynamics of coordination in a global game of regime change. Similarly, Manz [2010] shows that one firm's failure can trigger a chain of failures when investors learn about a common state

5 Bruche [2011] develops a continuous-time version of Morris and Shin's [2004] model, and Takeda and Takeda [2008] investigate the role of large creditors in determining the price of corporate bonds based on Morris and Shin [2004].

influencing all firms within an industry, such as a proxy variable for the demand for their products. Lando and Nielsen [2010] conduct an empirical analysis of default contagion effects across firms based on rating covariates. However, instead of focusing on the learning process concerning economic fundamentals, the present paper examines how creditors' learning process involving one another's strategies plays a role in the contagion of a liquidity crisis from one firm to another. That is, based on Chamley [1999] and Steiner [2008], who investigate a repeated coordination game among the same players, the present paper shows how creditors' action in an initial coordination game (i.e., the first firm) influences other creditors' strategic behavior and then the result of a subsequent game (i.e., the second firm). This approach highlights the importance of coordination mechanism among creditors in crisis episodes (e.g., Fischer, 1999; Radelet & Sachs, 2000).

This study examines a sequential framework in which the rollover game among creditors for firm A takes place before that for firm B. In the proposed model, creditors hold loans for two firms' investment projects.[6] For each firm, they can either roll over their loans until the maturity date (in this case, they can get a full repayment from the firm if the investment project succeeds) or recall their loans in the interim stage (in this case, they can get some premature liquidation value, i.e., collateral debt, but less than the full repayment amount). The success of an investment project depends on the fundamentals of the firm and on the number of the firm's creditors who continue to roll over loans until the maturity date. That is, creditors' coordination effort to roll over loans influences the likelihood of a firm encountering a liquidity crisis.

In a sequential context similar to that of the present paper, Scharfstein and Stein [1990] examine some forces that can lead to herd behavior in investment

6 Co-creditors, for example, can be viewed as common bank creditors for different firms.

activity. For the banking sector, Chen [1999] shows that there may be systemic risk in the absence of interbank relationships because of the first-come, first-served rule and information externalities associated with negative payoffs. That is, he models banking panic as an outcome of depositors' "information-based herding behavior." However, the global game approach that this paper takes has a mechanism that is quite different from the herding model. As indicated by Morris and Shin [2003], the global game analysis is driven by strategic complementarities and highly correlated signals generated by the noisy observation technology. However, the sensitivity to the information structure arises in a purely static setting. Stories based on herding have no payoff complementarities and simple information structures but rely on sequential choices.

There are two types of creditors: "pessimistic" and "optimistic" creditors. Pessimistic creditors are more likely to worry about the failure of a firm's investment project than optimistic ones. In practice, these two types of creditors reflect both the strength of the balance sheet (financial status) of each creditor and any information advantage in firm-related issues, including the economic situation. That is, a creditor with a weak balance sheet and/or an information disadvantage is more likely to have pessimistic attitudes toward the risk it takes than one with a strong balance sheet and/or an information advantage. Guimaraes and Morris [2007] show that market participants' risk attitudes influence their positions in a pegged foreign currency and thus may have important effects on the sustainability of currency pegs. Considering a more general class of games, Izmalkov and Yildiz [2010] emphasize that in strategic environments, the relevant measure of sentiments (e.g., pessimistic/optimistic outlook) can vary arbitrarily and have considerable influence on strategic behaviors even under a low level of uncertainty. The present paper uses the same terminology (i.e., pessimistic/optimistic) because in the model, pessimistic

creditors are less likely to predict successful rollovers (and thus use a smaller discount factor) than optimistic ones.

Following the global game method, this paper assumes that creditors do not have common knowledge of the fundamentals of firm A and firm B. Instead, creditors have noisy signals of the firm's fundamentals after they are realized. In this setting, based on private signals of the firm's fundamentals, the two types of creditors uniquely determine not only their own beliefs about the fundamentals of each firm but also their own action concerning whether to roll over the firm's loans until the maturity date. After the rollover game for firm A, creditors observe the aggregate outcomes for firm A, which depend not only on firm A's fundamentals but also on creditors' actions for firm A.

Observing what occurred for firm A, creditors can conjecture other creditors' types because the outcome of the rollover game for firm A depends on different actions of different types of creditors. Hence, before the rollover game for firm B, creditors can revise their beliefs about other creditors' types. After learning about other creditors' types from the outcome for firm A, creditors uniquely determine their beliefs about the fundamentals of firm B and their actions for firm B. If firm A has a liquidity crisis and if firm B also suffers a liquidity crisis because of creditors' learning process, then there is the "contagion" of a liquidity crisis from firm A to firm B. Further, this paper refers to the increased probability of firm B having a liquidity crisis as a result of the contagion as the "severity of contagion" for firm B's liquidity crisis.

After demonstrating the severity of the contagion of a liquidity crisis from firm A to firm B, this paper shows that the severity of contagion increases when the originating firm's "failure point" (the probability of failure for the firm's investment project) decreases. In other words, the liquidity crisis of a firm with a low probability of failure is more contagious than that of a firm

that is more likely to fail. This result is striking in comparison with the findings of previous contagion studies, which typically address contagion among international financial markets and/or financial institutions by considering capital linkages and changes in asset prices. Such studies find that the larger the negative effect of poor fundamentals, the more severe the effect of linkages among financial institutions or countries on those institutions and countries.

This study also provides some important policy implications of reducing the severity of the contagion of a liquidity crisis from firm A to firm B. Firm B can minimize the severity of contagion from firm A to itself by setting a low value for its collateral because this represents an increase in the cost of not rolling over loans from creditors' perspective. In addition, the government can play a role in reducing damage from the severe contagion of a liquidity crisis by making pessimistic creditors more optimistic about the success of firms' investment projects (e.g., by providing bailouts to firms suffering transitory liquidity problems) and by reducing the amount of incomplete information on types of creditors in the market (e.g., by implementing a policy requiring the disclosure of types of creditors).

In terms of creditors' information structure, an increase in the accuracy of creditors' information on a firm's fundamentals can reduce the failure point for that firm. However, in the same way that the severity of contagion is more serious when the originating firm's failure point is lower, the severity of contagion is also more serious when creditors have more accurate information. That is, a liquidity crisis facing a firm considered less likely to fail (i.e., a firm with a low failure point from creditors' precise information on its fundamentals) represents a large shock to the market, and thus, the liquidity crisis can be more contagious. Based on this phenomenon, this paper argues that policy measures promoting transparency and precise information on firms' fundamentals are not a panacea in crises. Although the transparency of a firm's

fundamentals can reduce the probability of a crisis for the firm, it may worsen the severity of contagion between firms in the whole market.

The rest of this paper is organized as follows: Section 2 presents the model, and Section 3 solves the equilibrium for firm A and firm B and demonstrates how the contagion of a liquidity crisis from firm A to firm B occurs through creditors' learning process. Section 4 defines the severity of the contagion of a liquidity crisis between firms and discusses some policy implications for reducing this severity. Section 5 discusses the applicability of the proposed model to real-world phenomena by focusing on Korea's 1997 financial crisis, and Section 6 concludes.

II. The Model

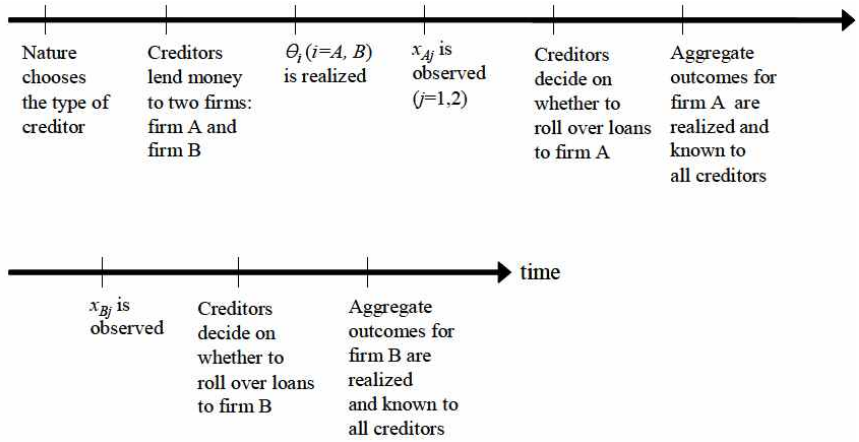
The model considers two firms: firm A and firm B. Both firms own no capital, and their investment projects are financed only through loans from creditors. There are two groups of creditors: group 1 and group 2. The sequence of events (see Figure 1) is as follows:[7] First, nature determines what the creditors are like. Second, creditors lend money to both firms A and B. Third, the state of each firm's fundamentals (θ_A and θ_B) is realized. Fourth, creditors in each group ($j=1,2$) receive a private signal (x_{Aj}) of the fundamentals of firm A.[8] Fifth, creditors decide whether to roll over loans to firm A. Sixth, the exact realization of the fundamentals of firm A and the result of creditors' actions (i.e., firm A's project failure or success) are known to all creditors after the rollover game for firm A.[9] Seventh, creditors in each

7 The present study generally follows Goldstein and Pauzner's [2004] sequence. Note that the model is sequential, that is, the activity takes place in firm A and then in firm B.

8 Note that creditors in each group receive the same signal here. Of course, we can assume that each creditor k receives its own private signal x_{Aj}^k. In any case, the equilibrium (a firm's switching fundamentals and the creditor's switching private signal) is the same.

group ($j=1,2$) receive a private signal (x_{Bj}) of the fundamentals of firm B. Eighth, creditors decide whether to roll over loans to firm B. Ninth, the exact realization of the fundamentals of firm B and the aggregate behavior in firm B are known to all creditors.

Figure 1: Timeline



Creditors provide both firms with financing for investment projects. In other words, the two firms share the same creditors. The two groups of creditors (group 1 and group 2) consist of a continuum of small creditors such that any individual creditor's share in the whole is negligible. All creditors are in a unit interval [0,1]. The size of group 1 is λ, and that of group 2 is $(1-\lambda)$, where $0<\lambda<1$. There is uncertainty about the type of creditor, that is, about the creditor's attitude toward the risk associated with a firm's investment project. Thus, group 1's type is privately known to group 1 creditors. There are two

9 That is, before creditors decide on their actions, they do not know the exact value of the firm's fundamentals. However, the present study assumes that after the rollover game, creditors know the true value of the firm's fundamentals. As indicated by Goldstein and Pauzner [2004], in equilibrium, it is sufficient that creditors receive information either on the fundamentals or on the aggregate behavior of creditors because one can be inferred from the other.

possible types of group 1 creditors: “pessimistic” creditors with probability q and “optimistic” ones with probability $(1-q)$. That is, all group 1 creditors are pessimistic (optimistic) with probability q $(1-q)$. For simplicity, all group 2 creditors are pessimistic, and this is common knowledge to all creditors.[10] The type of each group remains the same without large exogenous shocks such as state intervention or a complete break down of the market.

Pessimistic creditors are more likely to worry about the failure of a firm’s investment project than optimistic creditors. These two types reflect both the strength of the balance sheet (financial status) of each creditor and any information advantage in firm-related issues, including the economic situation.[11] That is, a creditor with a weak balance sheet and/or an information disadvantage is more likely to have pessimistic attitudes toward the risk it takes than one with a strong balance sheet and/or an information advantage. We assume that pessimistic creditors use δ_P as their discount factor, which is less than δ_O, the discount factor for optimistic creditors (i.e., $0 < \delta_P < \delta_O < 1$). That is, pessimistic creditors put a lower present value on the firm’s investment project than optimistic creditors.

The state of firm i’s fundamentals is θ_i, where $i = A, B$. Here θ_i can be interpreted as a measure of the ability of firm i to meet creditors' short-term claims. A high θ_i value indicates better fundamentals. After both firms raise funds from creditors and invest them in their projects, θ_i is randomly drawn

10 We can set group 2 creditors as optimistic instead of pessimistic, but this does not change the contagion results obtained using the proposed model because the type of group 2 creditor is public information in the market. Of course, the type of group 2 creditor influences the probability of a liquidity crisis for each firm.

11 In practice, a creditor's financial status can change over time and its informativeness varies from firm A to firm B. For simplicity, this study assumes that a creditor's financial status does not change in the course of the model's timeline and that its informativeness is the same for two firms.

from the real line, with each realization equally likely. Here we assume that θ_A and θ_B are independent of each other, which means that there is no linkage of fundamentals (e.g., no capital or trade linkages) between firm A and firm B.

After θ_i $(i = A, B)$ is realized, a rollover game among creditors takes place first for firm A and then for firm B. In each rollover game, there are two periods: period 1 (interim stage) and period 2 (maturity). In these periods, creditors lend money for the firm's investment project.[12] Each firm's investment project is completed in period 2 and yields the return v_i $(i = A, B)$, which is initially uncertain because it depends on creditors' actions in period 1. The financing of firm A and firm B is undertaken by a standard debt contract.[13] For simplicity, we assume that both firms have the same debt contract. That is, the face value of the repayment is L, and each creditor receives this full amount in period 2 if the realized value of v_i is large enough to cover the debt repayment.

In period 1, before the final realization of v_i, creditors have an opportunity to review their investment. Hence, in this period, creditors have to decide whether to roll over their loans until period 2. The loans are collateralized, and if creditors collect and liquidate the collateral after deciding not to roll over the loans (period 1), then the liquidation value of the seized collateral is $K^* \in (0, L)$. However, if creditors collect and liquidate the collateral because they cannot get the full repayment after they roll over the loans (period 2),

12 This two-period rollover game among creditors is based directly on Morris and Shin's [2004] model.

13 In general, firms use various debt contracts and can screen the type of creditor. Indeed, the linkage between loans (standard/innovative loans) and financial crises has been widely discussed (e.g., Biais, Rochet & Woolley, 2009; Shleifer & Vishny, 2010; Thakor, 2012). However, the proposed model explains the process in which creditors learn about one another's type by focusing on the standard debt contract. By analyzing creditors' learning process, we define the contagion of a liquidity crisis from firm A to firm B in Section 3.

then the liquidation value of the seized collateral is K_*, which is less than (i.e., $K_* < K^* < L$). That is, if we denote the proportion of creditors who do not roll over loans to firm i in period 1 by l_i $(i = A, B)$, then the firm's investment project fails if and only if $l_i > \theta_i$ and creditors get K_* in period 2.[14]

As in Morris and Shin [2004], for simplicity, we normalize the payoffs so that $L = 1$ and $K_* = 0$. Then those creditors who do not roll over loans in period 1 get K, which is in $(0,1)$.[15] In sum, the present value of payoffs in period 1 to a creditor is indicated by the following matrix:

	Project succeeds	Project fails
Roll over	$\delta_m \cdot 1 = \delta_m$	$\delta_m \cdot 0 = 0$
Not roll over	K	K

Here m is P for a pessimistic creditor and O for an optimistic one. As indicated by this payoff matrix, pessimistic creditors are less likely to expect a successful rollover than optimistic creditors. Specifically, we assume $0 < K < \delta_P < \delta_O < 1$.

If creditors know the value of θ_i perfectly before deciding on whether to roll over loans (period 1), then their optimal strategy reflects Obstfeld's [1996] self-fulfilling features as follows: If $\theta_i > 1$, then creditors will roll over their

14 The firm remains in operation as long as θ_i is large enough to meet creditors' claims. Otherwise, it is pushed into a default. Specifically, if $\theta_i \geq l_i$, then the firm's investment project succeeds, and the realized value of v_i is equal to V, which is a constant greater than L. However, if $l_i \geq \theta_i$, then the project fails, and $v_i = K_*$.

15 The exact value of K is $\frac{K^* - K_*}{L - K_*}$, which is obtained by normalizing payoffs, and it is in (0.1) because $K_* < K^* < L$.

loans regardless of other creditors' actions because the project survives even if every other creditor recalls. Conversely, if $\theta_i \leq 0$, then it is optimal for creditors not to roll over loans because the state of the fundamentals of the firm is so poor that the project will fail even if all other creditors roll over their loans. When $\theta_i \in (0,1]$, there is a coordination problem among creditors. If all other creditors roll over their loans, then the payoff for rolling them over is 1 at maturity (period 2),[16] and thus, rolling over loans yields a payoff greater than the premature liquidation value K. However, if all creditors recall their loans, then the payoff is 0, which is less than K, and thus, early liquidation is optimal. Hence, creditors' common knowledge assumption about θ_i leads to multiple equilibrium outcomes.[17]

To obtain a unique equilibrium outcome, we apply a global game method in which θ_i is not common knowledge. Instead, in period 1, when creditors decide whether to roll over loans, they receive private information on θ_i, but such information is not perfect. In other words, creditors in group j $(j=1,2)$ get a private signal: $x_{ij} = \theta_i + \varepsilon_{ij}$, where ε_{ij} is uniformly distributed over the interval $[-\varepsilon, \varepsilon]$.[18] Note that a creditor's present value (in period 1) of the expected utility of rolling over loans based on its private signal is $U = \delta_m \cdot \Pr[\theta_i \geq l_i \mid x_{ij}]$, where $m = P$ or O, and that for recalling loans is K. A *strategy* for creditors is a decision rule that maps each realization of x_{ij} to

16 In period 1, the present value of 1 is δ_P for pessimistic creditors and δ_O for optimistic ones.

17 This type of coordination problem among creditors is analogous to the bank run problem in Diamond and Dybvig [1983]. However, Diamond and Dybvig [1983] do not cover contagion issues and focus only on analyzing coordination failures among a single bank's patient depositors, providing results for multiple equilibria (Morris & Shin, 2001).

18 Morris and Shin [2004] consider both private and public signals of the firm's fundamentals. For simplicity, the present paper just assumes that creditors obtain private signals of the firm's fundamentals.

an action: rolling over loans or not rolling them over. An *equilibrium* consists of (1) *a firm's switching fundamentals* ($\bar{\theta}_i$) below which the project fails (i.e., a liquidity crisis in the firm) and (2) *the creditor's switching private signal* ($\bar{x}_{ij}$) in which every creditor who receives a signal below $\bar{x}_{ij}$ does not roll over loans.[19]

In the following section, we first solve for the equilibrium for firm A ($\bar{\theta}_A$ and $\bar{x}_{Aj}$, where $j=1,2$). After the rollover game for firm A, every creditor observes what occurred for firm A, including the exact value of θ_A. Then group 2 creditors can conjecture or learn the "type" of group 1 creditor based on the outcomes for firm A (i.e., the existence of a liquidity crisis facing firm A) and on firm A's switching fundamentals. We then solve for the equilibrium for firm B ($\bar{\theta}_B$ and $\bar{x}_{Bj}$, where $j=1,2$), which is influenced by creditors' revised beliefs (formed after the rollover game for firm A) about other creditors' types. This explains how and why firm A's liquidity crisis can trigger a liquidity crisis for firm B (i.e., it can explain the contagion of a liquidity crisis from firm A to firm B).

19 According to Morris and Shin [1998, 2003, 2004], even if ε becomes very small, the realization of θ_i will not be common knowledge among creditors. Moreover, in this case, Morris and Shin [1998, 2003, 2004] and Corsetti, Dasgupta, Morris, and Shin [2004] show that the equilibrium consists of a unique value for a firm's switching fundamentals and that for the creditor's switching private signal.

III. Solving the Model

1. Equilibrium for Firm A

Firm A's equilibrium consists of (1) *a firm's switching fundamentals* ($\bar{\theta}_A$) below which the project fails (i.e., a liquidity crisis in firm A) and (2) *the creditor's switching private signal* ($\bar{x}_{Aj}$) in which every creditor who receives a signal below $\bar{x}_{Aj}$ does not roll over loans. Here the equilibrium values $\bar{\theta}_A$ and $\bar{x}_{Aj}$ are as follows:

$$\bar{\theta}_A = \begin{cases} \theta^*_{AP} & \text{if group 1 creditors are pessimistic;} \\ \theta^*_{AO} & \text{if group 1 creditors are optimistic;} \end{cases}$$

$$\bar{x}_{A1} = \begin{cases} x^*_{A1P} & \text{if group 1 creditors are pessimistic;} \\ x^*_{A1O} & \text{if group 1 creditors are optimistic;} \end{cases}$$

$$\bar{x}_{A2} = x^*_{A2}.$$

After getting private signals in period 1, creditors have to decide whether to roll over their loans. The indifference condition gives the following equation:

$$\underbrace{K}_{\text{payoff from recalling}} = \underbrace{\delta_m \cdot \Pr\,[\text{rollover is successful } |\bar{x}_{Aj}]}_{\text{PV of the payoff from a successful rollover}}. \qquad (1)$$

Further, note that the critical threshold value of firm A's fundamentals (i.e., switching fundamentals) is determined when the proportion of creditors who do not roll over loans (l_A) is equal to θ_A. Using Equation (1) for creditors in each group and the condition of the critical threshold value of firm A's fundamentals, we calculate unique equilibrium values: switching fundamentals of

firm A (θ^*_{AP} and θ^*_{AO}) and switching private signals (x^*_{A1P}, x^*_{A1O} and x^*_{A2}). Firm A's equilibrium is summarized in the following proposition:

Proposition 1 *There exists a unique equilibrium for firm A that consists of (1) a firm's switching fundamentals ($\bar{\theta}_A$) below which the project fails (i.e., a liquidity crisis in firm A) and (2) the creditor's switching private signal ($\bar{x}_{Aj}$, $j=1,2$) in which every creditor who receives a signal below $\bar{x}_{Aj}$ does not roll over loans. Specifically, firm A's switching fundamentals are*

$$\theta^*_{AP} = \frac{K}{\delta_P}(1-\Sigma_1);$$
$$\theta^*_{AO} = \frac{K}{\delta_P}(1-\Sigma_1-\Sigma_2);$$

and creditors' switching private signals are

$$x^*_{A1P} = \frac{K}{\delta_P}(1-\Sigma_1+\Sigma_3);$$
$$x^*_{A1O} = \frac{K}{\delta_P}\left(1-\Sigma_1-\Sigma_2+\frac{\delta_P}{\delta_O}\Sigma_3\right);$$
$$x^*_{A2} = \frac{K}{\delta_P}(1-\Sigma_1-(1-q)\Sigma_2+\Sigma_3);$$

where

$$\Sigma_1 = \frac{\lambda(1-\lambda)(1-q)(\delta_O-\delta_P)}{\delta_O(1+2\varepsilon-\lambda)},\ \Sigma_2 = \frac{2\lambda\varepsilon(\delta_O-\delta_P)}{\delta_O(1+2\varepsilon-\lambda)},\ \textit{and}\ \Sigma_3 = \left(\frac{2K-\delta_P}{K}\right)\varepsilon.$$

Note that $\theta^*_{AP} > \theta^*_{AO}$ and $x^*_{A1P} > x^*_{A2} > x^*_{A1O}$ hold because λ, q, and ε are in (0, 1), and $0 < \delta_P < \delta_O < 1$. The intuition behind the inequalities is as follows: x^*_{A1P} is greater than x^*_{A1O} because pessimistic creditors are less likely to roll over loans than optimistic ones. Similarly, θ^*_{AP} is greater than θ^*_{AO} because firm A's project is more likely to fail (i.e., more likely to be liquidated early) if group 1 creditors are pessimistic.

2. Equilibrium for Firm B

All creditors observe what occurs for firm A, including the exact value of θ_A. This provides the market with information on the type of group 1 creditor because different types use different switching signals, resulting in different outcomes for firm A under certain conditions.

There are two possible scenarios: First, if $\theta_A \notin [\theta^*_{AO}, \theta^*_{AP}]$, then the type of group 1 creditor remains hidden because if $\theta_A \leq \theta^*_{AO}$, then there is a liquidity crisis in firm A regardless of the type of group 1 creditor. On the other hand, if $\theta_A \geq \theta^*_{AP}$, then there is no liquidity crisis in firm A regardless of the type of group 1 creditor. Hence, if $\theta_A \notin [\theta^*_{AO}, \theta^*_{AP}]$, then group 2 creditors do not have knowledge of the type of group 1 creditor and face the same rollover game, which has been played for firm A, in determining whether to roll over loans to firm B.[20]

Second, if $\theta_A \in [\theta^*_{AO}, \theta^*_{AP}]$, then the type of group 1 creditor is revealed to the market. Conditional on such θ_A, there is a liquidity crisis in firm A if and only if group 1 creditors are pessimistic. Similarly, conditional on θ_A, which is between θ^*_{AO} and θ^*_{AP}, the liquidity crisis does not occur in firm A if and only if group 1 creditors are optimistic. Hence, if $\theta_A \in [\theta^*_{AO}, \theta^*_{AP}]$, then the new rollover game is played by creditors to determine whether to roll over loans to firm B.

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20 Note that in the case of $\theta_A \notin [\theta^*_{AO}, \theta^*_{AP}]$, although the number of creditors not rolling over their loans is known, the type of group 1 creditor is not revealed because x_{A1} is in the ε -neighborhood of θ_A and x^*_{A1P} and x^*_{A1O} are very closely located around θ^*_{AP} and θ^*_{AO}, respectively.

We now discuss two scenarios: $\theta_A \notin [\theta^*_{AO}, \theta^*_{AP}]$ and $\theta_A \in [\theta^*_{AO}, \theta^*_{AP}]$. In each scenario, that is, conditional on the realized underlying state of the fundamentals of firm A (θ_A) and the existence of a liquidity crisis in firm A, we derive a unique equilibrium for firm B (i.e., $\overline{\theta}_B$ and $\overline{x}_{Bj}$, $j = 1, 2$).

A. Scenario 1: $\theta_A \notin [\theta^*_{AO}, \theta^*_{AP}]$

In this scenario, the type of group 1 creditor is not revealed. Hence, the equilibrium values of the switching fundamentals and private signals for firm B are exactly the same as those for firm A. This is the benchmark case of firm B, and in particular, the benchmark switching fundamentals of firm B are (1) θ^*_{AO} if group 1 creditors are optimistic and (2) θ^*_{AP} if they are pessimistic.

B. Scenario 2-1: Firm A's liquidity crisis when $\theta_A \in [\theta^*_{AO}, \theta^*_{AP}]$

This scenario implies that group 1 creditors are pessimistic. In this case, both creditors in both group 1 and group 2 have the same switching strategy signal (i.e., x^*_B). Hence, the equilibrium consists of (1) *a firm's switching fundamentals* (θ^*_{BP}) below which the project fails (i.e., a liquidity crisis in firm B) and (2) *the creditor's switching private signal* (x^*_B) in which every creditor who receives a signal below x^*_B does not roll over loans. Here we obtain the following equilibrium:

$$\theta^*_{BP} = \frac{K}{\delta_P},$$
$$x^*_B = \frac{K}{\delta_P}(2\varepsilon + 1) - \varepsilon.$$

C. Scenario 2-2: No liquidity crisis facing firm A when $\theta_A \in [\theta^*_{AO}, \theta^*_{AP}]$

This scenario implies that group 1 creditors are optimistic. In this case, creditors in both group 1 and group 2 have different switching strategy signals (i.e., x^*_{B1} for group 1 and x^*_{B2} for group 2). Hence, the equilibrium consists of (1) *a firm's switching fundamentals* (θ^*_{BO}) below which the project fails (i.e., firm B faces a liquidity crisis) and (2) *the creditor's switching private signals* (x^*_{B1} for group 1 and x^*_{B2} for group 2) in which creditors in group 1 who receive a signal below x^*_{B1} do not roll over loans and creditors in group 2 who receive a signal below x^*_{B2} do not roll them over. Here we obtain the following equilibrium:

$$\theta^*_{BO} = \frac{\lambda K}{\delta_O} + \frac{(1-\lambda)K}{\delta_P},$$
$$x^*_{B1} = \frac{K(\lambda+2\varepsilon)}{\delta_O} + \frac{(1-\lambda)K}{\delta_P} - \varepsilon,$$
$$x^*_{B2} = \frac{\lambda K}{\delta_O} + \frac{K(1-\lambda+2\varepsilon)}{\delta_P} - \varepsilon.$$

Note that $\theta^*_{BO} \leq \theta^*_{BP}$ and $x^*_{B1} < x^*_{B2} < x^*_B$ hold because λ and ε are in (0,1), and $0 < \delta_P < \delta_O < 1$. The intuition behind the inequalities is as follows: x^*_B is greater than x^*_{B1} and x^*_{B2} because when all creditors are pessimistic, they are less likely to roll over loans than when there are optimistic creditors. By the same logic, θ^*_{BP} is greater than θ^*_{BO} because firm B's project is more likely to fail (i.e., more likely to be liquidated early) if group 1 creditors are pessimistic.

3. Contagion of a Liquidity Crisis from Firm A to Firm B

A. What is contagion?

In this paper, financial contagion is defined as the spread of solvency problems between two firms, and the contagion of a liquidity crisis from firm A to firm B is propagated by creditors who determine whether to roll over loans. After observing the outcomes for firm A, creditors update their beliefs about other creditors' types and reflect this information in their optimal decision concerning firm B.[21]

If the realized value of the fundamentals of firm A (θ_A) is quite poor, which implies $\theta_A \leq \theta^*_{AO}$, then firm A suffers a liquidity crisis regardless of the type of group 1 creditor. In this case, the type of group 1 creditor remains hidden. Thus, if $\theta_A \leq \theta^*_{AO}$, then there is no contagion of a liquidity crisis from firm A to firm B because group 2 creditors' decisions concerning firm B are not influenced by firm A's situation. We can discuss the existence of the contagion of a liquidity crisis from firm A to firm B only when θ_A is between θ^*_{AO} and θ^*_{AP} and when firm A has a liquidity crisis.

As discussed in the previous section, if $\theta_A \in [\theta^*_{AO}, \theta^*_{AP}]$ and firm A has no liquidity crisis, then the type of group 1 creditor is assumed to be optimistic. This information is reflected in group 2 creditors' decisions, and θ^*_{BO} is

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21 Similarly, Taketa [2004] analyzes the phenomenon of the contagion of a currency crisis between two countries by using a global game method considering speculators' learning behavior toward one another's "type" (i.e., the level of their aggressiveness with respect to speculative activity) as a mechanism triggering the contagion. However, he does not numerically analyze the contagion effect and its severity. In this regard, by focusing on nonfinancial institutions, the present paper specifically analyzes the contagion effects and proposes some policy measures for reducing the severity of the contagion of a liquidity crisis from one firm to another.

determined. Similarly, if $\theta_A \in [\theta^*_{AO}, \theta^*_{AP}]$ and firm A has a liquidity crisis, then the type of group 1 creditor is assumed to be pessimistic. This information is reflected in group 2 creditors' decisions, and θ^*_{BP} is determined. That is, the behavior of creditors toward firm A influences the behavior of creditors toward firm B only when $\theta_A \in [\theta^*_{AO}, \theta^*_{AP}]$.

Here if the realized value of the fundamentals of firm B (θ_B) is quite poor, that is, $\theta_B \leq \theta^*_{BO}$, then firm B faces a liquidity crisis regardless of whether firm A has a liquidity crisis. Hence, in this case, although there are liquidity crises in both firms, we cannot assume the actual contagion of solvency problems from firm A to firm B. Meanwhile, if θ_B is between θ^*_{BO} and θ^*_{BP} and firm B has a liquidity crisis, then this implies the contagion of a liquidity crisis from firm A to firm B because firm B can have a liquidity crisis when $\theta_B \in [\theta^*_{BO}, \theta^*_{BP}]$ only if firm A has a liquidity crisis when $\theta_A \in [\theta^*_{AO}, \theta^*_{AP}]$.[22]

By summarizing the above arguments, we define the contagion of a liquidity crisis between two firms as follows:

Definition 1 *The contagion of a liquidity crisis from firm A to firm B refers to the case in which, because of creditors' learning process, firm B has a liquidity crisis when $\theta_B \in [\theta^*_{BO}, \theta^*_{BP}]$ and firm A has a liquidity crisis when $\theta_A \in [\theta^*_{AO}, \theta^*_{AP}]$.*

22 The model assumes that after the rollover game for firm A, creditors know not only whether there is a liquidity crisis but also the exact level of the fundamentals of firm A. However, if the fundamentals of firm A do not become commonly known after the rollover game, then there will be an inference problem, according to which the realization of firm A's liquidity crisis provides creditors with some information not only on other creditors' types but also on the fundamentals of firm A. The rollover game for firm B then becomes more complicated but interesting and can potentially lead to a smoother version of contagion in which the contagion gradually changes with the fundamentals (this represents a possible avenue for future research).

B. Scenario 1 versus scenario 2

We now compare scenario 1 ($\theta_A \notin [\theta^*_{AO}, \theta^*_{AP}]$) with scenario 2 ($\theta_A \in [\theta^*_{AO}, \theta^*_{AP}]$). Scenario 1 provides the benchmark switching fundamentals (θ^*_{AO} and θ^*_{AP}) of firm B, whereas scenario 2 provides the new switching fundamentals (θ^*_{BO} and θ^*_{BP}) of firm B. By comparing the values of these switching fundamentals, we obtain the following lemma:

Lemma 1 $\theta^*_{BO} < \theta^*_{AO} < \theta^*_{AP} < \theta^*_{BP}$.

Proof. *From the values of* θ^*_{AO}, θ^*_{AP}, θ^*_{BO}, *and* θ^*_{BP}, *we obtain*

$$\theta^*_{BP} - \theta^*_{AP} = \frac{\lambda K(\delta_O - \delta_P)}{\delta_O \delta_P}\left(\frac{(1-\lambda)(1-q)}{1+2\varepsilon-\lambda}\right) > 0,$$

$$\theta^*_{AO} - \theta^*_{BO} = \frac{\lambda K(\delta_O - \delta_P)}{\delta_O \delta_P}\left(\frac{q(1-\lambda)}{1+2\varepsilon-\lambda}\right) > 0.$$

Here $\theta^*_{BO} < \theta^*_{AO} < \theta^*_{AP} < \theta^*_{BP}$ *holds based on the fact that* $\theta^*_{AP} - \theta^*_{AO} > 0$.

The intuition behind the inequalities is as follows: A liquidity crisis is less likely for firm B if the type of group 1 creditor is revealed to be optimistic than if it is not revealed (i.e., $\theta^*_{BO} < \theta^*_{AO}$). On the other hand, a liquidity crisis is more likely for firm B if the type of group 1 creditor is revealed to be pessimistic than if it is not revealed (i.e., $\theta^*_{BP} > \theta^*_{AP}$). That is, the revelation of the type of group 1 creditor increases the sensitivity of a liquidity crisis to the fundamentals of firm B, which implies that the contagion channel of the present study's proposed model (i.e., creditors' learning process concerning other creditors' types) is significant in real-world situations. In fact, particularly referring to empirical studies on crises (e.g., Baig & Goldfajn, 2001; Broner, Gelos & Reinhart, 2006), Guimaraes and Morris [2007] emphasize the effect of

market participants' risk attitudes ("types" in the present study) on their coordination behavior and thus on the likelihood of currency crises, consistent with the intuition of Lemma 1.

IV. Comparative Statics and Policy Implications

In this section, after defining the severity of the contagion of a liquidity crisis, we find that a firm is more likely to have contagion effects if it is considered less likely to fail. Then, through comparative statics for the severity of contagion, we consider some policy implications for reducing the severity of contagion.

1. Severity of Contagion for a Liquidity Crisis

As indicated in Section 3, $\theta^*_{BO} < \theta^*_{AO} < \theta^*_{AP} < \theta^*_{BP}$ holds, which implies that if the type of group 1 creditor is revealed as pessimistic, then the probability of firm B having a liquidity crisis increases by the difference between θ^*_{BP} and θ^*_{AP}. This indicates a negative contagion effect on firm B's liquidity crisis. If the type of group 1 creditor is revealed as optimistic, then the probability of firm B's liquidity crisis decreases by the difference between θ^*_{AO} and θ^*_{BO}, which can be interpreted as a positive effect of reducing the probability of a liquidity crisis for firm B through the revelation of group 1 creditors as optimistic. Focusing on negative contagion effects on firm B's liquidity crisis, we define the severity of contagion as the difference between new switching fundamentals (θ^*_{BP}) and benchmark switching fundamentals (θ^*_{AP}) for pessimistic creditors.[23]

Definition 2 *The severity of contagion for firm B's liquidity crisis indicates the increased probability of firm B having a liquidity crisis because of the negative contagion effect: the difference between new switching fundamentals θ^*_{BP} and benchmark switching fundamentals θ^*_{AP}. Specifically, this is expressed as*

$$\textbf{SC} \;::= \theta^*_{BP} - \theta^*_{AP} = \frac{\lambda(1-\lambda)(\delta_O - \delta_P)(1-q)K}{\delta_O \delta_P (1+2\varepsilon-\lambda)},$$

which is greater than 0 because λ, ε, q, K, δ_O, and δ_P are in $(0,1)$.

We now obtain the following proposition:

Proposition 2 *A liquidity crisis facing a firm that is less likely to fail is more contagious than that facing a firm more likely to fail.*

Proof. *We show that the severity of contagion ($\theta^*_{BP} - \theta^*_{AP}$) decreases with θ^*_{AP}.*[24] *This is trivial because a decrease in θ^*_{AP} increases the difference between θ^*_{BP} and θ^*_{AP}. Specifically, we can express θ^*_{AP} as*

$$\begin{aligned}\theta^*_{AP} &= \frac{K}{\delta_P}\left(1 + \frac{\lambda(1-\lambda)(\delta_O-\delta_P)(1-q)}{\delta_O(-1-2\varepsilon+\lambda)}\right) \\ &= \underbrace{\frac{K}{\delta_P} - \frac{\lambda(1-\lambda)(\delta_O-\delta_P)(1-q)K}{\delta_O\delta_P(1+2\varepsilon-\lambda)}}_{=\text{SC}}.\end{aligned}$$

By rearranging the above equation, we get

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23 That is, we define the severity of contagion for firm B's liquidity crisis as an increase in the probability of firm B facing a liquidity crisis as a result of creditors' learning from firm A's liquidity crisis.

24 According to the definition of a firm's switching fundamentals, a low value for switching fundamentals implies a low probability of failure for the firm, that is, the value for a firm's switching fundamentals can be interpreted as its failure point.

$$\mathbf{SC} = -\theta^{*}_{AP} + \frac{K}{\delta_P},$$

*which implies that the severity of contagion (***SC***) decreases with* θ^{*}_{AP}.

This proposition illustrates that the severity of contagion decreases with the level of firm A's failure point (i.e., firm A's switching fundamentals). That is, the probable contagion of a liquidity crisis facing a firm considered less likely to fail far exceeds that for a firm considered not strong enough to endure a liquidity crisis. The intuition behind this argument is as follows: The occurrence of a liquidity crisis for a firm considered less likely to fail (i.e., the firm having a lower failure point) is more likely to represent a large shock to the market than that for a firm considered more likely to fail, and hence, the liquidity crisis is likely to be more contagious. As indicated by Taketa [2004], the 2002 financial crisis in Argentina provides support for this theoretical finding, that is, a crisis in a country expected to have relatively poor economic fundamentals does not lead to severe contagion.

This is noteworthy in that most of the previous studies of contagion focus on contagion among international financial markets and/or financial institutions through capital linkages and changes in asset prices and find that the negative effect of poor fundamentals increases the severity of contagion for other financial institutions or countries through their linkages.[25] However, in the present study, the severity of contagion increases when the originating firm's failure point is lower. This finding is based on the following: First, this paper focuses on and considers the process by which co-creditors learn about one

25 However, Dasgupta [2004] shows another possibility in balance sheet connections in which sizes of links between financial institutions are endogenously determined. That is, consistent with the results of the present study, it is precisely when the probability of a crisis is low that balance sheet connections are strong, which makes the contagion of a crisis all the more severe.

another's type during their rollover games for two nonfinancial institutions in unrelated business areas (i.e., independent fundamentals) as a mechanism triggering contagion. Second, the paper assumes that the exact realization of the fundamentals of the originating firm and the results of creditors' actions (i.e.,the failure or success of the firm's project) are known to creditors before they determine their actions for the other firm.

2. Changes in the Value of the Collateralized Debt (K)

As indicated in Morris and Shin [2003, 2004], increasing the value of the collateral (K) has two contrasting effects: First, it increases the value of the debt (loan) in the event of a default (i.e., a direct effect). In a similar context, Besanko and Thakor [1987] and Greenbaum and Thakor [2007] examine the signaling issue surrounding collateral and suggest that low-risk borrowers tend to choose contracts with heavy collateral requirements because their low risk implies that the likelihood of defaulting and losing the collateral to creditors is low (i.e., heavy collateral requirements become less onerous).

Second, the value of the collateral (K) increases the range of θ at which a default occurs (i.e., a strategic effect).[26] In other words, from creditors' perspective, a decrease in the value of the collateral is an increase in the cost of not rolling over loans, and thus, creditors have more incentivesto rollover their loans until the maturity date when the value of the collateral is low. In the contagion context, the strategic effect exceeds the direct effect, indicating that reducing the value of K can help to reduce the severity of contagion for firm B. The following proposition summarizes the results:

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26 In the proposed model, this result for strategic effects can be verified from θ^*_{AP} and θ^*_{BP}.

Proposition 3 *The severity of contagion for firm B's liquidity crisis is reduced by a decrease in the value of its collateral (K).*

Proof.

$$\frac{\partial \mathrm{SC}}{\partial K}=\frac{\lambda(1-\lambda)(\delta_O-\delta_P)(1-q)}{\delta_O\delta_P(1+2\varepsilon-\lambda)}>0,$$

*which implies that if firm B reduces the value of K, then the severity of contagion (***SC***) for firm B's liquidity crisis is reduced.*

3. Changes in the Gap Between Discount Factors (δ_O and δ_P)

Thakor [2008] argues that government bailouts are intended to mitigate bankruptcy/liquidity problems and to recover investors' sapped confidence. In the proposed model, we can consider government bailouts for firms facing transitory liquidity problems as follows:[27] After observing firm A's liquidity crisis and understanding the type of group 1 creditor as pessimistic, the government can expect the contagion of the liquidity crisis from firm A to firm B. If the government provides firm B (a firm facing a transitory liquidity problem, even though its fundamentals are not poor) with a bailout, then it is a good signal for the success of firm B's investment project in the market. In this case, pessimistic creditors become more optimistic about the success of firm B's investment project (i.e., $\delta_P \rightarrow \delta_O$).[28] That is, the gap between δ_O and δ_P decreases, which in turn reduces the severity of contagion for firm B's liquidity crisis.[29] We can summarize this argument in the following proposition:

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27 Note that the government's provision of bailouts does not fully guarantee the success of a firm's investment project.

28 Here we focus only on creditors' optimistic attitudes toward a firm's fundamentals. However, from the perspective of the whole economy, if the government implements fiscal and/or monetary expansion policies, then pessimistic creditors become more optimistic, and thus, $\delta_P \rightarrow \delta_O$.

29 In extreme cases where the government "fully" guarantees firm B's investment project, there

Proposition 4 *The severity of contagion for firm B's liquidity crisis is reduced by a decrease in* $(\delta_P - \delta_O)$*, which can be secured through the government's bailout of firm B.*

Proof.

$$\frac{\partial \mathrm{SC}}{\partial(\delta_O - \delta_P)} = \frac{\lambda(1-\lambda)(1-q)K}{\delta_O \delta_P (1+2\varepsilon-\lambda)} > 0,$$

which implies that if the government reduces $(\delta_P - \delta_O)$ *by providing firm B with a bailout, then the severity of contagion (***SC***) for firm B's liquidity crisis decreases.*

4. Changes in the Information Structure (ε)

As creditors' information on a firm's fundamentals becomes very precise (i.e., $\varepsilon \to 0$), the value of the firm's switching fundamentals decreases.[30] That is, the increased transparency of the firm's fundamentals helps to reduce market uncertainty and thus reduces creditors' incentives for not rolling over their loans. Similarly, Heinemann and Illing [2002] emphasize the role of transparent/precise information during a crisis. In this regard, what effect does small noise (i.e., precise information on the firm's fundamentals) have on these verity of contagion? Can precise information on the firm's fundamentals reduce the severity of contagion? The results are surprising because it increases the severity of contagion.

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is no contagion of a liquidity crisis from firm A to firm B.

30 In the proposed model, we can verify this result from, for example, θ^*_{AP}. Note that θ^*_{BP} and θ^*_{BO} do not have ε because the type of group 1 creditor is known when those switching fundamentals are determined.

Proposition 5 *The severity of contagion for firm B's liquidity crisis increases with the accuracy of the information structure.*

Proof.

$$\frac{\partial \mathrm{SC}}{\partial \varepsilon} = -\frac{2\lambda(1-\lambda)(\delta_O - \delta_P)(1-q)K}{\delta_O \delta_P (1+2\varepsilon-\lambda)^2} < 0,$$

which implies that if creditors' (private) information on the firm's fundamentals is very precise (i.e., $\varepsilon \to 0$*), then the severity of contagion (***SC***) for firm B's liquidity crisis increases.*

If creditors' information on firms' fundamentals is very accurate (i.e., if is very small), then the probability of firm A having a liquidity crisis decreases (i.e., the failure point of firm A (θ^*_{AP}) is lower). However, if firm A has a liquidity crisis, even though the probability of its failure is low, then the contagion of the liquidity crisis to firm B is more severe. This can be interpreted using Proposition 2. That is, if there is a liquidity crisis facing a firm considered less likely to fail (i.e., a firm having a low failure point (θ^*_{AP}) via small ε), then there is a large shock to the market, and thus, the liquidity crisis can be more contagious. This result indicates that policies facilitating agents' transparent/precise information on fundamentals are not a panacea during a crisis. Although the transparency of economic fundamentals can help reduce the probability of a crisis in one economy, it can worsen the severity of contagion in the whole market because of agents' responses to other economies based on their knowledge of one another's type.

5. Changes in the Size of Group 1 (λ)

The size of group 1 creditors, which is measured by λ, represents incomplete information in the market. That is, although group 2 creditors are pessimistic and this is public information in the market, the type of group 1 creditor is not known in the market initially. This raises the question of what effect this incomplete information has on the severity of contagion. In other words, what is the impact of the degree of incomplete information on the severity of contagion? The following proposition shows the effect of λ on the severity of contagion when ε converges to zero:[31]

Proposition 6 *The severity of contagion for firm B's liquidity crisis is reduced by a decrease in the size of group* 1.

Proof.

$$\frac{\partial \mathrm{SC}}{\partial \lambda} = \frac{(\delta_O - \delta_P)(1-q)K}{\delta_O \delta_P} > 0 \text{ as } \varepsilon \to 0,$$

which implies that as the size of group 1 *decreases and creditors' (private) information on the firm's fundamentals becomes very precise, the severity of contagion (***SC***) for firm B's liquidity crisis decreases.*

This implies that, as discussed above, the size of group 1 indicates incomplete information in the market initially. If the size of this incomplete information is small, then the contagion of the liquidity crisis is less severe. Hence, the government can mitigate the severity of contagion by regulating the amount of this incomplete information. For example, the government can induce

31 When ε does not converge to zero, the effect of λ on the severity of contagion depends on relative sizes of λ and ε. Hence, this paper considers the case in which ε converges to zero, that is, creditors' information on firms' fundamentals is very precise.

creditors to reveal their types through a policy measure requiring appropriate financial disclosure (i.e., the disclosure of creditors' financial information).[32] In extreme cases where such financial disclosure perfectly reflects the type of group 1 creditor, there is no learning process among creditors, and thus, there is no contagion of a liquidity crisis from firm A to firm B.

With respect to the issue of the revelation of the type of group 1 creditor via a financial disclosure policy, what is the effect of the type of group 1 creditor on the severity of contagion? Because group 1 creditors are pessimistic with probability q, the severity of contagion decreases with q.[33] This implies that if group 2 creditors initially expect group 1 creditors to be the same type, then the process of learning creditors' types has little effect on the contagion of a liquidity crisis.

6. Positive Effects of Learning on a Liquidity Crisis

We express the positive effects of reducing the probability of firm B facing a liquidity crisis as a result of the revelation of group 1 creditors as optimistic as follows:

$$\text{PE} := \theta^*_{AO} - \theta^*_{BO} = \frac{\lambda(1-\lambda)(\delta_O - \delta_P)qK}{\delta_O\delta_P(1+2\varepsilon-\lambda)},$$

which is different from the severity of contagion (i.e., $\text{SC} := \theta^*_{BP} - \theta^*_{AP}$) only in terms of q. That is, the sign of the comparative statics for the positive

32 Note that although this revelation policy can help reduce the severity of contagion, it is not always good for individual firms because, as discussed in Section 3, if the creditor is revealed to be pessimistic, then the likelihood of a firm facing a liquidity crisis increases.

33 θ^*_{AP} is increasing in q, but θ^*_{BP} is independent of q. That is, **SC** ($:=\theta^*_{BP} - \theta^*_{AP}$) is decreasing in q. Specifically, we obtain $\frac{\partial \text{SC}}{\partial q} = -\frac{\lambda(1-\lambda)(\delta_O - \delta_P)K}{\delta_O\delta_P(1+2\varepsilon-\lambda)} < 0$.

effects with respect to the variables that compose them is exactly the same as that in the case of the severity of contagion (except for q).[34]

This highlights the trade-off relationship between policy proposals for reducing the severity of contagion, such as the initial policies regarding K, ε, and λ. In other words, if governments and/or firms first take measures to reduce the severity of contagion, then the positive effects of reducing the probability of firm B encountering a liquidity crisis as a result of the revelation of group 1 creditors as optimistic are reduced by those measures. This implies that the effectiveness of governments' or firms' predetermined policies depends on the type of group 1 creditor.[35]

V. Korea's Financial Crisis in 1997

To examine the applicability of the proposed model to real-world phenomena, we revisit Korea's financial crisis in 1997, which occurred at the height of the Asian Flu. According to Akama, Noro, and Tada [2003], Korean firms were highly leveraged by short-term loans from domestic and foreign banks. By the end of 1996, the ratio of corporate debt to nominal GDP exceeded 1.6, and that of external debt to GDP reached approximately 25%. The share of short-term debt in total external debt peaked at 58%. This is consistent with the proposed model's debt-financing assumption. Akama, Noro, and Tada [2003] argue that Korea had a bank-centered financial system. As of the end of 1997, among 26 domestic commercial banks, 16[36] were actually

34 Here we check whether **SC** ($:=\theta^*_{BP}-\theta^*_{AP}$) exceeds **PE** ($:=\theta^*_{AO}-\theta^*_{BO}$) if $q<\frac{1}{2}$.

35 Oh [2012] further analyzes the positive effects of contagion. Specifically, he explores the role of public information disseminated by a country's central bank in the contagion of a currency crisis, including both negative and positive contagion effects.

36 The others were local commercial banks.

common creditor s of the top 30 conglomerates in Korea.[37] This indicates that Korean firms had the same co-lending banks, which is consistent with the proposed model's assumptions about co-creditors. In sum, the overall business situation of Korean firms in 1997 indicates co-creditors' coordination for debt rollovers.

According to Rhee [1998], the bankruptcy of Hanbo Steel Group in January 1997 was a sobering experience for co-creditors. They started to strictly reexamine the profitability of their loans to other firms and call in most of their short-term loans. This led to a "domino effect" as an increasing number of firms faced liquidity crises. For example, Kia Motors (Korea's eighth largest conglomerate) failed, even though its reputation in the market was fairly positive.[38] This rush continued, and as mentioned in the Introduction section, Jinro (Korea's nineteenth largest conglomerate and also the largest liquor group) declared bankruptcy in September 1997. By the end of 1997, over 15,000 firms of all sizes declared bankruptcy. This process of serial failures indicates the following phenomena: First, these firms typically had common creditors, and as indicated by Rhee [1998], the fundamentals of most of these firms were not poor. Second, foreign banks (particularly those from Japan and the U.S.[39]) pulled out their money en masse, and some domestic banks in Korea (e.g., Korea First Bank (KFB)[40]) sharply reduced their rollovers, followed by other co-creditors.

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37 That is, those commercial banks lent money to multiple firms, including the top 30 conglomerates.

38 In 1998, Kia merged with Hyundai Motor Company.

39 For more information on this, see Kaminsky, Lyons, and Schmukler [2001] and Kaminsky and Reinhart [2000]. Kaminsky and Reinhart [2000] document that on the eve of Korea's financial crisis, there were claims from Japanese and U.S. banks, demonstrating their withdrawal from Korea during the financial crisis. Kaminsky, Lyons, and Schmukler [2001] analyze international mutual funds' withdrawal during Asian crises, including Korea's financial crisis.

40 KFB declared bankruptcy immediately after Jinro.

This interpretation of Korea's financial crisis in 1997 is consistent with the proposed model. Observing Hanbo Steel Group's liquidity crisis, common creditors can conjecture or learn about other creditors' types.[41] Here, foreign banks and KFB, for example, can be viewed as pessimistic creditors in the proposed model because of their information disadvantage and weak balance sheet, respectively. More specifically, foreign banks can be considered as group 2 creditors because they were at an information disadvantage with respect to Korea's overall business environment relative to their Korean counterparts, and this fact was known in the market. Of course, some domestic commercial banks in Korea can be treated as group 2 creditors if their poor financial status was known among creditors. In the case of KFB, its financial status was unknown initially, and thus, we can interpret KFB as belonging to group 1. Considering new information on other banks' types since Hanbo Steel Group's liquidity crisis, co-creditors decided to take their own action (i.e., whether to roll over their loans) for other firms.

Because there was no fundamental linkage among many of the failed firms whose fundamentals were not too poor and because foreign banks and KFB played leading roles in serial failures, Korea's financial crisis in 1997 provides clear empirical evidence of the applicability of the proposed model of the contagion-triggering mechanism: the process by which co-creditors learn about one another's type. That is, by learning about other creditors' types from debt rollover coordination for one firm, they determine their own action for another firm.[42] Note that Korea's financial crisis is different from simple herding cases

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41 Hanbo Steel Group was the fourteenth largest conglomerate in Korea, and its fundamentals were not poor.

42 In the proposed model of two firms, for simplicity, types of creditors are assumed to remain the same in the course of two debt rollover games among creditors. Of course, for a general sequential case involving more than two firms (e.g., Korea's financial crisis in 1997), we need to consider the dynamic effects of changes in creditors' wealth from previous rollover games on changes in the type of creditor. In other words, there is a need for extending the present

that rely solely on sequential choices of players. The crisis demonstrates newly repeated and static debt rollover coordination games among co-creditors for new firms through the process by which they learn about other creditors' types from debt rollover games for previous firms. Moreover, in the static coordination game setting for each firm, unlike in the simple herding model, there exist payoff (strategic) complementarities among co-creditors in the proposed model.

VI. Concluding Remarks

By focusing on liquidity crises facing nonfinancial institutions, this paper explores financial contagion, a phenomenon in which, even though the states of the fundamentals of two firms are not closely related, what happens to one firm influences the optimal behavior of creditors and thus what happens to the other firm. The mechanism of contagion between two nonfinancial firms is based on the process by which co-creditors learn about other creditors' types, which has received little research attention. Examining creditors' learning process is important because in a rollover coordination game, creditors' beliefs about other creditors' types can influence the probability of a firm having a liquidity crisis, i.e., creditors' learning process can be useful for explaining their strategic behavior in coordination games. Learning and revising beliefs about other creditors' types after observing what happens to one firm, creditors determine their own action for another firm, which influences the probability of a liquidity crisis facing the latter. The results for a real-world example (i.e., Korea's financial crisis in 1997) provide support for the proposed model.

The analysis of the contagion process involving creditors' learning indicates a noteworthy and new feature of financial contagion: Under the assumption that

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study to include a more dynamic process by which co-creditors learn about the types of other creditors through changes in their wealth.

there exists the exact realization of the fundamentals of one firm and that the results of other creditors' actions for that firm are known to creditors before they determine their action for another firm, the contagion effect of a liquidity crisis facing a firm with a lower failure point is more likely to be severe than that for a firm with a higher failure point. Moreover, although an increase in the accuracy of creditors' information on a firm's fundamentals can reduce the probability of that firm having a liquidity crisis, it can also increase the severity of contagion. As mentioned earlier, policy measures such as providing bailouts for firms facing transitory liquidity problems and requiring appropriate financial disclosure can help mitigate the severity of contagion. In addition, firms can reduce the severity of contagion by setting a low value for their collateral.

Appendix

Proof of Proposition 1

First, we consider group 1 creditors' decisions. They privately know their own type (pessimistic or optimistic) and also know the type of group 2 creditor (pessimistic). Hence, they know the value of $\bar{\theta}_A$:θ^*_{AP} or θ^*_{AO}. Note that $\varepsilon_{Aj} := x_{Aj} - \theta_A$ is uniformly distributed over the interval $[-\varepsilon, \varepsilon]$. Thus, Equation (1) becomes

$$\begin{aligned} K &= \Pr[\text{rollover is successful} \mid \bar{x}_{A1},\ \bar{\theta}_A] \cdot \delta_m \\ &= \Pr[\theta_A \geq \bar{\theta}_A \mid \bar{x}_{A1},\ \bar{\theta}_A] \cdot \delta_m \\ &= \Pr[\bar{x}_{A1} - \varepsilon_{A1} \geq \bar{\theta}_A \mid \bar{x}_{A1},\ \bar{\theta}_A] \cdot \delta_m \\ &= \Pr[\varepsilon_{A1} \leq \bar{x}_{A1} - \bar{\theta}_A \mid \bar{x}_{A1},\ \bar{\theta}_A] \cdot \delta_m \\ &= \frac{\bar{x}_{A1} - \bar{\theta}_A + \varepsilon}{2\varepsilon} \delta_m. \end{aligned} \tag{A1}$$

From (A1), we get the following two equations:

$$K = \frac{x^*_{A1P} - \theta^*_{AP} + \varepsilon}{2\varepsilon} \delta_P, \tag{A2}$$

$$K = \frac{x^*_{A1O} - \theta^*_{AO} + \varepsilon}{2\varepsilon} \delta_O. \tag{A3}$$

Next, we consider group 2 creditors' decisions. They know their own type (pessimistic) but do not know the type of group 1 creditor. They can simply conjecture the probability that group 1 creditors are pessimistic as q. Further, they do not know the value of $\bar{\theta}_A$: θ^*_{AP} or θ^*_{AO}. Thus, Equation (1) becomes

$$
\begin{aligned}
K &= \Pr[\text{rollover is successful} \mid x^*_{A2}] \cdot \delta_P \\
&= \left\{ \Pr\left[\begin{array}{l} \text{rollover is successful} \\ \text{When 1's are pessimistic} \end{array} \middle| \, x^*_{A2} \right] + \Pr\left[\begin{array}{l} \text{rollover is successful} \\ \text{When 1's are optimistic} \end{array} \middle| \, x^*_{A2} \right] \right\} \cdot \delta_P \\
&= q \times \Pr[\theta_A \geq \theta^*_{AP} \mid x^*_{A2}] \cdot \delta_P + (1-q) \times \Pr[\theta_A \geq \theta^*_{AO} \mid x^*_{A2}] \cdot \delta_P \\
&= q \times \frac{x^*_{A2} - \theta^*_{AP} + \varepsilon}{2\varepsilon} \delta_P + (1-q) \times \frac{x^*_{A2} - \theta^*_{AO} + \varepsilon}{2\varepsilon} \delta_P . \qquad \text{(A4)}
\end{aligned}
$$

Finally, we consider the critical threshold value of firm A's fundamentals (i.e., switching fundamentals). The proportion of creditors who do not roll over loans is expressed as follows:

$$
\begin{aligned}
l_A(\theta_A) &= \lambda \Pr[x_{A1} \leq \bar{x}_{A1} \mid \theta_A] + (1-\lambda) \Pr[x_{A2} \leq x^*_{A2} \mid \theta_A] \\
&= \lambda \Pr[\theta_A + \varepsilon_{A1} \leq \bar{x}_{A1} \mid \theta_A] + (1-\lambda) \Pr[\theta_A + \varepsilon_{A2} \leq x^*_{A2} \mid \theta_A] \\
&= \lambda \Pr[\varepsilon_{A1} \leq \bar{x}_{A1} - \theta_A \mid \theta_A] + (1-\lambda) \Pr[\varepsilon_{A2} \leq x^*_{A2} - \theta_A \mid \theta_A] \\
&= \lambda \frac{\bar{x}_{A1} - \theta_A + \varepsilon}{2\varepsilon} + (1-\lambda) \frac{x^*_{A2} - \theta_A + \varepsilon}{2\varepsilon}.
\end{aligned}
$$

The critical threshold value is determined by

$$
\theta_A = l_A(\bar{\theta}_A) = \lambda \frac{\bar{x}_{A1} - \bar{\theta}_A + \varepsilon}{2\varepsilon} + (1-\lambda) \frac{x^*_{A2} - \bar{\theta}_A + \varepsilon}{2\varepsilon}. \qquad \text{(A5)}
$$

From Equation (A5), we obtain the following two equations:

$$
\theta^*_{AP} = \lambda \frac{x^*_{A1P} - \theta^*_{AP} + \varepsilon}{2\varepsilon} + (1-\lambda) \frac{x^*_{A2} - \theta^*_{AP} + \varepsilon}{2\varepsilon}, \qquad \text{(A6)}
$$

$$
\theta^*_{AO} = \lambda \frac{x^*_{A1O} - \theta^*_{AO} + \varepsilon}{2\varepsilon} + (1-\lambda) \frac{x^*_{A2} - \theta^*_{AO} + \varepsilon}{2\varepsilon}. \qquad \text{(A7)}
$$

Solving Equations (A2), (A3), (A4), (A6), and (A7), we obtain x^*_{A1P}, x^*_{A1O}, x^*_{A2}, θ^*_{AP} and θ^*_{AO}. The unique equilibrium values of the switching fundamentals of firm (θ^*_{AP} and θ^*_{AO}) and creditors' switching private signals (x^*_{A1P}, x^*_{A1O}, and x^*_{A2}) are as follows:

$$\theta^*_{AP} = \frac{K}{\delta_P}(1-\Sigma_1),$$
$$\theta^*_{AO} = \frac{K}{\delta_P}(1-\Sigma_1-\Sigma_2),$$
$$x^*_{A1P} = \frac{K}{\delta_P}(1-\Sigma_1+\Sigma_3),$$
$$x^*_{A1O} = \frac{K}{\delta_P}\left(1-\Sigma_1-\Sigma_2+\frac{\delta_P}{\delta_0}\Sigma_3\right),$$
$$x^*_{A2} = \frac{K}{\delta_P}(1-\Sigma_1-(1-q)\Sigma_2+\Sigma_3),$$

where

$$\Sigma_1 = \frac{\lambda(1-\lambda)(1-q)(\delta_O-\delta_P)}{\delta_O(1+2\varepsilon-\lambda)},\ \Sigma_2 = \frac{2\lambda\varepsilon(\delta_O-\delta_P)}{\delta_O(1+2\varepsilon-\lambda)},\ \text{and}\ \Sigma_3 = \left(\frac{2K-\delta_P}{K}\right)\varepsilon.$$

We now need to show that creditors in each group strictly prefer not to roll over loans (prefer to roll over loans) if their private signal is below (exceeds) the switching private signal conditional on θ^*_{AP} and θ^*_{AO}. Suppose that all the creditors follow the switching strategy. Then creditors in each group take θ^*_{AP} and θ^*_{AO} as given. From Equations (A2), (A3), and (A4), the present value of the expected payoff of rolling over loans is strictly increasing in switching private signals (x^*_{A1P}, x^*_{A1O} and x^*_{A2}), given θ^*_{AP} and θ^*_{AO}. Therefore, for any private signal exceeding the switching signal, the expected payoff of rolling over loans is strictly greater than that of not rolling over. Thus, it is optimal for creditors to follow the switching strategy, given that all other creditors follow the switching strategy.

Derivation θ^*_{BP} and x^*_B

The proportion of creditors who do not roll over loans conditional on θ_B is expressed as follows:

$$
\begin{aligned}
l_B(\theta_B) &= \Pr[x_B \le x_B^* \mid \theta_B] \\
&= \Pr[\theta_B + \varepsilon_B \le x_B^* \mid \theta_B] \\
&= \Pr[\varepsilon_B \le x_B^* - \theta_B \mid \theta_B] \\
&= \frac{x_B^* - \theta_B + \varepsilon}{2\varepsilon}.
\end{aligned}
$$

The critical threshold value of firm B's fundamentals (i.e., switching fundamentals) is determined by

$$
\theta_{BP}^* = l_B(\theta_{BP}^*) = \frac{x_B^* - \theta_{BP}^* + \varepsilon}{2\varepsilon}. \tag{A8}
$$

Because the present value of the expected utility of rolling over loans for creditors should be equal to the payoff from recalling them in the indifference condition, we get

$$
\begin{aligned}
K &= \Pr[\text{rollover is successful} \mid x_B^*] \cdot \delta_P \\
&= \Pr[\theta_B \ge \theta_{BP}^* \mid x_B^*] \cdot \delta_P \\
&= \Pr[x_B^* - \varepsilon_B \ge \theta_{BP}^* \mid x_B^*] \cdot \delta_P \\
&= \Pr[\varepsilon_B \le x_B^* - \theta_{BP}^* \mid x_B^*] \cdot \delta_P \\
&= \frac{x_B^* - \theta_{BP}^* + \varepsilon}{2\varepsilon}\delta_P.
\end{aligned} \tag{A9}
$$

From Equations (A8) and (A9), we obtain the following equilibrium:

$$
\begin{aligned}
\theta_{BP}^* &= \frac{K}{\delta_P}, \\
x_B^* &= \frac{K}{\delta_P}(2\varepsilon + 1) - \varepsilon.
\end{aligned}
$$

Derivation θ_{BO}^*, x_{B1}^* and x_{B2}^*

The proportion of creditors who do not roll over loans conditional on θ_B is expressed as follows:

$$
\begin{aligned}
l_B(\theta_B) &= \lambda \Pr[x_{B1} \le x_{B1}^* \mid \theta_B] + (1-\lambda)\Pr[x_{B2} \le x_{B2}^* \mid \theta_B] \\
&= \lambda \Pr[\theta_B + \varepsilon_{B1} \le x_{B1}^* \mid \theta_B] + (1-\lambda)\Pr[\theta_{B2} + \varepsilon_{B2} \le x_{B2}^* \mid \theta_B] \\
&= \lambda \Pr[\varepsilon_{B1} \le x_{B1}^* - \theta_B \mid \theta_B] + (1-\lambda)\Pr[\varepsilon_{B2} \le x_{B2}^* - \theta_B \mid \theta_B] \\
&= \lambda \frac{x_{B1}^* - \theta_B + \varepsilon}{2\varepsilon} + (1-\lambda)\frac{x_{B2}^* - \theta_B + \varepsilon}{2\varepsilon}.
\end{aligned}
$$

The critical threshold value of firm B's fundamentals (i.e., switching fundamentals) is determined by

$$
\theta_{BO}^* = l_B(\theta_{BO}^*) = \lambda \frac{x_{B1}^* - \theta_{BO}^* + \varepsilon}{2\varepsilon} + (1-\lambda)\frac{x_{B2}^* - \theta_{BO}^* + \varepsilon}{2\varepsilon}. \tag{A10}
$$

Because the present value of the expected utility of rolling over loans for creditors should be equal to the payoff from recalling them in the indifference condition, we get the following equations for optimistic group 1 creditors and pessimistic group 2 creditors:

$$
\begin{aligned}
K &= \Pr[\text{rollover is successful} \mid x_{B1}^*] \cdot \delta_O \\
&= \Pr[\theta_B \ge \theta_{BO}^* \mid x_{B1}^*] \cdot \delta_O \\
&= \Pr[x_{B1}^* - \varepsilon_{B1} \ge \theta_{BO}^* \mid x_{B1}^*] \cdot \delta_O \\
&= \Pr[\varepsilon_{B1} \le x_{B1}^* - \theta_{BO}^* \mid x_{B1}^*] \cdot \delta_O \\
&= \frac{x_{B1}^* - \theta_{BO}^* + \varepsilon}{2\varepsilon}\delta_O.
\end{aligned} \tag{A11}
$$

and

$$
\begin{aligned}
K &= \Pr[\text{rollover is successful} \mid x_{B2}^*] \cdot \delta_P \\
&= \Pr[\theta_B \ge \theta_{BO}^* \mid x_{B2}^*] \cdot \delta_P \\
&= \Pr[x_{B2}^* - \varepsilon_{B2} \ge \theta_{BO}^* \mid x_{B2}^*] \cdot \delta_P \\
&= \Pr[\varepsilon_{B2} \le x_{B2}^* - \theta_{BO}^* \mid x_{B2}^*] \cdot \delta_P \\
&= \frac{x_{B2}^* - \theta_{BO}^* + \varepsilon}{2\varepsilon}\delta_P.
\end{aligned} \tag{A12}
$$

From Equations (A10), (A11), and (A12), we obtain the following equilibrium:

$$
\begin{aligned}
\theta^{*}_{BO} &= \frac{\lambda K}{\delta_O} + \frac{(1-\lambda)K}{\delta_P}, \\
x^{*}_{B1} &= \frac{K(\lambda+2\varepsilon)}{\delta_O} + \frac{(1-\lambda)K}{\delta_P} - \varepsilon, \\
x^{*}_{B2} &= \frac{\lambda K}{\delta_O} + \frac{K(1-\lambda+2\varepsilon)}{\delta_P} - \varepsilon.
\end{aligned}
$$

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<Abstract in Korean>

오동철*

본 논문에서는 채권투자자가 다른 채권투자자의 위험회피성향을 파악해가는 과정에서 한 기업의 유동성 위기가 사업상 직접적인 관련이 없는 다른 기업으로 전이되는 현상을 이론적으로 분석하였다.

이론 모형에서는 각 기업의 실상에 대한 불완전한 정보를 가진 두 유형의 채권투자자가 사업상 직접적인 관련이 없는 두 기업에 자금을 공여하는 상황을 상정하였다. 구체적으로 두 유형의 채권투자자는 각 기업에 대하여 공동채권자로서 협조게임에 직면하는 것으로 가정하였다. 이러한 협조게임을 통하여 채권투자자는 한 기업의 유동성 위기로부터 다른 채권투자자의 위험회피성향을 파악하게 되고, 이를 토대로 다른 기업에 자금을 지속적으로 공여할지 혹은 중도에 회수할지 여부를 결정하는 것으로 전제하였다. 이러한 상황에서 한 기업의 유동성 위기로부터 다른 채권투자자가 높은 위험회피성향을 가지고 있음을 확인한 채권투자자는 다른 기업에서 보다 적극적으로 공여자금을 회수하려는 성향을 보인다. 채권투자자의 이러한 태도는 결국 다른 기업이 유동성 위기를 겪을 가능성을 높이게 된다.

모형을 분석한 결과 본 논문은 유동성 위기가 발생할 가능성이 낮은 기업에서 위기가 발생할 경우 다른 기업으로 유동성 위기가 전이될 가능성이 높아진다는 것을 보였다. 아울러 정부가 실상은 양호함에도 일시적인 유동성 위기를 경험하는 기업에 대하여 유동성을 제공할 경우 유동성 위기가 다른 기업으로 전이되는 가능성을 낮출 수 있는 것으로 분석되었다.

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* 금융경제연구 제1~200호의 발간목록은 제320호 이전 책자를, 제201~300호의 발간목록은 제421호 이전 책자를 참고하십시오.