The Role of Public Information in a Contagious Currency Crisis

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This paper examines the effects of communication by the central bank on the likelihood of the contagion of a currency crisis between two countries. The quality of a central bank's communication strategy can influence speculators' strategies, which is a mechanism by which the contagion of a currency crisis from another country evolves either negatively or positively (i.e., increases or reduces the probability of the country experiencing a currency crisis). The result of the analysis of the threshold for a currency crisis for each country indicate that an increase in communication (i.e., providing more public information) by the central bank can facilitate positive contagion effects while reducing negative effects. Further, public information provides a "focal point" for speculators and makes policy tools more effective in promoting positive contagion effects. However, the effectiveness of accurate public information depends critically on the ex ante expected state of the economic fundamentals of the country.

Key words: Contagion; Currency Crisis; Global Game; Learning; Central Bank; Public Information; Coordination

JEL Classification: F31, G15, D82, D83

I. Introduction

Welfare effects of public information represent critical criteria for designing public policies in many economies. Morris and Shin [2002, 2005] analyze a class of economies characterized by strategic complementarities of agents' agents' actions in an asymmetric information environment. Agents have private information on the fundamentals of the economy and can obtain public information provided by social agents such as the central bank. Morris and Shin show that transparency in communication (e.g., the disclosure of information obtained by the central bank to private agents) can imply a reduction in social welfare.[1] In a similar context, Metz [2002] analyzes the effects of speculators' private and public information on the probability of a country having a currency crisis. However, these studies do not address the issue of contagion among economies.

In this regard, the present paper examines the effects of public information disseminated by the central bank on the contagion of a currency crisis between two countries. Bases on Oh [2012] and Taketa [2004], the present study focuses on 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 of a currency crisis between two countries. Speculators receive public information from central banks and form judgments about the economic fundamentals of each country based on such information. This study analyzes the effects of the information structure (including the

1 However, Svensson [2006] interprets the findings of Morris and Shin [2002] differently. He argues that more public information is better except in very special circumstances and that transparency has positive welfare effects if public signals are sufficiently precise. Morris, Shin, and Tong [2006] respond by accepting Svensson's comments and urge a more systematic analysis of the issue.

accuracy of public information disseminated by the central bank) on the contagion of a currency crisis between two countries.

This paper extends the second-generation model of a country's currency crisis in Obstfeld [1996] - that is, the "self-fulfilling crisis," a crisis that occurs just because speculators believe that it is going to occur - to two countries. The self-fulfilling nature of crises is important in that a country's currency crisis is often viewed as a result of a coordination problem among speculators. However, considering the nature of crises as self-fulfilling tends to produce multiple equilibrium outcomes, and thus, it is difficult to demonstrate the contagion effect. Therefore, to obtain a unique equilibrium (the threshold for a currency crisis), this paper employs the global game method introduced by Carlsson and van Damme [1993].[2] This method allows for unique equilibrium outcomes for each country and thus can capture the contagion effect in which an outcome (i.e., the existence of a currency crisis) for one country influences the likelihood of a crisis facing another.

The mechanism facilitating the contagion of a currency crisis between two countries is speculators' behavior concerning other speculators' types. There are two types of speculators: "bullish" and "chicken" speculators. In this paper, we assume that chicken speculators spend more money to attack a currency than bullish ones.[3] Because the payoff of each speculator's action (i.e., whether to attack the currency peg) depends on other speculators' actions based on their types, the optimal action of each speculator depends on his of her beliefs about other speculators' types. If what happens to one country reveals the type of speculator, then it can induce each speculator to update his or her beliefs

2 Dasgupta [2004] and Goldstein and Pauzner [2004] analyze the issue of contagion within a global game framework. However, the contagion mechanisms in their models are different from those in the present study. Dasgupta [2004] relies on the existence of capital linkages between financial institutions, and in Goldstein and Pauzner [2004], contagion arises from wealth effects.

3 That is, chicken speculators are less aggressive during speculative activity than bullish ones.

and thus revise his or her optimal action, which in turn can influence the probability of another country encountering a currency crisis.

This paper extends the concept of financial contagion beyond the traditional concept. Previous studies typically define financial contagion as negative effects of adverse outcomes for one economy on outcomes for another economy (e.g., Dasgupta, 2004; Goldstein & Pauzner, 2004; Morris & Shin, 2011; Oh, 2012; Taketa, 2004). However, as indicated by Manz [2010], there are also positive effects of favorable outcomes for one economy on outcomes for another. That is, favorable outcomes for one economy can rescue another, which is referred to as positive contagion effects. Hence, the present paper defines financial contagion in two ways: "negative contagion," which refers to negative effects of the contagion of a currency crisis from one country to another (i.e., a currency crisis in one country increases the probability of another country having a currency crisis), and "positive contagion," which refers to positive effects of contagion (i.e., no currency crisis in one country reduces the probability of another country encountering a currency crisis).[4]

As in Morris and Shin [2003, 2004], the present paper's proposed model guarantees the uniqueness of each country's equilibrium (i.e., the threshold for a currency crisis) if the accuracy of speculators' private information on each country's economic fundamentals exceeds that of public information on economic fundamentals distributed by the central bank of each country. Under this condition, the results indicate that the more the public signal of economic fundamentals disseminated by the central bank, the weaker the effect of negative contagion and the stronger the effect of positive contagion. Moreover, an increase in the amount of public information distributed by the central bank

4 Specifically, if a currency (no currency crisis) in one country reveals the type of speculator as bullish (chicken), then it increases (reduces) the likelihood of another country suffering a currency crisis.

is not sufficient to prevent negative contagion for the country. In particular, only when the state of economic fundamentals is expected to be sound ex ante can distributing accurate public information facilitate positive contagion and reduce negative contagion with respect to a currency crisis from another country.

The results of the numerical simulation of policy interventions (e.g., levies on FX liabilities of the banking sector) with respect to contagion effects show that the effect on positive contagion far exceeds that on negative contagion, which highlights the positive role of public information distributed by the central bank of each country as a "focal point" (i.e., a coordinating mechanism) for speculators. If coordination among speculators leads to a favorable outcome (i.e., no currency crisis through the prevention of attacks against the currency peg) for one country, then it can induce speculators to coordinate for a good equilibrium outcome for another country. In general, policies facilitating favorable equilibrium outcomes for one economy (based on the "focal point" role of pubic information) can trigger better outcomes for another economy.

The rest of this paper is organized as follows: Section 2 presents the model, and Section 3 solves for each country's equilibrium in sequence and demonstrates how the latter country's equilibrium is influenced by speculators' learning about one another's type from the former country's speculation process. Section 4 first defines the concepts of negative contagion and positive contagion, and then demonstrates the role of public information distributed by the central bank in the contagion of a currency crisis. In addition, numerical analyses with various model parameters are presented. Section 5 concludes, and the Appendix provides the proofs.

II. The Model

The model considers two countries: country A and country B. The central bank of each country pegs the currency at some level. Each country's economy is characterized by the state of the country's underlying economic fundamentals, $\theta_i\,(i = A,B)$. A high θ_i value indicates strong fundamentals, whereas a low value, weak fundamentals. We assume that θ_i is randomly drawn from the real line, with each realization equally likely. In addition, there is no linkage of economic fundamentals between country A and country B, that is, θ_A and θ_B are independent of each other.

There are two groups of speculators in the foreign exchange market: group 1 and group 2. Both groups consist of a continuum of small speculators, and hence, each individual speculator accounts for a negligible portion of total speculative activity. We index the set of speculators by the unit interval [0,1]. There exists some uncertainty about their attitudes toward foreign exchange risk.[5] Thus, group 1's type is privately known to group 1 speculators. There are two possible types of group 1 speculators in terms of their aggressiveness: "bullish" speculators with probability q and "chicken" ones with probability $1-q$. That is, all group 1speculators are bullish (chicken) with probability $q\,(1-q)$. For simplicity, all group 2 speculators are bullish, and this is common knowledge to all speculators. The size of group 1 is λ, whereas that of group 2 is $1-\lambda$, where $0 < \lambda < 1$.

Each speculator disposes of one unit of the currency and can decide

5 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.

whether to short this unit (i.e., attack the currency peg). If the attack is successful, he or she gets a fixed payoff D (> 0). However, taking a speculative position in the market can cost t for bullish speculators and $t+\delta$ for chicken ones, where $\delta > 0$.[6] That is, we assume that speculators who spend more to attack a currency are chicken ones. Further, we assume that a successful attack is profitable for any speculator, that is, $D-t-\delta > 0$.

Let the proportion of speculators attacking a currency peg be denoted by $l_i\,(i=A,B)$. If θ_i is sufficiently high, then the central bank is always able to defend the peg regardless of the number of such speculators. Nevertheless, if θ_i is sufficiently low, then the central bank abandons the peg and devalues the currency even if no speculator sells the currency. That is,

- if $l_i \leq \theta_{i,}$ then the central bank maintains the peg, that is, the attack is unsuccessful (there is no currency crisis);

- if $l_i > \theta_{i,}$ then the central bank devalues the peg, that is, the attack is successful (there is a currency crisis).

If the fundamental index θ_i is common knowledge to speculators, then we have the typical tripartition of fundamentals in a complete information game, as in the original model of multiple equilibrium outcomes by Obstfeld [1996]:[7]

- For $\theta_i > 1$, the currency peg is stable because the economy is sound enough such that the central bank is always able to defend the peg.

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6 This cost can be viewed as including the borrowing cost of domestic currency and the transaction cost.

7 For an explanation of this case of multiple equilibrium outcomes, see Metz [2002].

- For $\theta_i \leq 0,$ the central bank always abandons the peg regardless of the speculators' actions, and the currency peg is unstable.

- For $0 < \theta_i \leq 1,$ the currency peg is said to be an attack. In this interval, if all speculators attack, then the central bank is forced to devalue the currency, whereas the peg is maintained if speculators do not attack. However, because agents attack the currency only if they are certain of their success, their actions prove the initial beliefs such that their expectations are self-fulfilling for this range of fundamentals.

Based on Metz [2002] and Morris and Shin [1998, 2004], we structure the game between speculators and the central bank as follows to avoid multiple equilibrium outcomes: Nature chooses the type of group 1 speculator. Then the value of the fundamental index θ_i is drawn from the real line. The value of θ_i can be observed by the central bank but not by speculators. That is, θ_i is not common knowledge to speculators. After observing θ_i, the central bank disseminates a public signal $y_i = \theta_i + \upsilon_i,$ where $\upsilon_i \sim N(0,1/\alpha_i), \alpha_i > 0,$ and $E[\upsilon_i \theta_i] = 0,$ such that the noise parameter is independent of the truly chosen fundamental state. This signal is public because it is common knowledge to all market participants. The accuracy α_i of the public signal is exogenous to the model, that is, α_i is chosen before the central bank knows the true value of θ_i and stays constant throughout the course of the game. The distribution of the noise parameter υ_i is also common knowledge.

In addition to the public signal, speculators individually receive informative private signals of $\theta_{i.}$ Each group $j\,(j = 1,2)$ speculator gets the private signal $x_{ij} = \theta_i + \varepsilon_{ij},$ where $\varepsilon_{ij} \sim N(0,1/\beta)$ and $\beta > 0.$[8] The noise parameters of private signals are assumed to independent of each other, the fundamental state, and the noise parameter of the public signal, is, $E[\varepsilon_{ij}\varepsilon_{ik}] = 0$ for $j \neq k, E[\varepsilon_{ij}\theta_i] = 0,$ and $E[\varepsilon_{ij}v_i] = 0$. Further, the distributional properties of the noise parameter of private signals are presumed to be common knowledge to all speculators. However, as long as the accuracy β of private signals is finite, private signals may vary, and thus, speculators cannot accurately establish their opponents' signals. Note that because of the assumption of normally distributed noise parameters, of θ_i conditional on private and public information is also normal, and thus, the expected value of the unknown fundamental value of the economy conditional on private and public information is given by $E\left[\theta_i | x_{ij,} yi\right] = \frac{1}{\alpha_i + \beta}\left(\alpha_i y_i + \beta x_{ij}\right)$with variance $Var\left[\theta_i | x_{ij,} y_i\right] = \frac{1}{\alpha_i + \beta}$.

A speculator's *strategy* is a decision rule that maps each realization of x_{ij} to an action: to attack or not attack the currency peg. An *equilibrium* consists of the following values conditional on the type of group 1 speculator and the information structure: a unique value of switching economic fundamentals $\overline{\theta}_i$ up to which the central bank always abandons the peg and that of the switching private signal $\overline{x}_{ij}$ attacks the peg. That is, the equilibrium values $\overline{\theta}_i\,(i = A, B)$ and $\overline{x}_{ij}\,(j = 1, 2)$ belong to two cases of indifference: For $\theta = \overline{\theta}_{i,}$the central bank shows indifference to the choice between defending the currency peg and abandoning it, whereas a speculator with $\overline{x}_{ij}$ shows indifference to the choice between attacking and not attacking the peg.[9]

8 The superscript m, meaning the individual speculator m, is omitted from the private signal x_{ij}^m here, because we consider the symmetric switching strategy equilibrium where every speculator of the same type and group uses the same switching value $\overline{x}_{ij}$.

9 As shown in Carlsson and van Damme [1993], Corsetti, Dasgupta, Morris, and Shin [2004], and Morris and Shin [1998, 2003, 2004], this switching strategy is the only equilibrium strategy for the above setting.

The model is sequential. That is, the speculation game described above between speculators and each country's central bank first takes place for country A and then for country B. Before the speculation game for country A, nature determines what the speculators are like (i.e., the type of speculator),[10] and the states of each country's fundamentals $(\theta_A \text{ and } \theta_B)$ are realized. Then the speculation game for each country follows in sequence. The exact realization of the fundamentals of country A and the result of speculators' actions (i.e., whether country A has a currency crisis) are known to all speculators before they choose their action for country B.[11] Figure 1 depicts the order of events.

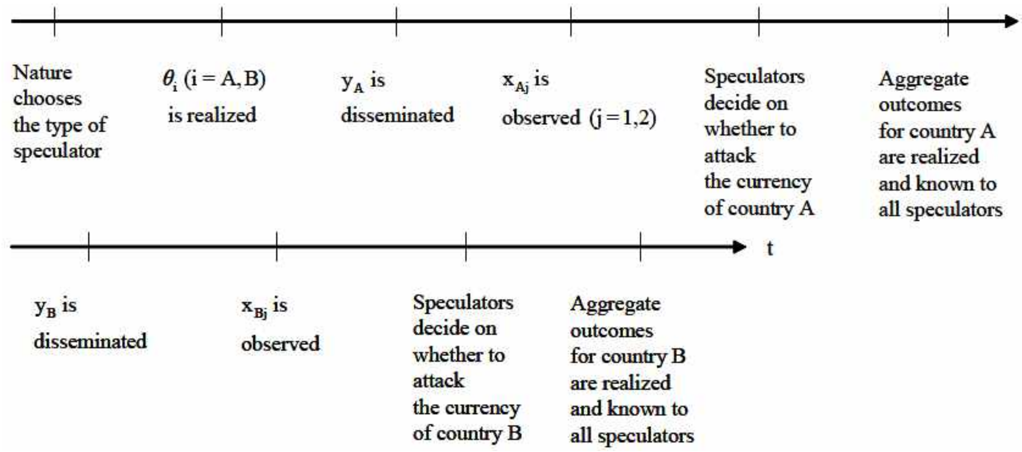

Figure 1: Timeline

10 Specifically, nature chooses the type of group 1 speculator. As explained earlier, for simplicity, group 2 speculators are always bullish, and this is common knowledge to all speculators.

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

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

III. Solving the Model

1. Equilibrium for Country A

Country A's equilibrium, that is, $\bar{\theta}_A$ and $\bar{x}_{Aj}$ (j = 1,2), can be expressed as follows:

$$\bar{\theta}_A = \begin{cases} \theta^*_{AB} & \text{if group 1 speculators are bullish;} \\ \theta^*_{AC} & \text{if group 1 speculators are chicken;} \end{cases}$$
$$\bar{x}_{A1} = \begin{cases} x^*_{A1B} & \text{if group 1 speculators are bullish;} \\ x^*_{A1C} & \text{if group 1 speculators are chicken;} \end{cases}$$
$$\bar{x}_{A2} = x^*_{A2}.$$

After receiving private and public signals, each speculator has to decide whether to attack the currency, which leads to an uncertain payoff D and costs

t for bullish speculators and $t+\delta$ for chicken ones. If the speculator does not sell the currency, then the net profit is zero with certainty. Speculators' indifference to the choice between is achieved if both lead to the same expected net payoff:

$$0 = D \cdot \Pr\ [\text{Attack is successful} \mid \overline{x}_{Aj}] - t; \qquad \text{(bullish type)}$$

$$0 = D \cdot \Pr\ [\text{Attack is successful} \mid \overline{x}_{Aj}] - t - \delta. \qquad \text{(chicken type)}$$

Note that the critical threshold value of country A's fundamentals (i.e., switching fundamentals) is determined when the proportion of speculators who attack the currency peg (l_A) is equal to $\theta_{A.}$ Using the indifference conditions for each type of speculator and condition of the critical threshold value of country A's fundamentals, we obtain unique equilibrium values: switching fundamentals of country A (θ^*_{AB} and θ^*_{AC}) and switching private signals ($x^*_{A1B,}$ $x^*_{A1C,}$ and x^*_{A2}).

Theorem 1 *Provided that* $\beta > \frac{\alpha_A^2}{2\pi}$, *there exists a unique equilibrium for country* A *that consists of country* A'*s switching economic fundamentals* $(\overline{\theta}_A)$ *and speculators' switching private signals* $(\overline{x}_{Aj},\ j = 1,2)$.

Note that the condition for a unique equilibrium for country A is $\beta > \frac{\alpha_A^2}{2\pi}$. The intuition follows Morris and Shin [2003, 2004]. Because α_A is the accuracy of the ex ante distribution of $\theta_{A,}$ the equilibrium depicted above is unique as long as the accuracy of the private signal (β) exceeds the underlying uncertainty. Based on this uniqueness condition $(\beta > \frac{\alpha_A^2}{2\pi})$, we can verify that $\theta^*_{AB} > \theta^*_{AC}$ and $\theta^*_{A1B} > x^*_{A2} > x^*_{A1C}$ hold. The intuition behind the inequalities is as follows: x^*_{A1B} is greater than x^*_{A1C} because bullish speculators are more likely to attack the peg than chicken ones. By the same logic, θ^{*}_{AB} is greater than θ^{*}_{AC} because country A is mote likely to suffer a currency crisis if group 1 speculators are bullish.

2. Equilibrium for Country B

Every speculator observes what occurs for country A, including the exact value of $\theta_{A.}$ This conveys information on the type of group 1speculator to the market because different types of speculators use different switching signals, resulting in different outcomes for country A under certain conditions.

There are two possible scenarios: First, if $\theta_A \not\in [\theta^{*}_{AC,} \theta^{*}_{AB}]$, then the type of group 1 speculator remains hidden because if $\theta_A \leq \theta^{*}_{AC}$, then country A has a currency crisis with certainty regardless of the type of group 1 speculator. On the other hand, if $\theta_A \geq \theta^{*}_{AB}$, then county A never has currency crisis regardless of the type of group 1 speculator. Hence, of $\theta_A \not\in [\theta^{*}_{AC}, \theta^{*}_{AB}]$, then group 2 speculators do not get to know the type of group 1 speculator and face the same game played for country A to determine whether to attack country $B's$ peg.

Second, if $\theta_A \in [\theta^{*}_{AC}, \theta^{*}_{AB}]$, then the type of group 1 speculator is revealed to the market. Conditional on such $\theta_{A,}$ country A has a currency crisis if and only if group 1 speculators are bullish. Meanwhile, conditional on such $\theta_{A,}$ country A does not have a currency crisis if and only if group 1 speculators are chicken. Hence, if $\theta_A \in [\theta^{*}_{AC}, \theta^{*}_{AB}]$, then a new game is played by speculators to determine whether to attack country B's peg.

We now discuss the following two scenarios: $\theta_A \not\in [\theta^{*}_{AC}, \theta^{*}_{AB}]$ and

$\theta_A \in [\theta^*_{AC}, \theta^*_{AB}]$. In each scenario, that is, conditional on the realized underlying state of the fundamentals of country A (θ_A) and the existence of a currency crisis in country A, we derive a unique equilibrium for country B (i.e., $\overline{\theta}_B$ and $\overline{x}_{Bj}$, $j = 1,2$).

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

In this scenario, the type of group 1 speculator is not revealed. Hence, the equilibrium values of the switching fundamentals and private signals for country B are exactly the same as those for country A. This is the benchmark case of country B, and in particular, the benchmark switching fundamentals of country B are $(1)\,\theta^*_{AC}$ if group 1 speculators are chicken and $(2)\,\theta^*_{AB}$ if they are bullish.

B. Scenario 2 − 1: Country A's currency crisis when $\theta_A \in [\theta^*_{AC}, \theta^*_{AB}]$

This scenario implies that group 1 speculators are bullish. In this case, speculators in both group 1 and group 2 have the same switching strategy signal (i.e., x^*_B). Hence, the equilibrium consists of (1) *a country's switching fundamentals* (θ^*_{BB}) below which the central bank abandons the peg. (i.e., there is a currency crisis in country B) and (2) *the speculator's switching private signal* (x^*_B) such that every speculator who receives a signal below x^*_B attacks the peg. We obtain the following equilibrium:

$$\theta^*_{BB} = \Phi\left[\frac{\alpha_B}{\sqrt{\beta}}\left(\theta^*_{BB} - y_B - \frac{\sqrt{\alpha_B + \beta}}{\alpha_B}\,\Phi^{-1}\left(\frac{t}{D}\right)\right)\right],$$

$$x^*_B = \frac{\alpha_B + \beta}{\beta}\,\theta^*_{BB} - \frac{\alpha_B}{\beta} y_B - \frac{\sqrt{\alpha_B + \beta}}{\beta}\,\Phi^{-1}\left(\frac{t}{D}\right).$$

Here we can easily check that θ^*_{BB} is unique if $\beta > \frac{\alpha_B^2}{2\pi}$. In addition, if θ^*_{BB} is unique, then x^*_B is unique.

C. Scenario 2 − 2: No currency crisis facing country A when $\theta_A \in [\theta^*_{AC}, \theta^*_{AB}]$

This scenario implies that group 1 speculators are chicken. In this case, speculators 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 country's switching fundamentals* (θ^*_{BC}) below which the central bank abandons the peg (i.e., country B suffers a currency crisis) and (2) *the speculator's switching private signals* (x^*_{B1} for group 1 and x^*_{B2} for group 2) such that every group 1 speculator who receives a signal below x^*_{B1} attacks the peg and every group 2 speculator who receives a signal below x^*_{B2} attacks the peg. We get the following equilibrium:

$$\begin{aligned}
\theta^*_{BC} &= \lambda \Phi\left[\frac{\alpha_B}{\sqrt{\beta}}\left(\theta^*_{BC} - y_B - \frac{\sqrt{\alpha_B+\beta}}{\alpha_B}\Phi^{-1}\left(\frac{t+\delta}{D}\right)\right)\right] \\
&\quad + (1-\lambda)\Phi\left[\frac{\alpha_B}{\sqrt{\beta}}\left(\theta^*_{BC} - y_B - \frac{\sqrt{\alpha_B+\beta}}{\alpha_B}\Phi^{-1}\left(\frac{t}{D}\right)\right)\right], \\
x^*_{B1} &= \frac{\alpha_B+\beta}{\beta}\theta^*_{BC} - \frac{\alpha_B}{\beta}y_B - \frac{\sqrt{\alpha_B+\beta}}{\beta}\Phi^{-1}\left(\frac{t+\delta}{D}\right), \\
x^*_{B2} &= \frac{\alpha_B+\beta}{\beta}\theta^*_{BC} - \frac{\alpha_B}{\beta}y_B - \frac{\sqrt{\alpha_B+\beta}}{\beta}\Phi^{-1}\left(\frac{t}{D}\right).
\end{aligned}$$

As in $\theta^*_{BB,}$ we can easily check that θ^*_{BC} is unique if $\beta > \frac{\alpha_B^2}{2\pi}$. In addition, if θ^*_{BC} is unique, then x^*_{B1} and x^*_{B2} are unique.

Based on this condition for a unique equilibrium for country B (i.e., $\beta > \frac{\alpha_B^2}{2\pi}$), we can verify that $\theta^*_{BB} > \theta^*_{BC}$ and $x^*_B > x^*_{B2} > x^*_{B1}$ hold. The intuition behind the inequalities is as follows: x_B^* is greater than x_{B1}^* and x_{B2}^* because when all speculators are bullish, they are more likely to attack the peg than when there exist chicken-type speculators. By the same logic, θ_{BB}^* is greater than θ_{BC}^* because country B is more likely to suffer a currency crisis if group 1 speculators are bullish.

IV. Contagion

1. What Is Contagion?

In this paper, we define the contagion of a currency crisis between two countries as the spread of what happens to country A to country B because of speculators' learning process. That is, the probability of a currency crisis in country B is influenced by speculators' revised beliefs about other speculators' type based on what happens to country A. Hence, only when θ_A is between θ_{AC}^* and θ_{AB}^* and when θ_B is between θ_{BC}^* and θ_{BB}^* can we discuss the existence of the contagion of a currency crisis from country A to country B. Here note that if $\theta_A \not\in [\theta_{AC}^*, \theta_{AB}^*]$, then group 2 speculators do not learn anything about the type of group 1 speculator. In addition, if $\theta_B \not\in [\theta_{BC}^*, \theta_{BB}^*]$, then the outcome for country A does not influence what happens to country B as a result of speculative activity.[12]

12 As in Oh [2012], the proposed model assumes that after the speculation game for country A, speculators know the exact level of the fundamentals of country A as well as whether there is a currency crisis in country A. However, if the fundamentals of country A does not become commonly known after the speculation game, then there will be an inference problem, according to which the realization of country A's currency crisis provides speculators with some information not only on other speculators' types but also on the fundamentals of country A. The speculation game for country B then becomes more

Definition 1 *The effect of the contagion of a currency crisis from country A to country B refers to the effect of outcomes for country A when $\theta_A \in [\theta^*_{AC}, \theta^*_{AB}]$ on outcomes for country B when $\theta_B \in [\theta^*_{BC}, \theta^*_{BB}]$ through the learning behavior of speculators.*

As discussed in Section 3, the probability of a currency crisis in country B is reduced when group 1 speculators are revealed as chicken after the speculation game for country A. This can be interpreted as the positive effect of the contagion of a currency crisis from country A to country B. In this sense, as in Manz [2010], we define $\theta^*_{AC} - \theta^*_{BC}$ as the positive contagion (PC) of a currency crisis from country A to country B. On the other hand, if group 1 speculators are revealed as bullish after the speculation game for country A, then the probability of a currency crisis in country B increases by $\theta^*_{BB} - \theta^*_{AB}$. This indicates the negative effect of the contagion of a currency crisis from country A to country B and is thus defined as the negative contagion (NC) of a currency crisis from country A to country B. We can easily check that NC and PC are greater than zero if each country's public signal and the accuracy of that signal are the same as those of another (i.e., homogeneity condition: $y_A = y_B$ and $\alpha_A = \alpha_B$) (see Figure 2).

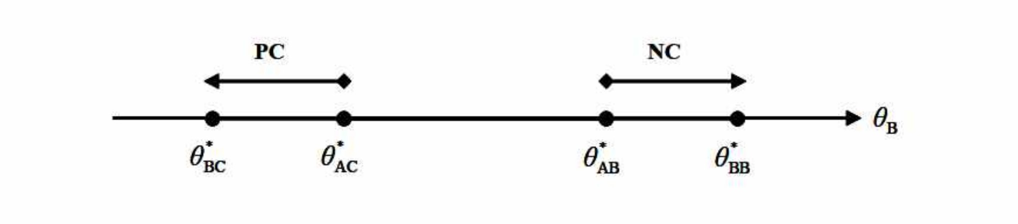

Figure 2: Positive Contagion (PC) /Negative Contagion (NC)

complicated but interesting and can potentially lead to a smoother version of contagion in which the contagion gradually changes with the fundamentals, which could be a possible avenue for our future research.

2. Effects of Public Information on Contagion

We now discuss the effects of country B's public information on contagion. That is, we examine the influence of different parameters (public signal: y_B; the accuracy of public signal: α_B) on positive contagion (PC) and negative contagion (NC) based on the fact that unique equilibrium outcomes are guaranteed, that is, $\beta > \frac{\alpha_B^2}{2\pi}$. For this, in addition to mathematical proofs, we conduct numerical simulations.[13]

Proposition 1 *The public signal distributed by the central bank of country* $B\,(i.e., y_B)$ *increases the effect of positive contagion* (PC) *and reduces the effect of negative contagion* (NC).

Proposition 1 implies that if the central bank distributes/announces more public information on the economic fundamentals of the country for the international financial market, then it can facilitate positive contagion effects and reduce negative contagion effects on the currency crisis from another country (see Figure 3). Based on the arguments of Metz [2002], Prati and Sbracia [2010], and Sbracia and Zaghini [2001], this proposition can also be interpreted as follows: Since the public signal y_B is symmetrically distributed around the realized fundamental index θ_B (i.e., $\mathrm{E}[y_B|\theta_B] = \theta_B$), the level of y_B

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13 For the numerical calculation, this paper refers mainly to Takeda and Takeda [2008]. As a benchmark case, the following set variables is used: $D = 11, t = 5, \delta = 1, \lambda = 0.3, q = 0.9,$ $y_A = y_B = 0.1, \alpha_A = \alpha_B = 5,$ and $\beta = 100.$ Specifically, the present paper employs numerical simulations to illustrate the effects of a change in a particular variable on contagion (**PC** and **NC**) by maintaining the other variables in the benchmark case. In all numerical simulations, the variables are kept within a range in which the uniqueness of the equilibrium outcome is guaranteed.

tends to be high if the realized level of fundamental index θ_B is high. Thus, from the result of Proposition 1, we can argue that the stronger the state of country B's fundamentals, the weaker the effect of negative contagion (NC) and the stronger the effect of positive contagion (PC) from country A.

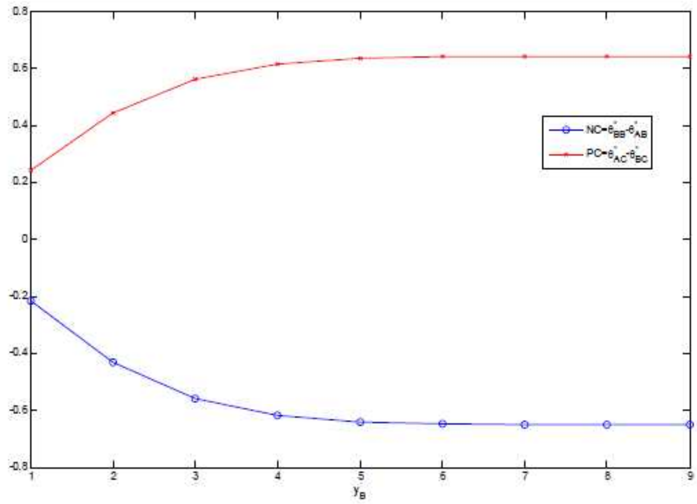

Figure 3: Effects of y_B on NC and PC

We can find the opposite effect of y_A on contagion (see Figure 4). That is, the public signal sent by the central bank of country A (i.e., y_A) can reduce positive contagion (PC) effects and exacerbate negative contagion (NC) effects on the currency crisis for country B. We can interpret this result as follows: Although an increase in the public signal of the fundamental state of the country's economy can reduce the likelihood of the negative contagion of a currency crisis from the former country as Proposition 1 addresses, it can trigger a negative effect on the currency crisis for the latter country.

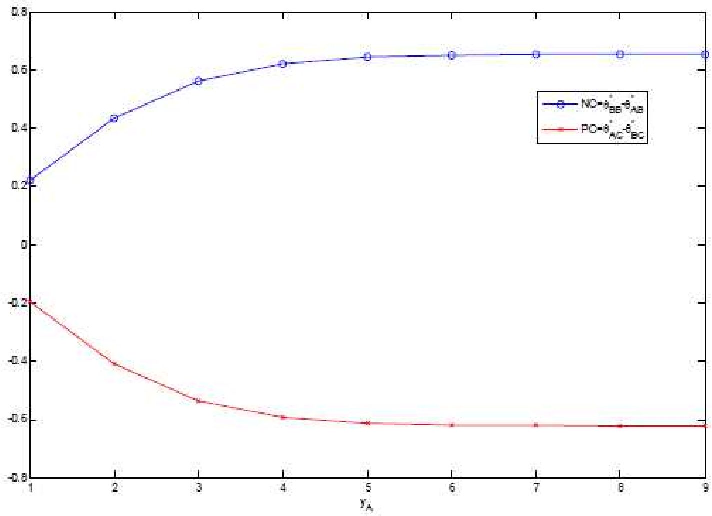

Figure 4: Effects of y_A on NC and PC

Now, what is the effectiveness of accuracy of the public signal on the contagion of a currency crisis? In fact, the desirability of central bank transparency (i.e., the degree of monetary/financial policy transparency) has been widely discussed and debated in each specific situation (e.g., Blinder, Ehrmann, Fratzscher, de Hann & Jansen, 2008; Cukierman & Meltzer, 1986; Cukierman, 2009; Eijffinger & van der Cruijsen, 2010; Goodfriend, 1986; Sarno & Taylor, 2001; Stein, 1989; Turdaliev, 2010). Our analyses in the context of contagious currency crises show that a highly accurate public signal does not always produce favorable outcomes (i.e., a reduction in negative contagion effects and/or an increase in positive contagion effects of a currency crisis from another country). Only when the country's economic fundamentals are expected to be strong ex ante can the accuracy of the public signal reduce negative effects and increase positive contagion effects of a currency crisis from another country.[14] The following proposition summarizes this argument.

14 Although the present paper does not consider the reputation effect of central banks in a

Proposition 2

1. If the state of country B's fundamentals is expected to be weak ex ante (i.e., if $\theta^{*}_{BC} > y_B + \frac{1}{2\sqrt{\alpha_B+\beta}}\Phi^{-1}\left(\frac{t+\delta}{D}\right)$ *and/or* $\theta^{*}_{BB} > y_B + \frac{1}{2\sqrt{\alpha_B+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)$*), then the accuracy of the public signal distributed by the central bank of country* B $\left(i.e., \alpha_B\right)$ *reduces positive contagion (*PC*) effects and exacerbates negative contagion (*NC*) effects.*

2. If the state of country B's fundamentals is expected to be strong ex ante (i.e., if $\theta^{*}_{BC} < y_B + \frac{1}{2\sqrt{\alpha_B+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)$ *and/or* $\theta^{*}_{BB} < y_B + \frac{1}{2\sqrt{\alpha_B+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)$*), then the accuracy of the public signal distributed by the central bank of country* B $\left(i.e., \alpha_B\right)$ *increases positive contagion (*PC*) effects and reduces negative contagion (*NC*) effects.*

Figure 5 presents the case of $y_B = 0.9$, and Figure 6, the case of $y_B = 0.1$. As shown in these figures, if the state of economic fundamentals is strong enough (i.e., Figure 5),[15] then improving the accuracy of public information increases positive contagion (PC) effects and reduces negative contagion (NC) effects of a currency crisis from another country and vice versa (i.e., Figure 6). Consistent with the opposite effects of y_B on contagion, Figure 7 and Figure 8 show that the effect of α_A on contagion contrasts what Proposition 2 addresses. For example, if the state of country A's fundamentals is expected to be strong ex ante (i.e., Figure 7), then the accuracy of the public signal

dynamic game of cheap talk with speculators, the results can be interpreted in the same manner as the findings of Turdaliev [2010]. Turdaliev shows that in a repeated game of cheap talk between a central bank and the public, an impatient central bank can be secretive (no informative equilibrium), whereas a sufficiently patient central bank talks truthfully (an informative equilibrium).

15 Note that θ^{*}_{BB} and θ^{*}_{BC} decrease with y_B, and thus, Figure 5 shows the case in which the state of country B's fundamentals is expected to be strong ex ante.

distributed by the central bank of country A (i.e., α_A) reduces positive contagion (PC) effects and exacerbates negative contagion (NC) effects on country B's currency crisis. This result can be interpreted as follows: If a currency crisis occurs in a country considered less likely to fail (i.e., a country with a low failure point as a result of the provision of accurate public information on the country's strong economic fundamentals), then it represents a large shock to the market, and thus, the currency crisis can be severely contagious.

As indicated by Born, Ehrmann, and Fratzscher [2011], central banks regularly communicate about monetary/financial issues by publishing written reports and offering speeches and interviews. These communication tools can indeed influence developments in the financial market. Of course, as in Hoerova, Monnet, and Temzelides [2009], in terms of the credibility of information transmission by central banks, simple announcements about economic fundamentals, including speeches/interviews delivered by central bank governors as well as financial stability reports published by central banks, are not sufficient because they may be treated purely as unreliable "cheap talk" in the market. It is necessary for central banks to implement monetary and macro-prudential policies with their announcements, which can induce market participants to take into account central banks' information in a rational manner. In the previous section, we discuss the effects of policy measures on contagion.

However as discussed earlier, the content of a central bank's communication needs to be carefully chosen and designed to reflect the state of a country's economic fundamentals. In addition, noteworthy is that the results in this section (i.e., Figure 3 — Figure 8) highlight that central banks should communicate with on another because one country's economic policy can spill over to other countries. Sutherland [2004] theoretically shows that welfare gains from policy coordination potentially arise when there are international spillover effects of policy (i.e., when policy in one country has an effect on economic outcomes in another country). In this regard, as proposed by Eichengreen, Prasad, and Rajan [2011], central bank governors should hold regular committee meetings (e.g., regular BIS meetings) to discuss their monetary/financial policies.

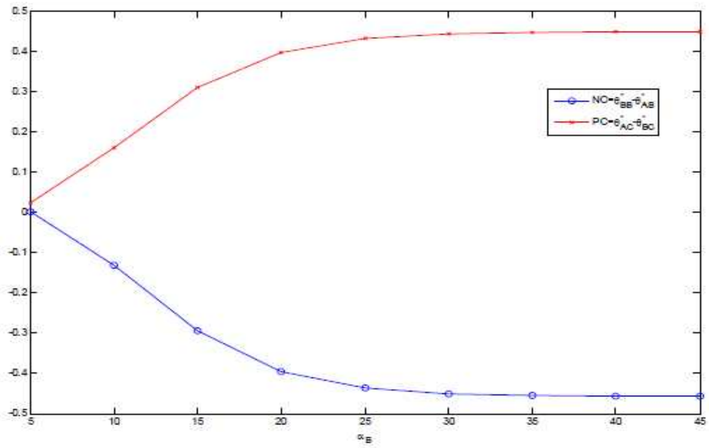

Figure 5: Effects of α_B on NC and PC $(y_B = 0.9)$

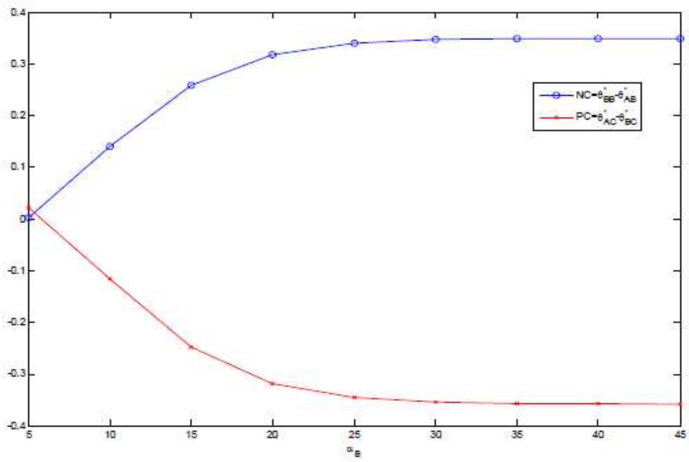

Figure 6: Effects of α_B on NC and PC $(y_B = 0.1)$

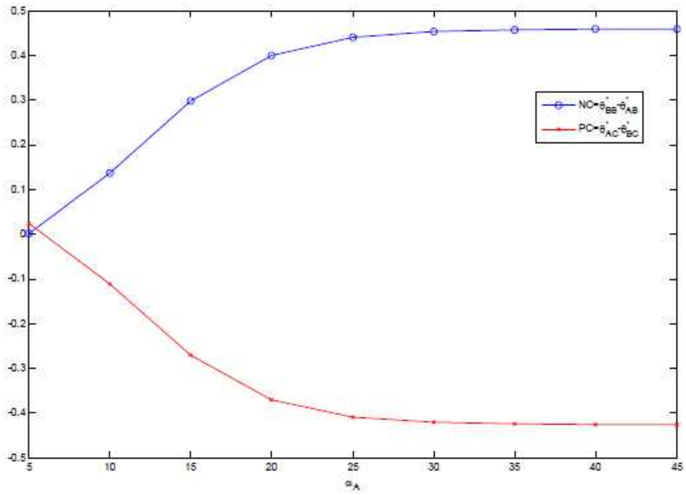

Figure 7: Effects of α_A on NC and PC $\left(y_A = 0.9\right)$

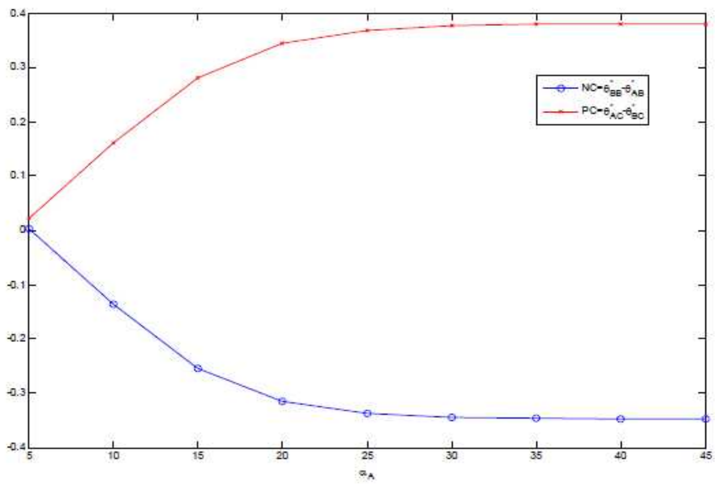

Figure 8: Effects of α_A on NC and PC $\left(y_A = 0.1\right)$

3. Effects of Other Parameters on Contagion

In this section, we numerically analyze the effects of other parameters of the proposed model (e.g., β, λ, t, D, and δ) on contagion.[16] We extend the concept of contagion in Oh [2012] by considering the effects of β, λ, t, D, and δ on positive contagion (PC). First, β, λ, t, D, and δ influence negative contagion (NC) and positive contagion (PC) in the same manner. This shows the tradeoff relationship of policy proposals for reducing negative contagion (NC) effects, which is addressed in Oh [2012]. If the central bank of country B takes measures to mitigate the negative contagion (NC) of a currency crisis from country A, then those measures can reduce positive contagion (PC) effects of the crisis.

Second, the effect of policy measures on positive contagion (PC) far exceeds that on negative contagion (NC). In other words, if coordination among speculators leads to favorable outcomes (i.e., no currency crisis through refraining from attacking the currency peg) for one country, then it can induce speculators to coordinate more for favorable equilibrium outcomes for another country. This result can be explained by the positive role played by public information distributed by the central bank of each country as a "focal point" (i.e., a coordinating mechanism) for speculators.[17] Oh [2012] does not consider the coordination role of public information and thus does not find that the effect of policy measures on positive contagion (PC) dominates that on negative contagion (NC) in that setting.

16 Because the closed-form solutions (**NC** $:= \theta^*_{BB} - \theta^*_{AB}$ and **PC** $:= \theta^*_{AC} - \theta^*_{BC}$) are complicated, in this section, we discuss the results by using computational simulations (except for mathematical proofs). We continue using the following set of variables as a benchmark case: $D=11$, $t=5$, $\delta=1$, $\lambda=0.3$, $q=0.9$, $y_A=y_B=0.1$, $\alpha_A=\alpha_B=5$, and $\beta=100$.

17 Boot, Milbourn and Schmeits [2006] argue that credit ratings provide a "focal point" for firms and their investors in situations in which there are multiple equilibrium outcomes.

A. Accuracy of Speculators' Private Information

We begin by considering how changes in the accuracy of private information available to speculators (β) influence contagion. Oh [2012] shows that an increase in the accuracy of creditors' private information increases the severity of contagion for a firm's liquidity crisis. This result indicates that policy measures for agents' transparent/precise information on fundamentals are not a panacea during crises. However, Oh [2012] does not cover the concept of positive contagion (PC) or the role of public information distributed by social agents as a coordination mechanism.

The results of the present paper indicate that the accuracy of the private signal β is much more likely to increase the effect of positive contagion (PC) than that of negative contagion (NC) (see Figure 9). These results can be interpreted as follows: As indicated by Morris and Shin [2003,2004] and Takeda and Takeda [2008], the lower the noise of private information, the less likely each speculator's information is to vary, making it easy for speculators to coordinate with one another. If coordination among speculators leads to favorable outcomes (i.e., no currency crisis through refraining from attacking the currency peg) for country A, then because of the "focal point" role that public information plays in facilitating coordination among speculators, the effect of accurate private information on country B exceeds that in the case in which speculators fail to coordinate for country A.[18]

18 Angeletos and Pavan [2004] show that if the market coordinates for socially desirable equilibrium outcomes, then facilitating such coordination is beneficial and that welfare can be maximized at high levels of transparency. The present paper demonstrates that transparency in one economy for favorable equilibrium outcomes (as a result of the "focal point" role of public information) can trigger better outcomes for another economy.

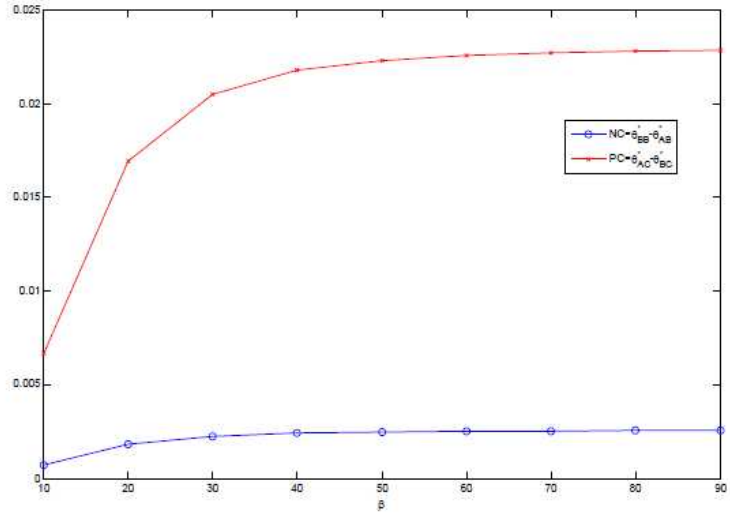

Figure 9: Effects of β on NC and PC

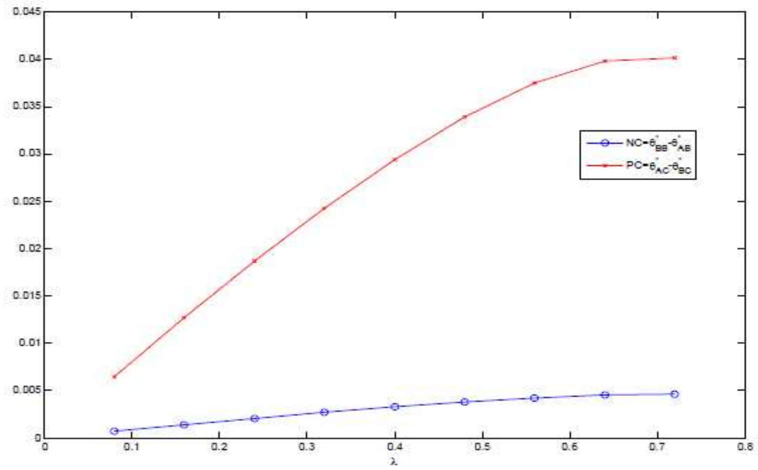

Figure 10: Effects of λ on NC and PC

B. Incomplete Information on the Type of Speculator

Figure 10 and Figure 11 illustrate how the degree of incomplete information on the type of speculator can influence contagion. In the proposed model, incomplete information on speculators is represented by the following two parameters: the size of group 1 speculators (λ) and the probability that group 2 speculators initially expect that group 1 speculators are of the same type (q). In particular, Figure 10 shows that both negative contagion (NC) and positive contagion (PC) effects decrease as λ decreases. That is, the less the incomplete information in the market, the less severe the contagion effects are for the latter country.

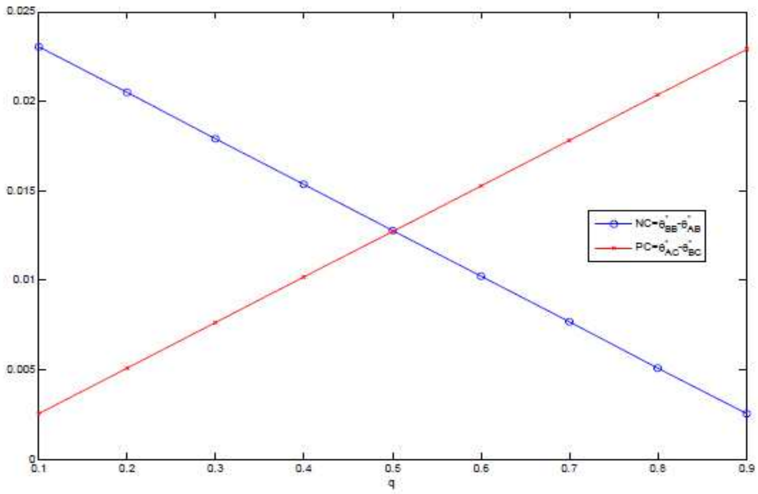

Figure 11: <u>Effects of q on NC and PC</u>

As shown in Figure 11, the effect of negative contagion (NC) decreases with q, whereas that of positive contagion (PC) increases with q. If group 2 speculators expect that group 1 speculators are likely to be of the same type (i.e., if q is higher), then the process by which they learn about the type of speculator has little effect on the negative contagion (NC). Further, coordination among speculators is enforced because of the expectation that group 1 speculators would be of the same type, which facilitates the effect of positive contagion (PC).

C. Costs of Speculative Trading

Finally, we examine the effects of costs associated with speculative trading on contagion. If the value of t and/or δ increases, then speculators are less likely to aggressively attack the currency peg. Similarly, speculators' incentive to attack the currency peg decreases as the value of D decreases. As a result, failure points for each country $\left(\theta^*_{AB}, \theta^*_{AC}, \theta^*_{BB}, \text{and } \theta^*_{BC}\right)$ decrease as costs associated with speculative trading increase. In terms of contagion effects, both positive contagion (PC) and negative contagion (NC) effects on country B increase as costs associated with speculative trading increase (see Figure 12, Figure 13, and Figure 14). However, the effect of positive contagion (PC) is much more likely to increase than that of negative contagion (NC).

These results indicate that implementing macroprudential policy measures such as bank levies on noncore liabilities may be a good way to deflate hot money bubbles in international financial markets.[19] Pointing out the rapidly rising share of foreign creditors in noncore liabilities for emerging economies, Shin [2010] suggests that levies on noncore liabilities should focus on the bank sector's liabilities denominated in foreign currencies. Such levies can influence foreign currency flows, but such a policy measure represents a macroprudential tool for financial stability, not for artificial capital control of for the management of exchange rates. Hence, this type of global tax on noncore banking liabilities is not inconsistent with free-market economics and can sustain the financial stability of the international financial market.

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19 Shin [2010] distinguishes between "core liabilities" - claims of domestic ultimate creditors on the intermediary sector - and "noncore liabilities" - claims on an intermediary by another intermediary and foreign creditors.

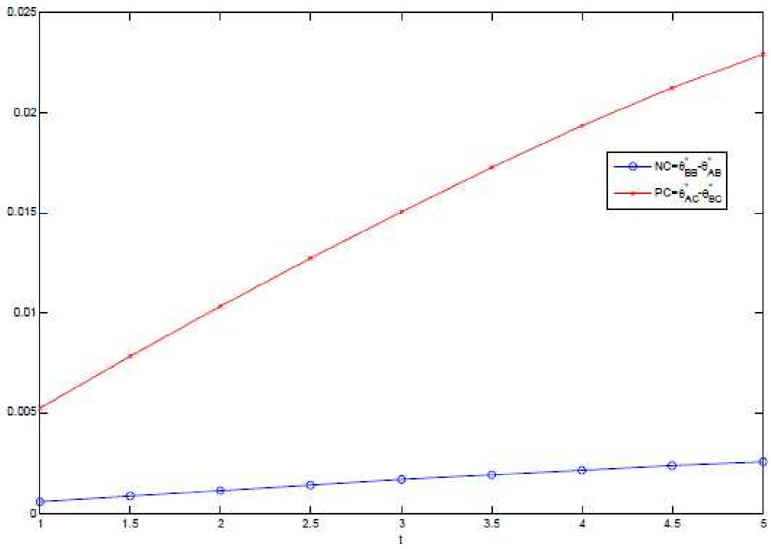

Figure 12: Effects of t on NC and PC

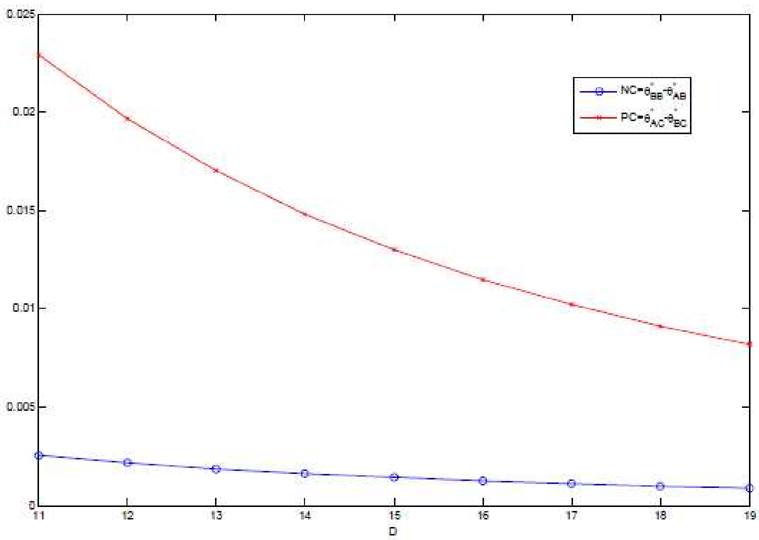

Figure 13: Effects of D on NC and PC

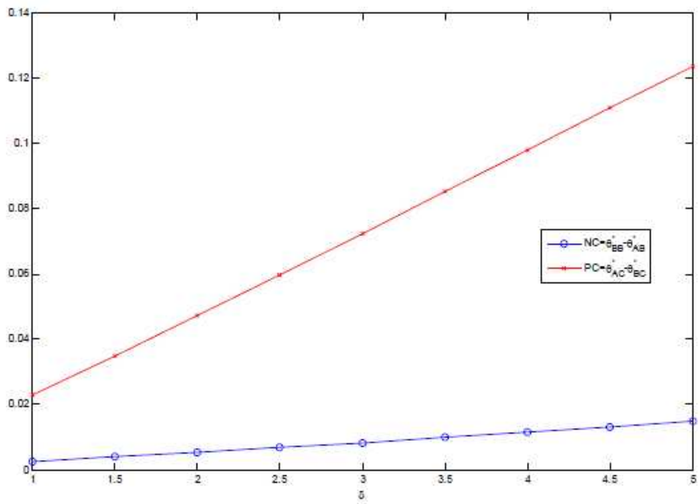

Figure 14: Effects of δ on NC and PC

V. Concluding Remarks and Discussion

By focusing on speculators' learning behavior toward one another's type — the level of their aggressiveness (i.e., bullish vs. chicken) with respect to their speculative activity — as a mechanism triggering the contagion of a currency crisis between two countries (e.g., Oh, 2012; Taketa, 2004), this paper explores the role of public information disseminated by central banks in the contagion of a currency crisis. Based on the traditional concept of financial contagion, in which unfavorable outcomes for one country have negative effects on those for another country (i.e., negative contagion), the paper investigates the concept of positive contagion, in which favorable outcomes for one economy make a currency crisis less likely for another country. In particular, the revelation of speculators participating in the speculation game for one country as chicken can reduce the probability of another country experiencing a currency crisis.

Even though the theoretical model is too stylized to be related directly to empirical evidence, various empirical findings show that the contagion channel of the model proposed in the present study (i.e., speculators' learning process concerning other speculators' types) is signigicant in real-world situations. First, while this paper focuses on the contagion channel with speculators, the proposed model can describe a rollover game among common foreign creditors as in Oh [2012]. In the rollover game, "not to roll over" ("to roll over") is a safe (risky) choice, which corresponds to "not to attack" ("to attack") in the speculation game of the proposed model. In terms of the equilibrium and other logics, the speculation game among speculators and the rollover game among foreign creditors are the same and complementary. A difference between them is that bullish speculators play an important role with respect to the contagion in the speculation game, while chicken creditors do so in the rollover game.

As addressed in Kaminsky, Lyons, and Schmukler [2000, 2001, 2004] and Kaminsky and Reinhart [2000], international investment funds engage in generating the contagion of international crises, which could be interpreted as the story of the rollover game among foreign creditors. In these crisis episodes, particularly referring to empirical studies done by Baig and Goldfajn [2001] and Broner, Gelos, and 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, which is consistent with the spirit of this paper. Accordingly, we can argue that the theoretical findings of this paper suggest some policy guidelines for central banks' communication strategies in the midst of the global financial crisis.

Under the condition for unique equilibrium outcomes for each country, the results indicate that the more the public signal of the fundamental state of the economy distributed by the central bank, the weaker the negative contagion effect and the stronger the positive contagion effect. In addition, only when the country's economic fundamentals are expected to be strong ex ante can the central bank's distribution of accurate public signals help mitigate the negative contagion of a currency crisis and facilitate the positive contagion of a currency crisis from another country. Hence, the welfare effects of disseminating accurate public information by the central bank on the contagion of a currency crisis between two economies depend on the economic fundamentals of the two countries.

However, noteworthy is that public information distributed by the central bank for the international market plays an important role in facilitating more effective and desirable coordination among speculators. By providing public information, central banks can enhance the effectiveness of policy measures for curtailing currency attacks by speculators, facilitating positive contagion, not negative contagion. Because of the double-edged effects of public information on the contagion of a currency crisis across countries, it is difficult but critical for central banks to strike a balance between providing accurate public information on the state of the economy and implementing policy initiatives.

Appendix

Proof of Theorem 1

First, consider group 1 speculators' decisions. These speculators not only privately know their type (bullish or chicken) but also know the type of group 2 speculator (bullish). Hence, they know the value of $\bar{\theta}_A : \theta^*_{AB}$ or θ^*_{AC}. If group 1 speculators are bullish, then we obtain the following indifference equation:

$$\begin{aligned} t &= D \cdot \Pr[\theta_A \le \theta^*_{AB} | x^*_{A1B}] \\ &= D \cdot \Phi\left[\sqrt{\alpha_A + \beta}\left(\theta^*_{AB} - \frac{\alpha_A}{\alpha_A + \beta} y_A - \frac{\beta}{\alpha_A + \beta} x^*_{A1B} \right) \right], \end{aligned} \tag{A1}$$

where Φ denotes the cumulated normal density. In the same way, we get the following indifference equation for chicken group 1 speculators:

$$t + \delta = D \cdot \Phi\left[\sqrt{\alpha_A + \beta}\left(\theta^*_{AC} - \frac{\alpha_A}{\alpha_A + \beta} y_A - \frac{\beta}{\alpha_A + \beta} x^*_{A1C} \right) \right]. \tag{A2}$$

Second, we consider group 2 speculators' decisions. These speculators know their own type (bullish) but not the type of group 1 speculator. They can only conjecture the probability that group 1 speculators are bullish as q. Hence, the indifference equation for group 2 speculators is as follows:

$$t = D \cdot \left\{ \begin{array}{l} q \cdot \Phi\left[\sqrt{\alpha_A + \beta}\left(\theta^*_{AB} - \frac{\alpha_A}{\alpha_A + \beta} y_A - \frac{\beta}{\alpha_A + \beta} x^*_{A2} \right) \right] \\ + (1-q) \cdot \Phi\left[\sqrt{\alpha_A + \beta}\left(\theta^*_{AC} - \frac{\alpha_A}{\alpha_A + \beta} y_A - \frac{\beta}{\alpha_A + \beta} x^*_{A2} \right) \right] \end{array} \right\}. \tag{A3}$$

Finally, we consider the critical threshold value of country A's fundamentals (i.e., switching fundamentals). The proportion of speculators who attack country A's currency is expressed as follows:

$$l_A(\theta_A) = \lambda \cdot \Pr[x_{A1} \le \overline{x}_{A1} | \theta_A] + (1-\lambda) \cdot \Pr[x_{A2} \le \overline{x}_{A2} | \theta_A]$$
$$= \lambda \cdot \Phi\left[\sqrt{\beta}(\overline{x}_{A1} - \theta_A)\right] + (1-\lambda) \cdot \Phi\left[\sqrt{\beta}(x^*_{A2} - \theta_A)\right].$$

The critical threshold value is determined by

$$\overline{\theta}_A = l_A(\overline{\theta}_A) = \lambda \cdot \Phi\left[\sqrt{\beta}(\overline{x}_{A1} - \overline{\theta}_A)\right] + (1-\lambda) \cdot \Phi\left[\sqrt{\beta}(x^*_{A2} - \overline{\theta}_A)\right]. \qquad \text{(A4)}$$

From Equation (A4), we get the following two equations:

$$\theta^*_{AB} = \lambda \cdot \Phi\left[\sqrt{\beta}(x^*_{A1B} - \theta^*_{AB})\right] + (1-\lambda) \cdot \Phi\left[\sqrt{\beta}(x^*_{A2} - \theta^*_{AB})\right], \qquad \text{(A5)}$$

$$\theta^*_{AC} = \lambda \cdot \Phi\left[\sqrt{\beta}(x^*_{A1C} - \theta^*_{AC})\right] + (1-\lambda) \cdot \Phi\left[\sqrt{\beta}(x^*_{A2} - \theta^*_{AC})\right]. \qquad \text{(A6)}$$

Solving Equations (A1), (A2), (A3), (A5), and (A6), we obtain $x^*_{A1B}, x^*_{A1C}, x^*_{A2}, \theta^*_{AB}$, and θ^*_{AC} :

$$x^*_{A1B} = \frac{\alpha_A + \beta}{\beta}\theta^*_{AB} - \frac{\alpha_A}{\beta}y_A - \frac{\sqrt{\alpha_A + \beta}}{\beta}\Phi^{-1}\left(\frac{t}{D}\right), \qquad \text{(S1)}$$

$$x^*_{A1C} = \frac{\alpha_A + \beta}{\beta}\theta^*_{AC} - \frac{\alpha_A}{\beta}y_A - \frac{\sqrt{\alpha_A + \beta}}{\beta}\Phi^{-1}\left(\frac{t+\delta}{D}\right), \qquad \text{(S2)}$$

$$x^*_{A2} = \theta^*_{AC} + \frac{1}{\sqrt{\beta}}\Phi^{-1}(K) = \theta^*_{AB} + \frac{1}{\sqrt{\beta}}\Phi^{-1}(G), \qquad \text{(S3)}$$

$$\theta^*_{AB} = \frac{\alpha_A + \beta}{\beta}\{\lambda\Phi(H) + (1-\lambda)\Phi(F)\} - \frac{\alpha_A}{\beta}y_A - \frac{1}{\sqrt{\beta}}\Phi^{-1}(G)$$
$$- \frac{\sqrt{\alpha_A + \beta}}{\beta}\Phi^{-1}\left[\frac{t}{D(1-q)} - \frac{q}{1-q}\Phi\left[\frac{\alpha_A}{\sqrt{\alpha_A + \beta}}\left(\theta^*_{AB} - y_A + \frac{\sqrt{\beta}}{\alpha_A}\Phi^{-1}(G)\right)\right]\right], \qquad \text{(S4)}$$

$$\theta^*_{AC} = \frac{\alpha_A + \beta}{\beta}\{\lambda\Phi(L) + (1-\lambda)\Phi(M)\} - \frac{\alpha_A}{\beta}y_A - \frac{1}{\sqrt{\beta}}\Phi^{-1}(K)$$
$$- \frac{\sqrt{\alpha_A + \beta}}{\beta}\Phi^{-1}\left[\frac{t}{qD} - \frac{1-q}{q}\Phi\left[\frac{\alpha_A}{\sqrt{\alpha_A + \beta}}\left(\theta^*_{AC} - y_A + \frac{\sqrt{\beta}}{\alpha_A}\Phi^{-1}(K)\right)\right]\right], \qquad \text{(S5)}$$

Where

$$K := \frac{1}{1-\lambda}\theta^*_{AC} - \frac{\lambda}{1-\lambda}\Phi\left[\frac{\alpha_A}{\sqrt{\beta}}\left(\theta^*_{AC} - y_A - \frac{\sqrt{\alpha_{A+}\beta}}{\alpha_A}\Phi^{-1}\left(\frac{t+\delta}{D}\right)\right)\right]$$

$$G := \frac{1}{1-\lambda}\theta^*_{AB} - \frac{\lambda}{1-\lambda}\Phi\left[\frac{\alpha_A}{\sqrt{\beta}}\left(\theta^*_{AB} - y_A - \frac{\sqrt{\alpha_{A+}\beta}}{\alpha_A}\Phi^{-1}\left(\frac{t}{D}\right)\right)\right]$$

and

$$\begin{aligned}
L &:= \sqrt{B}(x^*_{A1B} - \theta^*_{AB}) \\
&= \frac{\alpha_A\sqrt{\beta}}{\alpha_A+\beta}\left(\theta^*_{AC} - y_A + \frac{1}{\sqrt{\beta}}\Phi^{-1}(K)\right) - \frac{\sqrt{\alpha_A+\beta}}{\sqrt{\beta}}\Phi^{-1}\left(\frac{t}{D}\right) \\
&+ \frac{\alpha_A}{\sqrt{\beta}\sqrt{\alpha_A+\beta}}\Phi^{-1}\left[\frac{t}{qD} - \frac{1-q}{q}\Phi\left[\frac{\alpha_A}{\sqrt{\alpha_A+\beta}}\left(\theta^*_{AC} - y_A + \frac{\sqrt{\beta}}{\alpha_A}\Phi^{-1}(K)\right)\right]\right],
\end{aligned}$$

$$\begin{aligned}
M &:= \sqrt{B}(x^*_{A2} - \theta^*_{AB}) \\
&= \frac{\alpha_A\sqrt{\beta}}{\alpha_A+\beta}\left(\theta^*_{AC} - y_A + \frac{1}{\sqrt{\beta}}\Phi^{-1}(K)\right) \\
&- \frac{\sqrt{\beta}}{\sqrt{\alpha_A+\beta}}\Phi^{-1}\left[\frac{t}{qD} - \frac{1-q}{q}\Phi\left[\frac{\alpha_A}{\sqrt{\alpha_A+\beta}}\left(\theta^*_{AC} - y_A + \frac{\sqrt{\beta}}{\alpha_A}\Phi^{-1}(K)\right)\right]\right],
\end{aligned}$$

$$\begin{aligned}
H &:= \sqrt{B}(x^*_{A1C} - \theta^*_{AC}) \\
&= \frac{\alpha_A\sqrt{\beta}}{\alpha_A+\beta}\left(\theta^*_{AB} - y_A + \frac{1}{\sqrt{\beta}}\Phi^{-1}(G)\right) - \frac{\sqrt{\alpha_A+\beta}}{\sqrt{\beta}}\Phi^{-1}\left(\frac{t+\delta}{D}\right) \\
&+ \frac{\alpha_A}{\sqrt{\beta}\sqrt{\alpha_A+\beta}}\Phi^{-1}\left[\frac{t}{D(1-q)} - \frac{q}{1-q}\Phi\left[\frac{\alpha_A}{\sqrt{\alpha_A+\beta}}\left(\theta^*_{AB} - y_A - \frac{\sqrt{\beta}}{\alpha_A}\Phi^{-1}(G)\right)\right]\right],
\end{aligned}$$

$$\begin{aligned}
F &:= \sqrt{B}(x^*_{A2} - \theta^*_{AC}) \\
&= \frac{\alpha_A\sqrt{\beta}}{\alpha_A+\beta}\left(\theta^*_{AB} - y_A + \frac{1}{\sqrt{\beta}}\Phi^{-1}(G)\right) \\
&- \frac{\sqrt{\beta}}{\sqrt{\alpha_A+\beta}}\Phi^{-1}\left[\frac{t}{D(1-q)} - \frac{q}{1-q}\Phi\left[\frac{\alpha_A}{\sqrt{\alpha_A+\beta}}\left(\theta^*_{AB} - y_A - \frac{\sqrt{\beta}}{\alpha_A}\Phi^{-1}(G)\right)\right]\right].
\end{aligned}$$

Now the uniqueness condition (i.e., $\beta > \frac{\alpha_A^2}{2\pi}$) is proved by the following three lemmas (Lemmas 1, 2, and 3).

Lemma 1 $\frac{\partial}{\partial\theta^*_{AC}}\Phi\left[\sqrt{\beta}(x^*_{A1C} - \theta^*_{AC})\right] < 1 \; if \; \beta > \frac{\alpha_A^2}{2\pi}$**.**

Proof. From Equation (A2), we obtain

$$0=\phi\left[\sqrt{\alpha_A+\beta}\left(\theta^*_{AC}-\frac{\alpha_A}{\alpha_A+\beta}y_A-\frac{\beta}{\alpha_A+\beta}x^*_{A1C}\right)\right]\sqrt{\alpha_A+\beta}\left(1-\frac{\beta}{\alpha_A+\beta}\frac{\partial x^*_{A1C}}{\partial\theta^*_{AC}}\right),$$

and thus,

$$\frac{\partial x^*_{A1C}}{\partial\theta^*_{AC}}=\frac{\alpha_A+\beta}{\beta}.$$

Then we get

$$\begin{aligned}\frac{\partial}{\partial\theta^*_{AC}}\Phi\left[\sqrt{\beta}\left(x^*_{A1C}-\theta^*_{AC}\right)\right]&=\phi\left[\sqrt{\beta}\left(x^*_{A1C}-\theta^*_{AC}\right]\sqrt{\beta}\left(\frac{\partial x^*_{A1C}}{\partial\theta^*_{AC}}-1\right)\\&=\phi\left[\sqrt{\beta}\left(x^*_{A1C}-\theta^*_{AC}\right]\sqrt{\beta}\left(\frac{\alpha_A+\beta}{\beta}-1\right)\\&=\phi\left[\sqrt{\beta}\left(x^*_{A1C}-\theta^*_{AC}\right]\left(\frac{\alpha_A}{\sqrt{\beta}}\right)\\&\leq\frac{1}{\sqrt{2\pi}}\frac{\alpha_A}{\sqrt{\beta}}<1.\end{aligned}$$

Lemma 2 $\frac{\partial}{\partial\theta^*_{AC}}\Phi\left[\sqrt{\beta}\left(x^*_{A2}-\theta^*_{AC}\right)\right]<1\ if\ \beta>\frac{\alpha_A^2}{2\pi}$**.**

Proof. From Equation (A1), we can derive

$$\frac{\partial x^*_{A1B}}{\partial\theta^*_{AC}}=\frac{\alpha_A+\beta}{\beta}\frac{\partial\theta^*_{AB}}{\partial\theta^*_{AC}}.$$

From Equation(A5), we get

$$\begin{aligned}\frac{\partial\theta^*_{AB}}{\partial\theta^*_{AC}}&=\lambda\phi(L)\sqrt{\beta}\left(\frac{\partial x^*_{A1B}}{\partial\theta^*_{AC}}-\frac{\partial\theta^*_{AB}}{\partial\theta^*_{AC}}\right)+(1-\lambda)\phi(M)\sqrt{\beta}\left(\frac{\partial x^*_{A2}}{\partial\theta^*_{AC}}-\frac{\partial\theta^*_{AB}}{\partial\theta^*_{AC}}\right)\\&=\lambda\phi(L)\sqrt{\beta}\frac{\alpha_A}{\beta}\frac{\partial\theta^*_{AB}}{\partial\theta^*_{AC}}+(1-\lambda)\phi(M)\sqrt{\beta}\left(\frac{\partial x^*_{A2}}{\partial\theta^*_{AC}}-\frac{\partial\theta^*_{AB}}{\partial\theta^*_{AC}}\right).\end{aligned}$$

Rearranging the above equation, we obtain

$$(1-\lambda)\phi(M)\sqrt{\beta}\frac{\partial x^*_{A2}}{\partial\theta^*_{AC}}=\left[1-\lambda\phi(L)\sqrt{\beta}\frac{\alpha_A}{\beta}+(1-\lambda)\phi(M)\sqrt{\beta}\right]\frac{\partial\theta^*_{AB}}{\partial\theta^*_{AC}},$$

and thus,

$$\frac{\partial \theta_{AB}^{*}}{\partial \theta_{AC}^{*}} = \left[1 - \lambda \phi(L) \frac{\alpha_A}{\sqrt{\beta}} + (1-\lambda)\phi(M)\sqrt{\beta}\right]^{-1} (1-\lambda)\phi(M)\sqrt{\beta}\,\frac{\partial x_{A2}^{*}}{\partial \theta_{AC}^{*}}.$$

Let

$$P := \sqrt{\alpha_A + \beta}\left(\theta_{AB}^{*} - \frac{\alpha_A}{\alpha_A + \beta} y_A - \frac{\beta}{\alpha_A + \beta} x_{A2}^{*}\right),$$
$$Q := \sqrt{\alpha_A + \beta}\left(\theta_{AC}^{*} - \frac{\alpha_A}{\alpha_A + \beta} y_A - \frac{\beta}{\alpha_A + \beta} x_{A2}^{*}\right).$$

Then Equation (A3) can be rewritten as

$$\frac{t}{D} = q\Phi(P) + (1-q)\Phi(Q),$$

and from this equation, we get

$$0 = q\phi(P)\sqrt{\alpha_A + \beta}\left(\frac{\partial \theta_{AB}^{*}}{\partial \theta_{AC}^{*}} - \frac{\beta}{\alpha_A + \beta}\frac{\partial x_{A2}^{*}}{\partial \theta_{AC}^{*}}\right) + (1-q)\phi(Q)\sqrt{\alpha_A + \beta}\left(1 - \frac{\beta}{\alpha_A + \beta}\frac{\partial x_{A2}^{*}}{\partial \theta_{AC}^{*}}\right).$$

By rearranging the above equation, we get

$$(1-q)\phi(Q) = \left[\begin{array}{c} \{q\phi(P) + (1-q)\phi(Q)\}\dfrac{\beta}{\alpha_A + \beta} \\ -q\phi(P)\dfrac{(1-\lambda)\phi(M)\sqrt{\beta}}{1 - \lambda\phi(L)\dfrac{\alpha_A}{\sqrt{\beta}} + (1-\lambda)\phi(M)\sqrt{\beta}} \end{array}\right] \frac{\partial x_{A2}^{*}}{\partial \theta_{AC}^{*}}$$

and

$$\frac{\partial x_{A2}^{*}}{\partial \theta_{AC}^{*}} = (1-q)\phi(Q)\left[\begin{array}{c} \{q\phi(P) + (1-q)\phi(Q)\}\dfrac{\beta}{\alpha_A + \beta} \\ -q\phi(P)\dfrac{(1-\lambda)\phi(M)\sqrt{\beta}}{1 - \lambda\phi(L)\dfrac{\alpha_A}{\sqrt{\beta}} + (1-\lambda)\phi(M)\sqrt{\beta}} \end{array}\right]^{-1}.$$

Here we observe that

$$\frac{(1-\lambda)\phi(M)\sqrt{\beta}}{1-\lambda\phi(L)\dfrac{\alpha_A}{\sqrt{\beta}}+(1-\lambda)\phi(M)\sqrt{\beta}}=\frac{(1-\lambda)\phi(M)\sqrt{\beta}}{\sqrt{\beta}-\lambda\phi(L)\alpha_A+(1-\lambda)\phi(M)\beta}$$

$$<\frac{(1-\lambda)\phi(M)\beta}{\dfrac{\alpha_A}{\sqrt{2\pi}}+\lambda\dfrac{\alpha_A}{\sqrt{2\pi}}+(1-\lambda)\phi(M)\beta}$$

$$=\frac{\phi(M)\beta}{\dfrac{\alpha_A}{\sqrt{2\pi}}+\phi(M)\beta}$$

$$=\frac{\beta}{\dfrac{\alpha_A}{\sqrt{2\pi}\,\phi(M)}+\beta}$$

$$\leq\frac{\beta}{\alpha_A+\beta}.$$

Thus,

$$\left[\begin{array}{c}\{q\phi(P)+(1-q)\phi(Q)\}\dfrac{\beta}{\alpha_A+\beta}\\ -q\phi(P)\dfrac{(1-\lambda)\phi(M)\sqrt{\beta}}{1-\lambda\phi(L)\dfrac{\alpha_A}{\sqrt{\beta}}+(1-\lambda)\phi(M)\sqrt{\beta}}\end{array}\right]>\{q\phi(P)+(1-q)\phi(Q\}\frac{\beta}{\alpha_A+\beta}-q\phi(P)\frac{\beta}{\alpha_A+\beta}$$

$$=(1-q)\phi(Q)\frac{\beta}{\alpha_A+\beta}.$$

Then we get

$$\frac{\partial x^*_{A2}}{\partial x^*_{AC}}=(1-q)\phi(Q)\left[\begin{array}{c}\{q\phi(P)+(1-q)\phi(Q)\}\dfrac{\beta}{\alpha_A+\beta}\\ -q\phi(P)\dfrac{(1-\lambda)\phi(M)\sqrt{\beta}}{1-\lambda\phi(L)\dfrac{\alpha_A}{\sqrt{\beta}}+(1-\lambda)\phi(M)\sqrt{\beta}}\end{array}\right]$$

$$<(1-q)\phi(Q)\frac{1}{(1-q)\phi(Q)\dfrac{\beta}{\alpha_A+\beta}}$$

$$=\frac{\alpha_A+\beta}{\beta}$$

Finally, we obtain

$$
\begin{aligned}
\frac{\partial}{\partial x_{AC}^*}\Phi\left[\sqrt{\beta}(x_{A2}^*-\theta_{AC}^*)\right] &= \phi\left[\sqrt{\beta}(x_{A2}^*-\theta_{AC}^*)\right]\sqrt{\beta}\left(\frac{\partial x_{A2}^*}{\partial\theta_{AC}^*}-1\right) \\
&< \phi\left[\sqrt{\beta}(x_{A2}^*-\theta_{AC}^*)\right]\sqrt{\beta}\left(\frac{\alpha_A+\beta}{\beta}-1\right) \\
&= \phi\left[\sqrt{\beta}(x_{A2}^*-\theta_{AC}^*)\right]\frac{\alpha_A}{\sqrt{\beta}} \\
&\le \frac{1}{\sqrt{2\pi}}\frac{\alpha_A}{\sqrt{\beta}} < 1.
\end{aligned}
$$

Lemma 3 θ_{AC}^* *is unique if* $\beta > \frac{\alpha_A^2}{2\pi}$.

Proof. From Equation (A6), we obtain

$$
\begin{aligned}
&\frac{\partial}{\partial\theta_{AC}^*}(\lambda\Phi\left[\sqrt{\beta}(x_{A1C}^*-\theta_{AC}^*)\right]+(1-\lambda)\Phi\left[\sqrt{\beta}(x_{A2}^*-\theta_{AC}^*)\right] \\
&= \lambda\frac{\partial}{\partial\theta_{AC}^*}\Phi\left[\sqrt{\beta}(x_{A1C}^*-\theta_{AC}^*)\right]+(1-\lambda)\frac{\partial}{\partial\theta_{AC}^*}\Phi\left[\sqrt{\beta}(x_{A2}^*-\theta_{AC}^*)\right] \\
&< \lambda+(1-\lambda)=1,
\end{aligned}
$$

that is, θ_{AC}^* is unique if $\beta > \frac{\alpha_A^2}{2\pi}$.

From these three lemmas, we can easily cheek that the 5-tuple $(\theta_{AB}^*, \theta_{AC}^*, x_{A1B}^*, x_{A1C}^*, x_{A2}^*)$ is unique if $\beta > \frac{\alpha_A^2}{2\pi}$.

Proof of $\theta_{AB}^* > \theta_{AC}^*$

Let $\overline{K}(\xi)$ and $\overline{G}(\xi)$ be functions of ξ defined by

$$
\begin{aligned}
\overline{K} &:= \xi + \frac{1}{\sqrt{\beta}}\Phi^{-1}(K(\xi)), \\
\overline{G} &:= \xi + \frac{1}{\sqrt{\beta}}\Phi^{-1}(G(\xi)),
\end{aligned}
$$

Where

$$K(\xi) := \frac{1}{1-\lambda}\xi - \frac{\lambda}{1-\lambda}\Phi\left[\frac{\alpha_A}{\sqrt{\beta}}\left(\xi - y_A - \frac{\sqrt{\alpha_A+\beta}}{\alpha_A}\Phi^{-1}\left(\frac{t+\delta}{D}\right)\right)\right],$$
$$G(\xi) := \frac{1}{1-\lambda}\xi - \frac{\lambda}{1-\lambda}\Phi\left[\frac{\alpha_A}{\sqrt{\beta}}\left(\xi - y_A - \frac{\sqrt{\alpha_A+\beta}}{\alpha_A}\Phi^{-1}\left(\frac{t}{D}\right)\right)\right].$$

Because Φ and Φ^{-1} are continuous and increasing functions, $K(\xi)$ and $G(\xi)$ are continuous and increasing function if $\beta > \frac{\alpha_A^2}{2\pi}$. Therefore, $\overline{K}$ and $\overline{G}$ also are continuous and increasing. We see that $K(\xi) > G(\xi)$ for all ξ, and thus, $\overline{K}(\xi) > \overline{G}(\xi)$.

Here θ^*_{AC} is the solution to $\overline{K}(\xi) = x^*_{A2}$, and θ^*_{AB} is the solution to $\overline{G}(\xi) = x^*_{A2}$. Because $\overline{K}(\xi) > \overline{G}(\xi)$ and they are continuous and increasing, we can conclude that θ^*_{AB} is greater than θ^*_{AC}.

Proof of $x^*_{A1B} > x^*_{A2} > x^*_{A1C}$

Let $f(\xi)$ and $g(\xi)$ be functions of ξ defined by

$$f(\xi) := \Phi\left[\sqrt{\alpha_A+\beta}\left(\theta^*_{AB} - \frac{\alpha_A}{\alpha_A+\beta}y_A - \frac{\beta}{\alpha_A+\beta}\xi\right)\right],$$
$$g(\xi) := \Phi\left[\sqrt{\alpha_A+\beta}\left(\theta^*_{AC} - \frac{\alpha_A}{\alpha_A+\beta}y_A - \frac{\beta}{\alpha_A+\beta}\xi\right)\right].$$

Both functions are continuous and decreasing, and thus, we see that $f(\xi) < \lambda \cdot f(\xi) + (1-\lambda)\cdot g(\xi) < g(\xi)$ for $0 < \lambda < 1$.

Here x^*_{A1B}, x^*_{A2}, and x^*_{A1C} are the solutions to $f(\xi) = \frac{t}{D}$, $\lambda \cdot f(\xi) + (1-\lambda)\cdot g(\xi) = \frac{t}{D}$, and $g(\xi) = \frac{t+\delta}{D}$, respectively. Because $\frac{t}{D} = f(x^*_{A1B}) = \lambda \cdot f(x^*_{A2}) + (1-\lambda) \cdot g(x^*_{A2}) < f(x^*_{A2}), x^*_{A1B} > x^*_{A2}$ holds. In addition, because $g(x^*_{A2}) < \lambda \cdot f(x^*_{A2}) + (1-\lambda)\cdot g(x^*_{A2}) = \frac{t}{D} < \frac{t+\delta}{D} = g(x^*_{A1C})$, $x^*_{A2} > x^*_{A1C}$ holds.

Thus, $x^*_{A1B} > x^*_{A2} > x^*_{A1C}$.

Derivation of θ^*_{BB} and x^*_B

The proportion of speculators who attack the peg conditional on θ_B is expressed as follows:

$$\begin{aligned} l_B(\theta_B) &= \Pr\left[x_B \le x^*_B | \theta_B\right] \\ &= \Phi\left[\sqrt{\beta}(x^*_B - \theta_B)\right]. \end{aligned}$$

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

$$\theta^*_{BB} = l_B(\theta^*_{BB}) = \Phi\left[\sqrt{\beta}(x^*_B - \theta^*_{BB})\right]. \tag{A7}$$

From the condition for speculators' indifference to attacks, we get

$$t = D\cdot\Phi\left[\sqrt{\alpha_B+\beta}\left(\theta^*_{BB} - \frac{\alpha_B}{\alpha_B+\beta}y_B - \frac{\beta}{\alpha_B+\beta}x^*_B\right)\right]. \tag{A8}$$

From Equations(A7) and (A8), we get the following equilibrium:

$$x^*_B = \frac{\alpha_B+\beta}{\beta}\theta^*_{BB} - \frac{\alpha_B}{\beta}y_B - \frac{\sqrt{\alpha_B+\beta}}{\beta}\Phi^{-1}\left(\frac{t}{D}\right), \tag{S6}$$

$$\theta^*_{BB} = \Phi\left[\frac{\alpha_B}{\sqrt{\beta}}\left(\theta^*_{BB} - y_B - \frac{\sqrt{\alpha_B+\beta}}{\alpha_B}\Phi^{-1}\left(\frac{t}{D}\right)\right)\right]. \tag{S7}$$

Derivation of θ^*_{BC}, x^*_{B1}, and x^*_{B2}

The proportion of speculators who attack the peg conditional on θ_B is expressed as follows:

$$\begin{aligned} l_B(\theta_B) &= \lambda\cdot\Pr[x_{B1} \le x^*_{B1}|\theta_B] + (1-\lambda)\cdot\Pr[x_{B2} \le x^*_{B2}|\theta_B] \\ &= \lambda\cdot\Phi\left[\sqrt{\beta}(x^*_{B1} - \theta_B)\right] + (1-\lambda)\cdot\Phi\left[\sqrt{\beta}(x^*_{B2} - \theta_B)\right]. \end{aligned}$$

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

$$\theta^*_{BC} = l_B(\theta^*_{BC}) = \lambda\cdot\Phi\left[\sqrt{\beta}(x^*_{B1} - \theta^*_{BC})\right] + (1-\lambda)\cdot\Phi\left[\sqrt{\beta}(x^*_{B2} - \theta^*_{BC})\right]. \tag{A9}$$

From the condition for speculators' indifference to attacks, we get

$$t+\delta = D \cdot \Phi\left[\sqrt{\alpha_B+\beta}\left(\theta^*_{BC} - \frac{\alpha_B}{\alpha_B+\beta} y_B - \frac{\beta}{\alpha_B+\beta} x^*_{B1}\right)\right] \tag{A10}$$

for chicken group 1 speculators and

$$t = D \cdot \Phi\left[\sqrt{\alpha_B+\beta}\left(\theta^*_{BC} - \frac{\alpha_B}{\alpha_B+\beta} y_B - \frac{\beta}{\alpha_B+\beta} x^*_{B2}\right)\right] \tag{A11}$$

for bullish group 2 speculators.

From Equations (A9), (A10), and (A11), we obtain the following equilibrium:

$$x^*_{B1} = \frac{\alpha_B+\beta}{\beta}\theta^*_{BC} - \frac{\alpha_B}{\beta} y_B - \frac{\sqrt{\alpha_B+\beta}}{\beta}\Phi^{-1}\left(\frac{t+\delta}{D}\right), \tag{S8}$$

$$x^*_{B2} = \frac{\alpha_B+\beta}{\beta}\theta^*_{BC} - \frac{\alpha_B}{\beta} y_B - \frac{\sqrt{\alpha_B+\beta}}{\beta}\Phi^{-1}\left(\frac{t}{D}\right), \tag{S9}$$

$$\begin{aligned} \theta^*_{BC} = {} & \lambda\Phi\left[\frac{\alpha_B}{\sqrt{\beta}}\left(\theta^*_{BC} - y_B - \frac{\sqrt{\alpha_B+\beta}}{\alpha_B}\Phi^{-1}\left(\frac{t+\delta}{D}\right)\right)\right] \\ & + (1-\lambda)\Phi\left[\frac{\alpha_B}{\sqrt{\beta}}\left(\theta^*_{BC} - y_B - \frac{\sqrt{\alpha_B+\beta}}{\alpha_B}\Phi^{-1}\left(\frac{t}{D}\right)\right)\right]. \end{aligned} \tag{S10}$$

Proof of $\theta^*_{BB} > \theta^*_{BC}$ and $x^*_B > x^*_{B2} > x^*_{B1}$

Let $f_1(\xi) = \Phi[a(\xi - b_1)]$ and $f_2(\xi) = \Phi[a(\xi - b_2)]$, where $a > 0$ and $b_2 > b_1$. Because $\Phi(\xi)$ is an increasing function, $f_1(\xi) > f_2(\xi)$ always hold. In this case, $f_1(\xi) > \lambda \cdot f_1(\xi) + (1-\lambda) \cdot f_2(\xi)$ for $0 < \lambda < 1$.

Let $a = \frac{a_B}{\sqrt{\beta}}$, $b_1 = y_B + \frac{\sqrt{\alpha_B+\beta}}{\alpha_B}\Phi^{-1}\left(\frac{t}{D}\right)$, and $b_2 = y_B + \frac{\sqrt{\alpha_B+\beta}}{\alpha_B}\Phi^{-1}\left(\frac{t+\delta}{D}\right)$. Then we observe that $\theta^*_{BB} = f_1(\theta^*_{BB})$ and $\theta^*_{BC} = \lambda \cdot f_2(\theta^*_{BC}) + (1-\lambda) \cdot f_1(\theta^*_{BC})$. we know that $f_1(0)$ and $f_2(0)$ are greater than 0. Because $\beta > \frac{\alpha_B^2}{2\pi}$, both $\frac{\partial f_1(\xi)}{\partial \xi}$ and $\frac{\partial f_2(\xi)}{\partial \xi}$ are less than 1.

Hence, $\theta^*_{BB} > \theta^*_{BC}$ for unique θ^*_{BB} and θ^*_{BC}. Based on this result and Equation (S6), (S8), and (S9), we can easily check that $x^*_B > x^*_{B2} > x^*_{B1}$ holds.

Proof of NC>0 and PC>0

- **NC**>0 :

Define $L_A(\xi)$ by

$$L_A(\xi) := \frac{\alpha_A}{\sqrt{\beta}}\xi - \frac{\alpha_A}{\sqrt{\beta}}y_A - \frac{\sqrt{\alpha_A+\beta}}{\sqrt{\beta}}\Phi^{-1}\left(\frac{t}{D}\right).$$

Similarly, we define $M_A(\xi)$. Based on Equation (A5), θ^*_{AB} is the unique solution to $\xi = \lambda\cdot\Phi(L_A(\xi)) + (1-\lambda)\cdot\Phi(M_A(\xi))$.

We define $L_B(\xi)$ by

$$L_B(\xi) := \frac{\alpha_B}{\sqrt{\beta}}\xi - \frac{\alpha_B}{\sqrt{\beta}}y_B - \frac{\sqrt{\alpha_B+\beta}}{\sqrt{\beta}}\Phi^{-1}\left(\frac{t}{D}\right).$$

Form Equation (A7), θ^*_{BB} is the unique solution to $\xi = \Phi(L_B(\xi))$.

Assume that $y_A = y_B$ and $\alpha_A = \alpha_B$. Then $L_A(\xi) = L_B(\xi)$. Because $\Phi(L_B(\xi))$ is increasing and $Max\frac{d}{d\xi}\Phi(L_B(\xi)) < 1$, we have the following property:

1. If $\hat{\xi} < \theta^*_{BB}$, then $\hat{\xi} < \Phi\left(L_B\left(\hat{\xi}\right)\right)$;
2. If $\hat{\xi} > \theta^*_{BB}$, then $\hat{\xi} > \Phi\left(L_B\left(\hat{\xi}\right)\right)$;
3. If $\hat{\xi} = \theta^*_{BB}$, then $\hat{\xi} = \Phi\left(L_B\left(\hat{\xi}\right)\right)$.

Because $\theta^*_{AB} = \lambda\cdot\Phi(L_A(\theta^*_{AB})) + (1-\lambda)\cdot\Phi(M_A(\theta^*_{AB})) < \Phi(L_A(\theta^*_{AB})), \theta^*_{AB} < \theta^*_{BB}$ holds (i.e., NC>0).

• **PC**> 0 :

Because $\theta^*_{AB} = \theta^*_{AC}$, in Equation (A3), there exists some $\varepsilon > 0$ such that

$$\begin{aligned}\frac{t}{D} &= q\Phi\left[\sqrt{\alpha_A+\beta}\left(\theta^*_{AB} - \frac{\alpha_A}{\alpha_A+\beta}y_A - \frac{\beta}{\alpha_A+\beta}x^*_{A2}\right)\right] \\ &\quad + (1-q)\Phi\left[\sqrt{\alpha_A+\beta}\left(\theta^*_{AC} - \frac{\alpha_A}{\alpha_A+\beta}y_A - \frac{\beta}{\alpha_A+\beta}x^*_{A2}\right)\right] \\ &= q\varepsilon + q\Phi\left[\sqrt{\alpha_A+\beta}\left(\theta^*_{AC} - \frac{\alpha_A}{\alpha_A+\beta}y_A - \frac{\beta}{\alpha_A+\beta}x^*_{A2}\right)\right] \\ &\quad + (1-q)\Phi\left[\sqrt{\alpha_A+\beta}\left(\theta^*_{AC} - \frac{\alpha_A}{\alpha_A+\beta}y_A - \frac{\beta}{\alpha_A+\beta}x^*_{A2}\right)\right] \\ &= q\varepsilon + \Phi\left[\sqrt{\alpha_A+\beta}\left(\theta^*_{AC} - \frac{\alpha_A}{\alpha_A+\beta}y_A - \frac{\beta}{\alpha_A+\beta}x^*_{A2}\right)\right].\end{aligned}$$

From this, we get

$$x^*_{A2} = \frac{\alpha_A+\beta}{\beta}\theta^*_{AC} - \frac{\alpha_A}{\beta}y_A - \frac{\sqrt{\alpha_A+\beta}}{\beta}\Phi^{-1}\left(\frac{t}{D} - q\varepsilon\right),$$

and thus, Equation (A6) can be expressed by

$$\begin{aligned}\theta^*_{AC} &= \lambda\Phi\left[\frac{\alpha_A}{\sqrt{\beta}}\left(\theta^*_{AC} - y_A - \frac{\sqrt{\alpha_A+\beta}}{\alpha_A}\Phi^{-1}\left(\frac{t+\delta}{D}\right)\right)\right] \\ &\quad + (1-\lambda)\Phi\left[\frac{\alpha_A}{\sqrt{\beta}}\left(\theta^*_{AC} - y_A - \frac{\sqrt{\alpha_A+\beta}}{\alpha_A}\Phi^{-1}\left(\frac{t}{D} - q\varepsilon\right)\right)\right].\end{aligned}$$

Further, recall that θ^*_{BC} is obtained as follows:

$$\begin{aligned}\theta^*_{BC} &= \lambda\Phi\left[\frac{\alpha_B}{\sqrt{\beta}}\left(\theta^*_{BC} - y_B - \frac{\sqrt{\alpha_B+\beta}}{\alpha_B}\Phi^{-1}\left(\frac{t+\delta}{D}\right)\right)\right] \\ &\quad + (1-\lambda)\Phi\left[\frac{\alpha_B}{\sqrt{\beta}}\left(\theta^*_{BC} - y_B - \frac{\sqrt{\alpha_B+\beta}}{\alpha_B}\Phi^{-1}\left(\frac{t}{D}\right)\right)\right].\end{aligned}$$

Let

$$F_1(\xi) := \lambda\Phi\left[\frac{\alpha_A}{\sqrt{\beta}}\left(\xi - y_A - \frac{\sqrt{\alpha_A+\beta}}{\alpha_A}\Phi^{-1}\left(\frac{t+\delta}{D}\right)\right)\right]$$
$$+(1-\lambda)\Phi\left[\frac{\alpha_A}{\sqrt{\beta}}\left(\xi - y_A - \frac{\sqrt{\alpha_A+\beta}}{\alpha_A}\Phi^{-1}\left(\frac{t}{D} - q\varepsilon\right)\right)\right].$$
$$F_2(\xi) := \lambda\Phi\left[\frac{\alpha_B}{\sqrt{\beta}}\left(\xi - y_B - \frac{\sqrt{\alpha_B+\beta}}{\alpha_B}\Phi^{-1}\left(\frac{t+\delta}{D}\right)\right)\right]$$
$$+(1-\lambda)\Phi\left[\frac{\alpha_B}{\sqrt{\beta}}\left(\xi - y_B - \frac{\sqrt{\alpha_B+\beta}}{\alpha_B}\Phi^{-1}\left(\frac{t}{D}\right)\right)\right].$$

Then θ^*_{AC} is the unique solution to $\xi = F_1(\xi)$, and θ^*_{BC} is the unique solution to $\xi = F_2(\xi)$.

Assume that $y_A = y_B$ and $\alpha_A = \alpha_B$. Then $F_1(\xi) > F_2(\xi)$ holds because q>0. Under the uniqueness conditions,

$$\left|\frac{d}{d\xi}F_1(\xi)\right| < 1, \text{ and } \left|\frac{d}{d\xi}F_2(\xi)\right| < 1.$$

Hence, $\theta^*_{BC} < \theta^*_{AC}$ hold (i.e., **PC** > 0).

Proof of Proposition 1

From Equation (S10), we obtain

$$\frac{\partial\theta^*_{BC}}{\partial y_B} = \lambda\phi(\cdot)\left(\frac{\alpha_B}{\sqrt{\beta}}\frac{\partial\theta^*_{BC}}{\partial y_B} - \frac{\alpha_B}{\sqrt{\beta}}\right) + (1-\lambda)\phi(\cdot\cdot)\left(\frac{\alpha_B}{\sqrt{\beta}}\frac{\partial\theta^*_{BC}}{\partial y_B} - \frac{\alpha_B}{\sqrt{\beta}}\right)$$
$$= \left(1 - \lambda\phi(\cdot)\frac{\alpha_B}{\sqrt{\beta}} - (1-\lambda)\phi(\cdot\cdot)\frac{\alpha_B}{\sqrt{\beta}}\right)^{-1}\left(-\lambda\frac{\alpha_B}{\sqrt{\beta}}\phi(\cdot) - (1-\lambda)\frac{\alpha_B}{\sqrt{\beta}}\phi(\cdot\cdot)\right) < 0,$$

and thus, $\frac{\partial \mathrm{PC}}{\partial y_B}$>0. That is, PC increases with y_B.

From Equation (S7), we obtain

$$\frac{\partial\theta^*_{BB}}{\partial y_B}=\phi(\cdot)\left(\frac{\alpha_B}{\sqrt{\beta}}\frac{\partial\theta^*_{BB}}{\partial y_B}-\frac{\alpha_B}{\sqrt{\beta}}\right)$$
$$=\left(1-\frac{\alpha_B}{\sqrt{\beta}}\phi(\cdot)\right)^{-1}\phi(\cdot)\left(-\frac{\alpha_B}{\sqrt{\beta}}\right)<0,$$

and thus, $\frac{\partial \mathrm{NC}}{\partial y_B}$<0. That is, NC decreases with y_B.

Proof of Proposition 2

From Equation (S10), we obtain

$$\frac{\partial\theta^*_{BC}}{\partial\alpha_B}=\lambda\phi(\cdot)\left\{\frac{1}{\sqrt{\beta}}\theta^*_{BC}+\frac{\alpha_B}{\sqrt{\beta}}\frac{\partial\theta^*_{BC}}{\partial\alpha_B}-\frac{y_B}{\sqrt{\beta}}-\frac{1}{\sqrt{\beta}}\frac{1}{2\sqrt{\alpha_B+\beta}}\varPhi^{-1}\left(\frac{t+\delta}{D}\right)\right\}$$
$$+(1-\lambda)\phi(\cdot\cdot)\left\{\frac{1}{\sqrt{\beta}}\theta^*_{BC}+\frac{\alpha_B}{\sqrt{\beta}}\frac{\partial\theta^*_{BC}}{\partial\alpha_B}-\frac{y_B}{\sqrt{\beta}}-\frac{1}{\sqrt{\beta}}\frac{1}{2\sqrt{\alpha_B+\beta}}\varPhi^{-1}\left(\frac{t}{D}\right)\right\}$$
$$=\left(1-\lambda\phi(\cdot)\frac{\alpha_B}{\sqrt{\beta}}-(1-\lambda)\phi(\cdot\cdot)\frac{\alpha_B}{\sqrt{\beta}}\right)^{-1}\left(\frac{1}{\sqrt{\beta}}\right)$$
$$\times\left\{\begin{array}{l}\lambda\phi(\cdot)\left(\theta^*_{BC}-y_B-\frac{1}{2\sqrt{\alpha_B+\beta}}\varPhi^{-1}\left(\frac{t+\delta}{D}\right)\right)\\+(1-\lambda)\phi(\cdot\cdot)\left(\theta^*_{BC}-y_B-\frac{1}{2\sqrt{\alpha_B+\beta}}\varPhi^{-1}\left(\frac{t}{D}\right)\right)\end{array}\right\}.$$

If $\theta^*_{BC}>y_B+\frac{1}{2\sqrt{\alpha_B+\beta}}\varPhi^{-1}\left(\frac{t+\delta}{D}\right)$, then $\frac{\partial\theta^*_{BC}}{\partial\alpha_B}$ > 0, and thus, $\frac{\partial PC}{\partial\alpha_B}$ < 0. That is, if the state of country B's fundamentals is expected to be weak ex ante, then PC decreases with α_B. On the other hand, if $\theta^*_{BC}>y_B+\frac{1}{2\sqrt{\alpha_B+\beta}}\varPhi^{-1}\left(\frac{t}{D}\right)$, then $\frac{\partial\theta^*_{BC}}{\partial\alpha_B}$ < 0, and thus, $\frac{\partial PC}{\partial\alpha_B}$ > 0. That is, if the state of country B's fundamentals is expected to be strong ex ante, then PC increases with α_B.

From Equation (S7), we obtain

$$
\begin{aligned}
\frac{\partial \theta_{BB}^{*}}{\partial \alpha_B} &= \phi(\cdot)\left(\frac{1}{\sqrt{\beta}}\theta_{BB}^{*}+\frac{\alpha_B}{\sqrt{\beta}}\frac{\partial \theta_{BB}^{*}}{\partial \alpha_B}-\frac{y_B}{\sqrt{\beta}}-\frac{1}{\sqrt{\beta}}\frac{1}{2\sqrt{\alpha_B+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)\right) \\
&= \left(1-\frac{\alpha_B}{\sqrt{\beta}}\phi(\cdot)\right)^{-1}\phi(\cdot)\left(\frac{1}{\sqrt{\beta}}\right)\left(\theta_{BB}^{*}-y_B-\frac{1}{2\sqrt{\alpha_B+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)\right).
\end{aligned}
$$

If $\theta_{BB}^{*} > y_B + \frac{1}{2\sqrt{\alpha_B+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)$, then $\frac{\partial \theta_{BB}^{*}}{\partial \alpha_B} > 0$, and thus, $\frac{\partial NC}{\partial \alpha_B} > 0$. That is, if the state of country B's fundamentals is expected to be weak ex ante, then NC increases with α_B. On the other hand, if $\theta_{BB}^{*} > y_B + \frac{1}{2\sqrt{\alpha_B+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)$, then $\frac{\partial \theta_{BB}^{*}}{\partial \alpha_B} < 0$, and thus, $\frac{\partial NC}{\partial \alpha_B} < 0$. That is, if the state of country B's fundamentals is expected to be strong ex ante, then NC increases with α_B.

Comparative Statics for NC and PC with Respect to y_A

$\frac{\partial NC}{\partial y_A} > 0$ and $\frac{\partial PC}{\partial y_A} < 0$ hold by the following three lemmas (Lemmas 4, 5, and 6).

Lemma 4 *There exists some open interval of* y_A *that satisfies* $\frac{\partial \theta_{AC}^{*}}{\partial y_A} < 0$ *and* $\frac{\partial \theta_{AB}^{*}}{\partial y_A} < 0$.

Proof. $\theta_{AC}^{*}, \theta_{AB}^{*} \to 0$ as $y_A \to \infty$ because $\theta_{BC}^{*} < \theta_{AC}^{*} < \theta_{AB}^{*} < \theta_{BB}^{*}$ holds and $\theta_{BC}^{*}, \theta_{BB}^{*} \to 0$ as $y_B \to \infty$.

Lemma 5 $\frac{\partial \theta_{AC}^{*}}{\partial y_A} < 0$ for all y_A.

Proof. Assume that $\frac{\partial \theta_{AC}^{*}}{\partial y_A} = 0$ for some y_A. Then, from the partial derivatives of Equations (A6) and (S2) with respect to y_A, we obtain

$$0=\lambda\phi(H)\sqrt{\beta}\,(-\frac{\alpha_A}{\beta})+(1-\lambda)\phi(F)\sqrt{\beta}\,\frac{\partial x^*_{A2}}{\partial y_A}.$$

Rearranging the above equation, we get

$$\frac{\partial x^*_{A2}}{\partial y_A}=\frac{\lambda\phi(H)}{(1-\lambda)\phi(F)}\frac{\alpha_A}{\beta}.$$

With this equation, we obtain the following equation from the partial derivatives of Equations (A5) and (S1) with respect to y_A:

$$\frac{\partial\theta^*_{AB}}{\partial y_A}=\lambda\phi(L)\sqrt{\beta}\left(\frac{\alpha_A}{\beta}\frac{\partial\theta^*_{AB}}{\partial y_A}-\frac{\alpha_A}{\beta}\right)+(1-\lambda)\phi(M)\sqrt{\beta}\left(\frac{\lambda\phi(H)}{(1-\lambda)\phi(F)}\frac{\alpha_A}{\beta}-\frac{\partial\theta^*_{AB}}{\partial y_A}\right).$$

Rearranging the above equation, we get

$$\begin{aligned}&\frac{\partial\theta^*_{AB}}{\partial y_A}\left(1-\lambda\phi(L)\frac{\alpha_A}{\sqrt{\beta}}+(1-\lambda)\phi(M)\sqrt{\beta}\right)\\&=-\lambda\phi(L)\frac{\alpha_A}{\sqrt{\beta}}+\lambda\frac{\alpha_A}{\sqrt{\beta}}\frac{\phi(M)\phi(H)}{\phi(F)}\\&=\lambda\frac{\alpha_A}{\sqrt{\beta}}\left(-\phi(L)+\frac{\phi(M)\phi(H)}{\phi(F)}\right)\underset{H<F}{<}\lambda\frac{\alpha_A}{\sqrt{\beta}}(-\phi(L)+\phi(M))\underset{L>M}{<}0.\end{aligned}$$

Because $(1-\lambda)\phi(M)\sqrt{\beta}>0$, the assumption $1-\lambda\phi(L)\frac{\alpha_A}{\sqrt{\beta}}>0$ implies that there exists some y_A that satisfies $\frac{\partial\theta^*_{AC}}{\partial y_A}=0$ and $\frac{\partial\theta^*_{AB}}{\partial y_A}<0$.

However, from the partial derivative of Equation (A3) with respect to y_A and the above results, we obtain

$$\begin{aligned}\frac{\partial\theta^*_{AB}}{\partial y_A}&=\frac{1}{\alpha_A+\beta}\left(\alpha_A+\beta\frac{\lambda\phi(H)}{(1-\lambda)\phi(F)}\frac{\alpha_A}{\beta}\right)\left(1+\frac{(1-q)\phi(Q)}{q\phi(P)}\right)\\&=\frac{\alpha}{\alpha_A+\beta}\left(1+\frac{\lambda\phi(H)}{(1-\lambda)\phi(F)}\right)\left(1+\frac{(1-q)\phi(Q)}{q\phi(P)}\right)>0,\end{aligned}$$

a contradiction.

Therefore, by the intermediate value theorem (contrapositive statement), there exists no y_A that satisfies $\frac{\partial\theta^*_{AC}}{\partial y_A}=0$, and thus, $\frac{\partial\theta^*_{AC}}{\partial y_A}<0$ for all y_A.

Lemma 6 $\frac{\partial\theta^*_{AB}}{\partial y_A} < 0$ for all y_A.

Proof. Assume that $\frac{\partial\theta^*_{AB}}{\partial y_A} = 0$ for some y_A. Then, from the partial derivatives of Equations (A5) and (S1) with respect to y_A, we obtain

$$0 = \lambda\phi(L)\sqrt{\beta}(-\frac{\alpha_A}{\beta}) + (1-\lambda)\phi(M)\sqrt{\beta}\frac{\partial x^*_{A2}}{\partial y_A}.$$

Rearranging the above equation, we get

$$\frac{\partial x^*_{A2}}{\partial y_A} = \frac{\lambda\phi(L)}{(1-\lambda)\phi(M)}\frac{\alpha_A}{\beta}.$$

From the partial derivative of Equation (A3) with respect to y_A and the above equation, we can derive the following result:

$$\begin{aligned}(1-q)\phi(Q)\frac{\partial\theta^*_{AC}}{\partial y_A} &= \frac{q\phi(P)+(1-q)\phi(Q)}{\alpha_A+\beta}\left(\alpha_A+\beta\frac{\lambda\phi(L)}{(1-\lambda)\phi(M)}\frac{\alpha_A}{\beta}\right)\\ &= \frac{\alpha_A}{\alpha_A+\beta}(q\phi(P)+(1-q)\phi(Q))\left(1+\frac{\lambda\phi(L)}{(1-\lambda)\phi(M)}\right) > 0,\end{aligned}$$

which is a contradiction to $\frac{\partial\theta^*_{AC}}{\partial y_A} < 0$ from Lemma 5.

Therefore, by the intermediate value theorem (contrapositive statement), there exists no y_A that satisfies $\frac{\partial\theta^*_{AB}}{\partial y_A} = 0$, and thus, $\frac{\partial\theta^*_{AB}}{\partial y_A} < 0$ for all y_A.

Comparative Statics for NC and PC with Respect to α_A

From Equation (A1) and (A2), we get

$$\sqrt{\alpha_A+\beta}\left(\theta^*_{AB} - \frac{\alpha_A}{\alpha_A+\beta}y_A - \frac{\beta}{\alpha_A+\beta}x^*_{A1B}\right) = \Phi^{-1}\left(\frac{t}{D}\right) := U,$$
$$\sqrt{\alpha_A+\beta}\left(\theta^*_{AC} - \frac{\alpha_A}{\alpha_A+\beta}y_A - \frac{\beta}{\alpha_A+\beta}x^*_{A1C}\right) = \Phi^{-1}\left(\frac{t+\delta}{D}\right) := V,$$

which implies $U < V$. With P and Q, we can easily check that $P > U$ and $Q > V$. Specifically, from Equation (A3), we can check that

$$\frac{t}{D}=q\Phi(P)+(1-q)\Phi(Q)>q\Phi(U)+(1-q)\Phi(Q)=q\frac{t}{D}+(1-q)\Phi(Q),$$

which implies $Q<U$. Because $P>U>Q$ and $V>U>Q$, there exist $\varepsilon_1>0$ and $\varepsilon_2>0$ such that $P=\Phi^{-1}\left(\frac{t+\varepsilon_1}{D}\right)$ and $Q=\Phi^{-1}\left(\frac{t+\varepsilon_2}{D}\right)$.

From the partial derivatives of Equations (A3), (A5), and (A6) with respect to α_A, we obtain

$$\begin{aligned}&(\alpha_A+\beta)\left(q\phi(P)\frac{\partial\theta^*_{AB}}{\partial\alpha_A}+(1-q)\phi(Q)\frac{\partial\theta^*_{AC}}{\partial\alpha_A}\right)\\&=-\beta(q\phi(P)+(1-q)\phi(Q))\frac{\partial x^*_{A2}}{\partial\alpha_A}\\&+q\phi(P)\left(\theta^*_{AB}-y_A-\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t+\varepsilon_1}{D}\right)\right)\\&+(1-q)\phi(P)\left(\theta^*_{AC}-y_A-\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t-\varepsilon_2}{D}\right)\right);\end{aligned}\tag{A12}$$

$$\begin{aligned}(1-\lambda)\phi(M)\sqrt{\beta}\frac{\partial\theta^*_{A2}}{\partial\alpha_A}=&\frac{\partial\theta^*_{AB}}{\partial\alpha_A}\left(1-\lambda\frac{\alpha_A}{\sqrt{\beta}}\phi(L)+(1-\lambda)\phi(M)\sqrt{\beta}\right)\\&-\frac{\lambda}{\sqrt{\beta}}\phi(L)\left(\theta^*_{AB}-y_A-\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)\right);\end{aligned}\tag{A13}$$

$$\begin{aligned}(1-\lambda)\phi(F)\sqrt{\beta}\frac{\partial\theta^*_{A2}}{\partial\alpha_A}=&\frac{\partial\theta^*_{AC}}{\partial\alpha_A}\left(1-\lambda\frac{\alpha_A}{\sqrt{\beta}}\phi(H)+(1-\lambda)\phi(F)\sqrt{\beta}\right)\\&-\frac{\lambda}{\sqrt{\beta}}\phi(H)\left(\theta^*_{AC}-y_A-\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t+\delta}{D}\right)\right).\end{aligned}\tag{A14}$$

Rearranging Equation (A12) with Equations (A13) and (A14), we obtain the following two equations:

$$\left[\begin{array}{l}(\alpha_A+\beta)(q\phi(P)+(1-q)\phi(Q))\dfrac{\phi(F)}{\phi(M)}\dfrac{1-\lambda\dfrac{\alpha_A}{\sqrt{\beta}}\phi(L)+(1-\lambda)\phi(M)\sqrt{\beta}}{1-\lambda\dfrac{\alpha_A}{\sqrt{\beta}}\phi(H)+(1-\lambda)\phi(F)\sqrt{\beta}} \\ \qquad +\beta(q\phi(P)+(1-q)\phi(Q))\dfrac{1-\lambda\dfrac{\alpha_A}{\sqrt{\beta}}\phi(L)+(1-\lambda)\phi(M)\sqrt{\beta}}{(1-\lambda)\phi(M)\sqrt{\beta}}\end{array}\right]\frac{\partial\theta^*_{AB}}{\partial\alpha_A} \tag{A15}$$

$$\begin{aligned}
&=\frac{(\alpha_A+\beta)(1-q)\phi(Q)}{1-\lambda\dfrac{\alpha_A}{\sqrt{\beta}}\phi(H)+(1-\lambda)\phi(F)\sqrt{\beta}}\cdot\frac{\phi(F)\phi(L)}{\phi(M)}\frac{\lambda}{\sqrt{\beta}}\left(\theta^*_{AB}-y_A-\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)\right)\\
&-\frac{(\alpha_A+\beta)(1-q)\phi(Q)}{1-\lambda\dfrac{\alpha_A}{\sqrt{\beta}}\phi(H)+(1-\lambda)\phi(F)\sqrt{\beta}}\cdot\phi(H)\cdot\frac{\lambda}{\sqrt{\beta}}\left(\theta^*_{AC}-y_A-\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t+\delta}{D}\right)\right)\\
&+\frac{\beta(q\phi(P)+(1-q)\phi(Q))}{(1-\lambda)\phi(M)\sqrt{\beta}}\cdot\phi(L)\cdot\frac{\lambda}{\sqrt{\beta}}\left(\theta^*_{AB}-y_A-\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)\right)\\
&+q\phi(P)\left(\theta^*_{AB}-y_A-\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t+\varepsilon_1}{D}\right)\right)\\
&+(1-q)\phi(Q)\left(\theta^*_{AC}-y_A-\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t-\varepsilon_2}{D}\right)\right);
\end{aligned}$$

$$\left[\begin{array}{l}(\alpha_A+\beta)(q\phi(P)+(1-q)\phi(Q))\dfrac{\phi(M)}{\phi(F)}\dfrac{1-\lambda\dfrac{\alpha_A}{\sqrt{\beta}}\phi(H)+(1-\lambda)\phi(F)\sqrt{\beta}}{1-\lambda\dfrac{\alpha_A}{\sqrt{\beta}}\phi(L)+(1-\lambda)\phi(M)\sqrt{\beta}} \\ \qquad +\beta(q\phi(P)+(1-q)\phi(Q))\dfrac{1-\lambda\dfrac{\alpha_A}{\sqrt{\beta}}\phi(H)+(1-\lambda)\phi(F)\sqrt{\beta}}{(1-\lambda)\phi(F)\sqrt{\beta}}\end{array}\right]\frac{\partial\theta^*_{AC}}{\partial\alpha_A} \tag{A16}$$

$$=\frac{(\alpha_A+\beta)q\phi(P)}{1-\lambda\dfrac{\alpha_A}{\sqrt{\beta}}\phi(L)+(1-\lambda)\phi(M)\sqrt{\beta}}\cdot\frac{\phi(M)\phi(H)}{\phi(F)}\frac{\lambda}{\sqrt{\beta}}\left(\theta^*_{AC}-y_A-\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t+\delta}{D}\right)\right)$$

$$-\frac{(\alpha_A+\beta)q\phi(P)}{1-\lambda\frac{\alpha_A}{\sqrt{\beta}}\phi(L)+(1-\lambda)\phi(M)\sqrt{\beta}}\cdot\phi(L)\cdot\frac{\lambda}{\sqrt{\beta}}\left(\theta^*_{AB}-y_A-\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)\right)$$
$$+\frac{\beta(q\phi(P)+(1-q)\phi(Q))}{(1-\lambda)\phi(F)\sqrt{\beta}}\cdot\phi(H)\cdot\frac{\lambda}{\sqrt{\beta}}\left(\theta^*_{AC}-y_A-\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t+\delta}{D}\right)\right)$$
$$+q\phi(P)\left(\theta^*_{AB}-y_A-\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t+\varepsilon_1}{D}\right)\right)$$
$$+(1-q)\phi(Q)\left(\theta^*_{AC}-y_A-\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t-\varepsilon_2}{D}\right)\right).$$

Note that $\theta^*_{AB}-y_A-\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)>\theta^*_{AC}-y_A-\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t+\delta}{D}\right)$, $\frac{\phi(F)\phi(L)}{\phi(M)}>\phi(H)$, and $\frac{\phi(M)\phi(H)}{\phi(F)}<\phi(L)$. Therefore, from Equation (A15), we check whether $\frac{\partial\theta^*_{AB}}{\partial\alpha_A}>0$ if $\theta^*_{AC}>y_A+\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t+\delta}{D}\right)$ and $\theta^*_{AB}>y_A+\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t+\varepsilon_1}{D}\right)$, and thus, $\frac{\partial \mathrm{NC}}{\partial\alpha_A}<0$. That is, if the state of country A's fundamentals is expected to be weak ex ante, then NC decreases with α_A. On the other hand, from Equation (A16), we check whether $\frac{\partial\theta^*_{AC}}{\partial\alpha_A}<0$ if $\theta^*_{AB}<y_A+\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t}{D}\right)$ and $\theta^*_{AC}<y_A+\frac{1}{2\sqrt{\alpha_A+\beta}}\Phi^{-1}\left(\frac{t+\varepsilon_2}{D}\right)$, and thus, $\frac{\partial \mathrm{PC}}{\partial\alpha_A}<0$. That is, if the state of country A's fundamentals is expected to be strong ex ante, then PC decreases with α_A.[20]

20 The case of PC(NC) for fundamentals that are expected to be weak (strong) ex ante can be verified in the same manner.

References

Angeletos, G. M. and A. Pavan, 2004, "Transparency of Information and Coordination in Economies with Investment Complementarities," *American Economic Review Papers & Proceedings*, 94, 91-98

Baig, T. and I. Goldfajn, 2001, "The Russian Default and the Contagion to Brazil," *International Financial Contagion*, edited by S. Claessens and K. J. Forbes, Kluwer Academic Publishers.

Blinder, A. S., M. Ehrmann, M. Fratzscher, J. de Hann, and D.-J. Jansen, 2008, "Central Bank Communication and Monetary Policy: A Survey of Theory and Evidence," *Journal of Economic Literature*, 46, 910-945.

Boot, A. W. A, T. T. Milbourn, and A. Schmeits, 2006, "Credit Ratings as Coordination Mechanisms," *Review of Financial Studies*, 19, 81-118.

Born, B., M. Ehrmann, and M. Fratzscher, 2011, "Central Bank Communication on Financial Stability," ECB Working Paper Series No. 1332, European Central Bank.

Broner, F. A., R. G. Gelos, and C. M. Reinhart, 2006, "When in Peril, Retrench: Testing the Portfolio Channel of Contagion," *Journal of International Economics*, 69, 203-230.

Carlsson, H. and E. van Damme, 1993, "Global Games and Equilibrium Selection," *Econometrica*, 61, 989-1018.

Corsetti, G., A. Dasgupta, S. Morris, and H. S. Shin, 2004, "Does One Soros Make a Difference? A Theory of Currency Crises with Large and Small Traders," *Review of Economic Studies*, 71, 87-113.

Cukierman, A. and A. H. Meltzer, 1986, "A Theory of Ambiguity, Credibility, and Inflation under Discretion and Asymmetric Information," *Econometrica*, 54, 1099-1128.

Cukierman, A., 2009, "The Limits of Transparency," *Economic Notes*, 38, 1-37.

Dasgupta, A., 2004, "Financial Contagion through Capital Connections: A Model of the Origin and Spread of Bank Panics," *Journal of the European Economic Association*, 2, 1049-1084.

Eichengreen, B., E. Prasad, and R. Rajan, 2011, "Rethinking Central Banking," VoxEU (20 September 2011). <http://www.voxeu.org/index.php?q=node/7003>

Eijffinger, S. C. W. and C. A. B. van der Cruijsen, 2010, "The Economic Impact of Central Bank Transparency: A Survey," *Challenges in Central Banking: The Current Institutional Environment and Forces Affecting Monetary Policy*, edited by P. L. Siklos, M. T. Bohl and M. E. Wohar, Cambridge University Press.

Goldstein, I. and A. Pauzner, 2004, "Contagion of Self-Fulfilling Financial Crises due to Diversification of Investment Portfolios," *Journal of Economic Theory*, 119, 151-183.

Goodfriend, M., 1986, "Monetary Mystique: Secrecy and Central Banking," *Journal of Monetary Economics*, 17, 63-92.

Guimaraes, B. and S. Morris, 2007, "Risk and Wealth in a Model of Self-Fulfilling Currency Attacks," *Journal of Monetary Economics*, 54, 2205-2230.

Hoerova, M., C. Monnet, and T. Temzelides, 2009, "Money Talks," ECB Working Paper Series No. 1091, European Central Bank.

Kaminsky, G. L., R. K. Lyons, and S. L. Schmukler, 2000, "Economic Fragility, Liquidity, and Risk: The Behavior of Mutual Funds during Crises," Working Paper, George Washington University.

Kaminsky, G. L., R. K. Lyons, and S. L. Schmukler, 2001, "Mutual Fund Investment in Emerging Markets: An Overview," *World Bank Economic Review*, 15, 315-340.

Kaminsky, G. L., R. K. Lyons, and S. L. Schmukler, 2004, "Managers, Investors, and Crises: Mutual Fund Strategies in Emerging Markets," *Journal of International Economics*, 64, 113-134.

Kaminsky, G. L. and C. M. Reinhart, 2000, "On Crises, Contagion, and Confusion," *Journal of International Economics*, 51, 145-168.

Manz, M., 2010, "Information-based Contagion and the Implications for Financial Fragility," *European Economic Review*, 54, 900-910.

Metz, C. E., 2002, "Private and Public Information in Self-Fulfilling Currency Crises," *Journal of Economics*, 76, 65-85.

Morris, S. and H. S. Shin, 1998, "Unique Equilibrium in a Model of Self-Fulfilling Currency Attacks," *American Economic Review*, 88, 587-597.

Morris, S. and H. S. Shin, 2002, "Social Value of Public Information," *American Economic Review*, 92, 1521-1534.

Morris, S. and H. S. Shin, 2003, "Global Games: Theory and Applications," *Advances in Economics and Econometrics (Proceedings of the Eighth World Congress of the Econometric Society)*, edited by M. Dewatripont, L. P. Hansen and S. J. Turnovsky, Cambridge University Press.

Morris, S. and H. S. Shin, 2004, "Coordination Risk and the Price of Debt," *European Economic Review*, 48, 133-153.

Morris, S. and H. S. Shin, 2005, "Central Bank Transparency and the Signal Value of Prices," *Brookings Papers on Economic Activity*, 2, 1-66.

Morris, S. and H. S. Shin, 2011, "Contagious Adverse Selection," *American Economic Journal: Macroeconomics*, forthcoming.

Morris, S., H. S. Shin, and H. Tong, 2006, "Response to 'Social Value of Public Information: Morris and Shin (2002) Is Actually Pro Transparency, Not Con'," *American Economic Review*, 96, 453-455.

Obstfeld, M., 1996, "Models of Currency Crises with Self-Fufilling Features," *European Economic Review*, 40, 1037-1047.

Oh, F. D., 2012, "Contagion of a Liquidity Crisis Between Two Firms," Working Paper, The Bank of Korea.

Prati, A. and M. Sbracia, 2010, "Uncertainty and Currency Crises: Evidence from Survey Data," *Journal of Monetary Economics*, 57, 668-681.

Sarno, L. and M. P. Taylor, 2001, "Official Intervention in the Foreign Exchange Market: Is It Effective and, If So, How Does It Work?," *Journal of Economic Literature*, 39, 839-868.

Sbracia, M. and A. Zaghini, 2001, "Expectations and Information in Second Generation Currency Crises Models," *Economic Modelling*, 18, 203-222.

Shin, H. S., 2010, "Macroprudential Policies Beyond Basel III," Policy Memo, Princeton University.

Stein, J. C., 1989, "Cheap Talk and the Fed: A Theory of Imprecise Policy Announcements," *American Economic Review*, 79, 32-42.

Sutherland, A., 2004, "International Monetary Policy Coordination and Financial Market Integration," CEPR Discussion Paper No. 4251, Centre for Economic Policy Research.

Svensson, L. E. O., 2006, "Social Value of Public Information: Morris and

Shin (2002) Is Actually Pro-Transparency, Not Con," *American Economic Review*, 96, 448-452.

Takeda, F. and K. Takeda, 2008, "How Large Creditors Affect Corporate Bond Prices through Creditor Coordination," *Journal of International Economic Studies*, 22, 31-49.

Taketa, K., 2004, "Contagion of Currency Crises across Unrelated Countries," IMES Discussion Paper No. 2004-E-22, Institute for Monetary and Economic Studies, Bank of Japan.

Turdaliev, N., 2010, "Communication in Repeated Monetary Policy Games," *International Review of Economics and Finance*, 19, 228-243.

<Abstract in Korean>

오동철*

본 논문에서는 외환위기가 다른 나라로부터 전이되어 오는 상황에서 중앙은행의 커뮤니케이션 및 규제정책이 투기적 환거래자의 거래전략에 어떤 영향을 미치는지를 이론적으로 분석하였다.

이론 모형에서는 경제 펀더멘탈에 대하여 충분한 정보를 가지지 못한 환거래자가 두 나라 외환시장을 대상으로 투기적 환거래(공매도)를 하는 협조게임의 상황을 상정하였다. 환거래자는 한 나라에서의 환거래를 통해 다른 환거래자의 거래 성향을 알게 되고, 그 결과를 다른 나라의 환거래에 적용하는 것으로 가정하였다. 구체적으로 한 나라의 환거래에서 다른 환거래자가 공매도에 적극적인 것으로 확인한 환거래자는 다른 나라 협조게임의 환거래에서 보다 적극적인 성향을 갖게 된다. 이에 따라 다른 나라에서 외환위기가 발생할 가능성이 그만큼 커지게 된다. 이 상황에서 중앙은행은 환거래자에게 경제 펀더멘탈에 대한 정보를 제공함으로써 환거래자의 거래 행태에 영향을 미치게 된다.

모형을 분석한 결과 중앙은행이 제공하는 정보는 경제의 펀더멘탈에 대한 시장의 신뢰에 따라 환거래자의 거래 행태에 미치는 영향이 달라지는 것으로 분석되었다. 특히 경제 펀더멘탈의 강건성에 대한 시장의 신뢰가 강한 경우 중앙은행이 펀더멘탈과 관련하여 정확한 정보를 시장에 제공하는 것이 외환위기 전이의 가능성을 줄이는 효과가 있는 것으로 나타났다. 또한 중앙은행이 환거래의 비용을 늘리거나 수익을 낮추는 정책수단(예컨대, 거시건전성 부담금)을 시행할 경우 동 정책수단은 환거래자로 하여금 서로 (투기적) 환거래를 줄이는 방향으로 협조하게 하는 기제(focal point)로 작동하여 다른 나라로부터 전이되는 외환위기의 가능성을 줄일 수 있음을 보였다.

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457 거시건전성 감독을 위한 정보의 생산과 공유(2011.2) 이인호

458 글로벌 금융위기와 한국 기업부문의 구조조정 방향(2011.2) 김준경

459 인구 고령화의 파급영향 및 대응방향: 노동공급 및 연금제도를 중심으로(2011.2) 김태정

460 우리나라 제조업의 총요소생산성 분석(2011.3) 정선영

461 구조적 VAR 모형 및 세율자료를 이용한 재정정책의 효과 분석(2011.4) 김배근

462 Limits to Arbitrage in the Swap and Bond Markets: the Case of Korea(2011.5) 박하일

463 시스템리스크와 금융규제(2011.5) 이승환

464 경제의 대외개방도 증가가 숙련 및 비숙련 부문의 고용에 미치는 영향(2011.7) 김영준

465 국제금융시스템의 미래(Future of the International Financial Architecture) - 2011년 한국은행 국제컨퍼런스 결과보고서(2011.8) 한국은행 경제연구원

466 SVAR(structural VAR)를 이용한 거시·금융 기간구조(Macro-finance term structure) 모형 분석(2011.8) 윤재호

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