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International policy coordination for financial regime stability under cross-border externalities☆

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ABSTRACT

This paper examines the conditions for effective coordination in financial regulatory policy when banks are politically influential, considering cross-border externalities arising from multinational banking operation. We demonstrate that when banks are inefficient with high loan monitoring costs, regulatory effort is a strategic substitute so that each country's regulator tends to exert lower effort free-riding that of the other countries' regulator. On the other hand, when banks are efficient with lower monitoring costs, regulatory effort is a strategic complement and regulators have lower incentives to free-ride. However, regulators face multiple equilibria and thus financial instability if each of them responds in an overly sensitive manner to another's strategy. In this case, introducing informational barriers can refine multiple equilibria into a unique equilibrium. The results suggest that cooperative financial policy coordination mechanism is more likely to be sustained among countries whose banking sectors' political influence on regulators is smaller and more homogeneous.

1. Introduction

With toil and at times through turmoil, financial regulators around the world have long sought to coordinate their policies for internationally active banks, most notably with the Basel Accords since 1988. The need for international regulatory coordination is clear: regulators have free-riding incentives in their regulatory effort, since it incurs positive externality as well as costs to the regulator. Enforcing strict rules on banks is costly because regulators are not angels—they are concerned not only about financial stability but also about banks, whose political influence through either direct or grassroots lobbying make regulators care for bank profits. "If angels were to govern men, neither external nor internal controls would be necessary," wrote James Madison in support of then newly drafted U.S. Constitution. Likewise, because financial regulators are not angels (some would say *captured*), there is room for Pareto improvement by external or internal means of coordination.[1]

The latest global financial crisis was a spectacular example of a failure of such coordination. Since the revised Basel Accord in 2004 ("Basel II"), national regulators had significant leeway in determining the *de facto* required level of capital for banks,[2] even more so than the original Accord in 1988. Subsequently, mortgage-backed securities and credit default swaps derived from them were assessed to be much safer than later realized, and were assigned only meager amount of required capital. Because regulators were significantly biased toward banking sector profits in setting the required capital, they led banks to be insolvent later when those assets plummeted in prices.[3] Motivated by the culmination of this latest crisis, this paper examines the necessary conditions for success-

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[1] This analogy with government and the quote from James Madison's *Federalist No.51* is motivated from Barth et al. (2008).

[2] By allowing banks to assess the risks of own assets and letting the national authority to supervise, the revised Basel Accord in 2004 gave the national supervisors significant freedom to determine the required capital ratio even though the requirement was *de jure* fixed, at 8% of all risk-weighted assets.

[3] This narrative is a main thesis of Barth et al. (2012).

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ful coordination among financial regulators, given the cross-border regulatory externality and regulators' affinity towards banks.

In our model of multinational banks and captured regulators, we demonstrate that a voluntary coordination to a socially optimal, uniform level of regulation depends crucially on the efficiency of participating countries' banking sectors and the degrees of their political influence. Financial regulatory efforts are strategic substitutes when banks have high monitoring costs, and are strategic complements when monitoring costs are low. When regulatory efforts are strategic substitutes, financial regulators prefer to free-ride other countries' regulatory efforts, resulting in a globally inefficient, lax regulation. When regulatory efforts are strategic complements, multiple equilibria may still cause instability. Nevertheless, introducing informational barriers can reduce the multiple equilibria to a unique equilibrium, whose comparative statics show that the cooperative regulatory regime is more likely to be sustained when the political influence of banking sectors is smaller and more homogenous among participating countries. These findings imply that international policy coordination is more easily achieved among relatively homogenous countries in terms of their banking sector political influence.

The results follow from the setup of our model, which is based on that of Dell'Ariccia and Marquez (2006) and Eldridge et al. (2015). In our model, there are two countries whose representative banking sectors operate as multinational banks in both countries. Each government regulates the domestic and foreign bank operating in its country by setting the *de facto* capital adequacy requirements (or just capital ratio). Given the amount of equity for each bank, this required capital effectively determines the size of risky loans made by the banks. Given this capital regulation, each bank decides its level of monitoring effort which serves to reduce the likelihood of non-performing loans. The aggregate monitoring effort of the domestic bank and the foreign bank then determine the level of financial stability from which everyone benefits, and this gives rise to a positive externality in monitoring and strategic substitutability when it is sufficiently costly.

We contribute to the earlier body of literature by determining the conditions that provide financial regulators higher incentives to free ride other countries' regulatory efforts. Our finding that the financial policy coordination can be sustained effectively among relatively homogeneous countries is consistent with the results in Dell'Ariccia and Marquez (2006). While they do not consider strategic substitutability, they show that centralized regulation is more likely to emerge among relatively homogeneous jurisdictions and entails standards higher than those of the country with the highest individual standards.

We also contribute to the existing literature by adding an explicit discussion on policy coordination. This paper focuses on the difference between strategic complementarity and substitutability of regulatory effort, which is not addressed by the earlier literature that examines the features of cross-border externalities of financial stability. Numerous studies, including Stolz (2002), Aghion et al., (2007), Kohler (2002), and Dalen and Olsen (2004), investigate the optimal mechanism of banking regulation in the presence of cross-border lending. Stolz (2002) examines the optimal design of banking supervision in the presence of cross-border lending, and argues that if supervisors are only accountable to each of their own jurisdictions, they fail to implement the optimal level of supervision from a supranational perspective, and consequently, the probability of bank failures is significantly increased. Aghion et al. (2007) show that global policy coordination cannot be achieved when policy makers are heavily influenced by domestic interest groups. Assuming an overlapping generation model of two countries with a homogeneous, non-storable consumption good, Chang (1997) demonstrates that financial integration may deteriorate the welfare of countries under a non-cooperative policymaking regime. In addition, Kohler (2002) shows that positive spillovers of the coalition formation process and the resulting free rider problem limit the stable coalition size, and increases the incentives to deviate from the coalition. Dalen and Olsen (2004) analyze the optimal policy coordination mechanism by focusing on the impact of cross-border banking and the entry of multi-national banks (MNBs) for banking supervision and regulation. They show that an improper international coordination mechanism for regulation on MNB-subsidiaries lowers capital adequacy requirements.

Finally, as in Morris and Shin (2002) and Angeletos and Pavan (2007), this paper integrates a global game approach to refine multiple equilibria in the case of regulatory efforts being strategic complements. We claim that our approach could provide more explicit policy implications on the unique equilibrium through comparative statics, when compared to the existing literature that emphasize the importance of coordination when externalities are present, such as Loisel and Martin (2001), Jensen (1999), Botman and Jager (2002), Shin (2012), Bruche and Suarez (2010), and Freixas and Holthausen (2004).

The rest of the paper is organized as follows. Section 2 introduces the model and Section 3 examines the equilibrium of international financial policy coordination when regulators have free-riding incentives due to strategic substitutability. Section 4 shows that coordination is required even when banking sectors do not have such free-riding incentives. Section 5 provides empirical evidence supporting the results, and Section 6 discusses the policy implications and concludes.

2. Model

We consider two countries, domestic and foreign, each with a representative bank operating as a multinational bank in both domestic and foreign markets. À la mode of Dell'Ariccia and Marquez (2006) and Eldridge et. al. (2015), each country's financial supervisor regulates banks operating in its territory to maximize its policy objective function specified as a weighted sum of the bank profits and the country's financial stability.

After observing the decision of the financial regulator, the representative bank in each country decides how to allocate its loans between the domestic and foreign markets as well as how much monitoring effort to exert to optimize the amount of non-performing loans. The aggregate monitoring effort of the domestic and foreign banks then determines the overall financial stability of the country. For simplicity and without loss of generality, the banking sectors' aggregate monitoring effort level is interpreted as the level of financial stability that determines the effective rate of return from loans.[4] First, we examine the case of a one-shot game, in which policymakers are thought to be shortsighted and thus employ a non-cooperative Nash strategy.

2.1. Bank optimization

The representative bank uses two strategic variables: one being the monitoring effort over risky loans, and the other being the allocation of loans between domestic and foreign markets. The rate of return from loans in country i is represented as an inverse demand function of loans:

$$r_i = \bar{r}_i - (L_{ii} + L_{ji}) = \bar{r}_i - \left(\frac{\theta_i E_i}{k_i} + \frac{(1-\theta_j)E_j}{k_i} \right), \quad (1)$$

[4] The financial regulator in each country regulates both domestic and foreign banks operating within their domestic market, so a bank at home takes into consideration the foreign regulator's policy, too, when determining the loan allocation and monitoring effort to maximize profits. Since the foreign regulatory policies are already reflected in the domestic banks' decision, it does not make a significantly different qualitative result even if we assume instead that the banking sector makes differing monitoring effort across markets as opposed to our current setup.

where L_{ji} is the loan made by bank j in country i. More specifically, the amount of loans made by bank j in market i, is defined as $L_{ji} = \frac{(1-\theta_j)E_j}{k_i}$ where θ_j is the strategic variable decided by bank j as the share of loan made in market j. Therefore, $1-\theta_j$represents the share of bank j's loans made in market i out of its total loans. Also, E_j is the size of bank j's equity, and k_i is the required capital ratio imposed by country i's financial regulator. Then we have$k_i = \frac{\theta_i E_i}{L_{ii}} = \frac{(1-\theta_j)E_j}{L_{ji}}$, where $\theta_i E_i$represents the equity allocated to the market i by the bank i.[5,6]

Bank i maximizes her profits by deciding her loan portfolio across the domestic and foreign markets, as well as the level of monitoring effort on risky loans. The banks' profit function and its maximization problem are defined as follows[7]:

$$\underset{q_i,\theta_i}{Max}\prod_i = (q_i+\gamma_{ji}q_j)[r_iL_{ii} - \phi_iD_{ii} - \rho_i\theta_iE_i] - [1-(q_i+\gamma_{ji}q_j)]\rho_i\theta_iE_i - c_iq_i^2 + \mu[(q_j+\gamma_{ij}q_i)[r_jL_{ij} - \phi_jD_{ij} - \rho_j(1-\theta_i)E_i] - [1-(q_j+\gamma_{ij}q_i)]\rho_j(1-\theta_i)E_i \quad (2)$$

$$\text{such that } L_{ii} \le D_{ii}+E_{ii},\ L_{ij} \le D_{ij}+E_{ij} \quad (3)$$

where$E_{ii} = \theta_iE_i$and$E_{ij} = (1-\theta_i)E_i$. The choice variable q_i is bank i's level of monitoring effort to maximize its profit. The parameter γ_{ji} represents the degree of cross-border externality of foreign bank j's monitoring efforts on domestic financial stability in country i.[8] Another parameter, ϕ_i is the cost involved with raising deposits, and D_{ii} is the deposit that bank i receives in country i. Furthermore, ρ_i is a parameter representing how costly it is to raise equity (i.e., the cost of capital formation), and c_i represents the costliness of monitoring for bank i, which can also be interpreted as the bank's efficiency. Finally, μ denotes the extent of freedom in transferring profits from an affiliate bank in the foreign market to the headquarter bank in home country.

When banks make greater monitoring efforts, they reduce their non-performing loans and, as a result, improve the overall financial stability. Therefore, we set the level of monitoring effort as an input determining financial stability. Together with foreign bank's monitoring effort, the aggregate level of monitoring $q_i + \gamma_{ij}q_j$determines the domestic financial stability which in turn influences the rate of return from domestic loans. Here, cross-border externalities emerge because banks operate multinationally, making loans in foreign markets and thereby affecting the rate of return.[9]

Based on Eq. (1), assuming that the capital requirement is binding for both countries, the profit function of the banking sector is given as follows:

$$\underset{q_i,\theta_i}{Max}\prod_i = (q_i+\gamma_{ji}q_j)\left[\frac{r_i}{k_i} - \frac{\phi_i}{k_i}(1-k_i)\right]E_i\theta_i - \rho_i\theta_iE_i - c_iq_i^2 + \mu\left((q_j+\gamma_{ij}q_i)\left[\frac{r_j}{k_j} - \frac{\phi_j}{k_j}(1-k_j)\right]E_i(1-\theta_i) - \rho_j(1-\theta_i)E_i\right)$$

2.2. Regulatory choice

The objective of country i's financial regulator is to maximize a weighted sum of the utility (i.e. profit) of the banking sector and the utility of the public based on financial stability [10]:

$$\underset{k_i}{Max}\,W_i = \alpha_i\prod_i(L_i,L_j) + (1-\alpha_i)(q_i+\gamma_{ji}q_j), \quad (5)$$

where a_i is the coefficient representing the weight of political influence commanded by the banking sector of country i. The other coefficient, $1-\alpha_i$, is the political weight of the public's utility represented by the country's financial stability. It is interpreted that the higher α_i is, the heavier influence the banking sector has on the financial regulator, because, with higher value of this parameter, the regulator places higher importance to the banking sector's profit relative to general social welfare gained from financial and economic stability.[11,12]

The structure of the game can be summarized as follows: the financial regulator in each country decides the regulatory policy (the capital adequacy requirement) to maximize the objective function. After observing the government decision, the representative bank in each country maximizes its profit with respect to the two strategic variables: (1) allocation of loans at home and abroad and (2) level of monitoring effort.

3. Policy coordination for financial regulation involving strategic substitutability of regulatory policies

We first define a market equilibrium in which each policymaker decides the regulatory policy as a strategic substitute, in a non-cooperative Nash equilibrium fashion via backward induction. A bank decides how much of its loans to place overseas, and then decides how much effort to put into monitoring. In this setup, the

[5] The representative banking sector has two strategic variables to maximize its profits: i) the monitoring effort level to optimize risky assets and ii) the allocation of available funds between domestic and foreign markets. When the financial regulator increases the capital requirement ratio, the representative bank reduces its risky loans given its equity, eventually reducing the total amount of loans. This reduction in supply increases the rate of return from loans, further inducing greater monitoring effort. Since we examine the impact of cross-border externalities of financial regulation, we do not consider banks' investment opportunities that are free from regulation.

[6] The required capital ratio is therefore set on the basis of host country principle that both domestic and foreign bank subsidiaries follow the host country's regulation, assuming that multinational banks are organized as legally independent subsidiaries. This setup is consistent with the guideline by the Basel Committee on Banking Supervision (2012) under *Principle 13: Home-host relationship* that "supervisors require the local operations of foreign banks to be conducted to the same standards as those required of domestic banks."

[7] The costs of both liability and equity are integrated into the profit function thanks to suggestion by an anonymous reviewer. The separate balance sheet constraints make it clear that each subsidiary in one host country is regulated by the host country's rules only, not liable for the insolvency of the subsidiaries in other countries.

[8] We assume$(q_i+\gamma_{ji}q_j) \in [0,1]$. When there is no financial instability, there is no non-performing loan with $(q_i+\gamma_{ji}q_j) = [0,1]$. When financial stability is at its worst, all loans made by banks become non-performing loans with $(q_i+\gamma_{ji}q_j) = 0$; in other words, all bank assets are junk with no retrievable return.

[9] Further explanation on how such externalities emerge can be made as follows. Suppose we have bank i. When other banks have stricter screening and monitoring procedures, the aggregate defaults are reduced. Then individual loans of bank i too are improved because debtors from this bank have financial ties with debtors from the other banks. Because of this positive externality, we let $q_i+\gamma_{ji}q_j$ to be interpreted as bank i's redemption probability.

[10] The stability of the domestic financial market is determined not only by the domestic banks' monitoring effort but also by that of foreign banks, adjusted by the parameter γ. We also assume the objective function of the financial regulator to be equivalent to that of the social planner.

[11] Dell'Ariccia and Marquez (2006), whose model most closely resembles ours, set the weight of financial stability as $(1\text{-}\alpha)\beta$ in the objective function, assuming that β is a scaling factor of financial stability. As suggested by an anonymous reviewer, we simplify it by setting β=1. We know that bank profit is positively affected by the financial stability of the economy. The optimal level of financial regulation on capital adequacy requirements, that maximize social welfare, is higher than the level of capital adequacy requirements that maximize banking sectors' profits. Therefore, the higher α_i is, the lower the optimal k^*, eventually lowering the level of financial stability, $q_i+\gamma_{ji}q_j$, as shown in Proposition 2.

[12] It is conceivable that the influence of government on regulators can be as significant as that of banks. However, we do not make this distinction but rather interpret that even government influence can be traced back in origin to banks' lobbying and contribution to politicians in the first place. Therefore, we represent as the parameter α the extent of political connection between banks and regulators, either directly or through lobbying.

optimal level of monitoring effort by each bank is given by the first order condition of the bank's profit maximization problem as follows[13]:

$$\frac{\partial \prod_i}{\partial q_i} = 0 \rightarrow q_i^* = \frac{E_i}{2c_i L_i}\left(\phi_i + \mu\gamma_{ij}\phi_j + \frac{\theta_i}{k_i}(r_i - \phi_i) + \frac{\mu\gamma_{ij}}{k_j}(1-\theta_i)(r_j - \phi_j)\right) \tag{6}$$

The optimal allocation of loans is determined by the following other first order condition, represented in terms of the level of optimal effort given as the above.

$$\frac{\partial \prod_i (q_i^*)}{\partial \theta_i} = 0 \rightarrow \theta_i^* = \frac{2c_i}{E_i\omega^2}\left(z\omega + \rho_i + \frac{(\phi_i - r_i)(z+\gamma_{ij}q_i)}{k_i} - \frac{\phi_i\omega}{2c_i} + \mu\left(\left(\frac{r_j-\phi_j}{k_j}\right)\left(\gamma_{ij}\left(\frac{E_i\omega}{2c_i} - z\right) - q_i\right) + \phi_i\gamma_{ij}\frac{E_i\omega}{2c_i} + \rho_j\right)\right) \tag{7}$$

Taking the banks' strategies into account, the financial regulator in each country decides the required capital ratio k_i.[14] When a policymaker is shortsighted, it chooses a non-cooperative Nash equilibrium strategy of a one-shot game. The shortsighted financial regulator's objective is defined as maximizing its own politically influenced welfare function given the other country's regulatory policy, as follows:

$$\underset{k_i}{Max}\, W_i(k_i, k_j) = \alpha_i \prod_i^*(k_i, k_j) + (1-\alpha_i)\left(q_i^*(k_i, k_j) + \gamma_{ji}q_j^*(k_i, k_j)\right) \tag{8}$$

However, when the policymaker (i.e., the financial regulator), is more farsighted, with a sufficiently high discount factor, it chooses a cooperative strategy from the joint-welfare maximization :[15]:

$$\begin{aligned}&\underset{k_i}{Max}\left(W_i(k, q_i^*, q_j^*) + W_j(k, q_i^*, q_j^*)\right)\\ &= \underset{k}{Max}\left(\alpha_i \prod_i^*(k) + (1-\alpha_i)\left(q_i^*(k) + \gamma_{ji}q_j^*(k)\right)\right.\\ &\left.+\alpha_j \prod_j^*(k) + (1-\alpha_j)\left(q_j^*(k) + \gamma_{ij}q_i^*(k)\right)\right)\end{aligned}$$

From the comparative statics of the optimal monitoring effort levels and the equilibrium welfare under the non-cooperative regime, we obtain the cross-border externality of financial regulation as summarized in Lemma 1. [16,17]

Lemma 1. *Each country's financial regulation policy creates a positive externality in that a higher capital adequacy requirement of a country increases the monitoring effort of the other country's banking sector.*

Proof. See the Appendix.

Now, we examine the conditions for strategic substitutability in regulatory policies, given the current setting of capital requirement ratio regulation. By checking the cross partial derivatives of the social welfare function with respect to each country's regulatory policy variables, we can determine when the policies are strategic substitutes or complements. We show that all of higher cost of monitoring, bigger size of foreign bank's equity relative to domestic bank's, and greater degree of level of international financial market integration make the financial regulatory policy more likely to be a strategic substitute.

Proposition 1. *When banking sectors' monitoring cost c is higher than a critical level T and the foreign bank's equity E_j is smaller than the domestic bank's equity E_i, it is more likely that the financial regulatory policy (*i.e.*, the required capital ratio) is a strategic substitute.*

Proof. See the Appendix.

Proposition 1 demonstrates that when the banking sector is inefficient, it is more likely that the financial regulatory policy is a strategic substitute, so that there is a higher incentive for each country to free-ride the other country's policy. The intuition behind this result is that when monitoring is costly, stricter regulation is costly not only to the banking sector but also to the regulator whose objective function includes bank profits.[18] As a result, each regulator has greater incentive to free-ride the other's policy through lax regulation, while benefiting from the other country's relatively tighter regulation and higher level of monitoring.

Moreover, when the domestic banks' equity size is larger than that of the foreign banks, the foreign banking sector has a smaller impact on the domestic market, giving the domestic banking sector less incentive to coordinate with the foreign banking sector as shown in Fig. 1. [19] In addition, when the loan monitoring cost is higher than the critical level, the higher financial market integration provides increased incentive to free-ride the foreign country's regulatory effort. These results imply that when the banking sector of the partner country has greater equity and greater monitoring effort, a country's financial regulator has higher incentive to coordinate with that country as the gains from coordination are larger. In contrast, when a country's banking sector equity is larger than the partner's, the incentive for policy coordination becomes lower as the gains from coordination are smaller.

[13] We assume that banks do not make separate monitoring effort between the home and foreign markets but makes a single decision.

[14] The regulation of the capital requirement ratio can be interpreted as a form of general financial supervision to enhance banking sector's financial stability.

[15] The policy objective function of the non-cooperative game is the welfare maximization problem of each country given the other country's strategy, while the objective function of the cooperative game is the joint welfare maximization problem with respect to the coordinated regulatory policy. Although the discount factor that shows the level of far-sightedness can be considered as a continuous variable, the objective functions of the cooperative game and non-cooperative game cannot be combined to a single continuous function since the concept of the strategic variables and the functional forms of two games are different.

[16] The positive externality arises in such a way that more prudent financial regulation of a country induces greater monitoring in another country, resulting in greater welfare. Whether a bank's increased monitoring complements or substitutes that of another country depends on the assumption of the strategic characteristics of monitoring efforts of competing banks. The assumption of the cross-border spillover effects of financial stability implies strategic complementarity of the monitoring efforts of competing banking sectors.

[17] Alternatively, we may suppose that the monitoring effort of the subsidiary bank in the foreign country is decided independently from the parent bank in the home country. In that case, the equilibrium can be determined from solving the profit maximization with respect to both the monitoring at home and abroad, q_{ii} and q_{ij} as well as the loan allocation parameter θ. We then have the following new profit maximization problem, in which the financial stability in each country is determined by the domestic and foreign monitoring efforts set for that specific country. $\underset{q_{ii},q_{ij},\theta_i}{Max}\prod_i = (q_{ii} + \gamma_{ji}q_{jj})[r_i\frac{\theta_i}{k_i} - \phi_i\frac{\theta_i - k_i}{k_i}]E_i - \rho_i\theta_i E_i - \theta_i c_i q_{ii}^2 + \mu((q_{ij} + \gamma_{ij}q_{ii})[r_j\frac{(1-\theta_i)}{k_j} - \phi_j\frac{(1-\theta_i)-k_j}{k_j}]E_i - \rho_j(1-\theta_i)E_i) - (1-\theta_i)c_i q_{ij}^2$ The optimal levels of monitoring are determined from the following first order conditions: $\frac{\partial \prod_i}{\partial q_{ii}} = 0 \rightarrow q_{ii}^* = \frac{E_i}{2\theta_i c_i}\left(\frac{r_i\theta_i - \phi_i(\theta_i - k_i)}{k_i} + \frac{\mu\gamma_{ij}(r_j(1-\theta_i) - \phi_j(1-\theta_i-k_j))}{k_j}\right)$, $\frac{\partial \prod_i}{\partial q_{ij}} = 0 \rightarrow q_{ij}^* = \frac{E_i\mu\gamma_{ij}(r_j(1-\theta_i) - \phi_j(1-\theta_i-k_j))}{2(1-\theta_i)c_i k_j}$ As can be seen from above, even when the subsidiary abroad decides its monitoring separately, the headquarter bank's monitoring is still affected by the foreign country's regulation. Therefore, we still observe cross-border externalities.

[18] When a country's banking sector is inefficient, high required capital ratio is costly to its regulators since it reduces bank's profits and eventually their utility derived from the contribution from precisely those banks.

[19] Eldridge et. al. (2015) argue that the authority regulating a smaller market has a smaller impact on global interest rates and therefore a stronger incentive to relax regulatory enforcement. However, in this paper, when the foreign bank's equity is larger, it is more likely that regulatory efforts are strategic complements because the foreign regulator has less incentive to free-ride home country's effort. Our model's mechanism differs from that of Eldridge et. al. (2015) in that we explicitly set positive cross-border externalities of regulation that dominate the negative impact of the loan size on interest rates.

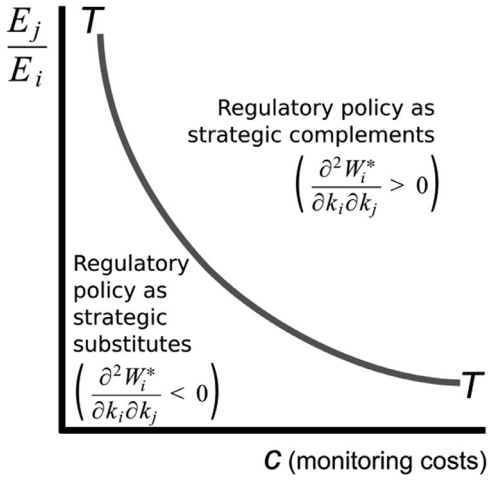

Fig. 1. Impact of relative equity size on the property of regulatory policies.

Based on Lemma 1 and Proposition 1, we show in Corollary 1 that a joint-welfare maximizing financial policy coordination cannot be sustained when both policymakers are shortsighted.

Corollary 1. *International policy coordination for cooperative regulatory policy might not be sustained when $c > T$ and both policy makers take shortsighted approaches.*

Proof. See the Appendix.

The intuition behind Corollary 1 is that positive cross-border externalities in financial regulation provide incentives to free-ride when there is no credible enforcement mechanism for cooperation (i.e., where a non-cooperative Nash regulatory strategy is taken in a shortsighted, one-shot game approach). However, when financial regulators are rather farsighted, the financial regulatory game becomes a repeated game, where cooperative regulatory strategies are Nash equilibrium. Therefore, introducing a coordination mechanism in regulation may help reach a cooperative equilibriums by making the cooperative strategies self-enforcing, turning the game into a repeated one.

The difference in the parameter expressing the banks' political influence, α_i, represents the asymmetry of the political structure of a financial regulatory system. We state as Corollary 2 that the degree of political asymmetry among countries plays a major role in implementing effective coordination mechanism.[20]

Corollary 2. *Given the strategic substitutability of financial regulatory policies when $c > T$, if countries show relatively low asymmetry in political economic characteristics and take long-term policy approaches as represented in a higher discount factor, adopting simple coordination mechanism may enable cooperation in international regulatory policies even without a credible enforcement mechanism.*

Proof. See the Appendix.

Corollary 2 implies that when countries show fairly large asymmetry in politico-economic structures and are relatively shortsighted (low discount factors), the self-enforcement condition for cooperation cannot be sustained without a credible external enforcement mechanism. As shown in Eq. (A6), when the asymmetry of the political economic structures is larger than a critical level, say with $\sigma > \underline{\sigma}$ where σ is defined as the difference $|\alpha_i - \alpha_j|$, it is more likely that each country has larger incentive to deviate from the cooperative policies.

Therefore, when the self-enforcement condition for cooperative policies is not satisfied due to low discount factors and high degree of politico-economic heterogeneity, it is necessary to introduce a third-party enforcement mechanism. Such credible enforcement mechanism should make the cooperative financial regulatory policy a dominant strategy, as summarized in Corollary 3.

Corollary 3. *When the self-enforcement condition for the cooperative financial regulatory policies is not satisfied due to policymakers' low discount factors and a high degree of politico-economic heterogeneity among coordinating countries, effective financial policy coordination can only be sustained with the introduction of a credible, third party enforcement mechanism.*

As has been shown in the Corollary 3, regulators that discount future financial stability more heavily choose more lax regulation. In addition, when the political economic heterogeneity among coordinating countries is higher than a critical level, (i.e., when $\sigma > \underline{\sigma}$), the financial regulator that is under higher banking sector influence (i.e. that with higher α) will deviate to a lower capital requirement ratio k leading to the eventual coordination failure.

Therefore, if $\sigma > \underline{\sigma}$, introducing a credible enforcement mechanism by a third party is required for effective coordination.[21] Considering the real world constraints that it is politically complicated to introduce such a mechanism among different countries, Corollary 3 suggests that cooperation in financial policy will more likely work among counties whose policymakers, in their decision-making processes, have high discount factors and relatively homogenous degrees of influence from banks.

Finally, taking cross-border externalities into consideration, we show in Proposition 2 that when financial regulatory policies are strategic substitutes, the greater political influence the banking sector commands in each country the less likely it is that the socially optimal policy is adopted. When a financial sector has higher political influence over the regulator, with higher α, the level of capital adequacy requirement determined by the regulator decreases, eventually leading to lower financial stability in each country.

Proposition 2. *When financial regulatory policies are strategic substitutes with $c > T$, if the representative banking sector commands higher political influence on the financial policy making process with higher α, it is more likely that the capital adequacy requirement k is lowered, leading to a lower level of financial stability.*

Proof. See the Appendix.

Proposition 2 shows that greater political pressure from banks can lead to lower standards in financial regulation with higher probability for financial instability. Therefore, even though α is

[20] We assume the policy coordination mechanism to take the form of a repeated game structure as in most coordination games. In a repeated game, each country's regulator takes a tit-for-tat strategy: a country keeps the cooperative strategy as long as the partner keeps the cooperative strategy. For simplicity and without loss of generality, we assume that the countries take the trigger strategy of indefinitely lasting retaliation once the other takes a non-cooperative move. As well known, the trigger strategy is an extreme type of retaliation against a deviation strategy, and in that respect, assuming that countries pursue this strategy may be regarded as unrealistic in comparison to the tit-for-tat strategy. However, the assumption of trigger strategy provides a clear-cut description of the impact of the discount factor on the equilibrium choice of the cooperative strategy.

[21] The role of a credible external enforcement mechanism is to make cooperative financial regulatory policy a dominant strategy for all countries involved in the policy coordination. The typical way used to make a cooperative financial regulatory policy into a dominant strategy is to impose heavy enough penalties against a deviation strategy, making the payoffs from the non-cooperative policy lower than the those from the cooperative policy. However, considering the international political reality that such credible mechanism to enforce the penalty does not exist, the self-enforcing condition for cooperative regulatory policy can be interpreted as a unique condition for cooperative policy coordination.

not a choice variable of the bank in this model, it is socially more desirable to have a lower α, i.e., the lower political influence of banks, which provides regulators lower incentives to free-ride other countries' regulatory efforts when financial regulatory policies are strategic substitutes with $c > T$.

4. Policy coordination for financial regulation under strategic complementarity of regulatory policies

When financial regulatory policies have strategic complementarity between countries with cross-border externalities, the regulatory effort of one country is complemented by those of others. Therefore, each country has no incentive to free-ride the regulatory efforts of neighboring countries; hence, the explicit arrangement of an international policy coordination mechanism for cooperative regulatory measures is not required to prevent the under-provision of aggregate regulatory effort.

Nonetheless, strategic complementarity of financial regulatory policies creates another problem, that of economic uncertainty due to multiple equilibria. When regulatory effort is a strategic complement, both under-provision and over-provision of regulatory effort may ensue as multiple equilibria. Conditions for each type of equilibrium are examined in the next section.

4.1. Multiple equilibria

In contrast to when financial regulatory policies are strategic substitutes among neighboring countries with cross-border externalities, each country does not have the incentive to free-ride on other countries' monitoring effort when the policies are strategic complements. In such case, a country's gains from monitoring increase as the other countries make similar effort. However, strategic complementarity induces multiple equilibria under complete information and generates uncertainty. We examine in this section the conditions for a unique equilibrium under such a case. First we present the condition for the regulatory policy's strategic complementarity as Lemma 2.

Lemma 2. *The strategic complementarity of financial regulatory policies holds when the loan monitoring cost is lower than a critical level.*

Proof. $\frac{\partial^2 W_i^*(k_i,k_j)}{\partial k_i \partial k_j} = \alpha_i \frac{\partial^2 \prod_i^*(k_i,k_j)}{\partial k_i \partial k_j} + (1-\alpha_i)\left(\frac{\partial^2 q_i^*(k_i,k_j)}{\partial k_i \partial k_j} + \gamma \frac{\partial^2 q_j^*(k_i,k_j)}{\partial k_i \partial k_j}\right) > 0$ if $c < T$ as shown in the proof of Proposition 1. □

Under complete information about payoffs from each type of regulatory policies, there are multiple equilibria when the policies are strategic complements. Eq. (9) represents such case of strategic complementarity that produces multiple equilibria [22]:

$$-\frac{\partial^2 W_i^*(k_i,k_j)/\partial k_i \partial k_j}{\partial^2 W_i^*(k_i,k_j)/(\partial k_i)^2} > 1 \tag{9}$$

These cases arise when the strategic complementarity is sufficiently strong so that each financial regulator responds to other country's regulatory policies quite sensitively. As a result, the existence of more than one equilibrium then leads to an inherent uncertainty in the regulatory regime, implying greater financial instability. Moreover, the high degree of cross-border externalities in financial markets aggravates the financial instability, as stated by Proposition 3.

[22] The condition for a unique equilibrium in the financial policy coordination game is given as: $|-\frac{\partial^2 W_i^*(k_i,k_j)/\partial k_i \partial k_j}{\partial^2 W_i^*(k_i,k_j)/(\partial k_i)^2}| < 1$. This condition implies that there can be a unique equilibrium when the strategic complementarity is contained within the following range: $0 < -\frac{\partial^2 W_i^*(k_i,k_j)/\partial k_i \partial k_j}{\partial^2 W_i^*(k_i,k_j)/(\partial k_i)^2} < 1$. In the same spirit, given strategic substitutability of financial regulator policies, the condition for a unique equilibrium is: $-1 < -\frac{\partial^2 W_i^*(k_i,k_j)/\partial k_i \partial k_j}{\partial^2 W_i^*(k_i,k_j)/(\partial k_i)^2} < 0$.

Proposition 3. *Given the strategic complementarity of financial regulatory policies, when financial cross-border externalities represented by γ and μ are higher, multiple equilibria are more likely to be present in the international financial regulatory policy game.*

Proof. See the Appendix.

This implies that, as financial markets are increasingly integrated along with higher cross-border externalities, the strategic complementarity of financial regulatory policies increases, with the regulatory decision becoming more sensitive to those of the other countries.[23]

It has been shown in Proposition 1 that when the banking sector's efficiency is lower than a critical level, financial regulatory policies are strategic substitutes, where each country has a strong incentive to deviate to non-cooperative policies. On the other hand, if the monitoring cost of the banking sector is lower than the critical value, the regulatory policies are strategic complements; the free-riding incentives then disappear, although financial stability is reduced due to multiple equilibria under complete information. The basic features of strategic complementarity and substitutability can be characterized with the following payoff matrix of each type of financial regulatory policy.

Under complete information about payoffs, financial regulatory policies are strategic complements if the payoffs are given as $C_i > H_i > N_i > D_i$. However, they are strategic substitutes if the payoffs are given as $H_i > C_i > D_i > N_i$. As shown in Proposition 1, financial regulatory policies become strategic complements when the monitoring costs are lower than a critical value. If, in addition, regulators are highly sensitive to each other's strategy as noted in Eq. (9), the financial regulatory regime displays multiple equilibria. Such case results in uncertainty in the financial regulatory regime, unless a coordination mechanism succeeds to reduce that uncertainty. This further condition is summarized in Corollary 4.

Corollary 4. *When financial regulatory policies are strategic complements, with relatively lower bank monitoring costs, it is required to introduce an international financial policy coordination mechanism to reduce the uncertainty in the financial regulatory regime due to multiple equilibria, even if there is no free-riding incentive among regulators.*

4.2. Unique equilibrium

To resolve the issues of uncertainty caused by multiple equilibria when financial regulatory policies are strategic complements, we take a global game theoretic approach by introducing informational barriers. In particular, we consider the case in which the differing degrees of banking sector efficiency (i.e., monitoring costs) are unknown. Given the barriers, each financial regulator has a normal prior on the state of the banking sector's efficiency, as $c \sim N(m_c, \sigma_c)$, and observes private signals about the its monitoring cost, $s_i = c + \varepsilon_i$ with normally distributed noise $\varepsilon_i \sim N(0, \sigma_\varepsilon)$. After refining the equilibrium through iterated elimination of dominated strategies, we obtain a unique equilibrium if the noise of the signal $\sigma_\varepsilon/(\sigma_c)^2$ is small enough as in the general context of a global game. For some critical value of monitoring cost, c^*, in the equilibrium obtained after iteratively eliminating dominated strategies, each country cooperates by exerting sufficient regulatory effort if and only if $c < c^*$.

If the noisy signals observed by regulators are reduced with a repeated refinement process, the multiple equilibria causing finan-

[23] This result may explain herd behavior and the resultant volatility in financial markets in that herd behavior is magnified when markets are integrated, having lower transaction costs.

cial instability can be reduced into a unique point.[24] This result is stated in Proposition 4.

Proposition 4. *Given financial regulatory policies as strategic complements, the multiple equilibria of financial regulation is reduced to a unique equilibrium if and only if* $\sigma_\varepsilon/(\sigma_c)^2 \leq 2\pi$.

Proof. See the Appendix.

Now we examine the features of the unique equilibrium thus derived. Through the comparative statics of the critical level $\hat{c}$ of monitoring costs with respect to both the absolute and relative degrees α of banks' political influence, we show that even in the unique equilibrium, the cooperative financial regulatory regime is more likely to be sustained when banking sectors in coordinating countries command smaller and more homogenous political influence.

The limiting critical value $\hat{c}$ of the monitoring cost as the size of the noise tends to 0 is defined as follows:

$$G(\hat{s},\hat{c}) = F((\hat{s}-\hat{c})/\sigma_\varepsilon)(N_i(\hat{c}) - D_i(\hat{c})) - \left(1 - F((\hat{s}-\hat{c})/\sigma_\varepsilon)\right)(C_i(\hat{c}) - H_i(\hat{c})) = 0.$$

With higher $\hat{c}$, the cooperative regime is more likely to be sustainable. First, we check via the implicit function theorem how the critical value of the monitoring cost is affected by the degree of financial sector influence. If the function $G(\hat{s},\hat{c})$is continuous in $\hat{c}$ and α, and $G_c \neq 0$, then the impact of the financial sector's political influence on financial stability can be determined by checking the sign of $\frac{\partial \hat{c}}{\partial \alpha} = -\frac{G_\alpha}{G_c}$.

Proposition 5. *The comparative statics of the unique equilibrium, obtained via repeated refinement of dominated equilibrium after introducing informational barriers about banking sectors' efficiency, shows that the cooperative financial regulatory regime is more likely to be sustained when the degrees of banking sectors' political influence are smaller and more homogeneous among coordinating countries.*

Proof. See the Appendix.

Propositions 2 and 5 together show that, regardless of whether financial regulatory efforts are strategic substitutes or complements, coordination is more likely to be sustained when banking sectors' political influence is smaller and more homogeneous in its form. In particular, when regulatory policies are strategic substitutes, international coordination mechanism can improve social welfare by reducing incentive to free-ride neighboring countries' efforts. Even when there is no such incentive, such as when the policies are strategic complements, a coordination mechanism can improve social welfare by reducing financial instability caused by multiple equilibria.

5. Empirical evidence

We present in this section some empirical tests of the main results obtained from the previous sections, which can be summarized as follows:

a. the greater the banking efficiency (i.e. the smaller the monitoring costs c) and the smaller the domestic banking sector equity E_i, the greater the incentive to implement stricter regulation, (Proposition 1) and
b. the greater the political influence banks have on regulatory decisions, the more likely that the regulator implements lenient regulation. (Propositions 2 and 5)

Table 2 shows the regression results that serve as tests of these theoretical findings. The first explanatory variable (z_1), the depth of credit information, proxies the banking efficiency parameter, inversely related to monitoring costs c. The index, available from the World Development Indicators at the World Bank (WB), is constructed so that it ranges from 0 to 8, with 8 indicating the highest degree of overall available credit information for each country. This index is described by WB as "a measure of rules affecting the scope, accessibility, and quality of credit information available through public or private credit registries" and is a good proxy for bank efficiency (or monitoring costs).[25] However, this index data has only been collected since 2013, and five data points are available at most. We thus take the average of the three values during 2013–2017 and treat the variable as time-invariant for each country.

The second explanatory variable (z_2), the supervisory authority independence index, proxies the political influence of the banking sector on the supervisory authority's regulatory decisions.[26] The index, available for four time periods during 1999–2011, was constructed by Barth, Caprio and Levine (2013) based on a series of four survey results obtained by the World Bank regarding banking supervision practices during the same years. The index score ranges from 0 to 3, with the latter representing the greatest degree of independence. The score is the sum of binary answers to three questions related to independence from government, independence from banks, and whether the head of the authority should have a fixed term of office, respectively. Because of its direct relevance, this index is, in our view, the best proxy available for measuring the political influence of banks. However, the questions on the surveys changed slightly each time, as did the criteria for the index, rendering the data incomparable across different time periods. For this reason, this index is averaged across time for each country as well.

The third explanatory variable (z_3), the supervisory authority power index, is also from Barth, Caprio and Levine (2013), based on the same World Bank surveys. This index ranges from 0 to 14 with the latter representing the greatest degree of supervisory power. It is composed, similar to the independence index, as the sum of binary answers to survey questions—this time regarding issues such as whether the supervisory authority has the right to meet banks' external auditors.[27] We include this variable to control for the effectiveness of supervisory authorities in imposing the appropriate bank capital ratios that they perceive optimal. Finally, the total banking sector equity (x_t) is included, calculated as the banking sector capital ratio times the total banking sector asset obtained from World Bank's Global Financial Development Data.

[24] As well known, when strategic variables are strategic complements under complete information with the sensitivity higher than a critical level, uncertainty is unavoidable due to multiple equilibria. However, the assumption of complete information under which every agent has fully correct information about the economic fundamentals with everyone obtaining the same correct information is unrealistic in actual financial markets. Therefore, the multiple equilibria and the resulted uncertainty under complete information can be regarded as rather theoretical uncertainty only possible under the not so likely, complete information case. To accommodate more realistic features, we introduce informational barriers as in Morris and Shin (1998) and proceed through equilibrium refinement with iterated updating of information, eventually leading to a unique equilibrium. This uniqueness of equilibrium enables us to predict market outcome and therefore draw policy implications to improve financial stability.

[25] Some other common measures of bank efficiency such as a bank overhead costs ratio, non-performing loans ratio, and net interest margin are more likely to be endogenously determined with bank capital ratios, as any changes to a banks' financing structure would incur them to change their portfolio/revenue structure and vice versa.

[26] Under the Basel Accords, national supervisory authorities have significant discretion on implementing the international capital regulations so that they can be considered regulators themselves. Therefore, we do not make a strict distinction between the two.

[27] Other questions include whether the supervisory authority can take legal actions against banks'external auditors, whether the authority can force a bank to change its internal organization structure, and whether off-balance sheet items are disclosed to supervisors. The full list can be seen in the authors' original paper.

Table 1
Payoffs from each case of financial regulatory regime.

	Cooperative financial regulatory regime	Non-cooperative financial regulatory regime
Cooperative financial policy (k^C)	$SW_i(k_i^C, k_j^C) = C_i$	$SW_i(k_i^C, k_j^N) = D_i$
Non-cooperative financial policy (k^N)	$SW_i(k_i^N, k_j^C) = H_i$	$SW_i(k_i^N, k_j^N) = N_i$

Table 2
Monitoring costs and bank capital ratios.

	Dependent variables (y, $\tilde{y}$): Simple capital ratio (%)			Risk-adjusted capital ratio (%)		
	(1)	(2)	(3)	(4)	(5)	(6)
(z_1) Depth of credit information index	0.460***	0.516***	0.480***	0.197	0.093	0.191
(from 0 = low to 8 = high)	(0.140)	(0.138)	(0.138)	(0.234)	(0.221)	(0.232)
(z_2) Supervisory authority independence index	0.210			0.935**		
(from 0 = low to 3 = high)	(0.414)			(0.397)		
(z_3) Supervisory authority power index		0.289**			0.101	
(from 0 = low to 14 = high)		(0.129)			(0.153)	
($z_2 z_3$) Supervisory independence times power			0.040			0.073**
			(0.033)			(0.032)
(x_t) Total banking sector capital (in log)	−0.879***	−0.921***	−0.878***	−0.949**	−0.973***	−0.941***
	(0.130)	(0.136)	(0.128)	(0.165)	(0.166)	(0.166)
Observations	1612	1647	1612	1593	1628	1593
Adjusted R^2	0.215	0.250	0.222	0.173	0.170	0.173

Note: Table 2 shows the results of regressing each of the 113 different countries' banking sector capital adequacy ratios from 1998–2015 based on its related characteristics collected from World Bank's World Development Indicators database. The depth of the credit information index measures rules affecting the scope, accessibility, and quality of credit information available through public or private credit registries. Higher values of the index indicate the availability of more credit information from either a public registry or a private bureau to facilitate lending decisions. Supervisory authority independence and power indices are from Barth, Caprio and Levine (2013), and are based on a series of World Bank surveys regarding banking supervision practices. Simple and risk-adjusted capital ratios are from World Bank's Global Financial Development Data. Arellano (1987)'s robust standard errors are used and reported in brackets. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

As for dependent variables, there are two different measures of bank's capital adequacy: one simple (y) and the other risk-adjusted ($\tilde{y}$). Specifically, the former is a naïve ratio of total bank equity capital to total assets, whereas the latter is the ratio of bank equity to the so-called "risk-weighted assets", calculated according to the Basel Accords and available at World Bank's Global Financial Development Data. The risk-weighting system adjusts the adequacy ratio downward when banks take more risky assets, and upward when they take safer assets.[28] In other words, if two banks have the same amount of assets and equity capital, the one with a riskier portfolio will have a lower risk-adjusted capital ratio.

Ordinary least square regressions are run based on the annual data of 113 countries over the period of 1998–2015. The panel is unbalanced, with T_i, the total number of periods of available data for each country ranging from 1 to 17. Summary statistics for top 40 countries in banking sector size are included in the Appendix. With this panel data, the regression equation is set up as follows:

$$y_{it} = \boldsymbol{z}_i \boldsymbol{\gamma} + x_{it}\beta + \lambda_t + \varepsilon_{it},$$

with $\boldsymbol{z}_i$ being the vector of the time-invariant variables (banking efficiency and banking sector political influence indices), and x_{it} being the time-varying variable (banking sector equity). The coefficient vectors γ and β are the estimated parameters of interest, and are the same lengths as z_i and x_{it}, respectively. In addition, a fixed-effect term for each year, λ_t, is included to account for overall movements in capital ratios across countries. The errors, ε_{it}, may be due to variables not included, or to the friction by which supervisory authorities are unable to impose their optimal regulatory ratios contemporaneously. The estimated parameters are presented under columns (1)–(3) for simple capital ratios and (4)–(6) for risk-adjusted bank capital ratios.

Overall, the regression results provide a solid evidence for the first main result and a mixed evidence for the second. Greater bank efficiency as measured by the credit information depth index is expected to make supervisory authorities adopt higher simple capital ratios, namely, by around 0.5 percentage points per index level. This amount is not trivial considering that most countries represented in our data have average simple capital ratios around 5–15%, and that the figure represents the entire banking sector of a given country. For example, if a country whose current depth of credit information is mildly low—at 5 or 6—such as Belgium, Japan and Sweden (see Table A1 in Appendix), achieving greater availability of credit information (thus lower monitoring costs) would lead to 1.0–1.5%p increase in simple bank capital ratios. The influence of credit information depth on the risk-adjusted capital ratio, on the other hand, is estimated to be positive but not statistically significant. This may be due to the fact that the supervisor has much discretion over calculating the ratio, hence can manipulate it to make banks to appear better capitalized than they truly are. As for the impact of banks' political influence, it is estimated that about a 0.94%p increase in risk-adjusted ratios can be expected to occur if a country can achieve one index level higher in independence for its supervisory authority. This means that countries such as China, Germany and the United Kingdom can make a jump from 1 to 3 in this index and expect to achieve nearly two percentage point increases in the risk-adjusted capital ratios, respectively. For simple adjusted ratio, however, the impact of supervisory independence is not significantly different from zero.

6. Concluding remarks

This paper examines the equilibria of an international policy coordination game in the two cases when financial regulatory

[28] By taking asset riskiness into account, the Basel rules aim to make banks solvent with 99.9% confidence for a year, given that they keep the risk-adjusted ratio higher than 8%. (See Basel Committee on Banking Supervision, 2005; also see Gordy and Howells, 2006)

Table A1
Summary statistics for selected countries.

Country	Start Year	End Year	Simple capital ratio	Risk-adjusted capital ratio	Depth of credit information	Supervisory authority independence	Supervisory authority power index	Banking sector capital (in trillion USD)
Argentina	1998	2014	12.0	16.7	8.0	1.0	9.5	92
Australia	1998	2015	6.0	11.0	7.0	2.8	11.5	602
Austria	2000	2015	6.2	14.5	7.0	2.5	12.0	239
Belgium	2000	2015	4.2	15.2	5.0	1.8	11.0	158
Brazil	1998	2015	10.2	16.9	7.0	1.3	13.5	1,188
Canada	1998	2008	4.5	12.8	8.0	2.5	8.5	539
Chile	1998	2015	7.4	13.3	6.0	0.0	11.5	83
China	1999	2015	6.1	10.7	6.8	1.0	11.1	5,283
Colombia	1998	2015	12.9	15.2	7.0	0.3	12.6	119
Denmark	1998	2015	6.0	14.8	6.0	1.7	9.5	301
Finland	1998	2015	6.6	15.1	6.0	2.3	7.0	107
France	2000	2015	5.2	12.7	6.0	2.3	8.3	1,236
Germany	1998	2015	4.5	14.2	8.0	1.0	9.3	1,626
Greece	1999	2015	7.3	12.5	7.0	1.7	10.0	174
India	1998	2015	6.5	12.6	7.0	2.3	9.5	470
Indonesia	2000	2015	10.2	19.2	6.2	2.5	14.3	193
Ireland	1998	2014	6.2	14.1	7.0	2.7	9.5	147
Israel	1998	2015	6.6	11.8	7.0	1.0	9.0	111
Italy	1998	2015	6.2	11.7	7.0	1.0	8.3	1,122
Japan	1998	2015	4.6	12.5	6.0	1.5	11.9	3,978
Malaysia	1998	2015	8.7	14.9	7.4	2.7	13.2	209
Mexico	1998	2015	9.9	15.3	8.0	0.7	11.6	302
Netherlands	2000	2015	4.4	13.6	6.2	2.0	8.6	399
New Zealand	2007	2010	5.8	11.8	7.8	2.8	9.1	110
Norway	1998	2011	6.7	12.2	6.0	3.0	9.2	187
Poland	1998	2015	8.1	13.7	8.0	1.3	9.9	165
Portugal	1998	2015	6.3	11.0	7.0	2.8	13.2	181
Republic of Korea	1998	2014	6.8	12.4	8.0	1.0	9.8	637
Saudi Arabia	1998	2015	11.1	19.0	8.0	0.7	13.7	244
Singapore	1998	2015	9.4	16.9	7.0	2.0	12.7	206
South Africa	1999	2015	7.8	13.6	7.2	1.0	7.0	156
Spain	1998	2015	6.8	12.3	7.0	1.8	9.9	1,183
Sweden	1998	2015	5.0	12.1	5.0	2.0	7.3	237
Switzerland	1998	2015	5.4	14.3	6.0	2.0	13.0	437
Thailand	1998	2015	8.1	14.1	6.4	2.0	10.9	247
Turkey	1999	2015	11.3	19.3	6.8	2.3	13.5	365
United Arab Emirates	2000	2014	13.6	18.3	7.0	2.0	12.3	251
United Kingdom	1998	2015	6.5	14.6	8.0	1.0	10.0	2,192
United States of America	1998	2015	10.4	13.4	8.0	1.8	13.4	8,570
Viet Nam	2008	2015	9.1	12.5	6.6	1.0	11.5	139

Note: Table shows data for 40 among 113 countries in the dataset with the highest banking sector capital. Variables represent averages in periods during which data are available.

policies are strategically substitutable and complementary. In doing so, we consider the cross-border externalities of multinational banks and banks' political influence on financial regulators, thereby examining the conditions for the cooperative regime to be self-enforcing.

On one hand, when financial regulatory policies are strategic substitutes, higher monitoring costs and the greater asymmetry in banks' political influence lead to higher free-riding incentives, thus deteriorating the self-enforcing condition for coordination. Still, if the degree of politico-economic asymmetry is lower and policymakers' discount factor is higher than some critical values, simple introduction of a policy coordination mechanism can make cooperative policy coordination self-enforcing, even without a credible external enforcement mechanism. When the asymmetry in the political economic structure is larger than the critical level, and policymakers' discount factor is lower than the critical value, an external enforcement should be adopted to ensure credible coordination. This implies that a cooperative financial regulatory policy coordination regime is more likely to be sustained among countries with relatively lower and more homogeneous degree of regulatory capture. Moreover, although banks benefit from financial stability, the country whose regulators are more captured by banks prefers a lower capital adequacy requirement, threatening stability.

On the other hand, when the policies are strategic complements—which is the case when banking sectors are highly efficient (i.e. with low monitoring cost)—financial regulators have no incentive to free ride each other's effort. However, multiple equilibria give rise to uncertainty in the financial regulatory regime as regulators follow sensitive, complementary responses to other's policies. Therefore, it is necessary to introduce a coordination mechanism in this case even without the free-riding incentives. Again, the cooperative unique equilibrium is more likely to be sustained with lower and more homogeneous degrees of banks' regulatory influence.

The findings suggest that the initial efforts to introduce an international policy coordination mechanism in financial regulation should be made among groups of countries that are relatively homogeneous. In the same context, more work needs to be done to harmonize differing degrees of outside influence that regulatory bodies bear when countries first coordinate. If not all differences are resolved among the coordinating countries in the short run, coordinating among a subset of them would be the next best approach. If possible, it would be socially desirable to reduce and

limit banks' seeking greater political influence, by making regulatory bodies' decision-making process more transparent.

These findings have the following implications for the coordination of financial regulation and supervision in Asia, as well as for the Basel Committee on Banking Supervision. First, in order to fundamentally increase incentives for each country to exert sufficient regulatory effort, the Committee should extend greater support to countries to make banks and other financial institutions more efficient. Secondly, the regulatory effort so far discussed should be interpreted in the context of not just capital regulation but also any effort to help financial institutions improve their asset quality. In that regard, international coordination should engage in improving explicit rules as well as their practical implementation. Thirdly, if reaching a consensus on an adequate coordination mechanism turns out to be difficult, it may be preferable to first work on establishing cooperation among countries whose financial sectors display similar politico-economic characteristics.

The results obtained in this study require a few caveats in interpretation. For one, our model does not consider cases where banking sectors have investment options other than loan-making. For another, incorporating borrowers' utility in the policy objective function may provide further insight, as such function would better represent overall welfare. These issues remain for future studies.

Appendix

Proof of Lemma 1. : The profit function of the banking sector j is given as:

$$\underset{q_j,\theta_j}{Max}\prod_i = (q_j+\gamma_{ij}q_i)\left[r_j\frac{\theta_j}{k_j}-\phi_j\frac{\theta_j-k_j}{k_j}\right]E_j-\rho_j\theta_jE_j-c_jq_j^2 +\mu\left((q_i+\gamma_{ji}q_j)\left[r_i\frac{(1-\theta_j)}{k_i}-\phi_i\frac{(1-\theta_j)-k_i}{k_i}\right]E_j-\rho_i(1-\theta_j)E_j\right)$$

From the first order condition of the profit maximization problem, we obtain the optimal monitoring efforts of bank j as:

$$\frac{\partial\prod_j}{\partial q_j}=0\rightarrow$$

$$q_j^*=\frac{E_j}{2c_j}\left(\frac{r_j\theta_j-\phi_j(\theta_j-k_j)}{k_j}+\frac{\mu\gamma_{ij}\left(r_i(1-\theta_j)-\phi_i(1-\theta_j-k_i)\right)}{k_i}\right)$$

From the comparative statics of optimal monitoring effort q_j^* with respect to the other country's regulatory policy, we have:

$$\frac{\partial q_j^*}{\partial k_i}=\frac{E_j\mu\gamma_{ij}(1-\theta_j)(r_j-\phi_j)}{2c_i{k_i}^2}>0 \tag{A.1}$$

Therefore, the financial regulatory policy has positive cross-border externality on foreign financial stability. □

Proof of Proposition 1. First, k_i and k_j are strategic substitutes if $\frac{\partial^2W_i^*(k_i,k_j)}{\partial k_i\partial k_j}<0$ where k_i and k_j represent the domestic and foreign required capital ratios. The sign of the cross derivative of country i's social welfare with respect to k_i and k_j is determined to be less than zero as follows:

Since the optimal monitoring effort is monotonous to the government's regulatory efforts, the cross derivative cross derivative of the optimal monitoring efforts with respect to two countries' regulatory efforts is zero as follows: $\frac{\partial^2q_i^*}{\partial k_i\partial k_j}=\frac{\partial^2q_j^*}{\partial k_i\partial k_j}=0$

Therefore,

$$\frac{\partial^2W_i^*(k_i,k_j)}{\partial k_i\partial k_j}=\alpha_i\frac{\partial^2\prod_i^*(k_i,k_j)}{\partial k_i\partial k_j}$$

$$+(1-\alpha_i)\left(\frac{\partial^2q_i^*(k_i,k_j)}{\partial k_i\partial k_j}+\gamma\frac{\partial^2q_j^*(k_i,k_j)}{\partial k_i\partial k_j}\right)=\alpha_i\frac{\partial^2\prod_i^*(k_i,k_j)}{\partial k_i\partial k_j}$$

$$=\frac{cr_ir_j\gamma\alpha_iE_i\left((2-c^2)E_i\mu(1-\theta_i)\theta_i+E_j(\mu^2(1-\theta_i)(1-\theta_j)+\theta_i\theta_j\right)}{2k_i^2\partial k_j^2}$$

$$<0\quad if c>T$$

Where $T=(\frac{E_j(\mu^2(1-\theta_i)(1-\theta_j)+\theta_i\theta_j)}{E_i\mu(1-\theta_i)\theta_i}+2)^{1/2}$.

Therefore, the regulatory policy of each country, k_i and k_i, is a strategic substitute when $c>T$, while it is a strategic complement if $c<T$. Moreover, we have $\frac{\partial T}{\partial E_j}>0$ and $\frac{\partial T}{\partial E_i}<0$ as shown in the follows:

$$\frac{\partial T}{\partial E_j}=\frac{1}{2}\left(\frac{E_j(\mu^2(1-\theta_i)(1-\theta_j)+\theta_i\theta_j)}{E_i\mu(1-\theta_i)\theta_i}+2\right)^{-1/2}\frac{\mu^2(1-\theta_i)(1-\theta_j)+\theta_i\theta_j}{E_i\mu(1-\theta_i)\theta_i}>0$$

$$\frac{\partial T}{\partial E_i}=-\frac{1}{2}\left(\frac{E_j(\mu^2(1-\theta_i)(1-\theta_j)+\theta_i\theta_j)}{E_i\mu(1-\theta_i)\theta_i}+2\right)^{-1/2}\left(\frac{E_j\left(\mu^2(1-\theta_i)(1-\theta_j)+\theta_i\theta_j\right)}{E_i^2\mu(1-\theta_i)\theta_i}\right)<0.$$

Lastly, when $c<T$, $\frac{\partial T}{\partial\mu}|_{c>T}=-\frac{E_j(\theta_i\theta_j-\mu^2(1-\theta_i)(1-\theta_j)}{E_i\mu^2(1-\theta_i)\theta_i}<0$. Therefore, when the loan monitoring cost is higher than the critical level, the strategic substitutability of the financial regulatory policies is increasing in the level of financial integration, μ. □

Proof of Corollary 1. The optimal capital requirement ratio under the one-shot, non-cooperative, Nash-type game of regulatory policy should satisfy the following first order condition:

$$\alpha_i\frac{\partial\prod_i^*(k_i,k_j)}{\partial k_i}+(1-\alpha_i)\frac{\partial\left(q_i^*(k_i,k_j)+\gamma_{ji}q_j^*(k_i,k_j)\right)}{\partial k_i}=0 \tag{A.2}$$

The joint welfare maximizing financial regulation policy, k^*, satisfies the following first order condition:

$$\alpha_i\frac{\partial\prod_i^*(k)}{\partial k}+(1-\alpha_i)\frac{\partial\left(q_i^*(k)+\gamma_{ji}q_j^*(k)\right)}{\partial k}+\alpha_j\frac{\partial\prod_j^*(k)}{\partial k}+(1-\alpha_j)\frac{\partial\left(q_j^*(k)+\gamma_{ij}q_i^*(k)\right)}{\partial k}=0 \tag{A.3}$$

However, when policymakers are shortsighted and credible enforcement mechanism is absent, each country may have an incentive to deviate from the cooperative strategy despite having the same politico-economic structure. This can be shown by

$$\left(\alpha_i\frac{\partial\prod_i^*(k_i,k_j)}{\partial k_i}+(1-\alpha_i)\frac{\partial\left(q_i^*(k_i,k_j)+\gamma_{ji}q_j^*(k_i,k_j)\right)}{\partial k_i}\right)\Bigg|_{k_i=k_j=k^{c*},\ c>T}<0 \tag{A.4}$$

The above inequality implies that the financial regulator in country i, who is shortsighted, has an incentive to deviate from cooperative policy, with$W_i(k_i^{N*},k_j^{C*})>W_i(k^{C*})$.[29] □

Proof of Corollary 2. In the coordination game, a long-term policy approach is reflected by a higher discount factor. In addition, the adoption of international policy coordination itself implies that the mode of the game is transformed from a one-shot game to a repeated one. The proposition is proven by demonstrating that when

[29] Inequality (A.4) shows that, at the given level of cooperative regulatory policies, the partial derivative of the social welfare, with respect to the capital requirement ratio, is negative. This result implies that the domestic government can improve the social welfare by reducing the level of capital adequacy requirements from the cooperative level.

a country chooses a cooperative financial regulatory policy, k^C, the cooperative regime is self-enforcing if the discount factor is higher and the political economic asymmetry is lower than a critical level.

The parameters representing the asymmetry in politico-economic structures is defined as $\sigma = |\alpha_i - \alpha_j|$ where $\sigma \in [0, \underline{\sigma})$. Then the following incentive compatibility condition for each policymaker should hold :[30]

$$W_i(k_i^{N*}, k_j^{C*}) + \frac{\delta^2 W_i(k_i^{N*}, k_j^{N*})}{1-\delta} \leq \frac{\delta W_i(k_i^{C*}, k_j^{C*})}{1-\delta} \tag{A.5}$$

where $k_i{}^N$ represents a non-cooperative regulatory policy that maximizes domestic political objective function, k^{C*} represents the cooperative regulatory policy that maximizes the joint political objective function, and δ represents the discount factor.[31]

When the regulator is extremely myopic and politico-economic structures of coordinating countries show maximal asymmetry, with $\delta \simeq 0$ and$\sigma \simeq \underline{\sigma}$, the incentive compatibility condition cannot hold even in the case of an infinitely repeated game:

$$\begin{aligned} &W_i(k_i^{N*}, k_j^{C*}) + \frac{\delta^2 W_i(k_i^{N*}, k_j^{N*})}{1-\delta} - \frac{\delta W_i(k_i^{C*}, k_j^{C*})}{1-\delta}\Big|_{\delta=0, \sigma=\underline{\sigma}} \\ &\simeq W_i(k_i^{N*}, k_j^{C*}) - W_i(k_i^{C*}, k_j^{C*}) > 0 \end{aligned} \tag{A6}$$

However, when $\delta \simeq 1$ and $\sigma = 0$, the incentive compatibility condition always holds, as follows:

$$\begin{aligned} &\frac{W_i(k_i^{C*}, k_j^{C*})}{1-\delta} - W_i(k_i^{N*}, k_j^{C*}) - \frac{\delta W_i(k_i^{N*}, k_j^{N*})}{1-\delta}\Big|_{\delta=1-\varepsilon, \sigma=0} \\ &> \frac{W_i(k_i^{C*}, k_j^{C*})}{1-\delta} - W_i(k_i^{N*}, k_j^{N*}) - \frac{\delta W_i(k_i^{N*}, k_j^{N*})}{1-\delta}\Big|_{\delta=1-\varepsilon, \sigma=0} > 0 \end{aligned}$$

Therefore, there are $\bar{\delta}$ and $\underline{\sigma}$ that satisfy the equality condition of (A5). Consequently, a self-enforcement condition for a cooperative financial regulatory policy, (A5), holds with some $\delta \in (\bar{\delta}, 1]$ and$\sigma \in [0, \underline{\sigma}]$. □

Proof of Proposition 2. The impact of government regulation on bank profit via the capital adequacy requirement is shown to be negative, as follows:

The financial regulator's objective function was defined as:

$$\underset{k_i}{Max} W_i = \alpha_i \prod_i (L_i, L_j) + (1-\alpha_i)(q_i + \gamma_{ji} q_j)$$

The total derivative of the equilibrium provides:

$$\frac{\partial W(k_i, k_j, \alpha)}{\partial \alpha} d\alpha + \frac{\partial W(k_i, k_j, \alpha)}{\partial k_i} dk_i + \frac{\partial W(k_i, k_j, \alpha)}{\partial k_j} dk_j = 0$$

Therefore,

$$\begin{aligned} \frac{dk_i}{d\alpha} = -\frac{\partial W(k_i, k_j, \alpha)/\partial \alpha}{\partial W(k_i, k_j, \alpha)/\partial k_i} = -\Big(\prod_i (L_i, L_j) - (q_i + \gamma_{ij} q_j)\Big) \\ \underbrace{\left(\frac{\partial W(k_i, k_j, \alpha)}{\partial k_i}\right)^{-1}\Big|_{k_i = k_i^*}}_{+} < 0 \end{aligned} \tag{A7}$$

Therefore, higher banking sector political influence induces the financial regulator to impose a lower capital adequacy requirement, eventually lowering the financial stability with lower banking sector monitoring effort. □

[30] Defined as the absolute value of difference between α_i and α_j, σ denotes the difference between the weights given to the banking sector profits in the coordinating countries.

[31] The discount factor δ describes the degree of regulators' farsightedness. In the worst case, $\delta = 0$ and the setup is equivalent to a one-shot game. In the best case where $\delta = 1$, the setup is an infinitely repeated game with no discount.

Proof of Proposition 3. There are multiple equilibria in a financial market when the absolute value of Eq. (9) is larger than unity. We show that the value of the equation is increasing in γ and μ, as follows:

$$-\frac{\partial^2 W_i^*(k_i, k_j)/\partial k_i \partial k_j}{\partial^2 W_i^*(k_i, k_j)/(\partial k_i)^2} = \gamma \mu^2 \alpha_i (1-\theta_i)\theta_i + (1-\theta_i)(1-\theta_j) + \theta_i \theta_j = L \tag{A10}$$

$$\begin{aligned} \frac{\partial L}{\partial \gamma} &= \mu^2 \alpha_i (1-\theta_i)\theta_i > 0, \\ \frac{\partial L}{\partial \mu} &= 2\gamma \mu \alpha_i (1-\theta_i)\theta_i > 0. \end{aligned}$$

Proof of Proposition 4. The unique equilibrium in the financial regulatory game is defined as the case where the financial regulators keep the cooperative regulatory policy if the signal of the monitoring cost, s, is lower than the threshold level, $\hat{c}$, while regulators deviate to non-cooperative policies if the signal is given to be higher than $\hat{c}$. Assume that there is a threshold level of the signal regarding the monitoring cost,$\hat{s}$, such that each regulator deviates to a non-cooperative regulatory policy if the regulator observes a signal $s \geq \hat{s}$. Then the probability of deviating is given as

$$A(s) = \Pr(s \geq \hat{s} \big| c) = F((\hat{s} - c)/\sigma_\varepsilon.$$

Therefore, the financial regulator will deviate to a non-cooperative financial regulatory policy if$s \geq \hat{c}$, where $\hat{c}$ is derived from the following condition:

$$F((\hat{s} - \hat{c})/\sigma_\varepsilon)(N_i(\hat{c}) - D_i(\hat{c})) = \Big(1 - F((\hat{s} - \hat{c})/\sigma_\varepsilon)\Big)(C_i(\hat{c}) - H_i(\hat{c})) \tag{A.11}$$

(A11) shows that when the signal for the monitoring cost of banking sector is given at the threshold level,$\hat{c}$, the expected payoff for the regulator from deviating to a noncooperating regulatory policyt is equivalent to the expected payoff from keeping the cooperative regulatory policy. Therefore, the posterior probability for the collapse of the policy coordination mechanism of financial regulatory regime is given as:

$$\begin{aligned} &\Pr(c \geq \hat{c} \big| s) \\ &= F\Big((\sigma_\varepsilon^{-2} s + \sigma_c^{-2} m_c)/(\sigma_\varepsilon^{-2} + \sigma_c^{-2})^{1/2} - \hat{c}(\sigma_\varepsilon^{-2} + \sigma_c^{-2})^{1/2}\Big). \end{aligned}$$

where $(\sigma_\varepsilon^{-2} s + \sigma_c^{-2} m_c)/(\sigma_\varepsilon^{-2} + \sigma_c^{-2})^{1/2}$ is the posterior mean of banking sector's monitoring cost after the signal for cost is revealed.

Denoting $F((\sigma_\varepsilon^{-2} s + \sigma_c^{-2} m_c)/(\sigma_\varepsilon^{-2} + \sigma_c^{-2})^{1/2} - \hat{c}(\sigma_\varepsilon^{-2} + \sigma_c^{-2})^{1/2})$as K, the critical value of c, $\hat{c}$, is defined as follows denoting that when the monitoring cost is given at the critical level, $\hat{c}$, the payoff from cooperative regulatory policy based on posterior beliefs should be equal to the payoff from non-cooperative regulatory policy again based on posterior beliefs:

$$U(\hat{c}; \sigma_\varepsilon^2, \sigma_c^2, m_c) = K(N_i(\hat{c}) - D_i(\hat{c})) - (1-K)(C_i(\hat{c}) - H_i(\hat{c})) = 0.$$

The existence of unique critical monitoring cost, $\hat{c}$, can be assured when the following three conditions hold: i) $\lim_{c \to 0} U(c) < 0$, ii) $\lim_{c \to \bar{c}} U(c) > 0$, iii) $U(c)$is monotonous.

i) When monitoring cost is given at the minimum level close to zero, the welfare gains from keeping the cooperative regulatory policies dominates the welfare gains from deviating to non-cooperative regulatory policies: $(1-K)(C_i|_{c=0} - H_i|_{c=0}) > K(N_i|_{c=0} - D_i|_{c=0})$. Therefore, we obtain: $\lim_{c \to 0} U(c) < 0$.

ii) When monitoring cost is near to the maximum level close to $\bar{c}$, the welfare gains from deviating to non-cooperative regulatory policies dominates the welfare gains from keeping the cooperative regulatory policies: $K(N_i|_{c=\bar{c}} - D_i|_{c=\bar{c}}) > (1-K)(C_i|_{c=\bar{c}} - H_i|_{c=\bar{c}})$. Therefore, we obtain: $\lim_{c\to\bar{c}} U(c) > 0$.

iii) Finally, the condition for the monotonicity of $U(c)$is that the following derivative of $U(c)$with respect to c be positive since $U(c)$is continuous and differentiable in c: $\frac{\partial U(c)}{\partial c} = \frac{\partial K(N_i - D_i)}{\partial c} - \frac{\partial (1-K)(C_i - H_i)}{\partial c} = (\sigma_c^{-2} + \sigma_\varepsilon^{-2})^{1/2} f(c) \frac{\partial (N_i + C_i - D_i - H_i)}{\partial c} (\frac{\sigma_\varepsilon}{\sigma_c^2} - \frac{1}{f(F^{-1}(c))})$.

Therefore, it follows that $U(c)$ is monotonous if and only if $\sigma_\varepsilon/(\sigma_c)^2 \leq 2\pi$. As long as the above condition holds, a unique equilibrium critical value, $\hat{c}$, exists due to single crossing property . □

Proof of Proposition 5. First, we show that $G_c \neq 0$ and then determine the sign of $-G_\alpha/G_c$by taking a total derivative of the equilibrium condition.

The sign of G_c is determined as follows:

$$\frac{\partial G(\hat{s},\hat{c})}{\partial \hat{c}} = -\underbrace{\frac{1}{\sigma_\varepsilon}}_{+\infty} \underbrace{\frac{\partial F(\hat{s},\hat{c})}{\partial \hat{c}}}_{-} (\underbrace{N - D + C - H}_{+})$$

$$+ F(\hat{s},\hat{c}) \left(\underbrace{\frac{\partial N(\hat{s},\hat{c})}{\partial \hat{c}}}_{-} - \underbrace{\frac{\partial D(\hat{s},\hat{c})}{\partial \hat{c}}}_{+} \right)$$

$$- \underbrace{\left(1 - F(\hat{s},\hat{c})\right)}_{+} \left(\underbrace{\frac{\partial C(\hat{s},\hat{c})}{\partial \hat{c}}}_{+} - \underbrace{\frac{\partial H(\hat{s},\hat{c})}{\partial \hat{c}}}_{-} \right) > 0$$

since $\frac{\partial F(\hat{s},\hat{c})}{\partial \hat{c}} = \frac{\partial F((\hat{s}-\hat{c})/\sigma_\varepsilon)}{\partial \hat{c}} = -(1/\sigma_\varepsilon) f(\hat{s},\hat{c}) < 0$, and when k_i is strategic complements, $N - D = SW_i(k_i^N, k_j^N) - SW_i(k_i^C, k_j^N) > 0$ and $C - H = SW_i(k_i^C, k_j^C) - SW_i(k_i^N, k_j^C) > 0$.

$\frac{\partial N(\hat{s},\hat{c})}{\partial \hat{c}} = \frac{\partial SW(k_i^N(\hat{s},\hat{c}), k_j^N(\hat{s},\hat{c}))}{\partial \hat{c}} < 0$, $\frac{\partial H(\hat{s},\hat{c})}{\partial \hat{c}} = \frac{\partial SW(k_i^N(\hat{s},\hat{c}), k_j^C(\hat{s},\hat{c}))}{\partial \hat{c}} < 0$, $\frac{\partial D(\hat{s},\hat{c})}{\partial \hat{c}} = \frac{\partial SW(k_i^C(\hat{s},\hat{c}), k_j^N(\hat{s},\hat{c}))}{\partial \hat{c}} > 0$, and $\frac{\partial C(\hat{s},\hat{c})}{\partial \hat{c}} = \frac{\partial SW(k_i^C(\hat{s},\hat{c}), k_j^C(\hat{s},\hat{c}))}{\partial \hat{c}} > 0$ due to lowered probability to deviate from cooperative regulatory policies with the higher $\hat{c}$ as shown above.

In the same way, the sign of G_α is determined as follows:

$$\frac{\partial G(\hat{s},\hat{c})}{\partial \alpha} = F(\hat{s},\hat{c}) \left(\underbrace{\frac{\partial N(\hat{s},\hat{c})}{\partial \alpha}}_{+} - \underbrace{\frac{\partial D(\hat{s},\hat{c})}{\partial \alpha}}_{-} \right)$$

$$- \underbrace{\left(1 - F(\hat{s},\hat{c})\right)}_{+} \left(\underbrace{\frac{\partial C(\hat{s},\hat{c})}{\partial \alpha}}_{-} - \underbrace{\frac{\partial H(\hat{s},\hat{c})}{\partial \alpha}}_{+} \right) > 0$$

Therefore, according to the implicit function theorem, the sign of $\frac{\partial \hat{c}}{\partial \alpha}$ is determined as follows: $\frac{\partial \hat{c}}{\partial \alpha} = -\frac{G_\alpha}{G_c} < 0$.

The above result implies that when the political influence of the banking sector is increased, the policy coordination mechanism for financial regulation is more likely to collapse.

Now we examine the impact of the asymmetry of banking sector political influence on the regulatory policy coordination by checking the sign of $\frac{\partial \hat{c}}{\partial \sigma}$. The sign of G_σ is determined as follows:

$$\frac{\partial G(\hat{s},\hat{c})}{\partial \sigma} = F(\hat{s},\hat{c}) \left(\underbrace{\frac{\partial N(\hat{s},\hat{c})}{\partial \sigma}}_{+} - \underbrace{\frac{\partial D(\hat{s},\hat{c})}{\partial \sigma}}_{-} \right)$$

$$- \underbrace{\left(1 - F(\hat{s},\hat{c})\right)}_{+} \left(\underbrace{\frac{\partial C(\hat{s},\hat{c})}{\partial \sigma}}_{-} - \underbrace{\frac{\partial H(\hat{s},\hat{c})}{\partial \sigma}}_{+} \right) > 0$$

Therefore, the sign of $\frac{\partial \hat{c}}{\partial \sigma}$ is determined as follows: $\frac{\partial \hat{c}}{\partial \sigma} = -\frac{G_\sigma}{G_c} < 0$. This result implies that when the asymmetry of the political influence of the financial sector between coordinating countries is increased, it is more likely that the cooperative regulatory policy coordination mechanism collapses. □

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