Myopic or farsighted: Bilateral Trade Agreements among symmetric three countries*

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Abstract

We examine network formation via bilateral trade agreement (BTA) among three symmetric countries. Each government decides the conclusion of a BTA depending on the differential of ex-post and ex-ante simple sum of real wages in the country. We model the governmental decision in two forms, myopic and farsighted and analyze the effects on the BTA network formation. Firstly, both myopic game and farsighted game never induce star networks as well as the empty network. Second, in most of the cases, the networks resulting from the myopic game coincide those resulting from the farsighted game, but there exist some cases where the two games yield distinct networks.

Keywords : Bilateral trade agreement, Network formation, Myopic, Farsighted,

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1 Introduction

In the last decades, the number of trade agreements among countries increase rapidly. Each trade agreement drastically reduces the explicit and implicit trade barriers, such as tariff and administration costs. In the same decades, we observe that developments in information and transportation technology induce the distance between any two countries much shorter and the transactions much smoother. However, as long as there is distance, transportation costs still remain. As shown by Bhagwati and Panagariya (1996), the negotiation for trade agreements would depends on this transportation costs. Thus the level of trade costs which includes several transaction costs would play an important role for the consequences of trade agreements among many countries. When reduction of trade costs results in lower price of goods, it increase domestic welfare unambiguously. However strategic interactions of the other countries could deteriorate the welfare at home. The decentralized conclusion of trade agreements could be interpreted as a network formation game. Furusawa and Konishi (2007) analyze network formations among many countries and heterogeneous countries, and the stability. However, the degree of farsightedness is not analyzed. Different from the study by Mukunoki and Tachi (2006), we employ monopolistic competition and analyze in network formation games. In the line of hub effect or, say differently, star link, initially adapted by Krugman (1993), the limitation of two country framework and also the emphasis on the role of hub has been provoked. With the models of monopolistic competitions, for example, by Ago, Isono and Tabuchi (2006), Behrens (2007), Mori and Nishikimi (2002), and Behrens, Gaigne, Ottaviano and Thisse (2006), the emergence of hub and its effects are analyzed in international economics and in economic geography.

The purpose of this paper is to consider the outcomes of trade agreement networks stemming out of the difference in the visions of government. Moreover, with the presence of transport costs, we examine the conclusion of trade agreements as an application of network formations by Jackson and Wolinsky (1996). We formulate our analysis to allow the endogenous determination of trade agreements and that trade agreement unambiguously decrease trade costs but doesn't have to vanish at all. Our basic set up is a symmetric three-country, Dixt-Stiglitz type monopolistic competition, and trade costs. Moreover we characterize the behavior of governments as welfare maximizing with respect to his eyesight, myopic or farsighted.

The rest of the paper is organized as follows. In Section II we present the basic framework of the model, while Section III formulates the types of government behavior and compare the outcomes. Finally, we offer some concluding comments.

2 The model

2.1 Consumers and firms

The economy consists of three countries called A, B, and C. There are two types of production sectors, competitive sector and manufacturing sector. In order to highlight the role of government behavior in the following section, three countries are assumed to be symmetric in population, endowments and technology. We normalize each population, the number of firms, and the amount of capital as one. Then the number of firms in each country is identical to the share of firms in this economy. We put the share of firms in country r by $\lambda_r \in [0,1]$ and from definition, $\sum_{r=1}^{3} \lambda_r = 1$ always holds.

Each individual supplies one unit of labour inelastically within their residential country and is assumed to be endowed one unit of capital. Consumers in each country have the utility function characterized by:

$$U_r = \frac{C_r^{1-\mu} M_r^{\mu}}{\mu^{\mu} (1-\mu)^{1-\mu}}, \quad \text{and} \quad M_r = \left(\sum_{s=1}^{3} \int_0^{\lambda_s} m_{sr}^{\frac{\sigma-1}{\sigma}} (v)\, dv \right)^{\frac{\sigma}{\sigma-1}} \tag{1}$$

where M stands for an index of the consumption of the manufactured good, σ is the elasticity of substitution between any manufactured goods, and the lower subscript, r, expresses the country of consumption or production. While C is the consumption of homogeneous good, e.g. agriculture good, $m_{sr}(v)$ expresses the demand for a differentiated manufactured good indexed v, which is produced at country s and is consumed at country r. $p_{sr}(v)$ is denoted by the price for a differentiated manufactured good indexed v whose lower subscripts expresses the same as in its demand. Moreover, while domestic transfer doesn't incur any transportation costs, for any shipment of a differentiated goods across countries, transportation costs is incurred and is expressed in the form of "*iceberg*" type. With assuming the symmetric transportation costs between any countries, we put this transportation costs as $\tau_{rs} = \tau$, $\tau_{rr} = 1$, where τ is the fraction which is melt away during its tranfer. Then the price of a product produced at country r and is transferred to country s can be expressed as, $p_{rs} = p_r \tau_{rs} = p_r \tau$.For later reference, we put the measure of trade openness by $\phi = (\tau)^{1-\sigma} \in [0,1]$, which can be interpreted as the fraction of products that can be reached to the destination. The budget constraint can be written as,

$$Y_r = w_r + k_r = C_r + P_r M_r, \qquad P_r = \left(\sum_{s=1}^{3} \int_0^{\lambda_s} (p_{sr}(v))^{1-\sigma} dv \right)^{\frac{1}{1-\sigma}} \tag{2}$$

where Y, w, k, $p(v)$ and P denote income, wage, capital reward, price of a manufactured good indexed v and the price index of manufactured varieties. Worker in country r maximizes utilities in (1), subject to her budget constraint (2). Standard utility maximization yields the following equations;

$$C_r = (1-\mu) Y_r, \tag{3}$$

$$m_{sr}(v) = \mu p_s^{-\sigma}(v) (\tau_{rs})^{1-\sigma} P_r^{\sigma-1} Y_r \tag{4}$$

$$V_r = \frac{Y_r}{P_r^{\mu}} \tag{5}$$

V_r is the indirect utility function in country r. Competitive sector produces a homogeneous good under constant returns to scale technology with using only labor. This homogeneous good is assumed to be shipped costlessly. Thus we take this as numeraire and normalize the labour wage into one, $w_r = 1$. On the contrary to the production of homogeneous good, manufacturing sector requires one unit of capital as fixed input and labor as marginal input requirement and exhibits increasing returns to scale. We set the cost function of manufacturing sector as $\pi_r + m_r(v)$, where π_r is the rental cost for one unit of capital in country r and m_r is the sum of national demands of a differentiated good, $m_r(v) = \sum_{s=1}^{3} m_{rs}(v)$. Taking the demand of its good as given, each firm set its price so as to maximize its profit;

$$p(v) = p = \frac{\sigma}{\sigma - 1} \tag{6}$$

In equilibrium all varieties are symmetric. Thus we could drop the variety index (v) for simpler notation. With the normalizations, we could rewrite the price index as,

$$P_r = \frac{\sigma}{\sigma - 1}\left(\sum_{r=1}^{3} \lambda_r \phi_{rs}\right)^{\frac{-1}{\sigma-1}} \tag{7}$$

Since capital is used only for fixed input and potential entrants in this sector ensure the zero-profit condition, rents to capital is expressed as a form of operating profit.

$$\pi_r(\lambda_r) = m_r(p_r - 1) = \frac{\mu}{\sigma} m_r \tag{8}$$

Denoted by $\pi_r(\lambda_r)$, capital moves to the highest country of its rent. When firms distribute among countries, it means the capital rent is identical in any countries in equilibrium. The equilibrium condition implies the following motion of capital arbitrage;

$$\pi = \pi_r(\lambda_r) = \pi_s(\lambda_s), \qquad r \neq s \tag{9}$$

Then national income is shown to be invariant to the distribution of firms and simply written as $Y_r = \pi + w$.

2.2 Trade agreements

We assume that a conclusion of trade agreements unambiguously decrease trade costs. However, as mentioned in introduction, transportation costs would remain even after the conclusion. The reduction of trade costs is evaluated by the level of ex-ante total trade costs which includes transportation costs. Since the measure of trade costs has the range of zero to one, $\phi \in [0, 1]$, even after the conclusion, the improved trade costs should not exceed one.

$$0 < \delta\phi < 1 \tag{10}$$

For further analysis, we specify the four phases respect to the conclusion of trade agreements. We define "Phase" as a state of a network formed on the way or finally. You may also interpret phases as histories of the action(s) of the previous conference(s) or the outcome of the game. We classify all possible "Phases" into four and call them as follows:

Phase 0 The empty network $g = \varnothing$:

$\phi_{AB} = \phi_{BC} = \phi_{CA} = \phi$.

Phase 1 A one-link network $g = \{AB\}, \{BC\}$ or $\{CA\}$:

$\phi_{ij} = \phi_{jk} = \phi, \phi_{ki} = \phi\delta$ for three distinct i, j and k.

Phase 2 A star network: two-link network $g = \{AB, BC\}, \{BC, CA\}$ or $\{CA, AB\}$:

$\phi_{ij} = \phi, \phi_{jk} = \phi_{ki} = \phi\delta$ for three distinct i, j and k.

Phase 3 The complete network $g = \{AB, BC, CA\}$:

$\phi_{AB} = \phi_{BC} = \phi_{CA} = \delta\phi$.

After specifying a network, we could obtain the capital rent for each country as,

$$\pi_r^i\left(\lambda_r^i\right) = \frac{\mu}{\sigma}\sum_{s=1}^{3}\frac{Y}{\Delta_s^i}\phi_{sr} \tag{11}$$

where $\Delta_r^i = \sum_{t=1}^{3}\lambda_t^i\phi_{tr}$ for country r and phase i. We put the upper subscripts for capital rent and for the expression of denominator in order to indicate a *phase*. We utilize these expressions for several variables in the reminder of this paper.

For example, in Phase 1, when a trade agreement is concluded between two countries, these two countries become superior in terms of access to all markets in each countries. Then firms are attracted by superior access in the two countries and this generates asymmetry in price index among countries. In Phase 1 and Phase 2, while three countries are already not symmetric, there is symmetry among two of three countries. The capital arbitrage condition should be examined between the countries where capital rent can be different due to the different transport costs. Applying the equilibrium condition for a given networks, $\pi_r^i\left(\lambda_r^i\right) = \pi_s^i\left(\lambda_s^i\right)$, we could solve the distribution of firms.

Moreover, we define the objective function of government as the indirect utility function of all residents in the country and it may be written as

$$W_r^i = \frac{Y_r}{P_r^{\mu}} = Y\left(\Delta_r^i\right)^{\frac{\mu}{\sigma-1}} \tag{12}$$

Using this equation, each government evaluates the conclusion of trade agreement as,

$$W_r{}^{ij} = \frac{W_r{}^j}{W_r{}^i} = \left(\frac{P_r{}^i}{P_r{}^j}\right)^{\mu} = \left(\frac{\Delta_r{}^j}{\Delta_r{}^i}\right)^{\frac{\mu}{\sigma-1}} \tag{13}$$

Note that $P_r{}^i = \left(\Delta_r{}^i\right)^{\frac{1}{1-\sigma}}$ and that $\frac{\mu}{\sigma-1} > 0$, the decision on the approval of BTA by a country depends on the value of $\Delta_r{}^j/\Delta_r{}^i$. Then we define and use the following equation as a useful criteria.

$$D_r^{ij} = \left(W_r^{ij}\right)^{\frac{\sigma-1}{\mu}} - 1, \quad \text{for } r = A, B, C \text{ and } i \neq j = 0, 1, 2, 3 \tag{14}$$

which implies the welfare change of country r from phase i to phase j. Each government could evaluate their decision based on this welfare differential in (14). For each given network, the distribution of firms and the welfare differential are analytically obtained and listed in appendix.

3 Visions of government

Now, we introduce a simple dynamic game for conclusion-network formation by national government. Suppose that countries A, B and C are facing situations to determine which conclusions of BTA to make. Every country is concerned only with its own social welfare. In order to maximize its own social welfare, each government organizes conferences to discuss the reduction of trade barriers by BTA. In this game, we assume that the multilateral conference is never held, but only bilateral conferences are. Each conference is to make at most one conclusion by the two participants. We assume the conclusions can not be deleted afterward, so that all countries decide their own actions without considering the break of connected links.

For further understanding, we specify a word, "Conference". "Conference" is defined as a meeting to consult about forming a link, whose participants are two governments, both the end points of the link. Then the conference on forming link X is denoted by Conference X for $X = AB$, BC, CA. In order to clarify the difference of these networks from the outcome network, we refer to a network formed on the way as "*en route* network".

As more detailed assumptions, we suppose that every welfare of a country is not transferable, and that both the participants take additional costs slightly enough when a conference decides to link, conclusion cost. This cost can be interpreted as the revision cost or the cost to sign[1]. As a technical aspect, when the cost is positive, the optimal action can be unique even if forming a new link is indifferent to staying unchanged especially in a myopic game. It is because the social welfare gets slightly worse off by linking. However, when the welfare strictly increases, we need not care about the effect of the conclusion cost since it is small enough.

From now on, we consider and compare two types on the vision of governments: myopic and farsighted. Thuroughout this section, we suppose that $1 < \delta < \min\left\{\bar{\delta}_1(\phi), 1/\phi\right\}$.

3.1 Myopic

First, we consider the case that all the government of countries are myopic decision makers: we suppose that participants of each conference take into account only how their payoffs change when they link, not how those finally change after all conferences. We denote the conclusion-network formation game with myopic governments by $\Gamma_M(\phi, \delta)$. In our paper, we simply call $\Gamma_M(\phi, \delta)$ the "myopic game" for (ϕ, δ).

By the above setup, we can assert the result of every conference with each change of the participant's social welfare by forming a link: a conference makes a conclusion to link only if both the welfares of the participants are strictly improved, and otherwise it decides not to link. Moreover, any conference does not make a conclusion once the previous one determines not to link since it faces the same situation as the previous one by symmetry. Hence the possible outcome networks are only $\varnothing$, $\{AB\}$, $\{AB, BC\}$ and $\{AB, BC, CA\}$ so far. Then we show that actually $\varnothing$ and $\{AB, BC\}$ can not be outcome networks and exhibit the condition where the outcome network is complete and that where it becomes $\{AB\}$.

Theorem 1 *Suppose all the governments of countries make choices myopically and let a profile (ϕ, δ) satisfy $1 < \delta < \min\left\{\bar{\delta}_1(\phi), 1/\phi\right\}$.*
If $1 < \delta < \dfrac{2\phi - 1 + \sqrt{4\phi^2 - 4\phi + 9}}{4\phi}$, then the outcome network is complete.
If $\dfrac{2\phi - 1 + \sqrt{4\phi^2 - 4\phi + 9}}{4\phi} \leq \delta < \dfrac{1}{\phi}$, then the outcome network has only one link, AB.
Therefore, star networks can not be formed.

[1] Note that, for instance, the cost to hold the conference itself is not included since it must be a "sunk cost".

3.2 Farsighted

Next, we consider the case that all the governments of countries are farsighted decision makers: we suppose that they take into account the social welfares they earn after all conferences. Therefore, they make actions thinking over how their actions affect the subsequent confereces, so that we need to specify the optimal strategy for each country by backward induction. We denote the conclusion-network formation game with farsighted governments by $\Gamma_F(\phi, \delta)$. In our paper, we simply call $\Gamma_F(\phi, \delta)$ the "farsighted game" for (ϕ, δ).

In order to simplify the discussion, we use the following scenario tree as in Figure 1. The time

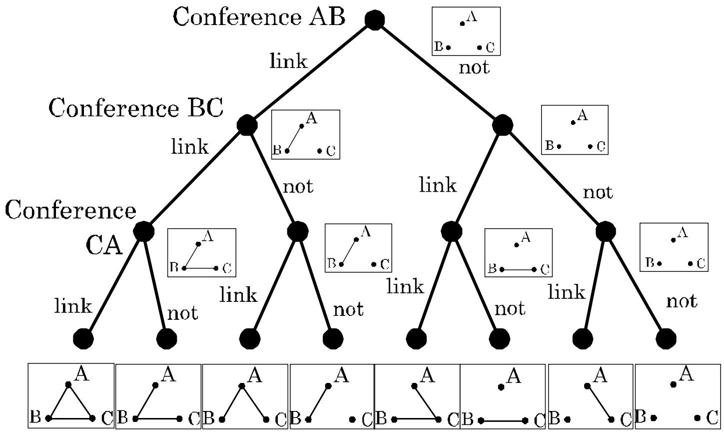

Figure 1: The scenario tree

flows from the top to the bottom as follows. the node at the top describes the turn of Conference AB which is of course given the empty network $\varnothing$ as the en route network, and the two branches grown from that node indicate the decision of Conference AB, linking together and not linking. Therefore, both of the two nodes at the second highest level describe the turns of Conference BC, but the en route network one node faces is different from that another faces. In fact, the en route networks are $\{AB\}$ and $\varnothing$. Similarly to Conference AB, the branches grown from the nodes indicate the decisions of Conference BC. Finally, the four nodes at the lower level describe the turns of Conference CA, whose en route networks are respectively $\{AB, BC\}$, $\{AB\}$,$\{BC\}$ and $\varnothing$, and the eight nodes at the bottom describe the outcome networks.

With the scenario tree, we analyze the outcomes of the dynamic games comparing it with those of the myopic games. Since we proved that the outcome network in a myopic game can only be the complete network $\{AB, BC, CA\}$ or a one-link network $\{AB\}$ in the previous subsection, we classify all profiles (ϕ, δ) into the two cases (see Figure 2 and Figure 3). When the outcome network is complete in $\Gamma_M(\phi, \delta)$, by symmetry, each conference must conclude to link whichever en route network it faces in $\Gamma_F(\phi, \delta)$. Hence, the outcome network in $\Gamma_F(\phi, \delta)$ is also complete. On the other hand, when the outcome network has only one link in $\Gamma_M(\phi, \delta)$, a conference must conclude to link if the en route network is empty, but never link if it is a one-link network. Note that this case does not restrict the result of a conference which faces a star network. If a conference never link when facing a star network, the outcome network is a one-link network also in $\Gamma_F(\phi, \delta)$. However, what would happen if a conference never link when facing a star network?

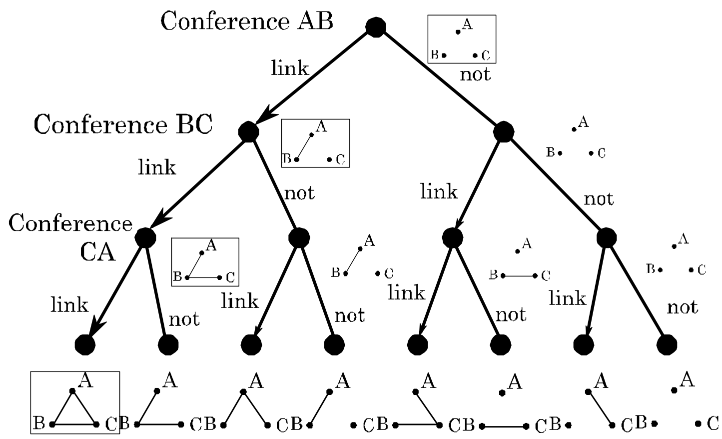

Figure 2: When $\Gamma_M(\phi, \delta)$ induces the complete network.

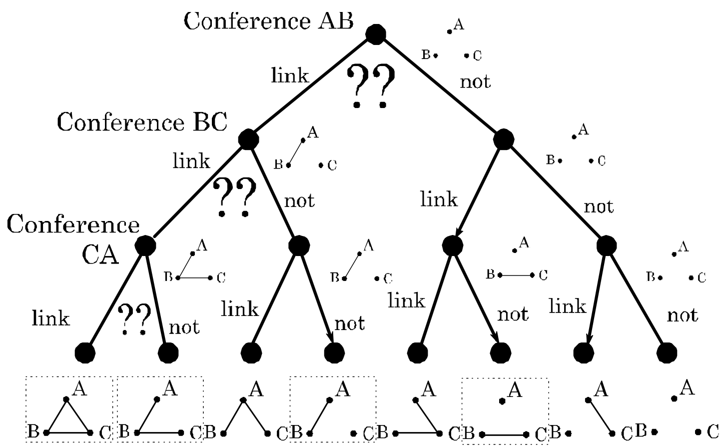

Figure 3: When $\Gamma_F(\phi, \delta)$ induces a one-link network.

We show that there exist some cases where the outcome network in the farsighted game is different from that in the myopic game at the following proposition.

Proposition 1 *(i) Suppose that the outcome of a myopic game $\Gamma_M(\phi,\delta)$ is the complete network. Then, the outcome of the farsighted game $\Gamma_F(\phi,\delta)$ is also the complete network.*

(ii) Suppose the outcome of a myopic game $\Gamma_M(\phi,\delta)$ is a one-link network.

(a) If $\delta < \sqrt{\frac{\phi+1}{2\phi^2}}$ and $\phi < \frac{1}{2}$, the outcome of the farsighted game $\Gamma_F(\phi,\delta)$ is the complete network,

(b) otherwise, the outcome of the farsighted game $\Gamma_F(\phi,\delta)$ is a one-link network.

As we proved in the proof of Propodititon 1, in the case (ii-b), the resulting one-link network is not always $\{AB\}$ in the farsighted games, though it is in myopic games. In fact, we have three possible one-link networks in the farsighted games. This result comes from the *exact* indifference which may arise at some conference given the empty network as the en route network. Even though we take the conclusion costs into account, either of the participants at the conference is indifferent between linking or not linking if, when linking then, it decide not to link with the oppsite in the next conference and if, when not linking, it decide to link (so that both of the outcome networks become one-link networks).

In order to break such the tie, we shall give conferences a rule, "the rule of conferences": we assume that when either of participants is indifferent between linking or not linking, the decision in the conference depends only on the other's preference. By the rule of conferences, we can get a little more strict corollary than the previous proposition.

Corollary 1 *Suppose that the outcome of the myopic game $\Gamma_M(\phi,\delta)$ is the one-link network $\{AB\}$ and either $\delta < \sqrt{\frac{\phi+1}{2\phi^2}}$ or $\phi < \frac{1}{2}$ does not hold for some (ϕ,δ). If the rule of conferences is adopted in the farsighted game $\Gamma_F(\phi,\delta)$, then the outcome network of $\Gamma_F(\phi,\delta)$ is also $\{AB\}$.*

Since the result is straightforward, we omit the proof.

4 Discussion and Conclusion

In the previous section, we showed the following propositions:

- That myopic games and farsighted games never induce a star network.
- For some (ϕ,δ), the myopic game yields a one-link network while farsighted game yields the complete network. Otherwise, both the outcomes of the myopic game and the farsighted game coincide.

Let us approach the relation between myopic games and farsighted games by using some figures. The areas in Figure 4 are classified by the cases in Proposition 1, (i), (ii-a) and (ii-b). The darkest area is where both of the myopic games and the farsighted ones yield a one-link network, the brightest (but not white) area is where both induce the complete network, and the medium gray area is where the myopic games yields a one-link area but the farsighted ones induces the complete

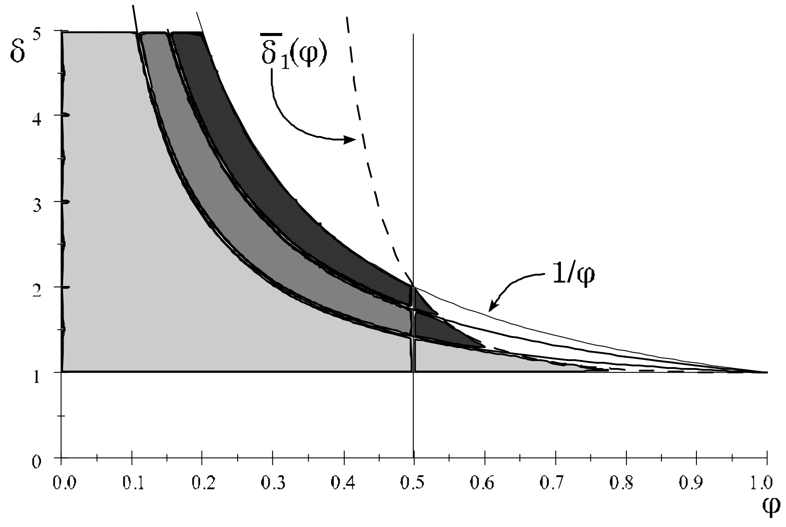

Figure 4: The relation between myopic games and farsighted games

network. By Figure 4, we can see that the case of (ii-a) in Proposition 1 is never negligible though it is not so frequent. Note that, in the case of (ii-a), the complete network $\{AB, BC, CA\}$ is better than the one-link network $\{AB\}$ for both countries B and C since $D_B^{13} > 0$ and $D_C^{13} > 0$. However, country B hesitates to conclude for fear the level of its own social welfare declines *just after* linking with country C although country C wants to link with country B. The cause of that hesitation is the outflow of capitals: that is, linking with country C results in the migration of some capitals from country B to countries A and C. In the farsighted game, since country B foresee that later Conference CA decide to link for certain, it wants to conclude to link with country C.

Finally, we refer an example of some actual affairs we can explain with our results. Some of our results can be applied to the formation of trading blocks by some suzerains after the world-wide financial crisis in 1929. Each suzerain must have hoped for a rapid growth because then it had been damaged extensively. So, the governments of suzerains must have been myopic with respect to the change of their own social welfare. Therefore, block economies were remained until the end of World War Ⅱ.

Appendix A

A.1 Distribution of firms

With specifying each phase, we explicitly solve the distribution of firms and the welfare differential for each countries.

Phase 0 $g = \varnothing$: $\phi_{AB} = \phi_{BC} = \phi_{CA} = \phi.$

Phase 1 $g = \{AB\}$: $\phi_{AB} = \phi_{BA} = \phi\delta, \phi_{BC} = \phi_{CB} = \phi_{AC} = \phi_{CA} = \phi$

Phase 2 $g = \{AB, BC\}$: $\phi_{AB} = \phi_{BA} = \phi_{BC} = \phi_{CB} = \phi_{AC} = \phi_{CA} = \phi\delta$

Phase 3 $g = \{AB, BC, CA\}$: $\phi_{AB} = \phi_{BC} = \phi_{CA} = \delta\phi.$

While the rotation of the conferences are specified in this appendix, due to the symmetry of three countries it doesn't change any results.

A.1.1 Phase 0 and 3

The solution for the distribution of firms are given by

$$\lambda_A^i = \lambda_B^i = \lambda_C^i = \frac{1}{3}, \quad where \;\; i = 0, 3$$

A.1.2 Phase 1

Applying the capital arbitrage condition, the solution for the distribution of firms are given by

$$\lambda_A^1 = \lambda_B^1 = \frac{1}{3}\frac{-3\phi + \phi^2 + \delta\phi + 1}{(1-\phi)(-2\phi + \delta\phi + 1)} > \lambda_C^1$$
$$\lambda_C^1 = \frac{1}{3}\frac{3\phi - 4\phi^2 - \delta\phi + 3\delta\phi^2 - 1}{(\phi - 1)(-2\phi + \delta\phi + 1)}$$

Note that although λ_r should not exceed 1 and varies negative values, keeping the restriction of $\delta\phi < 0$, we have $\lambda_r \in [0, 1]$.

We have the case such that $\lambda_C^1 = 0$. The critical value for this corner solution is $\overline{\delta_1} = \frac{1+4\phi^2-3\phi}{\phi(3\phi-1)}$ $\left(or \;\phi = \frac{\delta-3+\sqrt{6\delta+\delta^2-7}}{2(3\delta-4)}\right)$. When δ exceeds $\overline{\delta_1}$, λ_C^1 is always zero.

A.1.3 Phase 2

As is the same procedure for Phase 1, we obtain the solution for the distribution of firms by,

$$\lambda_A^2 = \lambda_C^2 = \frac{1}{3}\frac{\phi + \delta^2\phi^2 - 3\delta\phi + 1}{(\delta\phi - 1)(-\phi + 2\delta\phi - 1)} < \lambda_B^2$$
$$\lambda_B^2 = \frac{1}{3}\frac{\phi + 4\delta^2\phi^2 - 3\delta\phi - 3\delta\phi^2 + 1}{(\delta\phi - 1)(-\phi + 2\delta\phi - 1)}$$

Restriction in the parameter, $\delta\phi < 0$, allows us to keep the variable of interest in the reasonable range, $\lambda_r \in [0, 1]$.

We have the case such that $\lambda_A^2 = \lambda_C^2 = 0$. The critical value for this corner solution is $\overline{\delta_2} = \frac{3+\sqrt{5-4\phi}}{2\phi}$ $\left(or \;\phi = \frac{3\delta-1+\sqrt{5\delta^2+1-6\delta}}{2\delta^2}\right)$. When δ exceeds $\overline{\delta_2}$, λ_A^2 and λ_C^2 are always zero.

A.2 Welfare differential

Using the above results, (13) and (14) , we have welfare differential for each country at each phase.

	D_r^{01}	D_r^{12}	D_r^{23}	D_r^{13}
$r = A$	$\frac{\phi(\delta-1)}{(2\phi+1)(1-\phi)}$	$\frac{(\delta-2\delta\phi+1)\phi^2(\delta-1)}{(\delta\phi-1)(-2\phi^2+\delta\phi+1)}$	$\frac{\phi(\delta-1)}{(2\phi+1)(1-\phi)}$	$\frac{\phi(2\phi-1)(\delta-1)}{2\phi^2-\delta\phi-1}$
$r = B$	$\frac{\phi(\delta-1)}{(2\phi+1)(1-\phi)}$	$\frac{\phi(\delta-1)\left(\phi+2\phi^2-2\delta\phi^2-1\right)}{(-\phi+2\delta\phi-1)(-2\phi^2+\delta\phi+1)}$	$\frac{2\delta\phi^2(\delta-1)}{-\phi+2\delta^2\phi^2-1}$	$\frac{\phi(2\phi-1)(\delta-1)}{2\phi^2-\delta\phi-1}$
$r = C$	$-\frac{2\phi^2(\delta-1)}{(2\phi+1)(-2\phi+\delta\phi+1)}$	$\frac{\phi(\delta-1)\left(\phi+2\phi^2-2\delta\phi^2-1\right)}{(-\phi+2\delta\phi-1)(-2\phi^2+\delta\phi+1)}$	$\frac{\phi(\delta-1)}{(2\phi+1)(1-\phi)}$	$\frac{2\phi(\delta-1)(-\phi+\delta\phi+1)}{-2\phi^2+\delta\phi+1}$

Table 1: Welfare differential of three countries in each phase

Appendix B

B.1 The proof of Theorem 1

Proof. We check the condition to form a link at each conference:

Conference AB $D_A^{01} > 0$ and $D_B^{01} > 0$, so $\delta > 1$. Therefore countries A and B always link together. the phase transits from 0 to 1.

Conference BC $D_B^{12} > 0$ and $D_C^{12} > 0$, so $\phi + 2\delta\phi - 1 < 0$ and $2\delta^2\phi^2 + \delta\phi - 2\delta\phi^2 - 1 < 0$. Therefore, if $1 < \delta < \frac{2\phi - 1 + \sqrt{4\phi^2 - 4\phi + 9}}{4\phi}$, countries B and C link together and the phase transits from 1 to 2. Otherwise, if $\frac{2\phi - 1 + \sqrt{4\phi^2 - 4\phi + 9}}{4\phi} \leq \delta < \frac{1}{\phi}$, they are never connected and the phase remains 1.

Conference CA When link BC was not formed, by symmetry $D_C^{12} \leq 0$ or $D_A^{12} \leq 0$. So countries C and A are never connected. When countries B and C was connected, the conditions for countries C and A to link are $D_C^{23} > 0$ and $D_A^{23} > 0$, that is $\phi - 2\delta^2\phi^2 + 1 > 0$. Therefore, if $\delta < \sqrt{\frac{\phi+1}{2\phi^2}}$, countries C and A link together. Otherwise, they are never connected and the phase remains 2.

By the above, the resulting network is a one-link network $\{AB\}$ if $\frac{2\phi - 1 + \sqrt{4\phi^2 - 4\phi + 9}}{4\phi} \leq \delta < \frac{1}{\phi}$, the complete network $\{AB, BC, CA\}$ if $1 < \delta < \frac{2\phi - 1 + \sqrt{4\phi^2 - 4\phi + 9}}{4\phi}$ and $\delta < \sqrt{\frac{\phi+1}{2\phi^2}}$, and the star network centering B, $\{AB, BC\}$ if $1 < \delta < \frac{2\phi - 1 + \sqrt{4\phi^2 - 4\phi + 9}}{4\phi}$ but $\delta \geq \sqrt{\frac{\phi+1}{2\phi^2}}$. However, note that $\frac{2\phi - 1 + \sqrt{4\phi^2 - 4\phi + 9}}{4\phi} < \sqrt{\frac{\phi+1}{2\phi^2}}$. This implies that there exists no (ϕ, δ) such that $\delta < \frac{2\phi - 1 + \sqrt{4\phi^2 - 4\phi + 9}}{4\phi}$ and $\delta \geq \sqrt{\frac{\phi+1}{2\phi^2}}$, and that we can exclude $\delta < \sqrt{\frac{\phi+1}{2\phi^2}}$ from the conditions for the complete network. ■

B.2 The proof of Proposition 1

Proof. (i) By using backward induction, we extract the subgame perfect equilibria of the farsighted game $\Gamma_F(\phi, \delta)$.

First, we consider all the possible en route networks under which Conference CA makes a decision. There are four situations; $\{AB, BC\}$, $\{AB\}$, $\{BC\}$ and $\varnothing$. Note that, in the myopic game $\Gamma_M(\phi, \delta)$, all conferences AB, BC and CA decide to link together. Thus, by symmetry, Conference CA must determine to link together when given any decision profile; that is, $\{AB, BC\}$ is changed into $\{AB, BC, CA\}$, $\{AB\}$ into $\{AB, CA\}$, $\{BC\}$ into $\{BC, CA\}$, and $\varnothing$ into $\{CA\}$.

Secondly, consider all the possible en route networks under which Conference BC makes a decision. There are two situations; $\{AB\}$ and $\varnothing$. Using the above discussion, under $\{AB\}$, if countries B and C link together, the outcome network is complete, and otherwise that becomes $\{AB, CA\}$. Noting that countries B and C must have incentives to link at phase 2 given $\{AB, CA\}$, both their payoffs at $\{AB, BC, CA\}$ are higher than those at $\{AB, CA\}$. Thus Conference BC determines to link when given $\{AB\}$. On the other hand, under $\varnothing$, if countries B and C link together, the outcome network is $\{BC, CA\}$, and otherwise $\{CA\}$. Noting that countries B and

C must have incentives to link at phase 1 given $\{CA\}$, both their payoffs at $\{BC, CA\}$ are higher than those at $\{CA\}$. Thus Conference BC also determines to link when given $\varnothing$.

Finally, consider Conference AB. If countries A and B link together, the outcome network is complete, and otherwise $\{BC, CA\}$. Similarly to the above, both their payoffs at $\{AB, BC, CA\}$ are higher than those at $\{BC, CA\}$. Thus Conference AB concludes to link.

To sum up, every conference concludes to link when given any possible en route network. Therefore, the outcome network is complete.

(ii) Assume that the one-link network $\{AB\}$ is formed in a myopic game $\Gamma_M(\phi, \delta)$. Then, at phase 0, the participants want to link together but, at phase 1, the participants choose not to link. Note that the assumption never restrict the action at phase 2. Now, we proceed the proof similarly to (i).

First, consider the four possible en route networks under which Conference CA faces, which are $\{AB, BC\}$, $\{AB\}$, $\{BC\}$ and $\varnothing$. Under $\varnothing$, countries C and A decide to link, and under $\{AB\}$ or $\{BC\}$, they do not link together. While, under $\{AB, BC\}$, if $D_C^{23} > 0$ and $D_A^{23} > 0$, that is, if $1 < \delta < \sqrt{\frac{\phi+1}{2\phi^2}}$, then Conference CA concludes to link; otherwise they choose not to link together. Therefore, the en route network $\{AB, BC\}$ is changed into $\{AB, BC, CA\}$ if $1 < \delta < \sqrt{\frac{\phi+1}{2\phi^2}}$ and otherwise it remains unchanged, $\{AB\}$ and $\{BC\}$ remains unchanged, and $\varnothing$ is changed into $\{CA\}$.

Secondly, consider the two possible en route networks, $\{AB\}$ and $\varnothing$. Note that $D_B^{13} > 0$ and $D_C^{13} > 0$ imply $\phi < \frac{1}{2}$, and vice versa. So, under $\{AB\}$, if $\phi < \frac{1}{2}$ in addition to $1 < \delta < \sqrt{\frac{\phi+1}{2\phi^2}}$, Conference BC determines to link; otherwise, they choose not to link. And, under $\varnothing$, while country B wants to link with country C, whether to link or not is just indifferent for country C since, even though it does not link with country B, it will link with A in the next Conference CA. Hence, both to link and not to link can be concluded, so that $\{BC\}$ and $\{CA\}$ are both possible.

Finally, consider Conference AB by dividing into the two cases above.

(a) When $\phi < \frac{1}{2}$ and $1 < \delta < \sqrt{\frac{\phi+1}{2\phi^2}}$, if countries A and B link together, the outcome network is complete, $\{AB, BC, CA\}$; otherwise, that becomes $\{BC\}$ or $\{CA\}$. By $\phi < \frac{1}{2}$ and symmetry, both countries A and B want to link together. So, Conference AB chooses to link, and the outcome network is the complete network.

(b) When either $\phi < \frac{1}{2}$ or $1 < \delta < \sqrt{\frac{\phi+1}{2\phi^2}}$ does not hold, if countries A and B link together, the outcome network is $\{AB\}$; otherwise, that becomes $\{BC\}$ or $\{CA\}$. Although the network $\{AB\}$ is better than $\{BC\}$ for country A and than $\{CA\}$ for country B, $\{AB\}$ is indifferent to $\{BC\}$ for country B and to $\{CA\}$ for country A. Therefore, similarly to Conference BC given the en route network $\varnothing$, both to link and not to link can be concluded in Conference AB, so that $\{AB\}$, $\{BC\}$ and $\{CA\}$ are all possible. However, whichever netowork is realized at last, the number of the link is only one. ■

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