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ECONOMIC EFFECTS OF FORMING FREE TRADE AGREEMENT BETWEEN TECHNOLOGICALLY ASYMMETRIC COUNTRIES AND OPTIMAL GOVERNMENT POLICIES

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This paper examines the welfare effects of forming FTA between asymmetric countries in terms of technologies, and the influence of the technology asymmetry on the dynamic policy coordination for FTA. In addition, we determine the optimal policies with respect to FTA formation under incomplete information about the technology differences. We demonstrate that welfare gains for the FTA partner country with a higher technology is dominant to the welfare change to the home country with a lower technology, reducing the disagreement payoff of the partner country. In addition, with a higher technology asymmetry, efficient FTA policy coordination is less likely.

JEL Classification: F12, F13, F15
Keywords: FTA, Technology Asymmetry, Policy Coordination

1. INTRODUCTION

With the suggestion by the Japanese prime minister to launch a formal feasibility studies on forming free trade area between Japan and Korea in 1999, there has been a sharp upsurge in the discussion of FTA in the Asian region. Especially, the discussion of forming regional economic integration has expanded to the scale of 'ASEAN+3' in the summit meeting of 'ASEAN+3' in November 2001. While political and business leaders show deep interests in forming FTA in the Asian region, surprisingly there is little theoretical consensus on the economic impacts of forming FTA in the Asian region.

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There have been several approaches to examine the economic impacts of forming preferential trade agreement, and prior studies can be categorized into three groups. The first group, based on simulations about the impacts of FTA formation through CGE model, tried to provide a projection on the static effects on trade balance and other macroeconomic variables. The second group of studies focuses on the coalition formation issue based on the incentive mechanism to abide by the FTA arrangement. Through this analytical model based approach, they tried to examine whether FTA is a stumbling bloc or a stepping-stone towards multilateral trade liberalization. The third approach is led by economic geographic approaches with special emphasis on the spatial economy. This approach has its strong points in examining industrial agglomeration and relocation effect of FTA.

Regarding the economic impacts of FTA in the Asian region, most studies took the first approach, which is to estimate the impact of removing tariff barriers between FTA member countries based on computable general equilibrium model. It is well known that the CGE approach has several shortcomings caused by its static approach in addition to too strong assumptions such as perfectly competitive markets and the constant returns to scale in the production technology. Even with these shortcomings of CGE approaches, there have been few trials to provide comprehensive analytic model analysis on FTA issues in the Asia.

There are several representative prior researches, which can be categorized as a second group of FTA analysis focusing on coalition formation, and policy coordination incentive issue based on analytic model, although none of them paying special attention to the Asian region. Grossman and Helpman (1995) examine the conditions for the benefit from FTA to be larger than the loss in import competing industries. They assume two small countries with no market power. A policy with respect to FTA formation issue is decided to maximize the political objective function, while the aggregate welfare of voters is given by the summation of the aggregate labor supply, the firms' profit, the tariff revenue and the consumer surplus. The governments objective function is the summation of firms' political contributions and the weighted aggregate welfare. Based on these assumptions, Grossman and Helpman examine the condition for the government's support for the FTA, and demonstrate that FTA is supported when the enhanced protection is more likely, which deteriorates social welfare.

Bagwell and Staiger (1997) show that the formation of FTA between symmetric countries tends to increase tariff levels temporarily to reduce the incentive to deviate from the tariff cooperation based on the self-enforcing mechanism during the transition period. However, custom union tends to decrease the temporary tariff level because of the market power effect. Krishna (1998) argues that trade-diverting preferential agreement is more likely to be supported politically, and such preferential arrangements could critically change domestic incentives. So multilateral liberalization could be rendered infeasible by preferential arrangement. Freund (2000) shows that as the multilateral tariff was lowered, it is more likely that the tariff cooperation for FTA is sustained.

The prior studies provided much progress in understanding the welfare effects of FTA formation and dynamic incentive issues. However, most of them were based on the assumption of symmetric countries with complete information assumption. North East Asian region, composed of Korea, Japan and China, is characterized by sharp differences in the technology levels and market size. In addition, information about each country's technology level and government's indirect influences on corporate sectors are not fully shared by each other country.

With these backgrounds, this paper examines the effects of market size and technology asymmetry on the welfare level of FTA member country, and the dynamic incentive for policy coordination for FTA formation. In addition, this paper discusses the influence of the incomplete information about the technology level of each country, and the optimal policy response with respect to the informational problem. Based on a simple model of three countries with linear demand functions and differentiated products, this paper demonstrates that welfare might be deteriorated when FTA is formed with a country which has a smaller market size with a higher technology level. With a higher technology asymmetry, efficient FTA policy coordination is less likely. Under incomplete information, it is required for the home country to reduce the amount of side payment to induce the truthful self-revelation of the partner country as a separating equilibrium.

This paper is organized as follows. In section 2, the theoretical model is described focusing on the case of FTA formation between symmetric countries as a benchmark discussion. Section 3 examines the influences of technology asymmetry on the welfare level of each country, and Section 4 shows how dynamic incentive for policy coordination is influenced by the country asymmetry. Section 5 discusses the impact of incomplete information about the asymmetry and Section 6 discusses policy implications and concludes.

2. THE MODEL

Assume that there are three countries A, B, C and the inverse demand function of each countries is as follows: $P_i = a - bQ_i$ where $i = A, B, C$ and Q_i is the total quantity demanded in market i.[1] There is one representative firm in each country. The inverse demand function in country A is composed of three products supplied by three countries: Assume that there are three countries $P_A = a - b(q_A + \chi_{BA} + \chi_{CA})$ where q is the output produced for the home market and χ_{BA} is output produced by the firm in country B for export to country A.

When we assume that the marginal production cost is same among three countries, the profit function of A is described as:

[1] To focus on the impacts of the asymmetric technology, the market sizes of the three countries are assumed to be symmetric.

$$\Pi_A = (P_A - c)q_A + (P_B - c - t_B)\chi_{AB} + (P_c - c - t_c)\chi_{AC} \quad (1)$$

where t_i is the import tariff of country i.

The inverse demand functions and the profit functions for B and C are defined in similar way respectively. The government of each country decides its trade policy, i.e., the import tariff level simultaneously, and then each firm decides its output strategy after it observes the trade policies. In this two stage game, the equilibrium market condition can be obtained by backward induction.

First, we check the case when technologies of three countries are symmetric and the three countries abide by the MFN clause with no preferential tariff system as a benchmark discussion. In this case, the equilibrium output in country A is decided as follows:

$$q_A = \frac{a-c+2t}{4b}, \chi_{CA} = \frac{a-c-2t}{4b}, \chi_{BA} = \frac{a-c-2t}{4b} \quad (2)$$

With symmetric technologies and demand functions, the equilibrium output in country B and C are respectively:

$$q_B = \frac{a-c+2t}{4b}, \chi_{AB} = \frac{a-c-2t}{4b}, \chi_{CB} = \frac{a-c-2t}{4b} \quad (3)$$

$$q_C = \frac{a-c+2t}{4b}, \chi_{AC} = \frac{a-c-2t}{4b}, \chi_{BC} = \frac{a-c-2t}{4b}$$

Each firm sells in its domestic market by the amount of $a-c+2t/(4b)$ and two foreign markets by the amount of $a-c-2t/(4b)$ in equilibrium.

The social welfare function of the country A is defined as:

$$SW = CS + PS + GS = \int_{P_*}^{a} D(P)dP + \underset{AA}{\Pi} + \underset{AB}{\Pi} + \underset{AC}{\Pi} + t(\chi_{BA} + \chi_{CA}) \quad (4)$$

The optimal trade policy under MFN system is derived as a solution of the first order condition of the social welfare maximization problem with respect to the tariff as follows: $3(a-c)/10$. However, when a Free Trade Area is formed between country A and B, then, the tariffs between country A and B are reduced to 0, while the tariff against the non-member country C is decided non-cooperatively as $(a-c)/7$. Country C, which is a non-member country, sets its optimal tariff as $3(a-c)/10$[2].

The welfare effect of forming FTA on country A is summarized in table 1

[2] The reason for the outsider country(C)'s tariff after FTA formation to be same as the MFN tariff level is that, in this model, each market is separated. In addition, the optimal tariff of FTA member country towards non-member country is lower than the MFN tariff level because of the supermodularity in external tariffs.

comparing the welfare level before and after forming FTA between A and B.

[Table 1] The Welfare Effects of Forming FTA on a member country (A) with (symmetric technology)

	Most Favored Nation Condition (Non-Cooperative Nash Equilibrium)	FTA	Welfare change of FTA
Optimal tariff	$\frac{3(a-c)}{10}$	i) FTA Member country: $\frac{(a-c)}{7}$ ii) Non-member country: $\frac{3(a-c)}{10}$	-
Consumer Surplus of a member country (A)	$\frac{9(a-c)^2}{50b}$	$\frac{25(a-c)^2}{98b}$	$0.0751\frac{(a-c)^2}{b}$
Producer Surplus (A)	Total PS: $\frac{18(a-c)^2}{100b}$	Total PS: $\frac{849(a-c)^2}{4900b}$	$-0.0067\frac{(a-c)^2}{b}$
	PS in the domestic market (A): $\frac{4(a-c)^2}{25b}$	PS in the domestic market (A): $\frac{4(a-c)^2}{49b}$	$-0.0784\frac{(a-c)^2}{b}$
	PS in a foreign market (B): $\frac{(a-c)^2}{100b}$	PS in the non-member market (B): $\frac{4(a-c)^2}{49b}$	$0.0716\frac{(a-c)^2}{b}$
	PS in a foreign market (C): $\frac{(a-c)^2}{100b}$	PS in the non-member market (C): $\frac{(a-c)^2}{100b}$	0
Government Surplus (A)	$\frac{3(a-c)^2}{50b}$	$\frac{(a-c)^2}{49b}$	$-0.0396\frac{(a-c)^2}{b}$
Social Welfare (A)	$0.42\frac{(a-c)^2}{b}$	$0.4488\frac{(a-c)^2}{b}$	$0.0288\frac{(a-c)^2}{b}$

From table 1, it is found that the removal of the tariff between the FTA member countries increases the consumer welfare of the member country (A), while it decreases the domestic producer surplus and the government surplus. The consumer surplus improvement effect is dominant to the decrease in producer and government surplus, resulting in the overall improvement of social welfare. The removal of the tariff between the FTA member countries induces the reduction of the FTA member countries' tariffs toward the non-member country because of the supermodularity in external tariffs of FTA member countries. However, the tariff imposed by the non-member country is same as that of the MFN system.

Now we examine the welfare effect of FTA formation on the non-member country when the technology is symmetric.[3] When FTA is formed between A and B, the tariff imposed by the FTA member countries toward non-member country, C, is reduced from $\frac{3(a-c)}{10b}$ to $\frac{(a-c)}{7b}$ because of the complementarity effect of external tariffs. As a result, firm C's equilibrium profit in market A and B is increased from $\frac{(a-c)^2}{100b}$ to $\frac{(a-c)^2}{49b}$. Therefore, FTA formation in this model, which is equivalent to the unilateral tariff reduction by the FTA member country, is beneficial to the non-member country, too. The welfare improvement of the non-member country found in this model is possible due to the complementary effects of external tariffs in FTA member countries.[4]

[3] The details of the welfare effects are given in Appendix 1.

[4] It might seem surprising that the profit of firm C in market A and B is increased while the discriminatory tariff is imposed against firm C. The export amount of firm C to FTA member countries (A or B) is $(a-c-3t)/4b$, which is decreased more sharply with the import tariff than under MFN case, where the reaction function of firm C is $(a-c-2t)/4b$. The strategic effect of the preferential tariff removal toward the member country is reflected in the decrease of non-member countrys export to each FTA member country by the amount of $t/4b$. However, by the strategic complementarity of external tariff, the import tariff of FTA member country is reduced by $11/70b$. Therefore, the amount of the export by non-member country toward a member country is increased from $(a-c)/10b$ to $(a-c)/7b$. The reason behind this result is that the strategic complementarity of external tariff is dominant to the strategic effect of preferential tariff removal. With the complementarity of external tariff dominant to the strategic effect of preferential removal of tariff, world welfare is improved with FTA formation.

The super-modularity of external tariffs in Yi (2000) is found when a representative consumer has love-of-variety preferences. As a result, when a country is constrained to charge lower tariffs on imports in FTA arrangement, it is in the self-interest of the country to reduce external tariffs as well, since the reduction in external tariffs helps restore a balanced consumption portfolio. In our paper, to focus on the impact of technology difference, the consumer utility is assumed as not affected by the variety of commodities. Therefore, the super-modularity of external tariff appears more strongly in Yi (2000) than this paper. Even without the assumption of the utility function, which is affected by the commodity variety, the super-modularity of the external tariff is still found because the strategic complementarity of external tariff is dominant to the strategic effects of preferential tariff removal.

3. THE WEIFARE EFFECT OF FTA BETWEEN TECHNICALLY ASYMMETRIC COUNTRIES

When a country forms a FTA with technically asymmetric countries, the welfare effects can be measured by assuming different marginal cost of each country. We examine the case when the home country, A, forms a FTA with a technically more efficient country, B, leaving out a less efficient country, C, as a non-member country. Then, the marginal cost of three countries, A, B, C can be expressed in the following way: $c_B < c_A < c_C$. To simplify the discussion and notation, we assume that $c_B = c_A - \gamma$ and $c_C = c_A + \gamma$.[5] Then the profit functions of three countries firms are defined as:

$$\Pi_A = (P_A - c)q_A + (P_B - c - t_B)x_{AB} + (P_C - c - t_C)x_{AC}$$

$$\Pi_B = (P_B - (c-\gamma))q_B + (P_A - (c-\gamma) - t_A)x_{AB} + (P_C - (c-\gamma) - t_C)x_{BC} \quad (5)$$

$$\Pi_C = (P_C - (c+\gamma))q_C + (P_A - (c+\gamma) - t_A)x_{CA} + (P_B - (c+\gamma) - t_B)x_{CB}$$

The sequence of the game with asymmetric technology is same as the symmetric case. The optimal tariffs and other welfare effects for the cases before and after FTA formation between A and B are summarized in table 2.

The formation of FTA among technologically asymmetric countries always improves the consumer surplus of home country (A). The reason behind this result is that the technically more efficient partner country provides a chance for a larger consumption at a lower price.[6]

The producer surplus of the home country, A, is decreased as a result of forming FTA with a technically more efficient country, B. The reason is also clear as the reduction of firm A's sales in home market, A, is larger than the export increase to country B because of firm B's technical dominance over firm A. Especially, when the technology difference is large and the market size, which is represented by coefficient a, is large, A's producer surplus is decreased in larger scale as shown in figure 1.

The government surplus is decreased with the FTA formation due to the loss of tariff revenue from firm B. The impact of FTA on social welfare can be measured by adding up the impact of FTA in each sector. When the market size of the participating country is small (i.e., $a < \frac{344\gamma + c}{87}$)the higher technical difference

[5] The equilibrium conditions for the parameters should satisfy the following conditions: $a>0, b>0, c>0, \gamma>0, a-c>0, 3(a-c)-16\gamma>0$ i.e., the non-negative demand condition and equivalently non-negative price conditions.

[6] The improvement in consumer surplus will be increased with the increase in the technology difference as demonstrated by follows: $\frac{\partial \Delta CS(FTA)}{\partial \gamma} > 0$.

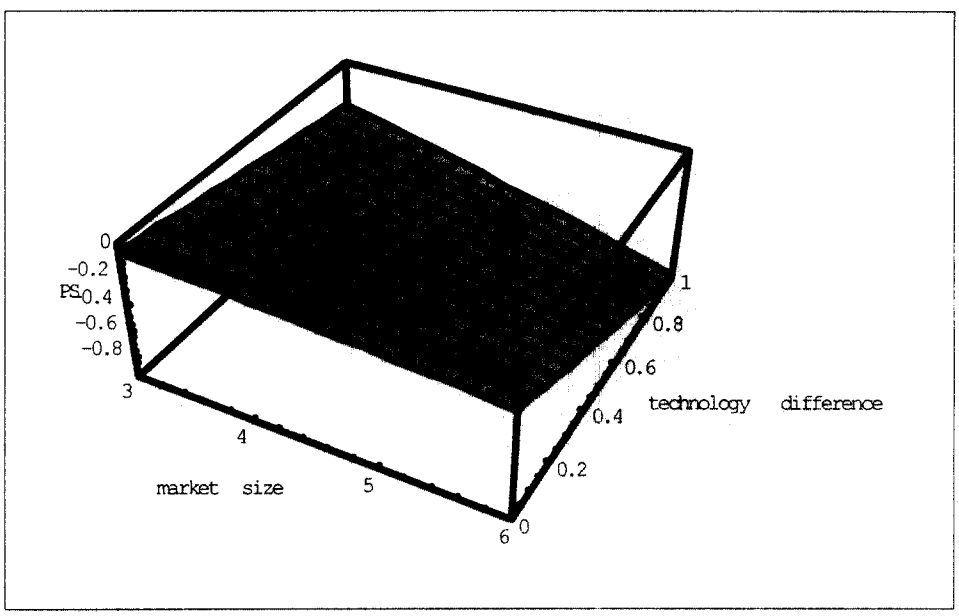
[Table 2] The Welfare Effects of Forming FTA on A with asymmetric technology

	MFN System	FTA between A and B	Welfare Effects of forming FTA
Optimal tariff	$\frac{3(a-c)}{10}$	i) FTA Member country (A): $\frac{3(a-c)-16\gamma}{21}$ (B)[7] : $\frac{3(a-c)-8\gamma}{21}$ ii) Non-member country(C): $\frac{3(a-c)}{10}$	- FTA member countries tariffs become lower when B is more efficient.
Consumer Surplus of A	$\frac{9(a-c)^2}{50b}$	$\frac{(15(a-c)+4\gamma)^2}{882b}$	$\Delta CS(FTA)>0$
Producer Surplus (A)	Total PS: $\frac{9(a-c)^2}{50b}$	Total PS: $\frac{4(3(a-c)-2\gamma)^2}{441b}$ $\frac{4(3(a-c)-\gamma)^2}{441b}+\frac{(a-c)^2}{100b}$	$\Delta PS(FTA)<0$ $\frac{\partial \Delta PS(FTA)}{\partial \gamma}<0$ $\frac{\partial \Delta PS(FTA)}{\partial b}>0$
	PS in the domestic market (A): $\frac{4(a-c)^2}{25b}$	PS in the domestic market (A): $\frac{4(3(a-c)-2\gamma)^2}{441b}$	$\Delta PS(FTA)<0$
	PS in a foreign market (B): $\frac{(a-c)^2}{100b}$	PS in the FTA member market (B): $\frac{4(3(a-c)-\gamma)^2}{441b}$	$\Delta PS(FTA)>0$
	PS in a foreign market (C): $\frac{(a-c)^2}{100b}$	PS in the non-member market (C): $\frac{(a-c)^2}{100b}$	0

[7] The intuition why the tariff of B is higher than that of A is as follows. In this model, three markets of three countries are separated markets with differentiated products. With the given symmetric linear demand functions in each countries, the tariff's impact on consumer surplus and the tariff revenue in country A and B is symmetric, while the impact on producer surplus is asymmetric in country A and B. In country B with a higher technology level, the profit increase caused by the protective measure is larger than that of country A, which has a lower technology as shown in follows: $\frac{\partial \Pi_A(t_A)}{\partial t_A}=\frac{a-c+t_A}{8b}<\frac{\partial \Pi_B(t_B)}{\partial t_B}=\frac{a-c+4\gamma+t_A}{8b}$. In the meantime, the change in the consumer surplus and the government surplus in country A and B show symmetric features as follows: $\frac{\partial CS_A(t_A)}{\partial t_A}=-\frac{3(a-c)-t_A}{16b}=\frac{\partial CS_B(t_B)}{\partial t_B}=-\frac{3(a-c)-t_B}{16b}$. The intuition behind this result is that the higher technology is reflected as a lower effective marginal cost. The protective measure of the country B can provide a higher marginal profit than country A. Therefore, the welfare maximizing tariff of B against the non-member country is higher than that of country A.

	MFN System	FTA between A and B	Welfare Effects of forming FTA
Government Surplus	$\frac{3(a-c)^2}{50b}$	$\frac{(3(a-c)-16\gamma)(a-c-3\gamma)}{147b}$	$\Delta GS(FTA)<0$
Social Welfare	$\frac{21(a-c)^2}{50b}$	$\frac{(15(a-c)+4\gamma)^2}{882b}$ $\frac{4(3(a-c)-2\gamma)^2}{441b}+$ $\frac{4(3(a-c)-\gamma)^2}{441b}+\frac{(a-c)^2}{100b}$ $\frac{(3(a-c)-16\gamma)(a-c-3\gamma)}{147b}$	$\frac{\partial^2(\Delta SW(FTA))}{\partial a\partial\gamma}<0$[8]

[Figure 1] Changes in producer surplus with FTA between asymmetric countries



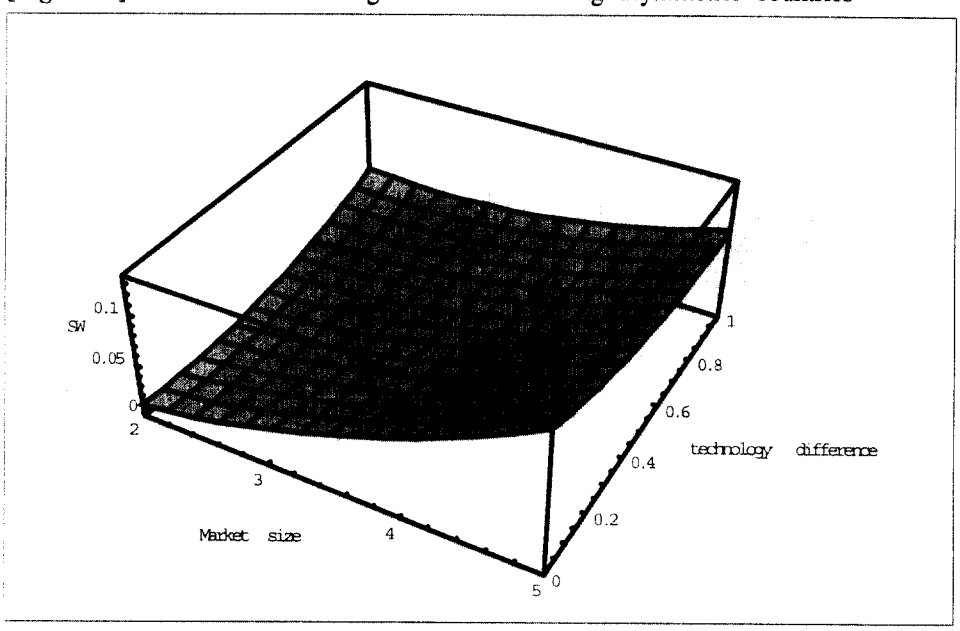
might improve the social welfare of the home country. Otherwise, the bigger technical difference among member countries might deteriorate social welfare of home country as shown in figure 2. The above result is confirmed straightforwardly from the follows:

[8] If the market size is sufficiently small, (i.e., $a<\frac{14\gamma+3c}{3}$) then, the higher technology difference enhances the social welfare with FTA. Otherwise, the higher technology difference decreases the social welfare with FTA.

$$\frac{\partial(\Delta SW(FTA))}{\partial \gamma} = -\frac{87(a-c)-344\gamma}{441} < 0 \quad \text{when} \quad a > 344\gamma/87 + c$$

From the non-negativity condition of the demand, parameter values should satisfy the following condition: $a > 3\gamma + c$. Therefore, for ranges such as $344\gamma/87 + c > a > 3\gamma + c$, it is possible that the larger technology asymmetry might improve the social welfare with FTA formation. The intuition behind this result is that when the partner country of FTA has a high technology level, FTA formation improves domestic social welfare via the reduction of equilibrium price level and the resulting improvement of consumer surplus. However, when the market size is relatively large, consumer surplus improvement effect is dominated by the producer surplus reduction and the government surplus reduction effect as demonstrated in figure 2.

[Figure 2] Social welfare change with FTA among asymmetric countries



The welfare effects the FTA formation between technically asymmetric counties on the non-member country, C, is always positive.[9] There is no change in the consumer surplus and in the government surplus of country C while the producer surplus of the firm C in the FTA member countrie's market is increased. The complementarity of external tariffs of the FTA member countries is the major reason for the welfare improvement of the non-member country by FTA formation as in the symmetric case. However, the

[9] The details of the welfare effects on the non-member country C are given in the Appendix B.

technology asymmetry causes the firm C's producer surplus increase in the country A, $\frac{(a-c-3\gamma)^2}{49b}$, to be higher than that in the country B, $\frac{(a-c-5\gamma)^2}{49b}$.

4. THE DYNAMIC INCENTIVE MECHANISM FOR FTA POLICY COORDINATION

The welfare analysis of FTA formation in the above section is based on the assumption of one-shot game in one period. However, in a repeated game, each county will keep the policy coordination only when the policy coordination is a dominant strategy. Then the condition for the policy coordination can be formulated as follows:

$$W(t_A^D, t_B^C) + \sum_{\tau=1}^{\infty} \delta^\tau W(t_A^N, t_B^N) \leq \sum_{\tau=0}^{\infty} \delta^\tau W(t_A^C, t_B^C) \tag{9}$$

where t_A^D is the deviation tariff of the country A while country B keeps the cooperative tariff, t_B^C, t_A^N, t_B^N, are non-cooperative Nash tariffs of country A and B.

$$W(t_A^D, t_B^C) + \sum_{\tau=1}^{\infty} \delta^\tau W(t_A^N, t_B^N) \leq \sum_{\tau=0}^{\infty} \delta^\tau W(t_A^C, t_B^C)$$

The above condition defines the self-enforcing condition for policy coordination for FTA. First, as a benchmark discussion, we examine the policy coordination condition among symmetric countries.

The coordinated trade policy under FTA is to impose a zero tariff towards the member country and the reduced tariff level towards non-member country. However, when the home country (A) deviates from the FTA policy coordination, A imposes a non-cooperative Nash tariff toward B and C, while country B keeps zero tariff towards country A and imposes and FTA tariff, which is lower than the non-cooperative Nash tariff, towards country C. By substituting these deviation tariffs into FTA policy coordination condition, we obtain:

$$\frac{2409(a-c)^2}{4900b} + \frac{\delta}{1-\delta}\frac{21(a-c)^2}{50b} \leq \frac{1}{1-\delta}\frac{2199(a-c)^2}{4900b} \rightarrow \delta \geq \frac{70}{117} \tag{10}$$

Therefore, only when discount factor is larger than 70/117, this policy coordination will be sustained in this given model. Now we examine the impact of technical asymmetry on this dynamic policy coordination condition.

When there is technical asymmetry among FTA member country, the deviation policy for A would be to impose the non-cooperative Nash tariff towards B, and C while the country B imposes no tariff on A and imposes a FTA tariff towards C. In this case, the dynamic policy coordination condition is as follows:

$$\frac{41(a-c)^2}{100b}+\frac{4(3(a-c)-\gamma)^2}{441b}+\frac{\delta}{1-\delta}\frac{21(a-c)^2}{50b}\leq\frac{1}{1-\delta}$$

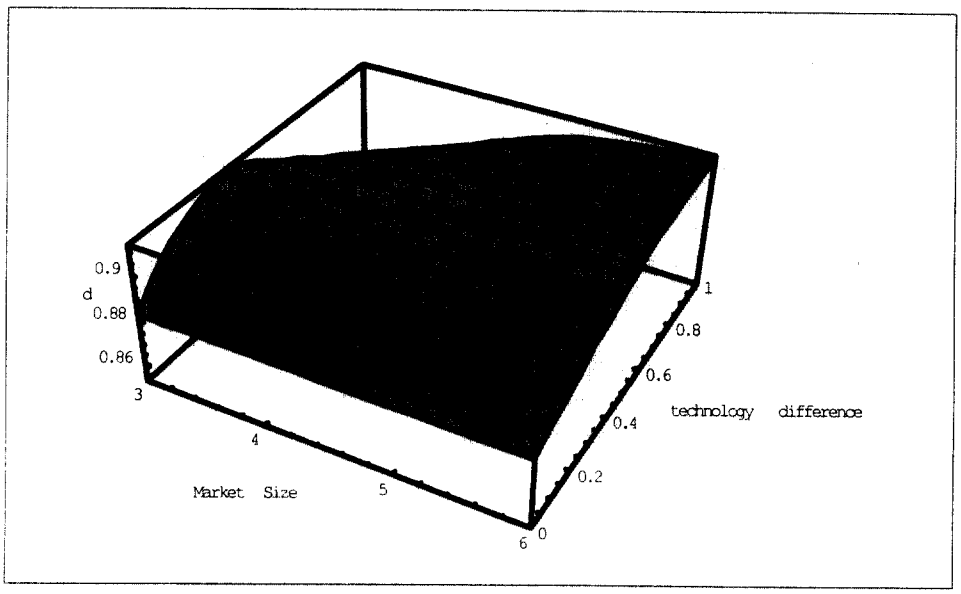
$$\left[\frac{15(a-c)+4\gamma)^2}{882b}\ \frac{4(3(a-c)-2\gamma)^2}{441b}\ \frac{4(3(a-c)-\gamma)^2}{441b}+\frac{(a-c)^2}{100b}\right]$$

The above FTA policy coordination condition for asymmetric countries is reformulated as follows:

$$\delta\geq d=\frac{30(93(a-c)^2-40\gamma(a-c+2\gamma))}{3159(a-c)^2-400\gamma(6(a-c)-\gamma)} \tag{11}$$

From the reduced policy coordination condition, it is found that when the market size is relatively small, it is less likely that the FTA policy coordination is sustained with the higher technical difference as shown in figure 5.[10] These discussions demonstrate that the policy coordination with FTA is less likely among the technically asymmetric countries than the symmetric economies.

[Figure 3] The FTA policy coordination condition with asymmetric countries



[10] When the market size is relatively small, the initial technical difference decreases the probability for policy coordination. As the technical difference is larger than the critical value, it might increase the probability for policy coordination.

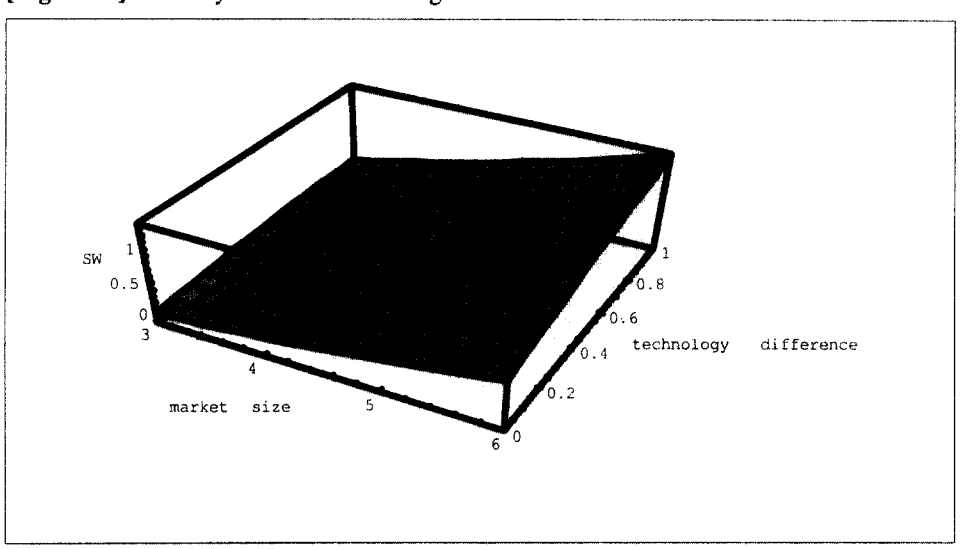
5. THE EFFECTS OF INCOMPLETE INFORMATION ON FTA FORMATION

As observed in past experiences of international negotiation on FTA formation, side payment among negotiating countries is required to reach at an equilibrium agreement when there is a difference in disagreement payoffs of two negotiating countries. In addition, when the actual technology difference is not known to a country, for example, the home country, A, the home country has to design an optimal side payment strategy with respect to each different cost report of the partner country, B.

It has been shown that when the country size is relatively small, i.e., $a < \frac{14\gamma + 3c}{3}$, the home country can benefit more from the higher technology difference, and vice versa. Then, when the market size is sufficiently large, the total social welfare level of A will deteriorate with larger technology difference, with the producer surplus always deteriorating with the higher technology difference. In addition, we found that the policy coordination for FTA becomes more difficult when the technology difference is large with relative large market size.

Contrarily, country B's social welfare strongly improves with FTA when the technology difference is large, i.e., when the γ is high, as shown in table 3. "γ" is increased not only by the technical difference, but by the invisible government involvement to support the firm in the country B. The higher technology difference provides higher welfare gains to B, which reduces the disagreement payoffs of B in the negotiating process as shown in figure 4. Therefore, under incomplete information about the technology difference, B has a strong incentive not to disclose the actual technology difference especially when γ is high.

[Figure 4] Country Bs welfare change with FTA



[Table 3] The Welfare Effects of Forming FTA on B with Asymmetric Technology

	Most Favored Nation Condition (Non-Cooperative Nash Equilibrium)	FTA between A and B	Welfare Effects of forming FTA
Consumer Surplus of B	$\frac{9(a-c)^2}{50b}$	$\frac{(15(a-c)+2\gamma)^2}{882b}$	$\Delta CS(FTA)>0$
Producer Surplus (B)	Total PS: $\frac{(a-c+10\gamma)^2}{50b}+\frac{(2(a-c)+5\gamma)^2}{25b}$	Total PS: $\frac{(6(a-c)+19\gamma)^2}{441b}+\frac{(6(a-c)+17\gamma)^2}{441b}+\frac{(a-c+10\gamma)^2}{100b}$	$\Delta PS(FTA)<0$ $\frac{\partial \Delta PS(FTA)}{\partial b}<0$ $\frac{\partial \Delta PS(FTA)}{\partial b}>0$
	PS in the domestic market(B): $\frac{(2(a-c)+5\gamma)^2}{25b}$	PS in the domestic market (B): $\frac{(6(a-c)+19\gamma)^2}{441b}$	$\Delta PS(FTA)<0$
	PS in a foreign market (A): $\frac{(a-c+10\gamma)^2}{100b}$	PS in the FTA member market (A): $\frac{(6(a-c)+17\gamma)^2}{441b}$	$\Delta PS(FTA)>0$
	PS in a foreign market (C): $\frac{(a-c+10\gamma)^2}{100b}$	PS in the non-member market (C): $\frac{(a-c+10\gamma)^2}{100b}$	0
Government Surplus (B)	$\frac{3(a-c)(a-c-5\gamma)}{50b}$	$\frac{(3(a-c)-8\gamma)(a-c-5\gamma)}{147b}$	$\Delta GS(FTA)<0$
Social Welfare (B)	$\frac{9(a-c)^2}{50b}+\frac{(a-c+10\gamma)^2}{50b}+\frac{(2(a-c)+5\gamma)^2}{25b}+\frac{3(a-c)(a-c-5\gamma)}{50b}$	$\frac{(15(a-c)+2\gamma)^2}{882b}+\frac{(6(a-c)+19\gamma)^2}{441b}+\frac{(6(a-c)+17\gamma)^2}{441b}+\frac{(a-c+10\gamma)^2}{100b}+\frac{(3(a-c)-8\gamma)(a-c-5\gamma)}{147b}$	$\frac{\partial^2(\Delta SW(FTA))}{\partial a \partial \gamma}<0$

Now, we examine that the impact of incomplete information about the technology level. We assume that the foreign partner country (B) owns private information about the technology difference. The larger increase in the welfare gains from FTA formation means the decrease in disagreement payoffs, which are equivalent to bargaining powers. Therefore, when the technology difference is large with relatively large market size, country B has an incentive not to reveal the actual technology differences. The welfare gains of B from FTA formation are described in Table 3.

Assume that the prior belief about the high technology difference (γ_H) is δ_H, and the prior belief is common knowledge. The welfare gains from FTA formation are allocated between two countries by a side-payment offer made by country A in this bargaining game. In this incomplete information game, the side-payments offer of country A is contingent on the country B's report on its technology difference level, actually including the implicit government support and involvement. There are two types of equilibrium, the pooling equilibrium and the separating equilibrium. In pooling equilibrium, country B with a high technology difference reports that the technology difference is low, and country A offers a side-payments regardless of the cost reports by country B. In this pooling equilibrium, the posterior belief system cannot be updated because the actual technology type is not revealed.

However, in the separating equilibrium, country A offers different side-payments depending on different cost reports of country B, i.e., S_H and S_L. And country B with high technology difference has no incentive to disguise its actual technology type. The efficient bargaining strategy for country A is determined when the equilibrium structure takes the separating equilibrium. Therefore, it is necessary for country A to make a contract during the FTA negotiation to induce country B to reveal its actual technology difference and invisible government involvement reaching at the separating equilibrium strategies. The separating equilibrium contract between A and B should satisfy the following incentive compatibility condition and the individual rationality conditions for B.[11]

$$\begin{aligned} &SW_B(w=\gamma_L;\gamma_H)+S_L \le SW_B(w=\gamma_H;\gamma_H)+S_H && \text{ICC} \\ &SW_B(w=\gamma_L;\gamma_H)+S_H \ge 0 && \text{IRC} \\ &SW_B(w=\gamma_H;\gamma_L)+S_L \ge 0 && \text{IRC} \end{aligned} \tag{12}$$

[11] Whether the incentive compatibility condition and the individual rationality condition are actually held depends on the parameter values of the model and the prior belief system. In usual case, when the prior belief, δ_H, is larger than the critical value, the separating equilibrium is the unique intuitive equilibrium, while the prior belief is lower than the critical value, pooling equilibrium might hold. In this paper, to focus on the general direction of contract, the detailed description of the critical value is not provided. The detailed characterization of the equilibria in the bargaining game would be the topics of the future studies.

where S_L is the side payment paid by A to B in the process of FTA negotiation when γ is low, and S_H is the side payment from A to B when γ is high.[12] 'w' is posterior belief of A on B's type based on B's report on its type of γ. If $w=\gamma_L$, A believes that B has low γ, and if $w=\gamma_H$, A believes B has high γ.

Because only B with high γ has an incentive not to reveal the actual type, individual rationality condition for B with lower γ should be binding. Then, the unique intuitive separating strategy for A would be as follows[13]:

$$S_H = SW_B(w=\gamma_L;\gamma_H) - SW_B(w=\gamma_L;\gamma_L) - SW_B(w=\gamma_H;\gamma_H) \tag{13}$$
$$S_L = -SW_B(w=\gamma_L;\gamma_L)$$

The policy implication for the above discussion is that the amount of side payment in both γ_H and γ_L cases are negative, i.e., the partner country with higher technology, B, is supposed to provide side payments to home country, A, because of B's low disagreement payoffs. However, under incomplete information, it is required for the country A to reduce the amount of side payment as a separating strategy. With this separating contract system, B with higher γ has an incentive to reveal its actual technology type.

6. POLICY IMPLICATIONS AND CONCLUDING REMARKS

Based on a simple model assuming the linear demand function with differentiated commodities, this paper has demonstrated that welfare gains from forming FTA between asymmetric countries differ depending on the technology level and the market size of each country. It has been found that welfare might be deteriorated when FTA is formed with a country which has a smaller market size with a higher technology level. In addition, the dynamic policy coordination with FTA becomes more difficult with the higher technology difference when the market size is relatively large. Finally, when there is incomplete information about the technology differences and other equivalent invisible government involvement, the privately informed country has an incentive not to reveal its actual type. Therefore, the unique separating equilibrium strategy is to set up a side payment strategy, as lower than the complete information case.

[12] These side payments can be positive or negative. Negative payment means the income transfer or additional concession from B to A.

[13] Intuitive separating strategy should satisfy the sequential rationality condition providing the optimal payoffs to A with the satisfaction of incentive compatibility condition and individual rationality condition. In addition, the off-the-equilibrium path belief system should be intuitively consistent, which is equivalent to the sequential rationality condition in this case. Therefore, the intuitive strategy for A would be to extract the maximum transfer satisfying the ICC and IRC.

These findings provide interesting policy implications towards the discussion of FTA formation in the Asian region. It is widely recognized that Japan is leading in technology level in majority fields of manufacturing sectors and high tech industries followed by Korea and China. In the meantime, the additional market access chances for Korean firms to the Japanese market is relatively limited comparing to the Chinese market. In this context, the formation of FTA between Korea and Japan leaving out China as a non-member country is highly likely to deteriorate social welfare as well as producer surplus of Korea based on this model analysis. This projection is consistent with the earlier studies based on CGE simulations.

More interesting policy implication is that as long as we assume both Korea and Japan is rational players, Korea is required to set the amount of side payment from Japan to Korea equivalent to the difference of disagreement payoffs of FTA formation between two countries under complete information. However, when we consider the possible incomplete information about the actual technology difference and the invisible government involvement such as Japanese government maneuvering of discriminatory distribution system, the separating strategy for Korea would be to reduce the amount of side payment from Japan when they reveal the actual type. Therefore, the equilibrium strategy for Korea in FTA negotiation would be to demand the side payment such as technology transfer and capital inflows in core manufacturing and high tech sectors and also the provision of the effective access to Japanese distribution system. Before the significant evidence for the truthful self-revelation from Japanese part is certified, simple removal of tariff and non-tariff policy measures with respect to Japan would be out-of-equilibrium strategy.

To provide more comprehensive understanding of FTA formation issues, the analysis on the difference of consumers attitude in each country would be necessary. In addition, to examine the dynamic effects and the relocation effect of industries after FTA formation, it is required to introduce concrete production function incorporating the forward and backward linkage in the industries. These issues should be addressed in the future studies.

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