

THE IMPACT OF INCOMPLETE INFORMATION UNDER BILATERAL AND MULTILATERAL TRADE POLICY COORDINATION*

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This paper examines the influences of informational distortion in bilateral and multilateral international trade policy coordination, and determines the optimal strategy under incomplete information. When a country owns private information about the indirect government intervention and other technical factors of its own firm, multilateral policy coordination mode is welfare dominant to the bilateral mode for a country under informational disadvantage. The world welfare is also improved with the adoption of multilateral coordination model from the initial stage of negotiation compared to bilateral one under incomplete information.

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I. INTRODUCTION

With the launch of the WTO system, which has increased the enforcement mechanism of trade dispute settlement body compared to the former GATT system, it has been expected that trade friction and delays in trade agreement would be reduced significantly. Contrary to the expectation, the actual occurrence of international trade friction and delays of trade agreement have been observed not less frequently compared to the old GATT system. A few examples of recent trade conflicts include the Banana war between EU and the US, and the trade dispute over hormone-fed agricultural product, in addition to a sharp increase of trade frictions over anti-dumping cases since 1995, when the WTO

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system was launched.

The trade dispute between the US and Japan over the issue of unfair treatment of Kodak film products in Japanese film distribution markets would be one example of the trade frictions mainly arising from informational distortion. The Japanese consumers had incomplete information about the actual quality of Kodak film compared to the incumbent firm's products, Fuji films. In addition, Kodak Film Company had incomplete information about the mechanism and details of the film distribution channels in Japan. The publicized lawsuit of the US government against the Japanese government to dispute settlement body of WTO is widely recognized as a screening measure for hidden involvement of the Japanese government in the Japanese distribution system and a signaling measure for the high quality of Kodak film to overcome informational barriers.¹ In addition, the issue of addressing the anti-dumping measure is one of the hot issues supported by many export-oriented countries while the political economic relationship of domestic industries and the trade policy authorities of major importing countries is not known to many export countries. In the process of resolving this issue in DDA, what is observed is that many exporting countries tend to form a coalition in the negotiation with the major importing country such as the US on establishing an international rule of anti-dumping measures, rather than taking the bilateral negotiation.²

The explanation for the reasons of the increased trade frictions is given from several perspectives such as the limited enforcement power of the dispute settlement body (DSB) in WTO. In addition to the malfunction of DSB in terms of the actual enforcement power, it has been argued that the informational distortion in the process of the international negotiation can provide a persuasive explanation for the reason for occurrence of trade friction and the delay of trade agreement by Admati and Perry (1987), Feenstra and Lewis (1991) and many other related literatures.³ The Basic idea of the earlier literatures on the effect of incomplete information on the bargaining structure is that the agreement is delayed under the incomplete information mainly for the signaling and the screening purpose depending on the structure of negotiation game.

As has been demonstrated elegantly by Rubinstein (1982), under complete information, the agreement on trade negotiation issue can be reached immediately

¹ Refer Raff and Kim (1999) for the details of the informational distortion and its impacts in Kodak film case.

² Refer Hart and Dymond (2003) for the detailed discussion of negotiation strategies on anti-dumping issues in DDA.

³ In addition to the above papers, the exemplary papers on the effect of incomplete information as the source of inefficiency in bargaining equilibrium include Riezman (1991), Jensen and Thursby (1988), Bac and Raff (1997), Grossman and Perry (1986), and Busch and Horstmann (2002). Refer Muthoo (1999) for a comprehensive survey on bargaining literatures under incomplete information. The contribution and the shortcomings of the earlier literatures in connection with this paper are discussed in the later part of literature review again.

as long as each negotiator behaves rationally. However, under incomplete information, various types of inefficiency occur to overcome informational distortion, and the typical cases are the delays of an agreement in negotiations under the form of international trade frictions. In addition, when there are more than two negotiating countries such as in WTO multilateral negotiation, the informational distortion induces different negotiation strategies depending on the number of negotiation and the mode of coordination in the negotiation as discussed above.

The issue of informational distortion in international trade negotiation has been addressed by many earlier literatures. Brainard and Martimort (1997) demonstrate that asymmetric information undermines the precommitment effect of unilateral government intervention due to the requirements of incentive compatibility in the context of strategic Cournot competition. They show that the screening effect induces a downward distortion in the optimal subsidy. The introduction of a rival interventionist government countervails the screening effect. That is, by the efforts of the foreign government to reduce the informational distortion, the informational distortion is reduced in domestic country. In case of non-intervention-profit participation constraint, government eschews intervention for the least efficient firms while it might impose a tax in case of zero-profit participation constraint.

McCalman (2002) has shown that when a small country's preference for a free trade and the market access to a large country's market is private information not known to the large country, the world welfare will be increased with a larger number of small countries due to the decreased informational distortion in the screening process. In a similar context, Qiu (1994) examines the effect of informational distortion on strategic trade policy, and shows that when a home country owns private information about the cost, the home country prefers menu policy, which is a separating strategy to a uniform policy, which is pooling strategy under Cournot competition while the opposite occurs under Bertrand competition, i.e., the uniform policy is preferred under Bertrand competition. The intuition behind this result is that social welfare is increased when the outputs of the efficient firm i.e., the low cost firm is increased relative to the inefficient firm. In case of Cournot competition, the government offers export subsidies, and the output of the efficient firm is increased under the separating equilibrium where the low cost firm gets a larger export subsidy. However, under Bertrand competition, the optimal government policy is to impose an export tax, and under separating equilibrium, a low cost firm is imposed a higher tax. Therefore, pooling strategy i.e., uniform policy is the equilibrium dominant strategy under Bertrand competition. However, Qiu's model considers only unilateral trade intervention and does not examine the foreign country's reaction in the policy intervention process.

Maggi (1999) shows that under incomplete information about the profitability of a firm, i.e., when firms have private information about its profitability,

information asymmetry may increase trade policy distortion in equilibrium and ultimately worsen the prisoner's dilemma problem in the trade policy game between governments. The author argues that when non-linear policy measures are adopted, governments can control their firms' reaction functions, as a residual rent-claimant. Park (2000, b) shows that when non-tariff barriers are known to each country privately, a mechanism that publicizes the information about non-tariff barriers, such as the Trade Policy Review Mechanism of WTO, plays a positive role in restoring cooperation by relaxing the incentive compatibility condition if there exists a large enough asymmetry in clarity of the country's trade policies.

While the earlier studies have significantly extended the understanding of the role of incomplete information on bargaining equilibrium, the issue of endogenous decision of the negotiation mode and strategy between bilateral and multilateral negotiation under incomplete information has not been tackled yet. Moreover, the comparative welfare analysis of the impact of incomplete information among bilateral and multilateral negotiation has not been tried yet. This paper aims at these unexplored issues focusing on the incomplete information about technology and the unobserved government intervention which might influence the mark-up rate of firms.

The main purpose of this paper is to examine the influence of incomplete information under bilateral and multilateral negotiation and determine the optimal negotiation strategy under incomplete information in terms of negotiation mode when the mode is endogenous as in the case of negotiation over the issue of renewing anti-dumping measure in DDA. Especially, this paper focuses on the issue of endogenous choice of negotiation mode between bilateral and multilateral negotiations under incomplete information.

Based on a model analysis assuming a simple linear demand function with symmetric demand structure in each country, it turned out that the informational distortion of the separating tariff for signaling purpose is larger in bilateral trade policy coordination regime than multilateral policy coordination. This larger upward distortion of the separating tariff in bilateral policy coordination means a lower welfare level for the negotiation partner countries which are not informed of the actual cost type of the signaling country's firm or of hidden policy intervention of the signaling countries.

The larger informational distortion of separating tariff under bilateral negotiation compared to that under multilateral negotiation provides the implication on the optimal negotiation strategies under incomplete information as follows. When a country faces a negotiating partner which has private information on its firm's technology or a hidden policy intervention, the multilateral trade policy coordination regime is welfare dominant to the case of bilateral policy coordination. On the other hand, when a country has private information on its firm's technology or the unobserved policy measures, which can influence the mark-up rate of the firm, which is unknown to the negotiating

partner country, bilateral policy coordination regime would be preferred to the case of multilateral policy coordination.

II. THE MODEL

Assume that there are four countries, A , B , C , and, D , and there is a representative firm in each country. The technology of firm A and the non-tariff measures of country A are not observed by the other trading countries, and the unobserved government measures influence the cost factors of the firm in the country A . The inverse demand function of each country is as follows: $P_i = a - bQ_i$ where $i = A, B, C$ and Q_i is the total quantity demanded in market i . The inverse demand function in country A is given as follows: $P_A = a - b(q_A + x_{BA} + x_{CA} + x_{DA})$ where q_A is the output produced for the home market and x_{BA} is the output produced by the firm in country B to export to country A .

The profit function of firm A , which exports to country B and C in addition to its domestic market, is defined as:

$$\begin{aligned} \Pi_A = & (P_A - c_A)q_A + (P_B - c_A - t_B)x_{AB} + (P_C - c_A - t_C)x_{AC} \\ & + (P_D - c_A - t_D)x_{AD} \end{aligned} \quad (1)$$

where c_A is the marginal cost of firm A , and t_i is the import tariff of country i .

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

III. BENCHMARK DISCUSSION: THE MARKET EQUILIBRIUM OF BILATERAL COORDINATION UNDER COMPLETE INFORMATION

The market equilibrium of bilateral coordination under complete information is examined first as a benchmark discussion. When country A and B coordinate with the trade policies, i.e., when they remove the trade barriers between two countries while country C and D remain outsiders of the trade policy coordination, the market equilibrium is determined as follows.

The profit function of each representative firm with a bilateral trade policy coordination between country A and B under complete information is defined as:

$$\Pi_A = (P_A - c_A)q_A + (P_B - c_A)\chi_{AB} + (P_C - c_A - t_C)\chi_{AC} + (P_D - c_A - t_D)\chi_{AD}$$

$$\Pi_B = (P_B - c_B)q_B + (P_A - c_B)\chi_{BA} + (P_C - c_B - t_C)\chi_{BC} + (P_D - c_B - t_D)\chi_{BD}$$

$$\Pi_C = (P_C - c_C)q_C + (P_A - c_C - t_A)\chi_{CA} + (P_B - c_C - t_B)\chi_{CB} + (P_D - c_C - t_D)\chi_{CD}$$

$$\Pi_D = (P_D - c_D)q_D + (P_A - c_D - t_A)\chi_{DA} + (P_B - c_D - t_B)\chi_{DB} + (P_C - c_D - t_C)\chi_{DC}$$

By backward induction, the equilibrium output of the firm in each country is derived first. The best response functions of firm A in each market are derived from the profit maximization problem with respect to output levels as strategic variables. The best response functions of firm B , C , D are derived in the same way. Then, the four representative firms' equilibrium outputs in country A are obtained by solving four firms' reaction functions in country A simultaneously as follows:^{4,5}

$$\begin{aligned} q_A &= \frac{1 - 4c_A + c_B + c_C + c_D + 2t_A}{5b}, & x_{BA} &= \frac{1 + c_A + 4c_B + c_C + c_D + 2t_A}{5b} \\ x_{CA} &= \frac{1 + c_A + c_B - 4c_C + c_D + 3t_A}{5b}, & x_{DA} &= \frac{1 + c_A + c_B - 4c_C + c_D + 3t_A}{5b} \end{aligned} \quad (2)$$

The social welfare function of the country A is defined as the summation of the consumer surplus, the producer surplus, and the government surplus, i.e., the import tariff revenue:

$$SW = CS + PS + GS = \int_P^1 D(P) dP + \Pi_{AA} + \Pi_{AB} + \Pi_{AC} + \Pi_{AD} + t(\chi_{CA} + \chi_{DA}) \quad (3)$$

With the continuously quasi-concave well-behaving social welfare function, the optimal trade policy for country A with the bilateral trade policy coordination with country B under complete information is derived as a solution of the first order condition of the social welfare maximization problem with respect to the tariff as follows: $t_A^* = \frac{1}{48}(6 - 4c_A + 16c_B - 9c_C - 9c_D)$. Under the bilateral trade

⁴ The concavity of the objective function of the representative firm and the government is shown as follows even with the zero cost assumption: $s.o.c. = \frac{\partial^2 \Pi_A}{\partial q_A^2} = -2b < 0$, $s.o.c. = \frac{\partial^2 SW_A}{\partial q_A^2} = -b < 0$. This concavity of the objective function is obtained from the assumption of Cournot fashion competition with the downward sloping demand function.

⁵ Each market of four countries is assumed to be a separate market, and each representative firm produces four different commodities for 4 markets. Therefore, the equilibrium outputs of a firm in each market are obtained by solving the 4 reaction functions of each representative firm in each market simultaneously. The equilibrium outputs for firm B , C , D are given in the appendix A.

policy coordination between country A and B , the equilibrium tariffs of country B , C , D are respectively: $t_B^* = \frac{1}{48}(6 + 16c_A - 4c_B - 9c_C - 9c_D)$, $t_C^* = \frac{1}{33}(9 - c_A - c_B - 6c_C - c_D)$ and $t_D^* = \frac{1}{33}(9 - c_A - c_B - c_C - 6c_D)$. The reason that each country's tariff is independent from other country's market size is that four markets are separated markets. In this bilateral trade policy coordination, the social welfare of each country is obtained by substituting the equilibrium tariffs and equilibrium outputs into the social welfare functions. When we assume the cost of country B , C , and D , which is common knowledge, is symmetric as c , the social welfare level of country A and B is given as $\frac{879(1-c)^2}{1936b}$, while that of country C and D is given as $\frac{1737(1-c)^2}{3871b}$.⁶

IV. MARKET EQUILIBRIUM WITH BILATERAL COORDINATION UNDER INCOMPLETE INFORMATION

When the country A has private information about its own cost factor, which is influenced by the indirect and invisible government intervention, the market equilibrium structure is changed with the informational distortion. For the simplicity of the discussion, we assume there are two types of cost structure, high cost, c_H , and low cost, c_L . The actual type of cost structure is privately known to country A , while the prior belief system, which assigns probability μ for low cost, and $1-\mu$ for high cost, is common knowledge.⁷

⁶ The equilibrium welfare of each country when the cost of each country is asymmetric is given in Appendix B.

⁷ Under incomplete information about the cost factor of country A , country A has private information about the actual cost of its own firm. When the cost of firm A is high, country B , which is a policy coordination partner, sets a higher tariff as shown in equilibrium tariff level in section 3. Under the tariff policy coordination between A and B , the higher tariff of country B prevents a possible trade diversion, or other tariff-jumping distortion to country A , which might occur when B 's tariff is lower than that of A . In addition, when the cost of firm A is higher, the non-member country, which does not join the policy coordination, sets a lower tariff. Therefore, there is an incentive for country A with a low cost, which has private information about its own cost, to mimic as if it has a high cost. In other words, based on our assumption about the impacts of indirect policy intervention on the firm's cost, the country with active intervention or supports for its own firm has an incentive to disguise as if it provides no special aids or support for its own firm. In this context, there would be an incentive for a country with a high cost to signal the truth that it has a low level of government supports and intervention through the separating strategy. However, the separating equilibrium can pass intuitive criterion only when its off-the-equilibrium path belief system is consistent, and the equilibrium strategy is welfare dominant to any possible deviation strategy. These condition for the intuitive separating equilibrium can be satisfied when the following incentive compatibility condition and the individual rationality conditions are satisfied. The implication of the incentive compatibility condition is that the country with a low cost, which might be a country with a high government

Under incomplete information, there are multiple equilibria when off-the-equilibrium-path belief systems are not restricted. To resolve the issue of multiple equilibria under incomplete information, the intuitive criterion is taken for equilibrium refinement with the removal of the equilibrium-dominated strategies, which have inconsistent off-the-equilibrium-path belief systems.⁸ There are two types of equilibrium under incomplete information, a pooling equilibrium and a separating equilibrium. First, we examine the separating equilibrium. For a separating equilibrium to hold, the country with a low cost firm should not have any incentive to disguise its actual type and mimic the country with a high cost firm, as shown in the following incentive compatibility condition.

$$SW_{AL}(t_S, t_B, t_C, t_D; w=1) \leq SW_{AL}(t_A, t_B, t_C, t_D; w=0) \quad IC \text{ for } A_H \quad (4)$$

where w represents the posterior belief system. That is, ' $w=1$ ' represents that country B , C , and D believe that the actual cost type of firm A is H .

In addition, the country with a high cost firm and the country with a low cost firm should have a non-negative welfare level to have an incentive to participate the policy game as shown in the following individual rationality condition.

$$SW_{AL}(t_S, t_B, t_C, t_D; w=1) \quad IR \text{ for } A_H \quad (5)$$

$$SW_{AL}(t_A, t_B, t_C, t_D; w=0) \quad IR \text{ for } A_L$$

where SW_{AH} denotes the social welfare level of the country A with a high cost firm, and t_S denotes a separating tariff of country A , while t_i denotes the Nash tariff of country i , and w denotes the posterior belief system about the cost type of country A . ' $w=1$ ' denotes that other countries believe that the cost type of country A is L after they update their belief systems.

By solving the binding condition of the incentive compatibility of A_H , we obtain the equilibrium dominant separating bargaining strategy for the government A . If there is no incentive to deviate from the given separating strategy - the separating strategy is an equilibrium dominant strategy - it satisfies the condition for the intuitive equilibrium. The left hand side of (5) represents the maximum social welfare of country A , when it pretends as if it has a low cost firm even though its actual cost type is high, while all other countries believe that

support, should have no incentive to mimic the separating strategy of the country with a high cost. However, when the separating strategy involves too much cost, pooling equilibrium might be an intuitive equilibrium, in which the pooling strategy is welfare dominant not only to the country with a low cost, but to a country with a high cost.

⁸ Refer Cho and Kreps (1987) for the detailed discussion of the intuitive criterion as an equilibrium refinement technique under incomplete information.

country A has a low cost firm and set the Nash tariff facing the country with a low cost under complete information. Incentive compatibility condition sets that this maximum social welfare should be equal or lower than the social welfare of country A_H under complete information. Under bilateral trade policy coordination between A and B , when countries' posterior belief about the cost type of country A is c_L , i.e., $w=1$, the optimal tariffs of country B , C , and D are as follows: $t_B^*(w=1) = \frac{(6+16c_L-4c_B-9c_C-9c_D)}{48}$, $t_C^*(w=1) = \frac{(9+c_L-c_B-6c_C-c_D)}{33}$, and $t_D^*(w=1) = \frac{(9+c_L-c_B-c_C-6c_D)}{33}$.

When country A with a high cost firm (A_H) mimics A_L , the tariff of country B , which is a member country of trade policy coordination, is lowered, while the tariff rates of other non-member countries are increased.⁹ On the other hand, when country A with a high cost firm reveals its true type, the tariff rates of country B , C , and D are as follows¹⁰: $t_B^*(w=0) = \frac{(6+16c_H-4c_B-9c_C-9c_D)}{48}$, $t_C^*(w=0) = \frac{(9+c_H-c_B-6c_C-c_D)}{33}$, and $t_D^*(w=0) = \frac{(9+c_H-c_B-c_C-6c_D)}{33}$.

Substituting the above tariffs into the binding condition of the incentive compatibility condition (ICC) of AH , we can obtain the equilibrium separating tariff rate by solving the binding condition of the ICC. In this calculation, we have to substitute not only the equilibrium tariff rates, but also the equilibrium output levels depending on different posterior beliefs. Firm A 's output is decided under the complete information. So, the output level of A reflects the actual cost type of firm A . The reaction function of firms B , C , D reflects only their own cost type, none of competing firm's cost type. However, in final stage of output decision, although each firm's reaction function does not reflect the cost type of each firm, the equilibrium output reflect the cost factor of other firms, because the market equilibrium output is obtained by solving 4 reaction functions simultaneously.

By solving the binding condition of the incentive compatibility condition for truth-revelation, we obtain two separate tariffs, $\frac{1}{264}(33-11c-11c_H-\sqrt{-11760+120380c-100983c_H-7637c_L}\sqrt{c_Hc_L-11c_L})$, and $\frac{1}{264}(33-11c-11c_H+\sqrt{-11760+120380c-100983c_H-7637c_L}\sqrt{c_Hc_L-11c_L})$. Between these two separating tariffs, the second separating tariff is equilibrium dominant separating tariff, because it is closer to the equilibrium tariff under complete information,

⁹ The above result might sounds contrary to intuition because the mimicking behavior induces tougher trade policies from the trading partners. However, this mimicking behavior also influences the output decision makings of the competing firms in foreign counties, inducing the lower outputs from the competing firms, eventually leading to higher profits and welfare.

¹⁰ In the bilateral trade policy coordination, the tariff of country B is imposed on the non-member countries of policy coordination such as country C and D . However, the tariffs of country C and D are imposed on all the other countries based on MFN clause of WTO.

$t_A^* = \frac{1}{48} (6 - 4c_A + 16c_B - 9c_C - 9c_D)$, which maximizes the social welfare. Based on the above specification of the separating strategy, the following proposition is derived.

Proposition 1. *There is a unique separating intuitive equilibrium when countries coordinate trade policies under incomplete information about the actual cost type and the indirect government support for its firm as long as the demand function is downward sloping.*

Proof: The existence of unique separating equilibrium can be proved by showing that the pooling equilibrium cannot pass the intuitive criterion, and the separating strategy is equilibrium dominant. Now we check about the pooling equilibrium. The pooling equilibrium can be an intuitive equilibrium when the off-the-equilibrium-path belief system is consistent and intuitive, i.e., the pooling strategy is an equilibrium dominant strategy for any player.¹¹ When country A takes a pooling strategy, the belief systems of the uninformed players are not updated remaining at the level of prior beliefs. To examine whether the pooling equilibrium is a sequential equilibrium or not, we examine whether the off-the-equilibrium belief system is consistent and intuitive. The pooling strategy is an equilibrium dominant strategy when each agent has no incentive to deviate from the supposed equilibrium strategy with all profiles of belief systems including the off-the-equilibrium belief system denoted in the following condition:

$$SW_{AH}(t_A, t_B, t_C, t_D; w=1) \leq SW_{AH}(t_P, t_B, t_C, t_D; w=\mu) \quad (6)$$

The above equilibrium dominance condition for the pooling equilibrium means that there is no incentive for country A with a low cost to deviate from the pooling strategy. The equilibrium-dominance condition for the pooling equilibrium can be checked by substituting the pooling equilibrium tariff, t_P , in condition (6). The pooling equilibrium tariff is derived from the following welfare maximization problem: $Max SW_{AH}(t_P, t_B, t_C, t_D; w=\mu)$.

When the country A takes the pooling strategy, the beliefs of the competing firms and governments cannot be credibly updated, and remain same as the prior beliefs. Then, the optimal tariffs and the output levels are as follows: $t_B^*(w=\mu) = \frac{(6 + 16c_E - 4c_B - 9c_C - 9c_D)}{48}$, $t_C^*(w=\mu) = \frac{(9 + c_E - c_B - 6c_C - c_D)}{33}$, and $t_D^*(w=\mu) = \frac{(9 + c_E - c_B - c_C - 6c_D)}{33}$. In addition, in a pooling equilibrium, the output level of each firm in each market is decided based on the posterior

¹¹ In this model, we assume a simultaneous movement of governments. Under simultaneous movement, a government decision-making can have a signaling effect although it is observed in the next stage of the game as long as the action can influence the belief updating process.

belief system, which is same as the prior belief system, at the expected level of cost as $c_E = \mu c_L + (1 - \mu)c_H$ while the output level of firm A is decided based on the actual cost, which is known only to firm A . However, the pooling equilibrium fails to be an intuitive equilibrium because the country with a low cost firm can obtain a higher social welfare by deviating from the pooling strategy to separate from the country with a high cost firm. This feature is consistent with the earlier results in Raff and Kim (1999) and Bagwell and Riordan (1991), which demonstrate that there is an incentive to deviate from the pooling strategy when the demand function is downward sloping.¹² Therefore, we focus our discussion on the separating equilibrium, which is a unique intuitive equilibrium in this model.

To determine the optimal negotiation strategy in terms of the negotiation mode, we examine the equilibrium in the multilateral policy coordination under the incomplete information in comparison with the equilibrium of bilateral policy coordination.

V. EQUILIBRIUM IN MULTILATERAL POLICY COORDINATION UNDER INCOMPLETE INFORMATION

To examine the equilibrium structure of multilateral trade policy coordination under incomplete information, we assume that country C joins the bilateral trade policy coordination between A and B while country D remains as an outsider. In this multilateral policy coordination, we assume that the three countries, A , B and C keep cooperative trade policy among themselves, i.e., removing trade barriers among themselves while the actual cost type of firm A is only known to country A , and countries B , C , and D have only prior beliefs about the probability that firm A might have a low cost, μ .

With basically the same downward sloping inverse demand function as in the bilateral policy coordination, the pooling equilibrium cannot pass the intuitive criterion in the multilateral policy coordination case either. The separating equilibrium in the multilateral trade policy coordination should satisfy the following incentive compatibility condition for the truth revelation and the individual rationality conditions for both types of firm A :

$$SW_{AL}(t_S, t_B, t_C, t_D; w=1) \leq SW_{AL}(t_A, t_B, t_C, t_D; w=0) \quad IC \text{ for } A_H$$

$$SW_{AL}(t_S, t_B, t_C, t_D; w=1) \geq 0 \quad IR \text{ for } A_H$$

$$SW_{AL}(t_A, t_B, t_C, t_D; w=0) \geq 0 \quad IR \text{ for } A_L$$

¹² Refer Kim & Raff (1999) and Bagwell & Riordan (1991) for the detailed discussion of the non-existence of intuitive pooling equilibrium with a downward sloping demand function.

Following the same procedure of equilibrium derivation with the intuitive criterion as the equilibrium refinement technique, we determine the equilibrium separating negotiating strategy by solving the binding condition of the incentive compatibility condition under multilateral policy coordination.¹³ As in the case of bilateral coordination, we examine the equilibrium of multilateral coordination under complete information first as a benchmark discussion. Based on the same downward sloping linear demand function under the multilateral policy coordination, the equilibrium output of each firm is derived by backward induction as follows:

$$\begin{aligned} q_A &\rightarrow \frac{1-4c_A+c_B+c_C+c_D+t_A}{5b}, & x_{BA} &\rightarrow \frac{1-c_A+4c_B+c_C+c_D+t_A}{5b} \\ x_{CA} &\rightarrow \frac{1-c_A+c_B+4c_C+c_D+t_A}{5b}, & x_{DA} &\rightarrow \frac{1-c_A+c_B+c_C+4c_D+4t_A}{5b} \end{aligned} \quad (7)$$

Substituting the above equilibrium outputs into the social welfare function, we can obtain the equilibrium tariff rate by solving the social welfare maximization problem. With continuously quasi-concave well-behaving social welfare function, the optimal trade policy for country *A* with the multilateral trade policy coordination with country *B* and *C* under complete information is derived as the solution of the first order condition of social welfare maximization with respect to tariff: $t_A^* = \frac{1}{37}(3-2c_A+8c_B+8c_C-17c_D)$. Under the multilateral trade policy coordination between country *A*, *B* and *C*, the equilibrium tariffs of country *B*, *C*, *D* are respectively: $t_B^* = \frac{1}{37}(3+8c_A-2c_B+8c_C-17c_D)$, $t_C^* = \frac{1}{37}(3+8c_A+8c_B+2c_C-17c_D)$ and $t_D^* = \frac{1}{33}(9-c_A-c_B-c_C-6c_D)$.

The equilibrium social welfare level of each country can be obtained by substituting the above equilibrium tariffs and equilibrium outputs into the social welfare functions as follows when the cost of country *B*, *C*, *D* is assumed to be symmetric as *c*:

- i) Country *A*: $\frac{41913-82872c+51913c^2-954c_A-20954cc_A+10954c_A^2}{90354b}$;
- ii) Country *B*, *C*: $\frac{1}{2981682b} (1391337+2602082c^2+544392c_A+699353c_A^2-2c(167033+955049c_A))$
- iii) Country *D*: $\frac{1}{90354b} (41913-81918c+2(-477-17207c)c+86327c^2+2(-477-10477c)c_A+10954c_A^2)$

¹³ Under the multilateral policy coordination, the tariff of the coalition member countries, such as *A*, *B*, and *C* is imposed only on the non-member country *D*. However, the tariff of country *D* is imposed on all the other countries according to MFN rule.

Now, we determine the separating equilibrium of multilateral trade policy coordination under incomplete information. The separating tariff is derived from the binding condition of the following incentive compatibility condition of A_L , which implies that the maximum social welfare of country A_L with a high level of government supports for its firm from mimicking A_H is lower than the social welfare from truth revelation:

$$SW_{AL}(t_S, t_B, t_C, t_D; w=1) \leq SW_{AL}(t_A, t_B, t_C, t_D; w=0) \quad (8)$$

Under the multilateral trade policy coordination, when country B , C , and D believe that firm A has a low cost, their optimal tariffs are as follows respectively:

$$\begin{aligned} t_B^*(w=1) &= \frac{(3+8c_L-2c_B-8c_C-17c_D)}{37}, \\ t_C^*(w=1) &= \frac{(3+8c_L-8c_B-2c_C-17c_D)}{37}, \\ t_D^*(w=1) &= \frac{(9+c_L-c_B-c_C-6c_D)}{33} \end{aligned} \quad (9)$$

When we substitute the above tariffs into the left hand part of the incentive compatibility condition, equation (8), we obtain the maximum social welfare of country A which has a high cost. On the other hand, when countries B , C , D know the actual cost of country A_H , the optimal tariffs of countries B , C , D are:

$$\begin{aligned} t_B^*(w=0) &= \frac{(3+8c_H-2c_B-8c_C-17c_D)}{37}, \\ t_C^*(w=0) &= \frac{(3+8c_H-8c_B-2c_C-17c_D)}{37}, \\ t_D^*(w=0) &= \frac{(9+c_H-c_B-c_C-6c_D)}{33} \end{aligned} \quad (10)$$

By solving the binding condition of the incentive compatibility condition for truth-revelation with substituting equation (10) into the right hand side of equation (8), we obtain two separating tariffs as follows:

$$\begin{aligned} t_S = \frac{3-c-c_H-c_L}{37} - \frac{\sqrt{205200+77234825c^2+62563611c_H^2+6138930c_L}}{1221\sqrt{37}} \\ + \frac{9337346c_L^2+66c_H(-1531530+1516223c_L)-10c(-9453165)}{1221\sqrt{37}} \\ + \frac{12411696c_H+12488434c_L}{1221\sqrt{37}}, \text{ and} \end{aligned}$$

$$t_S = \frac{3 - c - c_H - c_L}{37} + \frac{\sqrt{205200 + 77234825c^2 + 62563611c_H^2 + 6138930c_L} + 9337346c_L^2 + 66c_H(-1531530 + 1516223c_L) - 10c(-9453165)}{1221\sqrt{37}} \\ + \frac{12411696c_H + 12488434c_L}{1221\sqrt{37}}$$

Between these two separating tariffs, the second separating tariff is equilibrium dominant separating tariff, because it is closer to the equilibrium tariff under complete information, $t_A^* = \frac{1}{37}(3 + 2c_A - 8c_B + 8c_C - 17c_D)$, which maximizes the social welfare.

The impact of incomplete information on trade policy coordination equilibrium structure and the optimal negotiation strategy under the informational distortion can be determined by comparison of the two separating equilibria under the bilateral policy coordination and the multilateral policy coordination. The welfare levels of two separating equilibria can be compared straightforwardly by checking the amount of distortion of two separating tariffs from the Nash equilibrium tariff under complete information due to the signaling purpose.¹⁴ Under bilateral trade policy coordination, the amount of distortion in separating tariff for the signaling purpose is:

$$\frac{1}{264}(11c_H - \sqrt{(-11760 + 120380c - 100983c_H - 7637c_L)(c_Hc_L)} - 11c_L).$$

The amount of the upward distortion of the separating tariff in multilateral coordination is as follows:

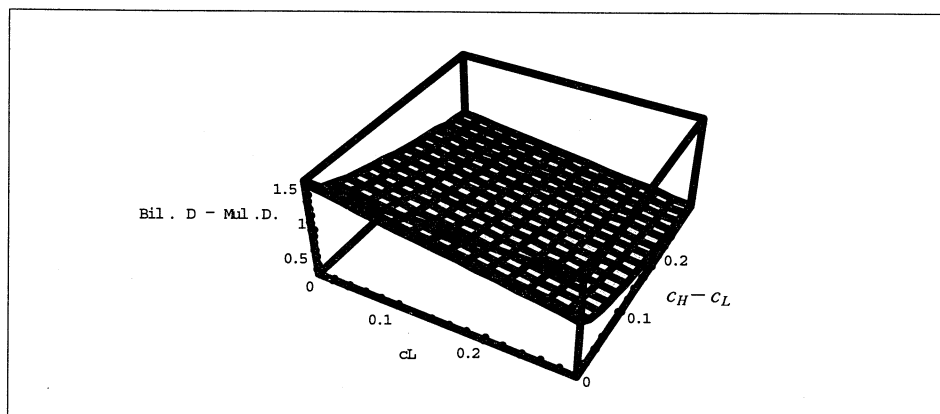
$$\frac{c_H - c_L}{37} - \frac{\sqrt{205200 + 77234825c^2 + 62563611c_H^2 + 6138930c_L} + 9337346c_L^2 + 66c_H}{1221\sqrt{37}} \\ - \frac{(-1531530 + 1516223c_L) - 10c(-9453165 + 12411696c_H + 12488434c_L)}{1221\sqrt{37}}$$

When we compare the amount of upward distortion in the separating equilibrium tariffs of two regimes of trade policy coordination, it is found that the amount of signaling distortion in the separating tariff under the bilateral coordination is always higher than the case of multilateral coordination.¹⁵

¹⁴ With the same number of player and the same inverse demand functions with the same parameter values, the curvature of the welfare functions are symmetric, and therefore, by simple comparison of the amount of distortion, we can measure the welfare effects of incomplete information between two types of trade policy coordination.

¹⁵ Figure 1 shows that the difference between the distortion in bilateral and multilateral policy coordination is always positive for all parameter values of the cost in each country which satisfy the non-negative demand condition. In other words, the informational distortion is always higher

[Figure 1] The informational distortion Bilateral and multilateral trade policy coordination



The vertical axis of Figure 1 represents the difference between the separating distortion in the bilateral coordination and the multilateral distortion. The right-hand side horizontal axis represents the level of difference between the high and low costs of the country that has private information about its own technology and implicit government measures. Figure 1 shows that the level of separating distortion in the bilateral coordination mechanism is higher than that of multilateral coordination in the whole range of parameter values that satisfy the non-negative demand condition. In addition, as the cost difference is smaller, the difference in the separating distortion between the bilateral and multilateral coordination is larger. This result reflects the fact that when there is more incentive for a country with a low cost to mimic, the higher separating distortion is required to prohibit the possible mimicking of the country. The above results yield the following proposition.

Proposition 2. *The upward distortion of separating strategy in bilateral policy coordination is larger than that in multilateral coordination under asymmetric information about the cost factors and indirect government interventions. Hence, multilateral coordination mode is welfare dominant for a country with an informational disadvantage.*

The above result implies that when a negotiating country has private information on the cost factor of its firm under bilateral policy coordination regime, the country with private information will choose a separating tariff which is more upwardly distorted than that under multilateral policy coordination. Therefore, when a country faces a negotiating partner which has private

in bilateral trade policy coordination compared to the multilateral policy coordination.

information about its firm, or takes unknown policy measures, the optimal negotiating strategy under the incomplete information is to arrange a multilateral trade policy coordination rather than a bilateral coordination. Conversely, when a country has private information about its firm or commands hidden policy measures, bilateral policy coordination regime would be welfare dominant for the country than a multilateral coordination regime. The larger informational distortion in bilateral trade policy coordination compared to multilateral coordination is reflected in the effect on the world welfare as well. The larger upward distortion of the separating tariff in bilateral negotiation causes a larger loss in the world welfare due to the fact that the welfare loss of the uninformed countries under bilateral coordination regime is much larger than that under multilateral coordination regime.¹⁶

VI. CONCLUDING REMARKS

This paper examined the impact of incomplete information on the equilibrium structure of bilateral and multilateral policy coordination, and the optimal strategy under the informational distortion. Based on a simple linear demand function with symmetric demand structure, it turned out that the informational distortion of the separating tariff for the signaling purpose is larger in bilateral trade policy coordination regime than the case of multilateral policy coordination. This larger distortion of the separating tariff under bilateral policy coordination means a lower welfare level for the negotiation partners which are not informed of the actual cost type of the partner country's firm or the hidden policy intervention of the partner countries.

The larger upward distortion of the separating tariff due to incomplete information under the bilateral coordination compared to the multilateral coordination implies the optimal negotiation strategies under incomplete information as follows. When a country faces an informational disadvantage such as facing a negotiating partner who has private information on its firm's technology or a hidden policy intervention, the multilateral trade policy coordination regime is welfare dominant to the case of bilateral policy coordination. On the other hand, when a country has private information on its firm's technology or the unobserved policy measures, which can influence the mark-up rate of the firm, which is unknown to the negotiating partner country, bilateral policy coordination regime would be preferred to the case of multilateral

¹⁶ As discussed earlier, when a country has private information about its actual quality type and the indirect intervention to support its own firm, it has an incentive to behave as if it did not provide any support for its firm. As proved in the model analysis, the upward distortion of the separating strategy required to induce the self-revelation is larger in the bilateral coordination case than that of multilateral case. Therefore, the dominant strategy for a country without private information is to choose a multilateral coordination case when the coordination mode can be decided as an endogenous strategic variable.

policy coordination.

The optimal policy coordination and the implied negotiation regime have been examined with the assumption of simultaneous movement of each country's trade policy measure. This assumption of simultaneity of policy measures can provide realistic interpretation for the case of DDA negotiation especially for the case when each member country has to submit its trade policy agenda and position simultaneously within a due date. However, even within the framework of DDA, most of bilateral negotiation takes the form of sequential negotiation, such as the offer and counter offer negotiation. To examine those features of sequential bargaining under multilateral negotiation with alternating offers will provide more realistic policy implication as a future research issue.

APPENDIX

Appendix A: The equilibrium output under complete information case

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

$$\begin{aligned} q_B &= \frac{1 + c_A - 4c_B + c_C + c_D + 2t_B}{5b}, & x_{AB} &= \frac{1 - 4c_A + c_B + c_C + c_D + 2t_B}{5b} \\ x_{CB} &= \frac{1 + c_A + c_B - 4c_C + c_D - 3t_B}{5b}, & x_{DB} &= \frac{1 + c_A + c_B + c_C - 4c_D - 3t_B}{5b} \\ q_C &= \frac{1 + c_A + c_B - 4c_C + c_D + 3t_C}{5b}, & x_{AC} &= \frac{1 - 4c_A + c_B + c_C + c_D - 2t_C}{5b} \\ x_{BC} &= \frac{1 + c_A - 4c_B + c_C + c_D - 2t_C}{5b}, & x_{DC} &= \frac{1 + c_A + c_B + c_C - 4c_D - 2t_C}{5b} \\ q_D &= \frac{1 + c_A + c_B + c_C - 4c_D + 3t_D}{5b}, & x_{AD} &= \frac{1 - 4c_A + c_B + c_C + c_D - 2t_D}{5b} \\ x_{BD} &= \frac{1 + c_A - 4c_B + c_C + c_D - 2t_D}{5b}, & x_{CD} &= \frac{1 + c_A + c_B - 4c_C + c_D - 2t_D}{5b} \end{aligned}$$

Appendix B: The equilibrium welfare of each country under bilateral policy coordination when the cost of each country is asymmetric:

Country A:

$$\begin{aligned} \frac{1}{69696b} & (31644 + 163968c_A^2 + 19824c_B^2 + 1788c_C + 15943c_C^2 + 1788c_D + 31374c_Cc_D \\ & + 15943c_D^2 + 8c_B(1398 + 2155c_C + 2155c_D) - 16c_A(4878 + 5332c_B \\ & + 5143c_C + 5143c_D)) \end{aligned}$$

Country B:

$$\begin{aligned} \frac{1}{69696b} & (31644 + 19824c_A^2 + 163968c_B^2 + 1788c_C + 15943c_C^2 + 1788c_D + 31374c_Cc_D \\ & + 15943c_D^2 + 8c_A(1398 + 10664c_B + 2155c_C + 2115c_D) - 16c_B(4878 \\ & + 5143c_C + 5143c_D)) \end{aligned}$$

Country C:

$$\begin{aligned} \frac{1}{139392b} & (62532 + 23432c_A^2 + 23432c_B^2 + 143916c_C + 31337c_C^2 + 16020c_D \\ & - 217710c_Cc_D + 46041c_D^2 + 4c_A(354 + 7360c_B + 33131c_C + 13701c_D) \\ & + c_B(1416 + 132524c_C + 54804c_D)) \end{aligned}$$

Country D:

$$\begin{aligned} \frac{1}{139392b} & (62532 + 23432c_A^2 + 23432c_B^2 + 16020c_C + 46041c_C^2 + 4c_B(354 + 13701c_C \\ & - 33131c_D) + 4c_A(354 + 7360c_B + 313701c_C + 33131c_D) \\ & - 143916c_D - 217710c_Cc_D + 313337c_D^2) \end{aligned}$$

Appendix C: The equilibrium output under multilateral policy coordination

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

$$\begin{aligned}
 q_B &= \frac{1 + c_A - 4c_B + c_C + c_D + t_B}{5b}, & x_{AB} &= \frac{1 - 4c_A + c_B + c_C + c_D + t_B}{5b} \\
 x_{CB} &= \frac{1 + c_A + c_B - 4c_C + c_D + t_B}{5b}, & x_{DB} &= \frac{1 + c_A + c_B + c_C - 4c_D - 4t_B}{5b} \\
 q_C &= \frac{1 + c_A + c_B - 4c_C + c_D + t_C}{5b}, & x_{AC} &= \frac{1 - 4c_A + c_B + c_C + c_D + t_C}{5b} \\
 x_{BC} &= \frac{1 + c_A - 4c_B + c_C + c_D + t_C}{5b}, & x_{DC} &= \frac{1 + c_A + c_B + c_C - 4c_D - 4t_C}{5b} \\
 q_D &= \frac{1 + c_A + c_B + c_C - 4c_D + 3t_D}{5b}, & x_{AD} &= \frac{1 - 4c_A + c_B + c_C + c_D - 2t_D}{5b} \\
 x_{BD} &= \frac{1 + c_A - 4c_B + c_C + c_D - 2t_D}{5b}, & x_{CD} &= \frac{1 + c_A + c_B - 4c_C + c_D - 2t_D}{5b}
 \end{aligned}$$

Appendix D: The equilibrium social welfare level under multilateral policy coordination when the cost of each country is asymmetric

i) Social welfare of A:

$$\begin{aligned}
 &\frac{1}{2981682b} (1391337 + 7240349c_A^2 + 699353c_B^2 + 511392c_C + 699353c_C^2 + 23706c_D \\
 &\quad + 543186c_Cc_D + 936162c_D^2 + 14c_B(36528 + 98663c_C + 38799c_D) \\
 &\quad - 2c_A(1914582 + 1917283c_B + 1917283c_C + 1491201c_D))
 \end{aligned}$$

ii) Social welfare of country B:

$$\begin{aligned}
 &\frac{1}{2981682b} (1391337 + 699353c_A^2 + 7240349c_B^2 + 511392c_C + 699353c_C^2 + 23706c_D \\
 &\quad + 543186c_Cc_D + 936162c_D^2 + c_A(511392 - 3834566c_B + 1381282c_C \\
 &\quad + 543186c_D) - 2c_B(1914582 + 1917283c_C + 1491201c_D))
 \end{aligned}$$

iii) Social welfare of country C:

$$\begin{aligned}
 &\frac{1}{2981682b} (1391337 + 699353c_A^2 + 699353c_B^2 + 3829164c_C + 7240349c_C^2 + 23706c_D \\
 &\quad - 2982402c_Cc_D + 936162c_D^2 + 2c_A(255696 + 690641c_B - 1917283c_C \\
 &\quad + 271593c_D) + c_B(511392 + 3834566c_C + 543186c_D))
 \end{aligned}$$

iv) Social welfare of country D

$$\begin{aligned}
 &\frac{1}{603546} (41913 + 10954c_A^2 + 10954c_B^2 + 954c_C + 10954c_C^2 + 2c_B(-477 + 6730c_C \\
 &\quad - 23937c_D) + 2c_A(-477 + 6730c_B + 6730c_C + 23937c_D) \\
 &\quad - 80964c_D - 47874c_Cc_D + 112293c_D^2)
 \end{aligned}$$

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