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International Trade and Rules of Origin under Oligopolistic Competition

寡占競争下の国際貿易と原産地規則

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To My Parents

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Chapter 1

Issues and Overview

In this chapter we present the motivations of research and the three main issues and overview each chapter of this thesis. In section one we explain our motivations of research and present three issues in the existing theoretical works on rules of origin. In section two we present a brief summary of each chapter in this thesis (chapters 2 to 6), including related studies and our main results and contributions.

1.1 Issues

Since the late of 1980's, regional trade agreements (RTAs) have proliferated around the world.[1] One could consider this proliferation of RTAs as complements to multilateral trade liberalization and as a step to multilateral free trade.[2] However, it is not necessarily true. RTAs are also called preferential trade agreements (PTAs) and include free trade agreement (FTA-or free trade area) and customs union (CU). It is important and necessary to emphasize that RTAs have a protectionist nature because countries can independently set RTAs under certain conditions (e.g., the Article XXIV of the GATT).

Rules of origin (ROO) are requirements that define the origin of a product by setting the minimum ratio of intra-region produced inputs (intermediates

[1]As for August 1st, 2008, there are 148 RTAs. See JETRO (2008) WTO/FTA Column Vol. 51 and WTO (`http://www.wto.org/english/tratop_e/region_e/region_e.htm`).

[2]Bhagwati (1991) referred to the proliferation of RTAs from the late 1980's as "second regionalism" and distinguished it from that of the 1960's. Also, Ethier (1998) called this dramatic proliferation of RTAs as "new regionalism", pointing out to some features of regionalization.

or parts) required to produce a final product.[3] That is, ROO limit the use of inputs originated from areas outside the preferential trade area. Therefore, in a preferential trade area, ROO distinguishes intra-regional trade from outside trade.[4] To enjoy duty-free access to a member country's market within an RTA, final good producers must include a minimum fraction of intermediates or parts produced within the region.[5] Thus, ROO essentially have functions similar to local content requirements (LCRs).[6]

The aspect of domestic content provision in ROO has the following important implication: if the price (productivity) of intermediate goods in a member country within the RTA is higher (lower) than that outside, ROO serve as a protectionist device for the less efficient country (Krueger, 1993; Krishna and Krueger, 1995; Lopez-de-Silanes, Markusen, and Rutherford, 1996; Rosellón, 2000). Furthermore, many RTAs individually set ROO.[7] Hence, it is highly important to consider the effects of ROO on firms behavior and its' welfare implication both inside and outside RTAs.

The proliferation of RTA with ROO attracted the attention of international

[3]ROO are classified in two categories: preferential and non-preferential ROO. Preferential ROO determine whether the product qualifies for preferential treatment in a PTA. On the other hand, non-preferential ROO are employed to distinguish between foreign and domestic products (Estevadeordal and Suominen, 2003, 2006; *the Report on Compliance by Major Trading Partners with Trade Agreements*, 2009, chapter 9: Rules of Origin). Here, we use the term "ROO" meaning "preferential ROO".

[4]The importance of ROO for the procurement of firms is argued in several studies and reports. For example, JETRO (2004) points out that ROO possibly has a crucial impact on the procurement strategies of firms. It seems that the existence of ROO is a factor for raising local procurement. We can verify this point in the following fact: more than half of the Japanese-affiliated firms in Thailand, Malaysia, and Indonesia have local content above 40% (JETRO, 2004). Also, Cadot et al. (2002) and Anson et al. (2005) indicate that the utilization rate of ROO (i.e., compliance with ROO requirements) in NAFTA is relatively high (64% in 2000).

[5]As pointed out by Krishna and Krueger (1995), ROO can be defined in at least four different criteria: (1) domestic content (defined in terms of value added or in physical content); (2) change in tariff heading; (3) specified process that must be performed within the region (FTA or CU); (4) product has been substantially transformed. However, an important point is that these four alternative criteria are essentially same in view of limiting the use of inputs from the outside the preferential trade area. For simplicity and analytical viewpoint, throughout this thesis we use physical content based definition of ROO, the above mentioned criterion (1).

[6]LCR is the policy that imposes to entrant foreign firms a certain ratio of the procurement of local inputs to produce a final product locally (Hara and Nakanishi, 2001). Note that LCR policy crucially differs from ROO. These two regulations have different purposes. To protect the domestic producer (especially, intermediate good producers), LCR is employed in an FDI host country. ROO is imposed to the intra-region firm which wills to gain duty-access in an RTA.

[7]At least 93 PTAs have some type of ROO, and the most frequently used criterion is value or domestic content (Estevadeordal and Suominen, 2003, 2006).

economists and trade theorists resulting in a series of studies on this issue. For example, Krueger (1993), Krishna and Krueger (1995), Lopez-de-Silanes, Markusen, and Rutherford (1996), Rosellón (2000), Falvey and Reed (2002), Ju and Krishna (2002, 2005), and Demidova and Krishna (2008) are important and representative studies that focus on the protectionist nature of ROO, employing analytical frameworks based on LCR.[8]

These existing studies mainly have the following features. First, theoretical studies on ROO just started in the middle of the 1990's (Krueger, 1993) so that the number of studies is relatively small. Second, by focusing on the protectionist nature of ROO, these studies mainly examine the effects of introducing and tightening the ROO requirement. Finally, there are three issues that lack examination: "**policy interaction between ROO and subsidy policy**", "**exporting firms' strategic choice of compliance with ROO**", and "**exporting firms' R&D activities in the presence of ROO**".

The purpose of this thesis is to examine these three issues under the framework of international oligopoly. First, we examine the relationship between ROO and the subsidy policy of the exporting country. The policy interaction between ROO and subsidy is an important issue in view of national welfare in each country. For example, in the presence of ROO a member country within an RTA may widely increase its national welfare through a sparing use of subsidy policy. Exceptionally, although Falvey and Reed (2002) examine the relationship between ROO and tariff policy of the final good importing country, their analysis is limited to tariff policy. It is still unclear as to how the relationship between ROO and subsidy policy is established. Thus, it is important to consider policy interactions between ROO and subsidy policy.

Second, we examine the exporting firms' strategic choice of compliance with ROO. Final good exporting firms may comply with the ROO requirement in order to enjoy duty-free access. They, however, do not necessarily comply with the ROO requirement in their RTA because exporting firms are only imposed with an external tariff upon exporting to a member country's market if they

[8]Since the study of Grossman (1981), a series of theoretical studies on LCR has arisen. In this field, there are several theoretical studies based on the framework of imperfect competitive market and vertical structure (e.g., Belderbos and Sleuwaegen, 1997; Fujita, 2001; Ishikawa, 1999; Lahiri and Ono, 1998, 2003, 2004; Kayalica and Lahiri, 2003; Qiu and Tao, 2001; Veloso, 2006; and Kwon and Chun, 2009). Hara and Nakanishi (2001) survey the existing studies on LCR in view of the relationship between direct investment and LCR policy by the host country.

do not meet the criterion required by the ROO. Thus, final good exporting firms face the alternatives of complying with the ROO requirement or not. For example, Anson et al. (2005)—an empirical study about NAFTA—points out that only 64% of final good exporters meet ROO requirements in Mexico. If we consider this fact as a result derived from the firms' strategic decision, then it becomes clear that existing studies fail to examine an important aspect of the issue. Therefore, it is necessary to examine the effects of ROO when firms behave strategically and the implications to welfare.

Third, we consider the effects of ROO on firms' behavior and on the welfare of each country when firms engage in R&D competition. ROO cause cost differences between firms complying with the ROO requirement and not complying with it. An initial cost difference between firms has a significant meaning when cost-reducing R&D competition is taken into account. In general, a major firm can expand market share because the larger (small initial cost) firm can invest a larger volume of expenditure rather than the smaller (large initial cost) firm (Barros and Nilssen, 1999; Lahiri and Ono, 1999). Therefore, it is necessary and important to examine the effects of ROO on firms' behavior and on each country's welfare when firms engage in cost-reducing R&D competition.

1.2 Overview

We briefly summarize each chapter of the thesis (from chapters 3 to 6), including related studies and our main results or contributions.

Chapter 2: Selected Survey

Chapter 2 presents related theoretical studies on ROO. We classify these studies and then present the position of each chapter in the thesis. In section 1, we explain the relationship between our research and the main studies that are in line with our three issues. In section 2, we present some other approaches or frameworks on ROO, which differ from our own, and the main related studies on RTA with ROO.

Chapter 3: ROO and Strategic Subsidies

The purpose of this chapter is to consider the interaction between ROO and the exporting country's subsidy policy. Although there is a small study on the policy interaction between ROO and ordinal tariff (Falvey and Reed, 2002), subsidy policy has not been sufficiently examined in the existing studies on ROO. However, subsidy policy has been thoroughly examined in the arguments concerning strategic trade policy.[9] To fill this gap, we extend Lahiri and Ono's (1998, 2003) standard LCR framework to the economic environment of FTA with ROO.

Our setup has three countries (countries A and B have already formed an FTA, and outside the FTA is country O) and three firms (firms a, b, and o, located in countries A, B, and O, respectively) in the world. Country A imports the final goods, and countries B and O export the final goods. Firm a uses the intermediate goods produced internally and supplies the final goods in the domestic market. Firm b can gain duty-free access to the final goods market in country A if it procures more than the predetermined proportion of ROO. On the other hand, firm o exports the final goods under a given level of the external tariff imposed by country A.

We consider the following two game types. In one type, government B is the first mover. In the first stage, government B chooses a level of production subsidy for its firm. In the second stage, governments A and O independently and simultaneously choose the content rate of ROO and a level of production subsidy. In the final stage, the firm chooses the quantity of supply. In the other type, the government of country A is the first mover. In the first stage, government A chooses the content rate of ROO. In the second stage, governments B and O independently and simultaneously choose their respective levels of production subsidy for their firms. The final stage is the same as that in the previous timing structure.

Our results are summarized in the following three points. In the first game type, government B imposes an export tax because government A sets a higher content rate of ROO as the productivity of firm b improves. In the second game type, government B offers a positive export subsidy for its firm. In this case,

[9]For example, see Brander (1995), Chang and Katayama (1995), and Ishikawa (2001). Furthermore, there are recent representative studies on strategic subsidization in argument concerning strategic trade policy from Creane and Miyagiwa (2008), Etro (2009), and Ishikawa and Komoriya (2007). Creane and Miyagiwa (2008) demonstrated that the results of strategic subsidization from standard omniscient-government assumption also hold under demand and cost uncertainties. Etro (2009) reexamined Brander and Spencer's (1985) and Eaton and Grossman's (1986) results under a free entry/exit environment with exchange rate. Ishikawa and Komoriya (2007) mainly argued the effects of countervailing duties (CVDs) when export and capital subsidies are offered.

government B does not directly affect the content rate of the ROO and faces a subsidy race with government O. In both game types, a decrease in the external tariff may increase the profit of firm b, which is located in the FTA. Because a positive correlation arises between the ROO requirement and the external tariff, a decrease in the external tariff may increase the profit of firm b.

Our main contributions are the following: We show how the relationship between ROO and subsidy policy arises in a situation of FTA with ROO. Specifically, in the policy game between ROO and the exporting country's subsidy, we demonstrate that ROO may induce positive export subsidy. The existing literature on FTA with ROO fails to examine this relationship. For example, Lopez-de-Silanes, Markusen, and Rutherford (1996) pointed out that ROO has rent-shifting and anti-competitive effects in an imperfect competitive market. However, it is not sufficient to consider the effects of ROO on firms' behavior and national welfare in a situation of FTA with ROO. In addition, Falvey and Reed (2002) examined the relationship between ROO and tariff policy. In their analysis, however, the effects of ROO on firm behavior and each member country's welfare under imperfect competition or strategic situation were not examined.

Chapter 4: ROO, External Tariff, and Market Structure

In this chapter, we emphasize the protectionist nature of ROO. We examine the relationship between endogenously determined ROO and the external tariff as well as the effects of differences in the number of firms inside and outside the RTA on that relationship.

As previously mentioned, many studies on ROO emphasize its protectionist nature and mainly examine the effects of the introduction and tightening of the ROO. There are small studies on the relationship between the ROO and other trade policies (Falvey and Reed, 2002). In contrast to Falvey and Reed (2002), our focus is the relationship between endogenously determined ROO and the external tariff under an international oligopolistic market.

To consider this point, we use a Brander and Krugman (1983)-type model with three countries, two types of firms, and a two-way oligopolistic trade model. Countries 1 and 2 are symmetric; they have already formed an RTA, and outside the RTA is country O. One type of firm is located in the RTA, and the other is located outside the RTA. In each member country, m firms produce a homogeneous final good for supply to the home and other member markets. The firms located in one member country face the ROO and procure a mixed proportion of input produced in the other member country when they export the final good to the other member market. On the other hand, there are n firms outside the RTA. These firms export the final good to each member country, imposing each external tariff.

In this environment, we consider the following simple two-stage game. In the first stage, governments of countries 1 and 2 simultaneously choose their respective content rates of the ROO. In the second stage, each firm independently and simultaneously chooses a quantity of the final good.

In our model, the following three results hold. First, by treating ROO as an endogenous variable of member countries within an RTA, we derive that a positive relationship between ROO and the external tariff arises. An external tariff reduction (ETR) implies a decrease in the domestic supply. Then, an incentive to protect the domestic firm weakens. Second, the welfare of member countries improves due to an ETR only if the market size of those countries is sufficiently small. A larger market size implies a larger profit for domestic firms. If the market size is sufficiently large, a reduction in the profit of domestic firms due to an ETR dominates any other effects. Third, the way the relationship between the effects of ETR and the number of inside and outside firms (i.e., market structure) arises is demonstrated. For example, when the number of inside and outside firms is one, it is easier for an ETR to increase social welfare rather than input revenue. However, when the number of inside and outside firms is two, this relationship reverses.

In this chapter, our contributions are summarized into the following three points. First, we treat ROO as an endogenous variable of RTA member countries. In the existing literature (e.g., Krueger, 1993; Krishna and Krueger, 1995; Lopez-de-Silanes, Markusen, and Rutherford, 1996; Rosellón, 2000; Falvey and Reed, 2002) this point is not sufficiently examined. Second, we show that a sufficiently small market size is needed to improve social welfare in an RTA member country. Third, we demonstrate the relationship between the effects of ETR and market structure. As previously mentioned, when the number of inside and outside firms is one, it is easier for ETR to increase social welfare rather than input revenue. However, when the number of inside and outside firms is two, this relationship reverses. This implies that the economic structure of member countries changes significantly based on an increase in the number of firms. This relationship is overlooked in the existing literature.

Chapter 5: ROO and Strategic Choice of Compliance

This chapter focuses on the strategic choice of homogeneous exporting firms that face two alternatives: compliance or non-compliance with the ROO. Although Ju and Krishna (2002, 2005) and Demidova and Krishna (2008) are representative studies that focus on the firms' choice (i.e., whether or not to comply with ROO), their studies fail to examine the strategic situation among exporting firms.

In view of the strategic behavior of firms, we present a simple trade model in a standard Cournot competition among homogeneous exporters. There is an RTA consisting of two countries—one with a final good market and one without it. There is one intermediate good producer (firm ℓ) and final good producer (firm L) in the local country, and two final good producers in the other member country (firms F). Firm L exclusively procures intermediate goods from firm ℓ because tariff/nontariff barriers exist. Firms F export the final good to the local country's market. In order to enjoy duty-free access, these exporters must use at least some level of the intermediate good produced in the RTA.

In our model, the following three results hold: First, a heterogeneous regime (one exporter complying with ROO requirements, but the other not doing so) occurs when the content rate of ROO is not too high (and not too low) as compared to the external tariff rate. When the external tariff is relatively high, each exporter prefers to comply with ROO if the other exporter does. Moreover, when the external tariff is not too high, each exporter prefers not to comply with ROO if the rival does. Hence, a heterogeneous regime occurs. Second, if either exporter complies with ROO requirements, the welfare level of the final good importer within the RTA is the worst among the three cases of both exporters complying with ROO, neither exporter complying with ROO, to only one exporter complying with ROO. In this case, tariff revenues dominate any other effects. Third, a tightening of ROO may reduce the profits of any final good producing firms. An input cost advantage for exporters does not exist when the ROO requirement is sufficiently high. Thus, the profits of all final good producers decrease due to an increase in the ROO requirement.

Our contributions in this chapter are mainly the following two points: First, we show that a heterogeneous regime arises among homogeneous exporting firms.

This point is crucially important. Demidova and Krishna (2008) indicated that a heterogeneous regime arises because firms are different in their productivity. Here, it is demonstrated that firm heterogeneity is not necessarily needed to cause a heterogeneous regime. Second, we demonstrate that a tightening of ROO may reduce the profits of any final good producing firms within the RTA. This implies that the conflict of interest between intra-regional final good producers may be eliminated when the content rate of ROO decreases. Ju and Krishna (2005) demonstrated that a conflict of interest between producers inside and outside the FTA occurs when ROO is changed. However, it is more important to examine the conflict of interest between intra-regional final good producing firms, because complying and non-complying firms arise in the preferential trade area.

Chapter 6: ROO and R&D Rivalry

This chapter focuses on the final good producers' R&D competition. Many works on ROO exclusively examine firms' export activities—they do not sufficiently consider firms' R&D activity. When exporting firms engage in cost-reducing R&D competition, ROO considerably affects their behavior, because ROO causes cost differences between the firms conforming to it and those not doing so.

As shown by Barros and Nilssen (1999) and Lahiri and Ono (1999), a lower-cost firm undertakes a larger cost-reducing investment than a higher-cost one. As a result, major firms' market share expands due to R&D competition. Therefore, the welfare implication of the ROO is crucially important when exporting firms engage in cost-reducing R&D competition.

To examine the effects of ROO under international R&D competition, we extend Barros and Nilssen's (1999) and Lahiri and Ono's (1999) asymmetric R&D rivalry framework to the economic environment, including FTA with ROO. Consider an FTA consisting of two countries: one with a final good market (country M) and the other without it (country E). Outside the FTA is country O. One final good producer is located in each country, and they engage in cost-reducing R&D competition. The exporting firm in this FTA (firm E) faces ROO and chooses a mixed ratio of intermediate good produced in the other member country and outside the FTA. In both countries M and O, the intermediate good industries produce under perfect competition. However, the intermediate good industry in country M is inefficient as compared to that in country O.

We focus on the following three-stage game. In the first stage, the government of country M sets the rate of the external tariff. In the second stage, each firm chooses its volume of cost reduction, respectively. Finally, each firm chooses a quantity of the final good.

We obtain the following three results: First, an increase in the ROO requirement increases the output, R&D investment, and profit of the exporting firm within the FTA when the efficiency of R&D investment is sufficiently high. An optimal external tariff increases due to an increase in the ROO requirement (positive correlation). This relationship is strengthened when the efficiency of R&D is sufficiently high. Second, the government of country M gives an import subsidy to the outside firm if the efficiency of R&D is not too high and productivity inside the FTA is sufficiently low. When the intra-regional firms are less efficient, the government of country M undertakes an encouragement to import. Third, the ROO requirement minimizes the welfare in country M when the efficiency of R&D is not too low and productivity inside the FTA is not relatively high. Because intra-regional firms are sufficiently less efficient, production substitution effects basically worsen the welfare of country M.

Our contributions are the following two points: First, we demonstrate that the rent-shifting effects of ROO do not necessarily harm an exporting firm that complies with ROO. Second, we extended the discussion of welfare-enhancing production substitution effects to the situation of FTA with ROO, including R&D competition. As referenced by Matsumura (2003), welfare-enhancing production substitution effects are discussed in several areas (e.g., FDI and mixed oligopolistic market and so on).[10] The above second and third results are related to the discussions of welfare-enhancing production substitution effects. These results are based on the production substitution from a high-cost firm to a low-cost firm.

[10]For example, see Brander (1981), Ono (1990), Lahiri and Ono (1988, 1998, 2003, and 2004), and Matsumura (1998). Further, Kikuchi (2006) referred to the welfare-enhancing production substitution effects. Although his arguments were more closely related to the framework of monopolistic competition and trade liberalization, Kikuchi (2006) suggested that it is important to use a Lahiri and Ono (1988)-type asymmetric oligopoly (i.e., asymmetric productivities) in order to examine the reallocation effects of market share through trade liberalization.

Chapter 2

Selected Survey

This chapter surveys some related theoretical literature on ROO and demonstrates our position on those studies.

	Issue 1	Issue 2	Issue 3
• Krueger (1993) • Krishna & Krueger (1995) • Lopez-de-Silanes et al. (1996) • Rosellón (2000) • Grinols & Silva (2008a, b) • Lahiri & Ono (1998, 2003)	No	No	No
• Falvey & Reed (2002) • **Takauchi** (**Ch. 3**) • **Takauchi & Mizuno** (**Ch. 4**)	Yes	No	No
• Ju & Krishna (2002, 2005) • Demidova & Krishna (2008) • **Takauchi** (**Ch. 5**)	No	Yes	No
• Lahiri & Ono (1999) • Barros & Nilssen (1999) • **Takauchi** (**Ch. 6**)	Yes	No	Yes

Table 2.1: Relationship between three issues and main related literature

Table 2.1 classifies studies according to our three issues: "policy interaction between ROO and subsidy policy" (labeled Issue 1), "exporting firms' strategic choice of compliance with ROO" (labeled Issue 2), and "exporting firms' R&D activities in the presence of ROO" (labeled Issue 3). Classifying these studies,

Table 2.1 presents the position of each chapter in this thesis.

In section 2.1, we provide the relationship between our research and the main related studies in line with our three issues. In section 2.2, we present other approaches or frameworks for ROO that differ from our framework, but are related to the topic of RTA with ROO.

2.1 Main related studies

In this sub-section, we present the main related studies. In section 2.1.1, we explain the three pioneering studies, more complete forms of some studies that consider RTA with ROO, and two essential studies for our oligopolistic framework. In section 2.1.2, we present studies related to issue 1. In section 2.1.3, we present some studies related to issue 2. In section 2.1.4, we provide some studies related to issue 3.

2.1.1 Pioneering studies, more complete models, and the basic framework for our studies

First, we explain three pioneering studies. A pioneering study on RTA with ROO can be traced back to Krueger (1993). She pointed out that, using a value-added-based definition of ROO and a numerical example, ROO may protect the U.S. auto and textile industries in NAFTA.

After her study, a series of studies arose. Krishna and Krueger (1995) pursued further analysis. They compared the effects of a cost-based definition of ROO to those of a price-based definition on Mexican firms' behavior and suggested that it is desirable for Mexican producers to use a price-based definition of ROO.

Lopez-de-Silanes, Markusen, and Rutherford (1996) suggested that ROO has more important effects in an imperfect competitive market. They demonstrated that ROO has rent-shifting and anti-competitive effects. Using a numerical example, they verified the protective effects of ROO on firms' behavior in a duopolistic final good market and a monopolistic competitive parts sector.[1]

The above-mentioned studies are important, and all suggest or emphasize

[1]Similarly, using differentiated Bertrand duopoly and numerical example, Deardorff (2004) examined the effects of ROO on firms' behavior.

an aspect of the protectionist nature of ROO.[2] These studies are mainly based on numerical examples and focused on final good producers' profit. However, other more complete studies do consider RTA with ROO. For example, Rosellón (2000) examined the long-term effects of ROO, and Grinols and Silva (2008a, b) considered that by allowing cross-country transfer within an FTA, it is feasible to have a welfare-enhancing FTA formation with ROO.

Rosellón (2000) examined the effects of ROO in static and dynamic situations. In the static case, he mainly suggested that a more restrictive ROO in a situation initially without it slightly increases the use of the input produced in the preferential trade area. In the dynamic case, he demonstrated that the enforcement of ROO increases demand for the input produced in the area if technological development is achieved enough.[3]

Grinols and Silva (2008a, b) built a three-country, multi-sector, perfect competitive trade model with ROO to prevent trans-shipment, where two countries form a FTA and the other is the rest of the world. Grinols and Silva (2008a) mainly demonstrated that FTA formation is welfare-enhancing if cross-country transfers within the FTA are allowed and one member country offers a subsidy to maintain output at the pre-FTA level. Furthermore, Grinols and Silva (2008b) proved that welfare-enhancing FTA formation is feasible, and that all consumers are not worse-off post FTA formation.

Second, we refer a more basic framework for our studies. Lahiri and Ono (1998, 2003) had a similar form as our studies in view of LCR, but they did not examine the situation of RTA with ROO. They examined an optimal LCR policy and foreign firms' FDI under an oligopolistic final good market with unemployment in the host country. Specifically, Lahiri and Ono (1998) considered the optimal combination of profit tax for foreign firms and LCR policy, and the relationship between the optimal level of policies and the number of domestic firms.[4] They suggested that the host country's FDI policies have employment

[2]This aspect of ROO was also examined by Krishna (2006). She presented a general consideration on the conditional policy (i.e., ROO) in production.

[3]In the context of economic growth and international trade, there is a study on the LCR and growth. For example, see Miyagiwa and Yeo (1995). They found that even if LCR exists, economic welfare improves due to factor accumulation or technological progress in a small open, multiple-sector trade model.

[4]Lahiri and Ono (2003) is a modified version of Lahiri and Ono (1998). Lahiri and Ono (2003) considered a two-country (countries 1 and 2) partial equilibrium trade model. The foreign firms (FDI firms) locate in country 1 and compete with one domestic firm in country 2 (consuming country). In this study, they considered the following two cases—allowing foreign

and price-lowering effects. They demonstrated that the employment effect is large when FDI is inefficient, but the price-lowering effect is large when FDI is efficient. For example, the host country government's optimal LCR policy is zero when the efficiency of foreign firms is more efficient than the domestic ones (FDI is efficient) and the number of domestic firms is small.

Lahiri and Ono's (1998, 2003) work is significant in view of examining the relationship between LCR policy as a provision against unemployment and the number of firms (efficiency of production) under international oligopoly. Although they used a similar form as our studies in view of LCR, their studies did not consider the situation of RTA with ROO. To examine our three issues, it is necessary to extend these studies to a framework including RTA and ROO.

2.1.2 Studies related to issue 1

As mentioned in the previous chapter, there are small studies on the policy interaction between ROO and other trade policy. Falvey and Reed (2002) is an important and representative study that focused on the policy interaction between ROO and the final good-consuming or importing country's tariff policy.

Falvey and Reed (2002) considered a three-country, perfect competition, partial equilibrium trade model, where one country is a final good-consuming country and the others are final good-exporting countries with intermediate good industries. The final good-consuming country and one final good-exporting country form a preferential trade agreement (PTA) with ROO. In the presence of ROO, the firm located in one final good-exporting country must procure the intermediate good in its own country.

In this environment, Falvey and Reed (2002) examined the welfare-enhancing use of ROO for the final good-consuming country. They mainly demonstrated that the final good-consuming country may improve domestic welfare when the country uses ROO complementary to its tariff policy. This analysis is important in view of the following point. That is, it demonstrates the relationship between ROO and an ordinal tariff policy.

However, their analysis is limited to the policy interaction between ROO and ordinal tariff policy, and it relies on perfect competition. They did not

firms' free entry/exit with a fixed number of foreign firms. They mainly demonstrated that it is desirable for the consuming country to raise LCR (at country 1) when the number of foreign firms is fixed.

examine the policy interaction between ROO and subsidy policy under imperfect competition.

2.1.3 Studies related to issue 2

Ju and Krishna (2002, 2005) and Demidova and Krishna (2008) emphasized firms' choice of non-compliance with ROO. Here, we focus on Ju and Krishna (2005) because both studies are based on the same logic.[5]

Ju and Krishna (2005) considered a three-country perfect competitive trade model, where countries A and B have formed an FTA and the other is outside the FTA. In their setting, the firms located in country B have incentive to export the final good to the market of country A when the final good price in country A is higher than that in country B. To gain duty-free access, these firms must comply with ROO. These firms face ROO, and can export to country A by complying with this requirement or only supply domestically by not doing so.

Ju and Krishna (2005) demonstrated that either a homogeneous regime (all final good producers comply with ROO or do not comply with ROO) or a heterogeneous regime (some firms comply with ROO but others do not) arises, depending on the level of the intra-regional input price. They also indicated that a conflict of interest between intra-regional final good producers and outside producers occurs when the requirement of ROO is strengthened. Moreover, they demonstrated that a conflict of interest between intra-regional final good producers and intra-regional intermediate good producers occurs when the requirement of ROO is strengthened.

Demidova and Krishna (2008) presented a monopolistic competition trade model.[6] They considered a two-country (home and foreign), small open, Melitz-type firm heterogeneity (Melitz, 2003). In this framework, relatively high productivity firms can export, but relatively low productivity firms cannot export—they supply only domestically. To get preferential access, home-country firms

[5]Precisely speaking, Ju and Krishna (2005) is a modified version of their 2002 content preference scheme. Ju and Krishna (2005) extended their previous analysis to the situation of FTA with ROO.

[6]Bombarda and Gamberoni (2008) and Demidova, Kee, and Krishna (2009) employed the same framework,but their focus was empirical study. Bombarda and Gamberoni (2008) considered diagonal rules of cumulation. They mainly found that diagonal rules of cumulation relax ROOs in the EU. Also, Demidova, Kee, and Krishna (2009) considered specific demand shocks and suggested that relaxed ROO significantly expands the market access from developing countries to developed countries because firms with lower productivity can export.

must pay an additional per-unit cost (i.e., comply with ROO). Demidova and Krishna (2008) mainly demonstrated that either a homogenous or a heterogeneous regime arises, according to the level of the firms' productivity. These studies are important in view of focusing on the firms' choice. However, they fail to consider a strategic situation among firms.

2.1.4 Studies related to issue 3

To our knowledge, cost-reducing R&D activity has not been sufficiently examined in the presence of ROO. On the other hand, there are some seminal works on R&D with cost asymmetries. Lahiri and Ono (1999) and Barros and Nilssen (1999) presented standard cost-reducing R&D activity with cost asymmetries.

Lahiri and Ono (1999) considered a market in which there are two firms with different initial (marginal) costs.[7] These firms compete in a two-stage game. In the first stage, each firm invests in cost-reducing R&D. In the second stage, they compete *à la* Cournot in the product market. In this general and simple situation, they demonstrate that a firm with a lower (higher) initial cost invests more (less) in cost-reducing R&D.

The above studies are important because they demonstrate that an initial cost asymmetry may affect firms' market share. This idea is more important when we examine the welfare effect of ROO. ROO causes initial cost asymmetry between conforming firms and non-conforming firms. However, Lahiri and Ono (1999) (and Barros and Nilssen, 1999) did not analyze the situation of RTA with ROO.

[7] Barros and Nilssen (1999) presented a more specific model. They considered the same situation as Lahiri and Ono (1999), but they added asymmetry in R&D efficiency and modified cost function of R&D. Their focus is the relationship between R&D subsidy (industrial policy) and the above asymmetries.

2.2 Another approach and framework for ROO

In section 2.2, we present some other approaches or frameworks for ROO.[8] To our knowledge, the other approaches are roughly classified into three types: The first type is an IO approach, the second type is a multistage production approach, and the third type is a political-economy approach.[9] The first type is based on the industrial organizational perspective (Ishikawa, Mizoguchi, and Mukunoki, 2007; Thoenig and Verdier, 2006). The second type mainly focuses on the production process, and employs a Dixit and Grossman (1982)-type multistage production model (Rodriguez, 2001). The third type emphasizes lobbying activity or employs a Grossman and Helpman (1994, 1995)-type lobbying model (Cadot, de Melo, and Olarreaga, 1999; Duttagupta and Panagariya, 2007).[10]

2.2.1 IO approach

Ishikawa, Mizoguchi, and Mukunoki (2007) emphasized the price-discrimination behavior of firms that produce a final good originating outside of the FTA. They considered a three-country (an FTA includes countries 1 and 2 and the other is outside of the FTA), two-firm, (intra FTA and outside firm) Bertrand competition trade model. They assume that the firm producing products originating in the FTA sets the uniform price, but the firm producing products originating outside can take price-discrimination behavior.[11]

They mainly demonstrate that ROO is not necessarily a protectionist device for the firms located in the FTA. That is, the profit of intra-regional firms decreases due to the introduction of ROO when the extent of product differentiation in the good is sufficiently large.

[8]As pointed out by Ju and Krishna (2002), we must note that the mechanism of the ROO requirement (or content preference scheme) can be applied in various situations. Actually, in topics of environmental economics, there are several studies related to this mechanism. For example, Dinopoulos, Livanis, and West (2009, forthcoming) focused on international trade of an unsafe (or risky) food. Higashida and Jinji (2006) used the framework of a content preference scheme to examine recycling policy from the viewpoint of the strategic use of environmental policy.

[9]There is another topic on ROO. Georges (2008) performed a computation general equilibrium (CGE) analysis on the effects of liberalizing ROO in NAFTA.

[10]See also Dixit, Grossman, and Helpman (1997).

[11]The products that meet the ROO are freely traded within the FTA but the products that do not meet the criterion have an external tariff imposed. Therefore, the market for a product produced in the FTA is perfectly integrated, while the market for a product that does not meet ROO is not integrated.

Theonig and Verdier (2006) focused on the strategic outsourcing behavior of firms. They considered a three-country, two-firm strategic outsourcing trade model, where the three countries are A, B, and C, the final good market exists in country B, and countries B and C form an FTA; and where one firm is located in country A and the other is located in country B. They considered a two-firm imperfect competitive situation. Each firm decides how many intermediate production stages to produce in-house and how many of those stages to outsource to an outside supplier in the presence of a rival firm.

In this situation, Theonig and Verdier (2006) mainly found that ROO may create co-ordination problems in the product market, because multiple equilibria may emerge in the outsourcing decision when ROO is introduced.

2.2.2 Multistage production approach

Rodriguez (2001) employs a Dixit and Grossman (1982)-type multistage production model. In the framework of Dixit and Grossman (1982), a good is produced through a continuum of vertical production stages, where some value is added at each stage. Rodriguez (2001) extended this model to a three-country trade model including FTA with ROO. He assumed that production cost differs from each country and it is linear with respect to production stages. In each country, a different range of production is realized.[12]

In the above-mentioned situation, Rodriguez demonstrated that the midstream (i.e., the order of production range is middle) country's production range expands, and this relocation of production has a trade-creating effect between FTA members when the midstream country and downstream (i.e., the order of production range is end) country form an FTA and their ROO is met. Moreover, he suggested that more restrictive ROO may induce trade regression through the inefficient relocation of production among member countries within the FTA.

2.2.3 Political-economy approach

Cadot, de Melo, and Olarreaga (1999) examined the impact of regional trading arrangements on tariff policy, introducing Grossman and Helpman (1994, 1995)-

[12] Lloyd (1993) examined the effects of ROO on production stages in a more primitive example. Further, Lloyd (2002) examined three distinct applications of ROO in the same framework: the first is related to ROO in FTA, the second is preferences of developing countries, and the third is treatment of imports that have some domestic contents.

type lobbying activity. They compared the situation of FTA with ROO and the situation of FTA without ROO. They considered a three-country (labeled A, B, and C) and three-good (labeled 1, 2, and 3) trade model. Countries A and B form an FTA with (or without) ROO, which is designed to prevent transshipment of goods within the FTA. Each country produces and consumes three homogenous goods. Each country exports the good that is produced at the least cost compared to other countries, but it imports the other two goods. Country A is the least-cost producer of good 1, country B is the least-cost producer of good 2, and country C is the least-cost producer of good 3. In each country, the export industry undertakes lobbying activities against import tariffs in other sectors.

They suggested that a different political incentive leads to a different tariff regime. That is, in a case of FTA with ROO, one member country eliminates its external tariff, whereas the other maintains a positive external tariff, because exporting producers in the low-protection country have no incentive to contribute (but exporting producers in the high-protection country do) and both member countries are small. However, they demonstrated that both member countries eliminate their external tariffs when ROO does not exist.

Duttagupta and Panagariya (2007) examined the effects of ROO under lobbying activity in an intermediate good industry. They considered a three-country (labeled Home, Foreign, and the rest of the world) three-good (labeled 0, 1, and 2), perfect competitive trade model. In their model, Home and Foreign are potential partners in an FTA and the requirement of ROO is cost (or content) based. Home imports intermediate input and Foreign imports final good 1. Home producers of good 1 can gain duty-free access to Foreign's market when their cost from the intra-regional input is at least a predetermined ratio.

They pointed out that FTA with ROO remains acceptable to Home because the owners of a specific factor (i.e., lobbyists) gain a larger benefit in the presence of the ROO than in the absence of it. Further, they showed that a tightening of ROO need not always result in increased protection to the intermediate input within the region.

Chapter 3

ROO and Strategic Subsidies

3.1 Introduction

In regional trade blocks, certain rules are required to determine whether a product can be considered "domestic" (produced inside the block) in order to qualify for free trade among member countries (Lopez-de-Silanes, Markusen, and Rutherford, 1996). Rules of origin (ROO) are rules that define the origin of a product by setting the minimum ratio of domestic (or intra-block produced) intermediates required to produce a product. This aspect of domestic content provision is mainly represented by the mechanisms of the local content requirement (LCR)—an important feature of ROO.

As a significant contribution to the context of LCR, Lahiri and Ono (1998, 2003) analyzed the effects of LCR in a model with an oligopolistic setting and summarized the basic implications derived from such a protectionist policy. Their analysis stated that the producers of final goods in a foreign country must satisfy a minimum level of LCR to supply goods to the market of the host country if both the countries serve as sources of intermediate goods. Therefore, if the price (productivity) of intermediate goods in a member country is higher (lower) than that of another member country in their FTA, ROO serve as a protectionist device for the less efficient country.

Several studies on ROO focus on their protectionist nature and mainly examine the effects of their introduction and tightening (e.g., an increase in the content rate) as a singular policy variable.[1]

[1]The literature on FTAs with ROO has mainly focused on the issue of LCR, and the generally adopted analytical framework is the local content protection (LCP) model. Three

Falvey and Reed (2002) is an exceptional study that examines the relationship between ROO and other trade policies. They constructed a three-country model (one country importing final goods and two others exporting final goods) with a perfect competitive framework and highlighted the relationship between ROO and the tariff policy imposed by the importing country. They showed that the importing country can benefit from introducing a tariff policy for final goods complementarily to ROO. However, their analysis is limited to the importing country's tariff policy. Thus, it is still unclear as to how the relationship between ROO and trade policies other than the tariff policy is established.

In this chapter, we mainly consider the interaction between ROO and the subsidy policy. Following the pioneering studies of Brander and Spencer (1985) and Eaton and Grossman (1986), the subsidy policy has been significantly examined in the arguments concerning the strategic trade policy. However, existing studies on FTAs with ROO do not sufficiently examine the subsidy policy, despite the fact that it is important in terms of trade and similar to tariffs in a strategic trade policy.[2] To fill this gap, we consider the effect of the exporting countries' subsidy policies in the presence of ROO.

We present a three-country (countries A and B have already formed an FTA, and outside the FTA is country O), three-firm (firms a, b, and o, located in countries A, B, and O, respectively) oligopolistic model in order to describe the effects of ROO and the subsidy policy. Country A is the country importing the final goods and countries B and O are the countries exporting the final goods. Firm a uses the intermediate goods produced internally and supplies the final goods in the domestic market. Firm b can gain duty-free access to the final goods market in country A if it procures more than the predetermined proportion of ROO. On the other hand, firm o exports the final goods under a given level of the external tariff imposed by country A.

different definitions of ROO are found in the existing literature on FTAs with ROO that focuses on the issue of LCR. These are the cost- (or price-) based definition (Ju and Krishna, 2002; 2005), value addition-based definition (Krueger, 1993; Falvey and Reed, 2002), and physical content-based definition (Lopez-de-Silanes, Markusen, and Rutherford, 1996). Krishna and Krueger (1995) compared the results of the cost-based definition with that of the price-based definition. Ishikawa, Mukunoki, and Mizoguchi (2007) omitted the direct effects or mechanism of ROO in the intermediate goods market. They exclusively focused on a situation that resulted from the presence of ROO in the final goods market and compared consumer surplus, profits, and the welfare of countries inside and outside the FTA in the absence of ROO as well as in its presence.

[2] For example, see Brander (1995), Chang and Katayama (1995), and Ishikawa (2001).

In the abovementioned environment, we consider the following three-stage game. In the first stage, government B chooses a level of production subsidy for its firm. In the second stage, governments A and O independently and simultaneously choose the content rate of ROO and a level of production subsidy for the domestic firm. In the final stage, the firm chooses the quantity of supply. In equilibrium, government B imposes an export tax (a negative export subsidy) on its firm in order to decrease the content rate of ROO. Irrespective of whether or not the paradoxical result "export tax" holds, we also consider a different timing structure. In the first stage, government A chooses the content rate of ROO. In the second stage, governments B and O independently and simultaneously choose their respective level of production subsidy for their firms. The final stage is the same as that in the previous timing structure. In this case, government B offers a positive export subsidy for its firm. Further, we show that a counter-intuitive result holds with respect to a change in the profit of the firm in country B due to a change in the external tariff. A decrease in the external tariff helps firm b, which is located in the FTA.

The logic behind our results is as follows. When government B is the first mover, the content rate of ROO is high if the productivity of firm b is high. Government A (second mover) sets a higher content rate of ROO as the productivity of firm b increases. Government B imposes the export tax to earn tax revenue rather than offering an export subsidy. On the other hand, when government A is the first mover, the content rate of ROO is determined in the first stage so that government B's subsidy level does not directly affect the content rate of ROO. Government B is in a subsidy race with government O. Thus, if the former does not subsidize its firm, the market share of firm b decreases considerably. Therefore, government B subsidizes its firm.

Next, we examine the effects of the external tariff. The market share of firm o is relatively large (small) if the external tariff is relatively low (high). Government A sets a lower (higher) content rate of ROO because its effects on consumer surplus (domestic firm's profit) dominate any other effect. A positive correlation arises between the content rate of ROO and the external tariff such that the content rate of ROO decreases due to a decrease in the external tariff. The profit of firm b increases due to a decrease in the content rate of ROO.

3.2 The model

Suppose that an FTA comprises two countries, A and B. Only country A has a final goods market and we label the country outside the FTA as O. In country A, there exists unemployment and the government imposes a sufficiently high specific tariff on imported intermediate goods.[3] The intermediate goods industry in country A is inefficient as compared to that in foreign countries. That is, $k^a > k^o$, where k^a (k^o) is the price of the intermediate goods in country A (O). Thus, if there is no trade barrier, the intermediate goods industry in country A vanishes. Inefficient workers have a strong incentive to apply political pressure because trade liberalization is the cause of their unemployment. Hence, the party in power in country A cannot assist in the creation of employment opportunities. As a result, government A imposes a high import tariff on the imported intermediate goods to ensure that the final goods producer in country A uses the domestically produced intermediate goods. Thus, the final goods are produced by using only domestically produced intermediate goods. In country B, however, firm b faces ROO and chooses a mixed proportion of intermediate goods produced in countries A and O, because firm b is exempted from the external tariff if it procures more than the predetermined proportion of ROO. In countries A and O, the intermediate goods industries produce under perfect competition.

The market inverse demand function in country A is assumed to be linear: $p = p(X)$, $p'(X) < 0$, and $p''(X) = 0$, where X and p represent the industry output and prices, respectively. Consider an oligopolistic market comprising three firms. Each firm, denoted by i $(= a, b, o)$, is located in country i. Let x^i denote the output of firm i. Thus, $X = x^a + x^b + x^o$. Further, we assume that one unit of intermediate goods is required to produce one unit of final goods. Thus, the net profits of firms b and o are

$$\pi^b \equiv (p(X) - c^b(\delta) + s^b)\, x^b, \qquad \pi^o \equiv (p(X) - k^o + s^o - t_x)\, x^o, \tag{3.1}$$

respectively, where s^j, $j = b, o$ denotes the export subsidy (tax) given by the government j to firm j, and t_x is a fixed external tariff imposed on an outside country. Following Lahiri and Ono (1998, 2003), the marginal (average) cost of

[3] That is, $k^a > k^o$ and $k^a < k^o + t_m$.

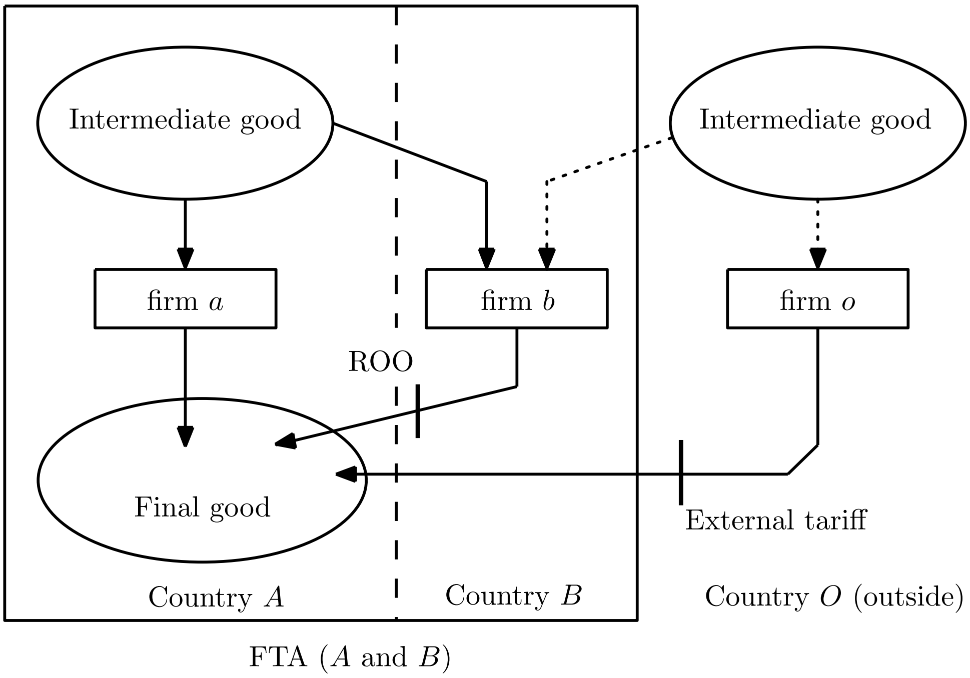


Figure 3.1: Trade structure

firm b becomes

$$c^b(\delta) \equiv \delta k^a + (1-\delta)k^o, \quad k^a > k^o \geq 0, \tag{3.2}$$

where $\delta \in (0,1)$ is the content rate of ROO imposed by country A's government. Note that only country A imposes a tariff on imported intermediates. Hence, the net profit of firm a is

$$\pi^a \equiv (p(X) - k^a)\, x^a. \tag{3.3}$$

As defined by equation (3.2), we assume that $k^a > k^o$, that is, the intermediate good industry in country A is less efficient.

First, we focus on the effects of each policy variable, namely, δ, s^j, and t_x at the final stage. From equations (3.1)–(3.3), the first-order profit maximization conditions become

$$0 = p(X) + p'(X)x^a - k^a, \tag{3.4}$$

$$0 = p(X) + p'(X)x^b - (c^b(\delta) - s^b), \tag{3.5}$$

$$0 = p(X) + p'(X)x^o - (k^o - s^o) - t_x. \tag{3.6}$$

From equations (3.4)–(3.6), we obtain the results of comparative statics on the firms' output x^i, industry output X, profits π^i, and consumer surplus CS at the final stage, as summarized in tables 3.1 and 3.2.

Table 3.1: Effects of policy changes on equilibrium outputs

	x^a	x^b	x^o	X
δ	$-(\Delta k/4p') > 0$	$3\Delta k/4p' < 0$	$-(\Delta k/4p') > 0$	$\Delta k/4p' < 0$
s^o	$1/4p' < 0$	$1/4p' < 0$	$-(3/4p') > 0$	$-(1/4p') > 0$
s^b	$1/4p' < 0$	$-(3/4p') > 0$	$1/4p' < 0$	$-(1/4p') > 0$
t_x	$-(1/4p') > 0$	$-(1/4p') > 0$	$3/4p' < 0$	$1/4p' < 0$

The elements of tables 1 and 2 are the partial derivatives of the variables in the first row with respect to the variables in the first column, e.g., the combination x^a and δ denotes $(\partial x^a/\partial\delta) = -(\Delta k/4p')$.

Table 3.2: Effects of policy changes on equilibrium profits and consumer surplus

	π^a	π^b	π^o	CS
δ	$-(f^a\Delta k/4p') > 0$	$3f^b\Delta k/4p' < 0$	$-(f^o\Delta k/4p') > 0$	$-(X\Delta k/4) < 0$
s^o	$f^a/4p' < 0$	$f^b/4p' < 0$	$-(3f^o/4p') > 0$	$X/4 > 0$
s^b	$f^a/4p' < 0$	$-(3f^b/4p') > 0$	$f^o/4p' < 0$	$X/4 > 0$
t_x	$-(f^a/4p') > 0$	$-(f^b/4p') < 0$	$f^o/4p' < 0$	$-(X/4) < 0$

We define that $f^a \equiv p-p'x^a-k^a$, $f^b \equiv p-p'x^b-(c^b(\delta)-s^b)$, and $f^o \equiv p-p'x^o-(k^o-s^o)-t_x$, where $f^i > 0$, $i = a, b, o$.

The scale of the changes in outputs due to the tightening of ROO depends on the difference between the price of the intermediate goods inside and outside the FTA, that is $\Delta k \equiv k^a - k^o > 0$.[4] The enforcement of ROO raises the marginal cost of firm b and decreases export x^b. If the other firms do not change their outputs, the price of the oligopolistic goods increases. Thus, the other firms try to increase their profits, leading to an increase in output. This is a rent-shifting effect due to the enforcement of ROO. However, this effect decreases the total output and increases consumer price, and as a result, it leads to a decrease in consumer surplus. This effect is anti-competitive.

An increase in the subsidy for firm j differs from the enforcement of ROO, since it causes an increase in the total output, thereby causing an increase in

[4]To avoid the case of "not conforming to ROO," we hereafter assume that the difference in the intermediate goods prices $\Delta k > 0$ is sufficiently small.

consumer surplus. Therefore, the production subsidy brings about a competitive effect. This point crucially differs from the effects of the tightening of the ROO. On the other hand, the external tariff has an effect similar to that of the ROO. An increase in the external tariff decreases the exports of firm o. This effect causes rent-shifting from firm o to the other firms. However, consumer surplus decreases due to an increase in the external tariff.

3.3 Other countries' intervention

In this section, we examine the relationship between ROO and the subsidy policy as well as the effects of a change in the external tariff. In section 3.1, when government B determines the subsidy level, we can show that government B imposes an export tax on its firm. In section 3.2, by switching the timing of the game to a more realistic sequence of moves (i.e., first, the ROO, and then, the subsidies), we can easily verify that the result depends on the timing of the policy decision.

3.3.1 Case 1: Government B is the first mover

Let us consider the following three-stage game. Stage 1: The FTA member (government B) chooses the level of subsidy s^b. Stage 2: Governments A and O independently and simultaneously choose the levels of the policy variables. Government A chooses the level of δ and government O chooses the level of subsidy s^o. Stage 3: Each firm independently and simultaneously chooses the output level. We use the subgame perfect Nash equilibrium as the equilibrium concept. The game is solved using backward induction. We have already examined the characteristics of the outcomes in the final stage; hence, we can begin the analysis in stage 2.

Country A's social welfare is assumed to be the sum of the producers' and consumers' surpluses, $\pi^a + CS$, and the input cost of both the domestic firm and firm b paid to country A, $k^a x^a + \delta k^a x^b$, and the tariff revenue, $t_x x^o$. This definition is the same as that used by Lahiri and Ono (1998, 2003), who assume the existence of unemployment. On the other hand, Country O's social welfare is equivalent to that of the net exporter of final goods because no unemployment exists. Hence, the objective functions of governments A and O are denoted by social welfare functions W^A and W^O, respectively.[5] Each government solves the following problem:

$$\begin{aligned} \max_{\delta\in(0,1)} \quad W^A &\equiv \pi^a + k^a x^a + \delta k^a x^b + CS + t_x x^o, \\ \max_{s^o} \quad W^O &\equiv \pi^o - s^o x^o, \end{aligned} \tag{3.7}$$

where $CS \equiv v(X) - p(X)X$, and $v(\cdot)$ is the utility for the oligopolistic good. Assuming $\delta \in (0,1)$, equation (3.7) yields reaction functions of both the governments, $\delta = \varphi^A(s^o, s^b)$ and $s^o = \varphi^O(\delta, s^b)$. Thus, we obtain

$$\frac{\partial \varphi^A}{\partial s^o}(s^o, s^b) = -\frac{7k^a - 3k^o}{(7k^a + k^o)3\varDelta k} < 0, \qquad \frac{\partial \varphi^O}{\partial \delta}(\delta, s^b) = \frac{\varDelta k}{3} > 0. \tag{3.8}$$

This result is summarized in proposition 1.

Proposition 3.1.

(*i*) *Government A's (O's) reaction curve has a downward (upward) slope that does not depend on* s^b.

(*ii*) *The slope of government A's reaction curve increases (decreases) due to an increase in the price* k^a *of the intermediate good inside the FTA if* $((\mu + 4k^o)^2/(\mu - 6k^o)\mu) > (<) 1/2$, *where* $\mu \equiv 7\varDelta k$.

(*iii*) *A sufficient condition for an equilibrium to be asymptotically stable is satisfied, i.e.,* $|\partial\varphi^A/\partial s^o| \times |\partial\varphi^O/\partial\delta| < 1$ *for all* $\varDelta k > 0$.

Government A considers both the domestic market and firm a, and it decreases the level of δ when government O raises its subsidy level. That is, government A tries to compensate for a loss in the profit of firm a by increasing consumer surplus. Government O, however, considers only firm o. Thus, it increases the level of subsidy and improves its own position when δ increases.

Next, we examine the change in the direction of the policy variables of both governments A and O due to a change in s^b. From equations (3.7) and (3.8), we obtain

$$\begin{pmatrix} (7k^a + k^o)3\varDelta k & 7k^a - 3k^o \\ -\varDelta k & 3 \end{pmatrix} \begin{pmatrix} \mathrm{d}\delta/\mathrm{d}s^b \\ \mathrm{d}s^o/\mathrm{d}s^b \end{pmatrix} = \begin{pmatrix} 9k^a + 3k^o \\ -1 \end{pmatrix}.$$

[5] These social welfare functions are strictly concave with respect to the policy parameters. Thus, the level of the imposed policy is positive. We show that this feature holds (see Appendix).

The change in the direction of each equilibrium value is respectively represented by

$$\frac{\mathrm{d}\delta}{\mathrm{d}s^b} = \frac{17k^a + 3k^o}{(35k^a + 3k^o)\Delta k} > 0, \qquad \frac{\mathrm{d}s^o}{\mathrm{d}s^b} = -\frac{6k^a}{35k^a + 3k^o} < 0. \tag{3.9}$$

Thus, from equation (3.9), we obtain the following proposition.

Proposition 3.2. *The equilibrium level of δ increases but that of s^o decreases due to an increase in the subsidy level s^b of the FTA member.*

Furthermore, from the governments' reaction functions at equilibrium in stage 2, $\delta(s^b) = \varphi^A(s^o(s^b), s^b)$ and $s^o(s^b) = \varphi^O(\delta(s^b), s^b)$, we obtain

$$\frac{\mathrm{d}\delta}{\mathrm{d}s^b}(s^b) = \underbrace{\frac{\partial\varphi^A}{\partial s^o}(s^o, s^b)\frac{\mathrm{d}s^o}{\mathrm{d}s^b}(s^b)}_{\text{indirect effect}} + \underbrace{\frac{\partial\varphi^A}{\partial s^b}(s^o, s^b)}_{\text{direct effect}}, \tag{3.10}$$

$$\frac{\mathrm{d}s^o}{\mathrm{d}s^b}(s^b) = \overbrace{\frac{\partial\varphi^O}{\partial\delta}(\delta, s^b)\frac{\mathrm{d}\delta}{\mathrm{d}s^b}(s^b)} + \overbrace{\frac{\partial\varphi^O}{\partial s^b}(\delta, s^b)}. \tag{3.11}$$

A change in the equilibrium values due to a change in s^b can be decomposed into a direct and an indirect effect. From equations (3.10) and (3.11), we obtain the following corollary.

Corollary 3.1. *The direction of the shift for the reaction curves is*

$$\frac{\partial\varphi^A}{\partial s^b} = \frac{105(k^a)^2 + 44k^ak^o + 3(k^o)^2}{(7k^a + k^o)(35k^a + 3k^o)\Delta k} > 0, \qquad \frac{\partial\varphi^O}{\partial s^b} = -\frac{1}{3} < 0.$$

Figure 3.2 shows the direction of the shift in the reaction curves due to a decrease in s^b (or an increase in tax). Suppose that only line A (reaction curve of government A) shifts leftward first ($A \to \overline{A}$). In this case, the new equilibrium point is "g" if line O (reaction curve of government O) does not move. However, country O's welfare decreases considerably because δ and s^o decrease at point g. Thus, government O shifts up (increases s^o) line O to improve social welfare ($O \to \overline{O}$). As a result, the new equilibrium point becomes e'.

Next, we shall consider the move of the FTA member. We define country B's social welfare as being equivalent to the net exporter of the final goods: $W^B \equiv \pi^b - s^b x^b$. Thus, we obtain the following proposition.

Proposition 3.3. *In the presence of ROO, the optimal policy for the FTA*

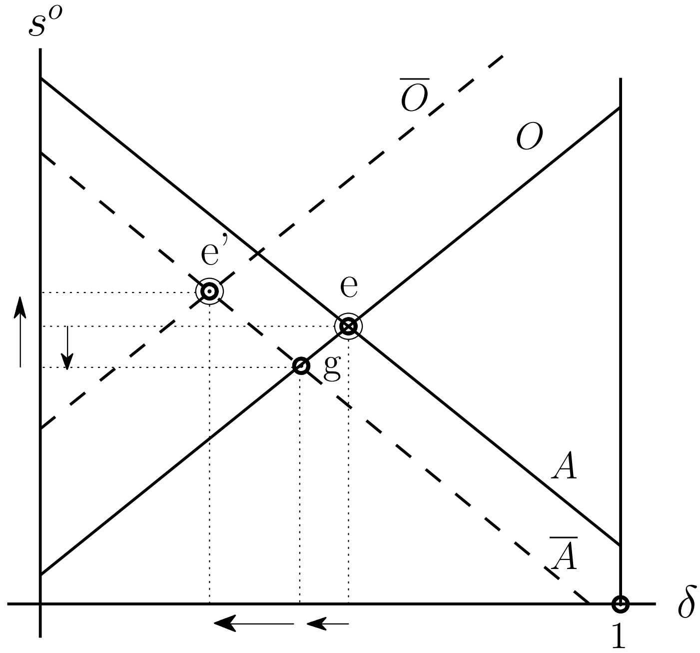


Figure 3.2: A change in each government's reaction curve due to a decrease in s^b

member is

$$s^b = \frac{(5k^a + 3k^o)p'x^b}{15k^a} < 0. \tag{3.12}$$

This result is explained as follows. In order to reduce the content rate of ROO, government B commits itself to reducing the exports. That is, by increasing the marginal cost of firm b, government B decreases the marginal cost of the home country. If the productivity of firm b after subsidy/tax is imposed is high, the content rate of ROO is high. Government B is aware of this beforehand; it is preferable for government B to decrease the volume of exports of firm b and earn tax revenues. Thus, the optimal policy for government B becomes (export) tax.

Finally, we shall examine the influence of government B's tax policy on country O. Using equations (3.6) and (3.7), we obtain

$$s^o = -\frac{2p'x^o}{3} > 0. \tag{3.13}$$

From equations (3.7) and (3.13), we obtain

$$\frac{\partial W^O}{\partial s^b} = -\frac{1}{3}\left(\frac{53k^a + 3k^o}{35k^a + 3k^o}\right) x^o < 0.$$

Thus, we establish the following proposition

Proposition 3.4. *In the presence of ROO, the social welfare of country O is monotonically decreasing with s^b.*

Thus, the social welfare of country O improves as compared to the case of non-intervention ($s^b = 0$) because government B chooses a tax policy (proposition 3.3).

The effect of the external tariff: In this game, we observe counter-intuitive results with respect to a change in the firm's profit due to a change in the external tariff. Let us first consider the results obtained in stage 2 of the game. Using solutions $\delta(s^b, t_x)$ and $s^o(s^b, t_x)$, and equation (3.7), we can easily find that

$$\begin{pmatrix} 3(3k^a + k^o) & 7k^a - 3k^o \\ -\Delta k & 3 \end{pmatrix} \begin{pmatrix} \mathrm{d}\delta/\mathrm{d}t_x \\ \mathrm{d}s^o/\mathrm{d}t_x \end{pmatrix} = \begin{pmatrix} 11k^a - 7k^o \\ -3 \end{pmatrix}.$$

Thus, we obtain

$$\frac{\mathrm{d}\delta}{\mathrm{d}t_x} = \frac{3(9k^a - 5k^o)}{(17k^a + 3k^o)\Delta k} > 0, \qquad \frac{\mathrm{d}s^o}{\mathrm{d}t_x} = -\frac{8(k^a + k^o)}{17k^a + 3k^o} < 0. \tag{3.14}$$

The intuition for this result is as follows: The rise in t_x implies that firm o becomes less efficient and firm a becomes more efficient. This effect provokes government A to enhance the competitiveness of firm a. Hence, government A increases δ. On the other hand, government O's incentive to encourage firm o becomes small. This is because the competitiveness of firm o decreases due to an increase in t_x.

Next, we consider the first stage.[6] From equation (3.12), we obtain

$$\frac{\mathrm{d}s^b}{\mathrm{d}t_x} = \frac{7(5k^a + 3k^o)(35k^a + 3k^o)\Delta k}{15k^a(17k^a + 3k^o)(20k^a + 3k^o)} > 0. \tag{3.15}$$

[6] In this stage of the game, note that $x^i = x^i(\delta(s^b(t_x), t_x), s^o(s^b(t_x), t_x), s^b(t_x), t_x)$.

Furthermore, using (3.4)–(3.6), (3.14), and (3.15), we obtain

$$\frac{\mathrm{d}\pi^a}{\mathrm{d}t_x} = \frac{2}{5}\left[\frac{1265(k^a)^2 + 109k^a k^o + 6(k^o)^2}{(17k^a + 3k^o)(20k^a + 3k^o)}\right] x^a > 0,$$

$$\frac{\mathrm{d}\pi^b}{\mathrm{d}t_x} = \frac{-14(35k^a + 3k^o)\varDelta k}{(17k^a + 3k^o)(20k^a + 3k^o)}\, x^b < 0,$$

$$\frac{\mathrm{d}\pi^o}{\mathrm{d}t_x} = -\frac{6}{5}\left[\frac{20k^a(20k^a + 3k^o) + 7(5k^a + 3k^o)\varDelta k}{(17k^a + 3k^o)(20k^a + 3k^o)}\right] x^o < 0.$$

Thus, we establish the following proposition.

Proposition 3.5. *In the presence of ROO, the external tariff reduction decreases (increases) the profit of firm a (firm o). However, it increases the profit of firm b.*

Intuitively, firm b is likely to benefit (suffer losses) from an increase (decrease) in the external tariff because the external tariff is imposed on the firm outside the FTA. However, proposition 3.5 indicates a contradictory result. This intuition is as follows. The market share of firm o is relatively large (small) if the external tariff is relatively low (high). Then, government A sets a lower (higher) content rate of ROO because the effects on consumer surplus (domestic firm's profits) dominate any other effect. A positive correlation arises between the content rate of ROO and the external tariff such that the content rate of ROO decreases due to a decrease in the external tariff. The market share of firm b increases due to a decrease in the content rate of ROO. Therefore, the profit of firm b strictly increases due to a reduction in the external tariff.

3.3.2 Case 2: Inverse timing

In this subsection, we discuss an alternative situation that has a different timing from that in section 3.3.1. Let us consider the following inverse timing game. Stage 1: Government A chooses the level, δ. Stage 2: Governments B and O independently and simultaneously choose the levels of the subsidy. Stage 3: Each firm independently and simultaneously chooses the output level.

In stage 2 of this game, governments B and O maximize social welfare:

$$W^B \equiv \pi^b - s^b x^b, \qquad W^O \equiv \pi^o - s^o x^o. \tag{3.16}$$

We define the policy reaction functions as $s^b = \vartheta^B(s^o, \delta)$ and $s^o = \vartheta^O(s^b, \delta)$. Applying a method similar to that used in section 3.1, from equation (3.16), we obtain

$$\frac{\partial \vartheta^B}{\partial s^o}(s^o, \delta) = -\frac{1}{2}, \qquad \frac{\partial \vartheta^O}{\partial s^b}(s^b, \delta) = -\frac{1}{2}. \tag{3.17}$$

Thus, equation (3.17) yields the following proposition.

Proposition 3.1⋆.

(*i*) *Government B's (O's) reaction curve has a downward slope.*

(*ii*) *A sufficient condition for the equilibrium to be asymptotically stable is satisfied, i.e.,* $\left|\partial \vartheta^B/\partial s^o\right| \times \left|\partial \vartheta^O/\partial s^b\right| < 1$.

Next, we consider a change in the direction of the policy variables s^j. From equation (3.16), we obtain

$$\begin{pmatrix} 1 & 3 \\ 3 & 1 \end{pmatrix} \begin{pmatrix} \mathrm{d}s^o/\mathrm{d}\delta \\ \mathrm{d}s^b/\mathrm{d}\delta \end{pmatrix} = \begin{pmatrix} -3\Delta k \\ \Delta k \end{pmatrix}.$$

Thus, the change in the direction of each equilibrium value is respectively represented by

$$\frac{\mathrm{d}s^b}{\mathrm{d}\delta} = -\frac{5\Delta k}{4} < 0, \qquad \frac{\mathrm{d}s^o}{\mathrm{d}\delta} = \frac{3\Delta k}{4} > 0. \tag{3.18}$$

This result is stated as

Proposition 3.2⋆. *The equilibrium level of s^o increases but that of s^b decreases due to an increase in the level of δ.*

The market share of firm b decreases if δ increases. This rising inefficiency discourages government B's incentive to subsidize firm b. On the other hand, the market share of firm o expands due to an increase in δ. Thus, government O increases the subsidy level in order to strengthen the competitiveness of the domestic firm (firm o).

Using equation (3.18), and the governments' reaction functions $s^b(\delta) = \vartheta^B(s^o(\delta), \delta)$ and $s^o(\delta) = \vartheta^O(s^b(\delta), \delta)$, we obtain the following corollary.

Corollary 3.1⋆. *The direction of the shift for the reaction curves is*

$$\frac{\partial \vartheta^B}{\partial \delta} = -\frac{7\Delta k}{8} < 0, \qquad \frac{\partial \vartheta^O}{\partial \delta} = \frac{\Delta k}{8} > 0.$$

In a different timing structure, the following result holds.

Proposition 3.3*. *In the presence of ROO, the optimal policy for the FTA member is* $s^b = -(2/3)p'x^b > 0$.[7]

It is clear that an important implication is included in proposition 3.3*. That is, in a more realistic sequence of moves, the ROO create an incentive for export subsidies for the FTA member. In this timing structure, government B's subsidy level does not directly affect the content rate of ROO because this content rate is determined in the first stage. Furthermore, government B is in a subsidy race with government O. Hence, if government B does not subsidize its firm, the market share of firm b considerably decreases. Therefore, government B offers a positive export subsidy for its firm.

Finally, we derive the optimal level of δ. In the first stage, from equation (3.7), we obtain the following implicitly determined optimal δ:

$$\delta = \frac{3(p + p'x^o + 3t_x)\Delta k - (5k^a + 3k^o)p'x^b}{15k^a \Delta k}. \tag{3.19}$$

The effect of the external tariff: Here, we also examine the effects of the reduction in the external tariff on each firm's profit. From equation (3.16), we derive the following results:

$$\frac{\mathrm{d}s^b}{\mathrm{d}t_x} = \frac{3}{4} > 0, \qquad \frac{\mathrm{d}s^o}{\mathrm{d}t_x} = -\frac{5}{4} < 0. \tag{3.20}$$

Equation (3.20) arises from a mechanism similar to those in equations (3.14) and (3.15).

In the first stage, from (3.19), we obtain

$$\frac{\mathrm{d}\delta}{\mathrm{d}t_x} = \frac{3(19k^a - 11k^o)}{(65k^a + 15k^o + 6)\Delta k} > 0. \tag{3.21}$$

The intuition for equation (3.21) is the same as that for equation (3.14). That is, government A increases δ when firm o becomes less efficient (i.e., a rise in

[7] Similarly, the optimal subsidy formula for government O is $s^o = -(2/3)p'x^o > 0$.

t_x).Using equations (3.1)–(3.3), (3.20), and (3.21), we have

$$\frac{\mathrm{d}\pi^a}{\mathrm{d}t_x} = \frac{3}{2}\left(\frac{61k^a - 9k^o + 3}{65k^a + 15k^o + 6}\right) x^a > 0,$$

$$\frac{\mathrm{d}\pi^o}{\mathrm{d}t_x} = -\frac{3}{2}\left(\frac{77k^a + 87k^o + 15}{65k^a + 15k^o + 6}\right) x^o < 0,$$

$$\frac{\mathrm{d}\pi^b}{\mathrm{d}t_x} = \frac{3}{2}\left(\frac{-49k^a + 81k^o + 6}{65k^a + 15k^o + 6}\right) x^b.$$

Thus, we establish the following proposition.

Proposition 3.5*. *In the presence of ROO, the reduction in the external tariff decreases (increases) the profit firm a (firm o). However, it increases the profit of firm b if* $k^a > (3/49)(27k^o + 2)$ *holds.*

Proposition 3.5* indicates that the results are similar to those observed in proposition 3.5 in section 3.1. On the other hand, when government A is the first mover, the effects of a decrease in due to a decrease in the external tariff weakens. Whether or not the profit of firm b increases due to a change in the external tariff depends on the price of the intermediate goods produced in country A. When k^a is sufficiently small, the inefficiency of production in firms a and b is small. Government A slightly raises δ because the effects on consumer surplus dominate any other effect. Therefore, the profit of firm b increases due to an increase in the external tariff. However, a large k^a implies that the inefficiency of production in firms a and b is relatively large. Then, government A sufficiently raises δ due to an increase in t_x. Because of this, the effect of a decrease in s^b due to an increase in t_x offsets the effect of an increase in s^b due to an increase in t_x. Thus, if k^a is sufficiently large, an increase in t_x decreases s^b. As a result, firm b's profits also decrease.

3.4 Conclusion of Chapter 3

Several existing studies on ROO mainly focus on the effects of ROO themselves and do not sufficiently consider ROO and other trade policies interact (for example, see Krueger, 1993; Lopez-de-Silanes, Markusen, and Rutherford, 1996; and Ju and Krishna, 2002; 2005). To fill this gap, we mainly examined the interaction between ROO and the subsidy policy. We presented a three-country, three-firm oligopolistic framework in order to describe this policy interaction. Our findings are summarized in the following three points.

First, if the government of the final goods exporter within the FTA (government B) is the first mover, it chooses export tax. To reduce the content rate of ROO, government B commits itself to decreasing the exports of the domestic firm. Second, government B offers a positive export subsidy to its firm if the ROO is set first. It suggests that ROO creates an incentive for export subsidies of the FTA member. In this case, government B does not directly affect the content rate of ROO and is in a subsidy race with the government of the outside country. Hence, government B offers a positive export subsidy for its firm. Third, a reduction in the external tariff helps firm b, which is located in the FTA. Generally speaking, in our model, when the efficiency of production in the firms located in the FTA is sufficiently low, the content rate of ROO sufficiently rises due to an increase in the external tariff. Then, the profit of firm b also decreases due to an increase in the external tariff.

Appendix of This Chapter

Proof of concavity. Twice differentiating the welfare function W^A (W^O) with respect to δ (s^o), we have

$$\frac{\partial^2 W^A}{\partial \delta^2} = \frac{3(8k^a - \Delta k)\Delta k}{16p'} < 0, \qquad \frac{\partial^2 W^O}{\partial (s^o)^2} = \frac{3}{8p'} < 0.$$

Thus, the welfare function of country A (O) is strictly concave. Q.E.D.

Proof of proposition 3.1.

(**i**) From equation (3.7), we obtain the following identities:

$$\begin{aligned} 0 = & -p'\Delta k \cdot X(\varphi^A(s^o, s^b), s^o, s^b) - \Delta k \cdot p(X(\varphi^A(s^o, s^b), s^o, s^b)) \\ & + p'\Delta k \cdot x^a(\varphi^A(s^o, s^b), s^o, s^b) + 4p'k^a x^b(\varphi^A(s^o, s^b), s^o, s^b) \\ & + 3k^a \Delta k \cdot \varphi^A(s^o, s^b) - t_x \Delta k, \end{aligned} \tag{A.1}$$

$$0 = -3p(X(\delta, \varphi^O(\delta, s^b), s^b)) - p'x^o(\delta, \varphi^O(\delta, s^b), s^b) + 3k^o + 3t_x. \tag{A.2}$$

Note that $\delta = \varphi^A(s^o, s^b)$ and $s^o = \varphi^O(\delta, s^b)$. Differentiating (A.1) ((A.2)) with respect to s^o (δ), we have

$$\begin{aligned} \left(-2p'\Delta k \frac{\partial X}{\partial \delta} + p'\Delta k \frac{\partial x^a}{\partial \delta} + 4p'k^a \frac{\partial x^b}{\partial \delta} + 3k^a \Delta k\right) \frac{\partial \varphi^A}{\partial s^o} = \; & 2p'\Delta k \frac{\partial X}{\partial s^o} - p'\Delta k \frac{\partial x^a}{\partial s^o} \\ & - 4p'\Delta k \frac{\partial x^b}{\partial s^o}, \end{aligned}$$

$$-\left(3p'\frac{\partial X}{\partial s^o} + p'\frac{\partial x^o}{\partial s^o}\right)\frac{\partial \varphi^O}{\partial \delta} = 3p'\frac{\partial X}{\partial \delta} + p'\frac{\partial x^o}{\partial \delta}.$$

Using the results of comparative statics (table 3.1) and rearranging the above equations, we obtain equation (3.8).

(**ii**) We define $F = 7k^a - 3k^o > 0$ and $L = (7k^a + k^o)3\Delta k = 3(7(k^a)^2 - 6k^a k^o - (k^o)^2) > 0$. Differentiating the slope of government A's reaction curve with respect to k^a, we have $-(7/L) + 6F^2/L^2$. Rearranging this expression, $(2(7k^a - 3k^o)^2/(7k^a + k^o)) > (<) 7\Delta k$ holds. Therefore, we have $((\mu + 4k^o)^2/(\mu - 6k^o)\mu) > (<) 1/2$.

(**iii**) From equation (3.8), statement (iii) clearly holds. Q.E.D.

Derivation of equation (3.12): From government B's objective function, we obtain

$$\frac{\partial W^B}{\partial s^b} = -\frac{60k^a(p-\delta\Delta k - k^o)}{4(35k^a+5k^o)p'} - \frac{12k^a}{4(35k^a+3k^o)p'}\,p'x^b - x^b\Delta k\cdot\left(\frac{\mathrm{d}\delta}{\mathrm{d}s^b}\right) = 0.$$

Using this equation and equation (3.9), we obtain equation (3.12).

Proof of proposition 3.4. Considering the conditions for maximizing a firm's profits and the national welfare of country O, we obtain

$$\begin{aligned}\frac{\partial W^O}{\partial s^b} &= -\frac{12k^a}{4(35k^a+3k^o)p'}\,p'x^o + \frac{p-k^o-t_x}{2p'},\\ &= \frac{-(41k^a+3k^o)p'x^o-(35k^a+3k^o)s^o}{2(35k^a+3k^o)p'}.\end{aligned}$$

Substituting equation (3.13) into the above equation, we obtain proposition 3.4. Q.E.D.

Proof of proposition 3.5. Differentiating each firm's equilibrium profit with respect to the external tariff, we have

$$\frac{\mathrm{d}\pi^a}{\mathrm{d}t_x} = p'x^a\left(\frac{\mathrm{d}X}{\mathrm{d}t_x}\right) + (p-k^a)\left(\frac{\mathrm{d}x^a}{\mathrm{d}t_x}\right), \tag{A.3}$$

$$\begin{aligned}\frac{\mathrm{d}\pi^b}{\mathrm{d}t_x} &= p'x^b\left(\frac{\mathrm{d}X}{\mathrm{d}t_x}\right) + (p-c^b(\delta)+s^b)\left(\frac{\mathrm{d}x^b}{\mathrm{d}t_x}\right)\\ &\quad - \Delta k\cdot x^b\left[\frac{\mathrm{d}\delta}{\mathrm{d}t_x} + \frac{\mathrm{d}\delta}{\mathrm{d}s^b}\left(\frac{\mathrm{d}s^b}{\mathrm{d}t_x}\right)\right] + x^b\left(\frac{\mathrm{d}s^b}{\mathrm{d}t_x}\right),\end{aligned} \tag{A.4}$$

$$\begin{aligned}\frac{\mathrm{d}\pi^o}{\mathrm{d}t_x} &= p'x^o\left(\frac{\mathrm{d}X}{\mathrm{d}t_x}\right) + (p-k^o+s^o-t_x)\left(\frac{\mathrm{d}x^o}{\mathrm{d}t_x}\right)\\ &\quad + x^o\left[\frac{\mathrm{d}s^o}{\mathrm{d}t_x} + \frac{\mathrm{d}s^o}{\mathrm{d}s^b}\left(\frac{\mathrm{d}s^b}{\mathrm{d}t_x}\right)\right] - x^o.\end{aligned} \tag{A.5}$$

Similarly, differentiating equilibrium outputs with respect to the external tariff, we have

$$\frac{\mathrm{d}x^a}{\mathrm{d}t_x} = \frac{1}{4p'}\left[\frac{-52k^a + 4k^o}{17k^a + 3k^o} + \frac{12k^a}{35k^a + 3k^o}\left(\frac{\mathrm{d}s^b}{\mathrm{d}t_x}\right)\right],$$

$$\frac{\mathrm{d}x^b}{\mathrm{d}t_x} = \frac{1}{4p'}\left[\frac{56k^a - 56k^o}{17k^a + 3k^o} + \frac{-60k^a}{35k^a + 3k^o}\left(\frac{\mathrm{d}s^b}{\mathrm{d}t_x}\right)\right],$$

$$\frac{\mathrm{d}x^o}{\mathrm{d}t_x} = \frac{1}{4p'}\left[\frac{48k^a + 48k^o}{17k^a + 3k^o} + \frac{36k^a}{35k^a + 3k^o}\left(\frac{\mathrm{d}s^b}{\mathrm{d}t_x}\right)\right],$$

$$\frac{\mathrm{d}X}{\mathrm{d}t_x} = \frac{1}{4p'}\left[\frac{52k^a - 4k^o}{17k^a + 3k^o} + \frac{-12k^a}{35k^a + 3k^o}\left(\frac{\mathrm{d}s^b}{\mathrm{d}t_x}\right)\right].$$

Plugging the above equations into (A.3)–(A.5), and using the FOCs of firms b and o (namely, $p - c^b(\delta) + s^b = -p'x^b$ and $p - k^o + s^o - t_x = -p'x^o$), equations (3.9), (3.14), and (3.15), we obtain proposition 3.5. Q.E.D.

Derivation of equation (3.17): From equation (3.16), we obtain the following FOCs

$$0 = -3p - p'x^b + 3\delta\Delta k + 3k^o, \qquad 0 = -3p - p'x^o + 3k^o + 3t_x.$$

Using these FOCs, we obtain equation (3.17).

Derivation of equation (3.19): The FOC for government A's welfare maximizing is given by

$$\frac{\partial W^A}{\partial \delta} = -\frac{3\Delta k}{8p'}p + \frac{3\Delta k}{8p'}p'x^a + k^a x^b + \frac{15\Delta k}{8p'}\delta k^a - \frac{3\Delta k}{8p'}p'X - \frac{9\Delta k}{8p'}t_x = 0,$$

From this FOC, we obtain equation (3.19).

Chapter 4

ROO, External Tariff, and Market Structure

4.1 Introduction

In recent years, many countries have formed regional trade areas (RTAs), and the proliferation of RTAs has emerged as a current trend in the world economy. Although the formation of an RTA is permitted as a means to achieve multilateral trade liberalization, is this really happening? For example, many RTAs have rules for evaluating whether or not a product is considered domestic (or produced within the area) in order to qualify for free trade among member countries. These rules are widely referred to as the rules of origin (ROO). The ROO imply that the final good producer located in a member country within an RTA can gain duty-free access to the other member countries if it chooses a mix of intermediates or parts from the region. Therefore, if the price (i.e., productivity in the production) of the intermediate good in a member country (or the region) is higher (or lower) than that of the other member countries in their RTA (or outside), then the ROO function as a protectionist device for the less efficient country.

In this chapter, we emphasize this protectionist nature of ROO and focus on the relationship between endogenously determined ROO and the external tariff. When we consider RTAs as a step toward multilateral trade liberalization, it is important and necessary to examine whether or not member countries in RTAs reduce the external tariff level. To consider this point, we expands Brander and Krugman (1983) type reciprocal market framework, presents a three-country

(country 1 and 2 have already formed an RTA, and outside the RTA is country O) two type firm (one is located in the RTA and the other is located in outside the RTA) model. We indicate that the welfare of member countries improves due to an external tariff reduction only if the market size of those countries is sufficiently small. Furthermore, we examine the relationship between the number of inside and outside firms (market structure) and the effects of external tariff reduction.

Many studies on the ROO focus on their protectionist nature and mainly examine the effects of the introduction and tightening of the ROO.[1] However, there are few studies on the relationship between the ROO and other trade policies.[2] Falvey and Reed (2002) analyzed the effects of the ROO on third world countries by focusing on the relationship between the ROO and optimal tariff policy, in the case of a country that exclusively imports final goods. However, our focus is the optimality of the ROO and the relationship between the ROO and the external tariff. Thus, in order to explicitly describe the policy effect, we assume an oligopolistic final good market and the external tariff as given, which significantly differs from Falvey and Reed (2002).

The remainder of this chapter comprises five sections. In section two, we describe the model setup. In section three, we calculate the equilibrium of the model. In section four, we examine the effects of external tariff reduction and the relationship between effects of the external tariff reduction and market structure. In section five, we offer concluding remarks.

4.2 The model

Let us consider a partial equilibrium model of an oligopolistic industry. There are three countries 1, 2, and O in the world. Countries 1 and 2 are symmetric, and these countries have already formed a RTA.[3] Country O denotes the outside of this RTA. In each country i $(= 1, 2)$, m (≥ 1) firms produce a homogenous final good X for supply in the home and other member country's market j $(\neq i)$.

[1]The existing works on ROO mainly focus on the issue of local content requirement (LCR), and these generally adopt the local content protection (LCP) model as the analytical framework. For example, see Krueger (1993), Ju and Krishna (2005), and Lopez-de-Silanes, Markusen, and Rutherford (1996).

[2]For example, Takauchi (2007, forthcoming) mainly examines the relationship between ROO and the subsidy policy.

[3]Generally speaking, most preferential trade areas (PTAs) have been formed among similar countries. Das and Gosh (2006) present theoretical proof for this phenomenon. In this chapter, we also assume that RTAs have been formed among similar countries.

On the other hand, there are n (≥ 1) firms outside of the RTA, and these firms export the final good to each member country imposing external tariff t^i. We assume that the number of firms is fixed and constant and that the final good market of both countries is characterized by Cournot oligopoly and segmented.

The firms located in a member country i $(= 1, 2)$ face the ROO and choose a mixed proportion of intermediate goods produced in the other member country j when they export the final good to the other member country's market. Let us denote this restriction as δ^j, $0 \leq \delta^j \leq 1$. Thus, δ^j represents the content rate of the ROO that is imposed by the other member country j, and it is uniform in the RTA. Thus, the firms located in both countries 1 and 2 face a uniform content rate when they export the final good to each other's markets, $\delta^1 = \delta^2$.

In each member country of this RTA, the inverse demand for the final good is assumed to be linear: $p_i = A - a(X_i^i + X_i^j + X_i^O)$, $i \neq j$, where A and a are positive constants. Moreover, we define $X_i^i \equiv \sum_{h=1}^{m} x_{i\,h}^i$, $X_i^j \equiv \sum_{h=1}^{m} x_{i\,h}^j$ and $X_i^O \equiv \sum_{\ell=1}^{n} x_{i\,\ell}^O$. Note that the notation x_i^i (x_i^j) denotes output of a firm located in the RTA member country i (j). We assume that one unit of the intermediate good is required to produce one unit of the final good. Thus, in each member country i, each firm's profit is defined by

$$\pi^i \equiv (p_i - k^O)\, x_i^i + (p_j - c_i(\delta^j))\, x_j^i, \tag{4.1}$$

where k^O denotes the price of the intermediate good produced outside this RTA. Following Lahiri and Ono (1998, 2003) and Kayalica and Lahiri (2003), the marginal cost of the member country's firm is defined by

$$c_i(\delta^j) \equiv \delta^j k + (1 - \delta^j)\, k^O, \quad k > k^O \geq 0, \tag{4.2}$$

where k denotes the price of the intermediate good in country i. In country O, each firm's profit is defined by

$$\pi^O \equiv \sum_{i}^{1,2} (p_i - k^O - t)\, x_i^O, \tag{4.3}$$

where t is a fixed (given) external tariff and we define $t = t^1 = t^2 > 0$.

Hereafter, for simplicity, we assume that the price of an intermediate good produced outside of RTAs is zero $(k^O = 0)$. Thus, from equation (4.2), the marginal cost where firm i exports from country i to country j is rewriten as

$\delta^j k$. We also assume that the price of the intermediate good produced in a member country within the RTA is sufficiently small.

Now, let us consider the following simple two-stage game: In the first stage, the governments of 1 and 2 simultaneously choose a content rate of ROO δ^i, respectively. In the second stage, each firm independently and simultaneously chooses a quantity of the product. We use the subgame perfect Nash equilibrium as the equilibrium concept. The game is solved by backward induction.

4.3 Calculating equilibruium

Second stage: In the second stage of the game, each firm maximizes its own output under the rival firm's output and δ^i, as given. From equations (4.1)–(4.3), we obtain equilibrium outputs in this stage.

$$x_i^i = \frac{A + nt + km\delta^i}{a\lambda}, \qquad x_j^i = \frac{A + nt - \gamma k\delta^j}{a\lambda}, \qquad x_i^O = \frac{A - \alpha t + km\delta^i}{a\lambda}, \quad (4.4)$$

where $\alpha \equiv 1 + 2m$, $\gamma \equiv 1 + m + n$, and $\lambda \equiv 1 + 2m + n$.

First stage: From equation (4.4), each government's social welfare is determined. The social welfare in country i, SW^i, is defined by the sum of consumer surplus, domestic firm's profit π^i, domestic input revenue IR, and tariff revenue TR.

Throughout this chapter, we assume that there is unemployment in each member country i of the RTA. In this case, input costs paid to the member country are included in the member country's income.[4] Therefore, both governments of member countries have an incentive to impose a positive level of δ. The social welfare in country i, SW^i, is

$$SW^i = \left(\frac{A - p_i}{2}\right) \times (mx_i^i + mx_i^j + nx_i^O) + m\,(\pi^i + \delta^i k x_i^j) + tnx_i^O. \qquad (4.5)$$

From the first-order conditions, using equations (4.4) and (4.5), we obtain equilibrium in this stage.

$$\delta = \delta^i = \frac{\alpha A + n(3\alpha + 2n)\,t}{k\Omega}, \qquad i = 1, 2, \qquad (4.6)$$

[4] On the treatment of unemployment, we follow Lahiri and Ono (1998, 2003, and 2004). They consider Brander and Spencer (1987)-type unemployment.

where $\Omega \equiv 2m^2 + 2(1+n)^2 + m(5+6n) > 0$. We assume that the uniform content rate of the ROO satisfies $0 \leq \delta \leq 1$. Then, we obtain the equilibrium outputs, final good price, and profits. Each equilibrium outcome is given by

$$x_i^i = \frac{2(\gamma A + \lambda nt)}{a\Omega}, \quad x_j^i = \frac{\beta A - \alpha nt}{a\Omega}, \quad x_i^O = \frac{2\gamma A - ((5+2m)m + 2\mu)\, t}{a\Omega}, \tag{4.7}$$

$$p_i = \frac{2(\gamma A + \lambda nt)}{\Omega}, \tag{4.8}$$

$$\pi_i^i = \frac{4}{a}\left(\frac{\gamma A + \lambda nt}{\Omega}\right)^2, \qquad \pi_j^i = \frac{1}{a}\left(\frac{\beta A - \alpha nt}{\Omega}\right)^2, \tag{4.9}$$

$$\pi^i = \frac{4(\gamma A + \lambda nt)^2 + (\beta A - \alpha nt)^2}{a\Omega^2}, \tag{4.10}$$

$$\pi_i^O = \frac{1}{a}\left[\frac{2A\gamma - ((5+2m)m + 2\mu)\, t}{\Omega}\right]^2, \tag{4.11}$$

where $\beta \equiv 1 + 2n$, $\mu \equiv 1 + mn + n$. We also assume that $0 < t < t_0$, where $t_0 \equiv 2A\gamma / [(5+2m)m + 2\mu]$.

4.4 External tariff reduction

In this section, we examine the effects of (uniform) external tariff reduction (ETR) in the RTA member countries. Let us assume that the governments of country 1 and 2 simultaneously decrease the external tariff level after the RTA was established.

From equations (4.7)–(4.11), we obtain the result of comparative statics with respect to the external tariff:

$$\frac{\partial x_i^i}{\partial t} = \frac{2\lambda n}{a\Omega} > 0, \qquad \frac{\partial x_j^i}{\partial t} = -\frac{\alpha n}{a\Omega} < 0, \qquad \frac{\partial x_i^O}{\partial t} = -\frac{\Omega - 2\gamma n}{a\Omega} < 0, \tag{4.12}$$

$$\frac{\partial p_i}{\partial t} = \frac{2\lambda n}{\Omega} = a\left(\frac{\partial x_i^i}{\partial t}\right) > 0,$$

$$\frac{\partial \pi_i^i}{\partial t} = \frac{8n\lambda(\gamma A + \lambda nt)}{a\Omega^2} > 0, \qquad \frac{\partial \pi_j^i}{\partial t} = -\frac{2\alpha n(\beta A - \alpha nt)}{a\Omega^2} < 0,$$

$$\frac{\partial \pi^i}{\partial t} = \frac{2n\big(4(\gamma A + \lambda nt)\lambda - \alpha(\beta A - \alpha nt)\, t\big)}{a\Omega^2} > 0, \tag{4.13}$$

$$\frac{\partial \pi^O}{\partial t} = -\frac{4(m(5+2m)+2\mu)}{\Omega}\, x_i^O < 0. \tag{4.14}$$

Note that ETR always causes a decrease in the domestic firm's profit. This effect is summarized in a change of the domestic firm's output. From equation (4.12), we can easily find that

$$\frac{\partial x_i^i}{\partial t} + \frac{\partial x_j^i}{\partial t} = \frac{\alpha n + 2n^2}{a\Omega^2} > 0.$$

To consider this effect, let us examine the relationship between optimal content rate of the ROO and the external tariff. From equation (4.6), we have

$$\frac{\partial \delta}{\partial t} = \frac{\partial \delta^i}{\partial t} = \frac{n(3\alpha + 2n)}{k\Omega} > 0, \quad i = 1, 2. \tag{4.15}$$

Frome equation (4.15), we immediately find that a tariff reduction reduces optimal δ.

The intuition for the complementarity between a content rate of the ROO and the external tariff is as follows: When the external tariff is relatively high (low), the efficiency of the outside firms (firm O) is relatively low (high) and the efficiency of the domestic firms (firm i) is relatively high (low). Thus, a positive corelation arises between a content rate of the ROO and the external tariff. Then, government i makes a point of the domestic firms' profit (consumer surplus and tariff revenue), sets a higher (lower) level of the content rate $\delta^i\,(= \delta)$. This intuition also holds about the price of the intermediate good produced in the RTA.

Thus, intra-industry trade within the RTA is enhanced by an external tariff reduction. However, in both countries within the RTA, a tariff reduction increases imports from the outside, but decreases supplies from domestic firms to the domestic market.

Furthermore, from equation (4.12), we find the following relation:

$$\frac{\partial x_i^i}{\partial t}+\frac{\partial x_i^O}{\partial t}\begin{cases}\geq 0 & \text{if} \quad n \geq \sqrt{(1/2)\left(2+5m+2m^2\right)}\,, \\ <0 & \text{otherwise.}\end{cases} \tag{4.16}$$

Clearly, $\left(\partial x_i^i/\partial t\right)+\left(\partial x_i^O/\partial t\right)<0$ when $n=m$ holds. Hence, from (4.16), increasing imports (from the outside) cancels a decrease in the domestic production due to a tariff reduction if and only if the number of the outside firms relatively small.

Similarly, from equations (4.5) and (4.7)–(4.11), we obtain equilibrium input (or intermediate-good) revenue IR, tariff revenue TR, and social welfare SW.

$$IR \equiv \delta^i k m x_i^j=\frac{m(\beta A-\alpha n t)(\alpha A+(3\alpha+2n)nt\,)}{a\Omega^2}, \tag{4.17}$$

$$TR \equiv t n x_i^O=\frac{(2\gamma A-(\Omega-2\gamma n)t\,)nt}{a\Omega}, \tag{4.18}$$

$$SW \equiv SW^i=\frac{A^2\Lambda+8A\Gamma t-\Psi t^2}{2a\Omega^2}, \tag{4.19}$$

where

$$\Lambda \equiv \left(\begin{array}{l}12m+29m^2+20m^3+4m^4+4(10m+17m^2+8m^3)n \\ +4(1+13m+11m^2)n^2+8(1+4m)n^3+4n^4\end{array}\right),$$

$$\Gamma \equiv\ (1+4m+5m^2+2m^3)n+2(1+3m+2m^2)n^2+\alpha n^3, \quad \text{and}$$

$$\Psi \equiv \left(\begin{array}{l}2(4+20m+33m^2+20m^3+4m^4)n+4(5+18m+18m^2+4m^3)n^2 \\ +8(2+4m+m^2)n^3+4n^4\end{array}\right).$$

From equations (4.17)–(4.19), we have

$$\frac{\partial IR}{\partial t}=\frac{((3\alpha+2n)m\beta-\alpha^2)nA-2\alpha(3\alpha+2n)n^2t}{a\Omega^2}, \tag{4.20}$$

$$\frac{\partial TR}{\partial t}=\frac{2n\gamma-(\Omega-2\gamma n)t}{a\Omega^2}, \tag{4.21}$$

$$\frac{\partial SW}{\partial t}=\frac{4A\Gamma-\Psi t}{a\Omega^2}. \tag{4.22}$$

Thus, from (4.20)–(4.22), we can establish the following result.

Proposition 4.1. *In the presence of the ROO, a small reduction of external tariff has the following effects:*

(i) an increase (or decrease) in the input revenue IR *if* $n \leq n^*(m)$*, or* $n > n^*(m)$ *and* $A < A^{IR}$ *(*$n > n^*(m)$ *and* $A \geq A^{IR}$*),*

(ii) an increase (or decrease) in the tariff revenue TR *if the market size* A *is smaller (or larger) than* A^{TR}*,*

(iii) an increase (or decrease) in the social welfare SW *in both member countries if the market size* A *is smaller (or larger) than* A^{SW}*,*

where $n^*(m) \equiv (1/2)\left[-(2+3m) + \sqrt{2+10m+13m^2}\,\right] \geq 0.$

This proposition implies that an incentive for the formation of an RTA will be small if both countries' market sizes are sufficiently large. When both countries' market sizes become large, the consumer surplus becomes large too. Hence, a change in the consumer surplus due to tariff reduction becomes large. An external tariff reduction decreases the final good price, so that consumer surplus always rises. Therefore, one can intuitively predict that an external tariff reduction causes an increase in the domestic welfare if the market size is sufficiently large. However, the proposition states the opposite. An external tariff reduction always decreases the domestic firm's profit. When the market size becomes large, a loss in profit becomes large too. Therefore, the condition for welfare improvement due to an external tariff reduction is that the market size should be sufficiently small.

Market structure

Finally, we consider the relationship between a pair of firm numbers (n, m) and the order of each threshold value—A^{IR}, A^{TR}, and A^{SW}—in the abovementioned proposition.

From the results of comparative statics, we obtain the following each threshold value of the sign $\big(\partial IR/\partial t\big)$, $\big(\partial TR/\partial t\big)$, and $\big(\partial SW/\partial t\big)$, respectively.

$$\frac{1}{t} \cdot A^{IR} = \frac{(3(1+4m+4m^2)+2(1+4m)n)n}{1+m+2\big((2+3m)n+(n^2-m^2)\big)}, \tag{4.23}$$

$$\frac{1}{t} \cdot A^{TR} = \frac{\xi+2(1+m)n}{\gamma}, \tag{4.24}$$

$$\frac{1}{t} \cdot A^{SW} = \frac{\xi^2+2\alpha(5+2\zeta m)n+4(2+\zeta m)n^2+2n^3}{2\alpha\gamma^2}, \tag{4.25}$$

where $\zeta \equiv 4+m$ and $\xi \equiv 2+5m+2m^2$.

Forming pairs of $A^{IR} = A^{TR}$, $A^{IR} = A^{SW}$, and $A^{TR} = A^{SW}$ and implementing numerical calculation, from (4.23)–(4.25), we obtain the following the order of each threshold value. These relations are depicted in table 1 and figure 2.

Region I	$A^{IR} < A^{SW} < A^{TR}$
Region II	$A^{SW} < A^{TR} < A^{IR}$
Region III	$A^{SW} < A^{IR} < A^{TR}$
Region IV	$A^{IR} < A^{TR} < A^{SW}$

Table 4.1: The order of each threshold values

In figure 2, the vertical (horizontal) axis denotes the number of each member (the outside) country's firms. We compare the size of A^{IR}, A^{TR}, and A^{SW} in this figure.

Insert Figure 4.1 here

A longitudinal curve labeled $n^*(m)$ is a condition that decides whether input revenue IR increases or decreases due to an ETR. The left-hand side of $n^*(m)$ is $n \leq n^*(m)$ and the right-hand side of $n^*(m)$ is $n \geq n^*(m)$.

In this figure, the widest regions are regions II and III. In particular, in these regions, we can clearly verify that the market size must be sufficiently small in order to compensate for a loss of the domestic firm's profit due to an ETR. Since the difference between the number of inside and outside firms in these regions is relatively small, the feature of the abovementioned proposition (i.e., social welfare improves only if the loss of the domestic firm's profit due to ETR is sufficiently small) appears strongly. Is it the same case for other regions?

For example, let us consider about region IV. In this region, the same result as $A < A^{SW}$ holds in the regions II and III and occurs when $A < A^{IR}$ holds. However, in this region, the uniform ETR reduces all components of social welfare, except for consumer surplus, when $A^{TR} < A < A^{SW}$ holds. Since the number of the outside firms is relatively large, the production of final goods is substituted by imports from outside the RTA. This increasing imports from outside sufficiently reduces the price of the final good and increases consumer surplus, so that social welfare improves as a result if $A^{TR} < A < A^{SW}$.

On the other hand, in region I, the number of the member country's firms is relatively large. In this region, an increase of consumer surplus due to an increase in imports from the outside becoms small. That is, the number of the outside firms n is relatively small, so that the effect of increasing imports becomes small. The price of the final good does not sufficiently fall due to an ETR, and the loss of the domestic firm's profit is not canceled out. Therefore, when $A^{SW} < A < A^{TR}$ holds, social welfare decreases even if tariff revenue increase due to an ETR. These results are summarized in the following remarks.

Result 4.1. *(i) Suppose that a pair of the number of outside-inside firms* (n, m) *belongs to regions II or III and the condition* $n > n^*(m)$ *holds. If* $A < A^{SW}$ *holds, then all components of social welfare, except for the domestic firm's profit, improve due to a decrease in the external tariff. (ii) In region IV, ETR decreases all components of social welfare, except for consumer surplus, if* $A^{TR} < A < A^{SW}$ *holds. (iii) In region I, ETR decreases social welfare; however, it increases tariff revenue if* $A^{SW} < A < A^{TR}$ *holds.*

Insert Figure 4.2 here

Result 4.2. *At the same competitive condition (on the line* $n = m$*), the order of threshold values in both member countries changes from* $n = m = 1$ *to* $n = m = 2$*, and from* $n = m = 3$ *to* $n = m = 4$*.*

4.5 Conclusion of Chapter 4

In this chapter, we have examined the effects of external tariff reduction (ETR) on the economy of member countries in an RTA with ROO, where the final good market is characterized by Cournot oligopoly.

Our main results are as follows. First, as mentioned in the proposition, external tariff reduction improves the social welfare of the RTA member countries if the market size of those countries is sufficiently small. Second, even if the number of firms inside and outside the RTA differs significantly, it is possible to improve social welfare within the RTA. For example, when the number of outside firms is extremely large, external tariff reduction improves the RTA member countries' social welfare through import substitution.

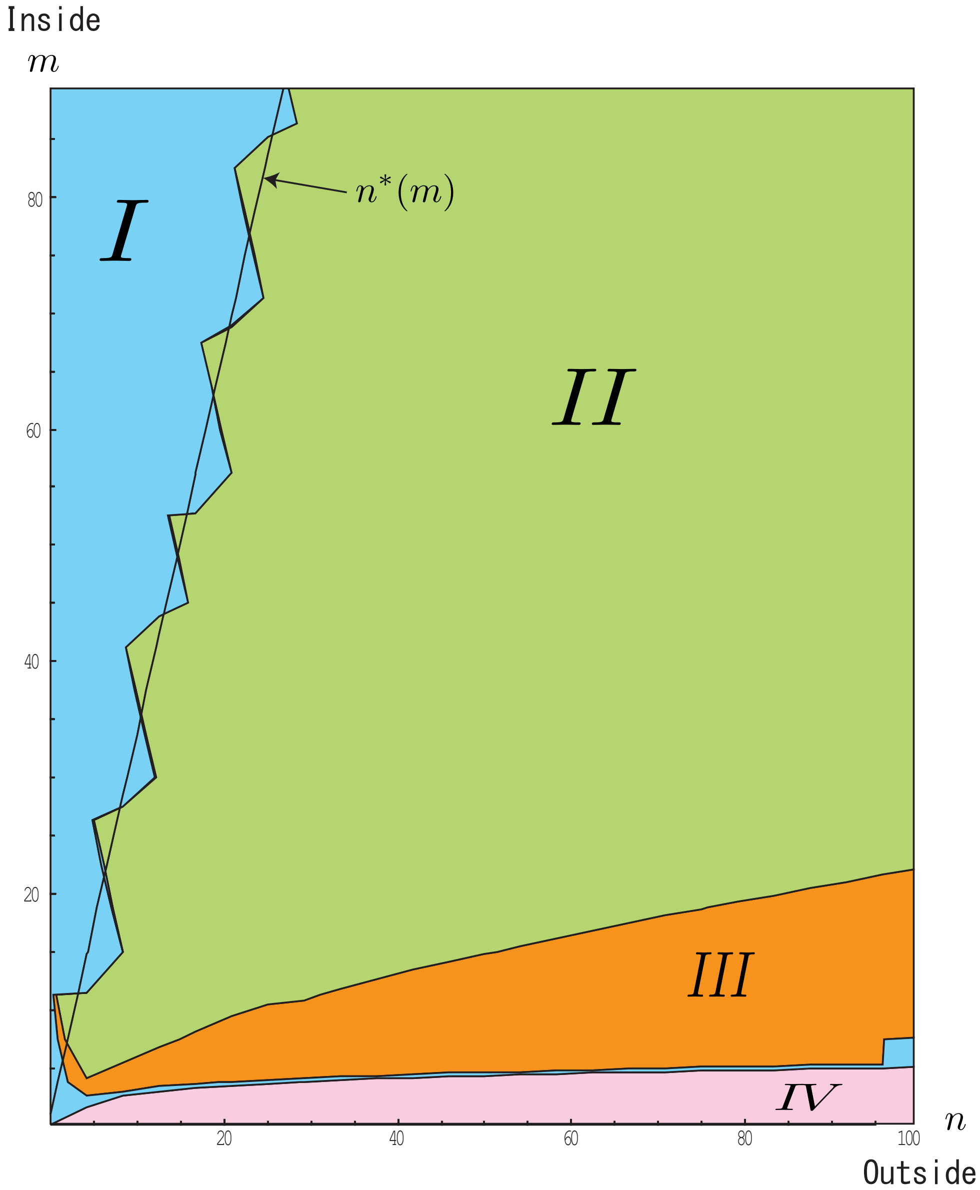


Figure 4.1: Market structure (n, m) and the order of each threshold values

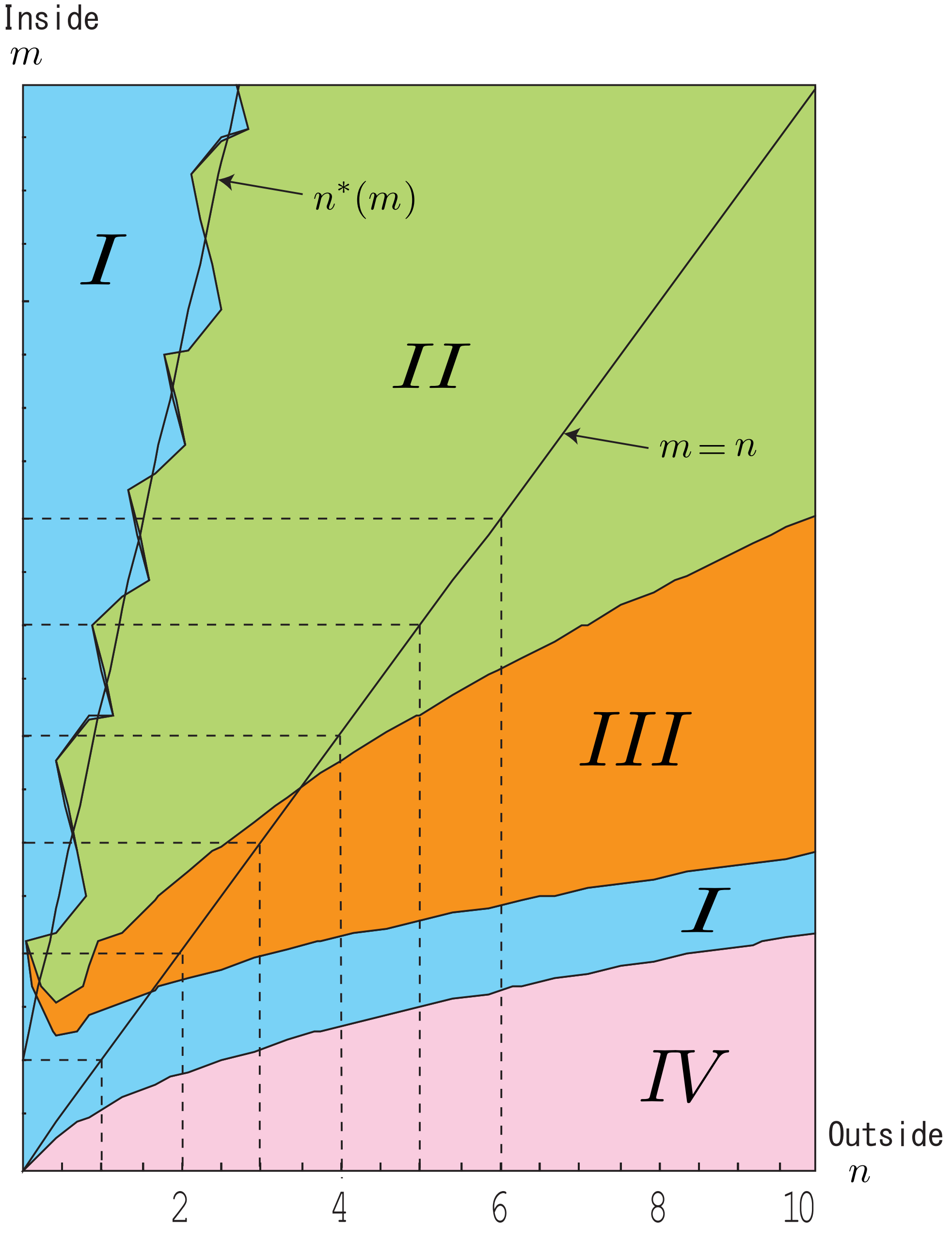


Figure 4.2: Change in economic structure

Chapter 5

ROO and Strategic Choice of Compliance

5.1 Introduction

In recent years, the formation of regional trade agreements (RTAs) is expanding rapidly, and many countries have agreed on them. In order to distinguish between intraregional trade and outside trade, rules of origin (ROO) are required in such RTAs and, in fact, most of the RTAs have introduced some kind of ROO. Furthermore, with the expansion of RTAs, the mechanism and effects of the ROO have attracted the attention of many international economists, and has generated a series of studies.[1]

To enjoy duty-free access to a member country's market within an RTA, final good producers must include a minimum fraction of intermediates produced within the region. Thus, ROO essentially have functions similar to local content requirements (LCRs). For example, in a seminal work by Lahiri and Ono (1998, 2003)—a typical study on the optimal LCR under an oligopolistic market with unemployment—foreign firms must include a minimum fraction of intermediates

[1]For example, see Krueger (1993), Lopez-de-Silanes, Markusen, and Rutherford (1996), Ju and Krishna (2002, 2005), Falvey and Reed (2002), and Takauchi (2007, forthcoming). Krueger (1993), Lopez-de-Silanes, Markusen, and Rutherford (1996), and Ju and Krishna (2002, 2005) focus on the protectionist nature of ROO and mainly examine the effects of their introduction and strengthening as a singular policy variable. On the other hand, Falvey and Reed (2002) and Takauchi (2007, forthcoming) examine the relationship between ROO and other trade policies. Falvey and Reed (2002) examine the relationship between the final good importing country's tariff policy and ROO. Takauchi (2007, forthcoming) mainly considers the policy interaction between ROO and the final good exporting country's subsidy/tax policies.

produced in the host country in order to produce a final good in that country. However, exporting firms are only imposed with an external tariff upon exporting the member country's market if they do not meet the criterion required by the ROO. Thus, there exists the outside option of "paying the going rate of the external tariff" (Demidova and Krishna, 2008). In view of this point, the ROO crucially differ from LCR.

In consideration of this outside option of ROO (i.e., non-compliance with ROO), the strategic behavior among exporting firms becomes a highly important issue. For example, if one firm does not export in conformity to a given ROO, but other firms do—except when the intermediate good industry is perfectly competitive—the derived demand for the intermediate good increases, the price of the intermediate good rises, and consequently, the non-conforming firm's market share expands. An empirical study conducted by Anson et al. (2005) points out that only 64% of final good exporters meet the ROO requirements in Mexico (NAFTA). Although this is just one example of heterogeneous regimes found in the real world, we can point out that strategic behavior among homogeneous firms generates such a heterogeneous regime.

The present chapter focuses on the strategic behavior of homogeneous exporting firms that face two alternatives: conformance or nonconformance with the ROO. We present a simple trade model that generates the heterogeneous regime in a standard Cournot competition among homogeneous exporters. Let us assume the following situation: there is an RTA consisting of two countries-one with a final good market (called "the local country") and one without (called "the other country"). There is one intermediate good producer (firm ℓ) and final good producer (firm L) in the local country and two final good producers in the other member country (firms F). Firm L mainly procures intermediate goods from firm because tariff/nontariff barriers exist. Firms F export the final good to the local country's market. In order to enjoy duty-free access, these exporters must use at least some level of the intermediate good produced in the RTA, otherwise, they pay the going rate of the external tariff.

In view of these circumstances, we obtain the following results. The exporters procure a fraction of the local intermediate good to meet the ROO requirement. The local intermediate good producer (firm ℓ) is aware of this and tries to raise the price of the intermediate good. This "rising price" pressure and the level of the external tariff determine the behavior of the exporting firms. As a result, when the external tariff is relatively low, each exporter prefers not to conform to ROO requirements if the other exporter does. On the other hand, when the external tariff is relatively high, each exporter prefers to conform to ROO requirements if the other exporter does not. For any level of the content rate of ROO, this "strategic substitution" arises at certain levels of the external tariff. Therefore, under some combinations of the content rate of ROO and the level of external tariff, a heterogeneous regime (one exporter conforming to ROO requirements but the other not doing so) occurs.

Moreover, surprisingly, the welfare-maximizing level of the external tariff in the local country is equivalent to its maximum value that generates the case in which neither exporter conforms to the ROO requirements. In addition, if either exporter conforms to these requirements, the welfare level is the worst among the three cases where both exporters conform to ROO requirements, neither exporter conforms to ROO requirements, and one exporter conforms but the other does not. In our model, the welfare-maximizing level of the external tariff is equivalent to the most desirable level of the domestic final good producer (firm L).

Our study is related to the following works. Ju and Krishna (2002, 2005) emphasized the outside option of ROO. They argued that in a three-country model two regimes—a homogeneous regime (all final good producers conform to ROO requirements/do not conform to ROO requirements) and a heterogeneous regime (some final good producers conform to ROO requirements but others do not)—arise depending on the level of the intra regional intermediate good price and a perfect competitive framework (specific factor model). They also showed that with a change in the ROO requirements, the interests between intra regional producers and outside producers, and between intra regional final good producers and intra regional intermediate good producers, move in opposite directions. Demidova and Krishna (2008) present a monopolistic competition model with Melitz-type firm heterogeneity (Melitz, 2003). Moreover, in order to broaden the analysis of Ju and Krishna (2002, 2005), they emphasized on firm heterogeneity (productivity differences), pointing out that some of the results of Ju and Krishna's (2002, 2005) studies have been modified because the composition of ROO conforming non-conforming exporters changes due to a change in the level of ROO requirement.

However, these studies crucially differ from our framework, because they are based on perfect competition and *ex ante* firm heterogeneity. The heterogeneous regime arises at only some price levels that make the choice between the conforming and non-conforming ROO insignificant (Ju and Krishna, 2002; 2005). Furthermore, since final good exporting producers choose different exporting patterns, these firms feature heterogeneity (Demidova and Krishna, 2008).

The remainder of this chapter comprises five sections. In section 2, we describe the model setup. In section 3, we derive the equilibrium of the model and examine the strategic behavior of exporters. In section 4, we examine the welfare implication of the strategic behavior of exporters, and in section 5, we offer concluding remarks.

5.2 The model

Consider an RTA consisting of two countries: one with a final good market and the other without it. We call a member country with a final good market "the local country." There are two producers, namely, an intermediate good producer (labeled firm ℓ) and a final good producer (labeled firm L) in the local country. The firm ℓ produces an intermediate good for the local market, the firm produces a final good and supplies the product to the domestic (local) final good market. On the other hand, there are two final good exporters (firms F or exporters) that export the final good from the other member country within the RTA to the local final good market. Let us suppose that both exporters face two alternatives: non- conformance to the ROO (labeled *NC*) and conformance to the ROO (labeled C). To enjoy duty-free access, both exporters must conform to the ROO of the RTA, that is, they must at least use a predetermined fraction of the intermediate good produced in the local country, otherwise, they must pay the going rate of the external tariff.

The inverse demand function of the final good in the local country is assumed to be linear: $p = a - bY$, where $Y \equiv y + z_1 + z_2$, and a, b are positive constants. The output of firm L is y, the outputs of exporter j are z_j, $j = 1, 2$.

Our focus is on the input cost of each firm. Hence, we assume that each firm has an identical technology and constant marginal cost of production, which is normalized to zero. We also assume that a shipment cost does not exist. Note that firm L mainly procures intermediate good from firm ℓ because of the presence of tariff/nontariff barriers exist. Thus, the profits of firms ℓ and L are represented by

$$\pi^{\ell} \equiv r^L x, \tag{5.1}$$

$$\pi^L \equiv (p - r^L)\, y, \tag{5.2}$$

where r^L denotes the price of the intermediate good in the local country and x denotes the output of the intermediate good. Following Lahiri and Ono (1998, 2003), the input (unit) cost of exporters that meet ROO becomes

$$\theta\, r^L + (1-\theta)\, \overline{r}.$$

A fraction, θ $(1 \geq \theta \geq 0)$ denotes a content rate of the ROO, which is imposed by the RTA. In addition, $\overline{r}$ denotes a competitive price of the intermediate good outside the RTA. Thus, $r^L > \overline{r}$ always holds. For a better understanding simplicity, we assume that a competitive price of the intermediate good ($\overline{r}$) is normalized to zero. Thus, the profit of each exporter is given by

$$\pi_j^F \equiv \begin{cases} (p-\tau)\, z_j & \text{if exporter } j \text{ chooses } NC, \\ (p-\theta r^L)\, z_j & \text{if exporter } j \text{ chooses } C, \end{cases} \tag{5.3}$$

where τ (≥ 0) denotes the external tariff and $j = 1, 2$.

5.3 Strategic choice of compliance with ROO

In this section, we consider the equilibrium outcomes of the following game. Stage 1: The exporters (firms F) independently and simultaneously choose either NC or C. Stage 2: Firm ℓ chooses the output level of the intermediate good. Stage 3: Each final good producer (firm L and both exporters) independently and simultaneously chooses the output level of the final good. We use the subgame perfect Nash equilibrium as the equilibrium concept. The game solved using backward induction.

More precisely, the procurement of intermediate good contains an aspect of technology choice. Since the exporters must procure the intermediate good under a given production technology, the exporters determine either NC or C in the first stage of the game.

First, we derive the equilibrium outcomes in each case.

I. Case (NC, NC)**:** From equations (5.2)–(5.3), the Cournot competition in the final good market yields

$$y = \frac{a + 2\tau - 3r^L}{4b}, \qquad z_j = \frac{a + r^L - 2\tau}{4b}, \tag{5.4}$$

where $j = 1, 2$. Market clearing condition $y = x$ and equation (5.1) yield the following derived demand for the intermediate good:

$$r^L = \frac{a + 2\tau}{3} - \frac{4b}{3}\,x. \tag{5.5}$$

From equations (5.1) and (5.5), the output of intermediate good is $x = (1/8b)(a + 2\tau)$. Thus, the equilibrium price of intermediate good becomes

$$r^L(NC, NC) = \frac{a + 2\tau}{6}. \tag{5.6}$$

Substituting equation (5.6) into equation (5.4), we obtain the equilibrium output of each firm, total supply Y, and the price of the final good p in (NC, NC).

$$\begin{aligned} y(NC, NC) &= \frac{a + 2\tau}{8b}, & z_j(NC, NC) &= \frac{7a - 10\tau}{24b}, \\ Y(NC, NC) &= \frac{17a - 14\tau}{24b}, & p(NC, NC) &= \frac{7(a + 2\tau)}{24}, \quad \text{and} \\ \pi^\ell(NC, NC) &= \frac{(a + 2\tau)^2}{48b}. \end{aligned} \tag{5.7}$$

The equilibrium profit of firms are $\pi^L(NC, NC) = b\big[y(NC, NC)\big]^2$ and $\pi_j^F(NC, NC) = b\big[z_j(NC, NC)\big]^2$, $j = 1, 2$.

II. Case (C, C)**:** From equations (5.2)–(5.3), the Cournot competition in the final good market yields

$$y = \frac{a - (3 - 2\theta)r^L}{4b}, \qquad z_j = \frac{a + (1 - 2\theta)r^L}{4b}. \tag{5.8}$$

The market clearing condition $y + 2\theta z_j = x$ and equation (5.1) yield the following derived demand for the intermediate good:

$$r^L = \frac{a(1 + 2\theta)}{3 - 4\theta + 4\theta^2} - \frac{4b}{3 - 4\theta + 4\theta^2}\,x. \tag{5.9}$$

From equations (5.1) and (5.9), the output of the intermediate good is $x = (a/8b)(1+2\theta)$, and the equilibrium price of the intermediate good is

$$r^L(C,C) = \frac{a(1+2\theta)}{2(3-4\theta+4\theta^2)}. \tag{5.10}$$

Substituting equation (5.10) into equation (5.8), we obtain the equilibrium output of each firm, total supply Y, and price of the final good p in (C,C).

$$\begin{aligned} y(C,C) &= \frac{3a(1-4\theta+4\theta^2)}{8b(3-4\theta+4\theta^2)}, & z_j(C,C) &= \frac{a(7-8\theta+4\theta^2)}{8b(3-4\theta+4\theta^2)}, \\ Y(C,C) &= \frac{a(17-28\theta+20\theta^2)}{8b(3-4\theta+4\theta^2)}, & p(C,C) &= \frac{a(7-4\theta+12\theta^2)}{8(3-4\theta+4\theta^2)}, \quad \text{and} \\ \pi^\ell(C,C) &= \frac{a^2(1+2\theta)^2}{16b(3-4\theta+4\theta^2)}. \end{aligned} \tag{5.11}$$

The equilibrium profit of firms are $\pi^L(C,C) = b\big[y(C,C)\big]^2$ and $\pi_j^F(C,C) = b\big[z_j(C,C)\big]^2$, $j = 1,2$.

III. Case (C, NC)**:** Without loss of generality, by symmetry exporters, we derive the outcomes in (C, NC). From equations (5.2)–(5.3), the Cournot competition in the final good market yields

$$y = \frac{a+\tau-(3-\theta)r^L}{4b}, \tag{5.12}$$

$$z_1 = \frac{a+\tau-(3\theta-1)r^L}{4b}, \quad \text{and} \quad z_2 = \frac{a-3\tau+(1+\theta)r^L}{4b}. \tag{5.13}$$

The market clearing condition $x = y + \theta z_1$ yields the following derived demand for the intermediate good:

$$r^L = \frac{(a+\tau)(1+\theta)}{3-2\theta+3\theta^2} - \frac{4b}{3-2\theta+3\theta^2}\,x.$$

The output of intermediate good is $x = (1/8b)(a+\tau)(1+\theta)$. The equilibrium price of the intermediate good becomes as

$$r^L(C,NC) = r^L(NC,C) = \frac{(a+\tau)(1+\theta)}{2(3-2\theta+3\theta^2)}. \tag{5.14}$$

Substituting (5.14) into equations (5.12) and (5.13), we obtain the equilibrium output of each firm, total supply Y, and price of the final good p in (C, NC)

(and (NC, C)).

$$
\begin{aligned}
y(C, NC) &= y(NC, C) = \frac{(a+\tau)(3-6\theta+7\theta^2)}{8b(3-2\theta+3\theta^2)}, \\
z_1(C, NC) &= z_2(NC, C) = \frac{(a+\tau)(7-6\theta+3\theta^2)}{8b(3-2\theta+3\theta^2)}, \\
z_2(C, NC) &= z_1(NC, C) = \frac{(7-2\theta+7\theta^2)\,a-(17-14\theta+17\theta^2)\,\tau}{8b(3-2\theta+3\theta^2)}, \\
Y(C, NC) &= Y(NC, C) = \frac{(17-14\theta+17\theta^2)\,a-(7-2\theta+7\theta^2)\,\tau}{8b(3-2\theta+3\theta^2)}, \\
p(C, NC) &= p(NC, C) = \frac{(a+\tau)(7-2\theta+7\theta^2)}{8(3-2\theta+3\theta^2)}, \quad \text{and} \\
\pi^\ell(C, NC) &= \pi^\ell(NC, C) = \frac{(a+\tau)^2(1+\theta)^2}{16b(3-2\theta+3\theta^2)}.
\end{aligned} \tag{5.15}
$$

The equilibrium profit of firms are $\pi^L(C, NC) = b\big[y(C, NC)\big]^2$ and $\pi_j^F(C, NC) = b\big[z_j(C, NC)\big]^2$, $j = 1, 2$.

In our model, the prohibitive tariff level depends on θ, and it is monotonically increasing with respect to θ. Hereafter, let us assume the following assumption.

Assumption 5.1.

$$
\gamma \equiv \frac{\tau}{a} \le \frac{7-2\theta+7\theta^2}{17-14\theta+17\theta^2} \equiv \xi(\theta), \tag{5.16}
$$

for cases, θ belongs to $[0, 1]$.

When this assumption holds, both exporters produce positive quantities of the final good in any of three cases. Of course, the value of equation (5.16) is always lesser than 7/10. From equations (5.7)–(5.16), we obtain the following payoff matrix of the exporters (see table 5.1). Thus, we obtain the following proposition.[2]

Proposition 5.1. *For all cases θ belongs to* $(0, 1]$*, the equilibrium is (i)* (C, C) *if $\gamma \ge f_2(\theta)$ holds; (ii)* (NC, NC) *if $f_1(\theta) \ge \gamma$ holds; and (iii)* (C, NC) *and* (NC, C) *if $f_2(\theta) \ge \gamma \ge f_1(\theta)$ holds.*

[2]In this chapter, all proofs are depicted in the appendix.

	NC	C
NC	$\pi_1^F(NC,NC),\ \pi_2^F(NC,NC)$	$\pi_1^F(NC,C),\ \pi_2^F(NC,C)$
C	$\pi_1^F(C,NC),\ \pi_2^F(C,NC)$	$\pi_1^F(C,C),\ \pi_2^F(C,C)$

Table 5.1: The payoff matrix of the exporters

Here, $f_j(\theta)$ is defined by

$$f_1(\theta) \equiv \frac{4\theta(1+3\theta)}{51-38\theta+39\theta^2}, \qquad f_2(\theta) \equiv \frac{4\theta(1+2\theta-\theta^2+4\theta^3)}{(3-4\theta+4\theta^2)(17-14\theta+17\theta^2)}.$$

Note that $f_2(\cdot) \geq f_1(\cdot)$ holds for any cases, θ belongs to $[0,1]$. The result of proposition 1 is depicted in the following Figure 5.1.

Inserts Figure 5.1 here

In cases (i) and (ii) of proposition 5.1, all exporters choose same action (i.e., a homogeneous regime is established). All exporters choose to conform with the ROO requirements when the level of external tariff is sufficiently high. Reversely, not all exporters conform to ROO requirements when the level of external tariff is not too high and content rate of ROO is relatively low. In addition, if the local intermediate good producer has no market power, then the outcomes of this game are only (NC,NC) and (C,C); this mechanism is highly intuitive.

However, by meeting the ROO requirements, the price of the intermediate good rises because firm ℓ has a market power. This "rising price" pressure and the level of the external tariff determines the behavior of the exporters. When the external tariff is relatively high ($\gamma \geq f_1(\theta)$), each exporter prefers to conform to ROO requirements if the other exporter does not, while when the external tariff is not too high ($f_2(\theta) \geq \gamma$), each exporter prefers not to conform to the ROO requirements if the other exporter does. Therefore, in equilibrium, the heterogeneous regime comes into existence when the external tariff is relatively high, but not too high ($f_2(\theta) \geq \gamma \geq f_1(\theta)$).

Next, we examine the profit of firm L. From equations (5.7)–(5.15), and f_j, $j=1,2$, we obtain the following proposition.

Proposition 5.2. *For all cases θ ($1 \geq \theta \geq 0$) and γ ($\xi(\theta) \geq \gamma \geq 0$), the ranking in the profit of firm L is $\pi^L(NC,NC) \geq \pi^L(C,NC) = \pi^L(NC,C) \geq \pi^L(C,C)$.*

Proposition 5.2 implies the following relatively intuitive mechanism. If all exporters conform to the ROO requirements, then the price of intermediate good becomes sufficiently high. This rising price effect harms both exporters, and firm L. In the case of (C, C), both exporters procure a predetermined fraction of the intermediate good produced in the local country (ROO requirement), and at the same time, they procure the intermediate good from another source. Since the competitive intermediate good is cheaper than the local intermediate good, both exporters are more competitive than firm L. Therefore, from the rising price effect and its competitiveness, in the case of (C, C), the output of firm L is smaller than in any other case; thus, the profit is smaller than in any other case.

This result has a simple policy implication. In our framework, the domestic final good producer prefers a relatively smaller protection than a higher one. It is desirable for the government of the local country to reduce the external tariff from its initial level to $f_1(\theta)$ when it emphasizes on the domestic final good producer and the initial level of the external tariff is larger than $f_1(\theta)$.

The equilibrium profit of each final good producer in each case is not necessarily a decreasing function with respect to the content rate of ROO. In view of this, we obtain the following proposition.

Proposition 5.3. *Suppose that (C, C) occurs. As the ROO requirement changes, the interests of all the final good producers move in the same direction as long as θ belongs to an open interval $\big((1/2)(2-\sqrt{3}\,),\ 1/2\big)$. In the case of the other outcomes, the interests of all the final good producers move in different directions due to a change in the ROO requirement.*

Proposition 5.3 implies a few interesting properties of the model. In the homogeneous regime (C, C), a decrease in the content rate of ROO helps all final good producers when θ belongs to an open interval $\big((1/2)(2-\sqrt{3}\,),\ 1/2\big)$. This mechanism is explained as follows: when $\theta < (1/2)(2-\sqrt{3}\,) \simeq 0.134$, the content rate of the ROO is sufficiently small and the input cost advantage in exporters is sufficiently large. Thus, strategic substitution works rather strongly in the final good market, and the exporters can take away market share from firm L due to an increase in θ. When $(1/2)(2-\sqrt{3}\,) \leq \theta$, the rising price effect in the intermediate good dominates any other effect. Thus, an increase in θ reduces the volume of exports in exporters.

On the other hand, for firm L, the rising price effect in the intermediate good dominates any other effect when $\theta < 1/2$. Moreover, when $1/2 < \theta$, the effect of taking away the market share from exporters dominates the rising price effect in the intermediate good because the input cost difference between firm L and the exporters is relatively small when $1/2 < \theta$. Consequently, the profit of firm L increases due to an increase in θ.

5.4 Welfare implication

In this section, let us compare the local country's welfare level among three cases: (I) where both exporters choose NC, (II) where both exporters choose C, and (III) where one exporter chooses NC and the other chooses C. The national welfare of the local country in each case is given by

$$W(NC, NC) = CS(NC, NC) + \pi^{\ell}(NC, NC) + \pi^{L}(NC, NC) + 2\tau z_j(NC, NC), \quad (5.17)$$

$$W(C, C) = CS(C, C) + \pi^{\ell}(C, C) + \pi^{L}(C, C), \quad (5.18)$$

$$W(C, NC) = CS(C, NC) + \pi^{\ell}(C, NC) + \pi^{L}(C, NC) + \tau z_2(C, NC), \quad (5.19)$$

where $CS(\cdot) = (b/2)[Y(\cdot)]^2$ is the consumer surplus, $\pi^{\ell}(\cdot)$ is the profit of firm ℓ (intermediate good producer), $\pi^{L}(\cdot)$ is the profit of firm L (final good producer), and $\tau z_j(\cdot)$ is the tariff revenue.[3] Here, note that $W(C, NC) = W(NC, C)$ holds.

After comparing the above equations (5.17)–(5.19), we obtain the following proposition.

Proposition 5.4. *For all cases, θ $(1 \geq \theta \geq 0)$ and γ $(\xi(\theta) \geq \gamma \geq 0)$, the ranking in the national welfare of the local country is $W(NC, NC) > W(C, C) > W(C, NC) = W(NC, C)$.*

The result of proposition 5.4 is explained as follows. When two exporters export in conformity to the ROO requirements, even if the consumer surplus is relatively small, the local government can expect an increase in the profit of the local intermediate good producer. However, when only one exporter exports in conformity to the ROO requirement, consumer surplus is relatively small and the tariff revenue and profit of the local intermediate good producer are relatively small. Therefore, $W(C, C) > W(C, NC) = W(NC, C)$ holds. On the other

[3]The welfare level in equilibrium is depicted in the appendix. See equations (B.6)–(B.8).

hand, when no exporters export in conformity to the ROO requirement, the volume of exports is relatively large, and then the volume of consumer surplus and tariff revenue can offset any other losses (i.e., losses in profits of firms ℓ L). Thus, $W(NC, NC) > W(C, C)$ holds. The national welfare in the local country is relatively large in the presence of a restrictive trade policy (τ or $\gamma > 0$). This corresponds to the conventional wisdom in the strategic trade theory. However, proposition 5.4 has an interesting implication. It is more desirable to have free trade (τ or $\gamma = 0$) than to have one exporter conforming to ROO (i.e., $f_2(\theta) \geq \gamma \geq f_1(\theta)$). This result is depicted in the following Figure 5.2.

Inserts Figure 5.2 here

Given θ, by increasing the external tariff from zero to $\xi(\theta)$, the welfare level rises on the interval $\left[0, f_1(\theta)\right]$. On the other hand, the welfare level suddenly decreases when the tariff level exceeds $f_1(\theta)$. Therefore, the welfare of both governments of the local country and firm L are maximized when $f_1(\theta)$.

Finally, let us verify that the welfare function of the local country has a non-monotonisity with respect to θ. Differentiating between equations (5.18) and (5.19) with respect to θ, we establish the following proposition.

Proposition 5.5.

(i) *Suppose that (C, C) occurs. The welfare of the local country monotonically decreases with respect to θ when $\theta < 1/2$. Otherwise, it monotonically increases with respect to θ.*

(ii) *Suppose that (C, NC) or (NC, C) occurs. The welfare of the local country monotonically decreases with respect to θ when $\gamma < g(\theta)$. Otherwise, it monotonically increases with respect to θ,*

where $g(\theta) \equiv (-7 + 21\theta - 27\theta^2 + 15\theta^3 + 6\theta^4)/(-17 - 5\theta + 27\theta^2 - 31\theta^3 + 18\theta^4)$.

Proposition 5.5 is explained as follows. When (C, C) occurs and $\theta < 1/2$ holds, in view of the national welfare of the local country, a smaller content rate of the ROO is desirable because the outputs of the final good decrease and the consumer surplus shows a relatively higher decrease if θ increases. Since this effect dominates any other effect, a smaller content rate of the ROO achieves a higher level in the national welfare. Reversely, all exporters are less efficient, and from Proposition 5.3, firm L is relatively dominant when $\theta > 1/2$ holds. Thus, an increase in the content rate of the ROO raises the price of the intermediate good and increases the market share of firm L, which can in turn increase the profits of the local intermediate good producer and firm L. As a result, domestic welfare can also improve. Moreover, in case (ii) of proposition 5.5, this mechanism basically holds.

5.5 Conclusion of Chapter 5

In this chapter we focus on the strategic behavior of identical final good exporting firms that face the alternative of either conforming or not conforming to the ROO. We present a simple trade model that generates heterogeneous regimes (one exporter conforms to the ROO requirements and the other does not) in a standard Cournot competition.

In the existing studies on ROO, Ju and Krishna (2002, 2005) and Demidova and Krishna (2008) emphasized the outside option of ROO. By focusing on the outside option of ROO, they skillfully examined the effects of ROO on market access and welfare. However, in view of the imperfectly competitive or strategic behavior of exporting firms and market power in the intermediate good market, it seems that the mechanism and the effects of ROO need further examination. We believe that the model developed herein complements their analysis from the view of strategic behavior among firms.

Our main findings are summarized in the following three points. First, under some combinations of content rate of ROO and the level of external tariff, a heterogeneous regime (one exporter conforming to ROO requirements but the other not) arises. Second, in the homogeneous regime (both exporters conform to ROO requirement), a decrease in the content rate of ROO may help all final good producers under a certain level of ROO. Third, surprisingly, the welfare maximizing level of the external tariff is equivalent to the maximum value that generates the case in which both exporters do not conform to ROO requirements. Furthermore, if either exporter conforms to ROO requirements, the welfare level is the worst.

Appendix of This Chapter

Proof of Proposition 5.1: From equations (5.7)–(5.15), we derive the payoff matrix of the exporters. First, let us consider exporter 1. Comparing the cases (NC, NC) and (C, NC), the following indifference condition holds:

$$\pi_1^F(NC, NC) = \pi_1^F(C, NC) \;\Leftrightarrow\; \frac{\tau}{a} = \frac{4\theta(1+3\theta)}{51-38\theta+39\theta^2} \equiv f_1(\theta) \tag{F.1}$$

Similarly, comparing the cases (NC, C) and (C, C), the following condition holds:

$$\pi_1^F(NC, C) = \pi_1^F(C, C) \;\Leftrightarrow\; \frac{\tau}{a} = \frac{4\theta(1+2\theta-\theta^2+4\theta^3)}{(3-4\theta+4\theta^2)(17-14\theta+17\theta^2)} \equiv f_2(\theta) \tag{F.2}$$

Note that exporters are symmetric, then (F.1) and (F.2) are valid for expoter 2 ((F.1) coressponds to exporter 2's (NC, NC) and (NC, C) cases, and (F.2) corresponds to exporter 2's (C, NC) and (C, C) cases). Thus, we obtain

$$\text{exporter 1} \begin{cases} \gamma \geq f_1(\theta) & \Rightarrow \quad \pi_1^F(C, NC) \geq \pi_1^F(NC, NC), \\ \gamma \leq f_1(\theta) & \Rightarrow \quad \pi_1^F(NC, NC) \geq \pi_1^F(C, NC), \\ \gamma \geq f_2(\theta) & \Rightarrow \quad \pi_1^F(C, C) \geq \pi_1^F(NC, C), \\ \gamma \leq f_2(\theta) & \Rightarrow \quad \pi_1^F(NC, C) \geq \pi_1^F(C, C). \end{cases}$$

$$\text{exporter 2} \begin{cases} \gamma \geq f_1(\theta) & \Rightarrow \quad \pi_2^F(NC, C) \geq \pi_2^F(NC, NC), \\ \gamma \leq f_1(\theta) & \Rightarrow \quad \pi_2^F(NC, NC) \geq \pi_2^F(NC, C), \\ \gamma \geq f_2(\theta) & \Rightarrow \quad \pi_2^F(C, C) \geq \pi_2^F(C, NC), \\ \gamma \leq f_2(\theta) & \Rightarrow \quad \pi_2^F(C, NC) \geq \pi_2^F(C, C). \end{cases}$$

For all θ belonging to $(0, 1]$, C becomes a dominant strategy for both exporters if $\gamma \geq f_2(\theta)$. Second, for all θ belonging to $(0, 1]$, NC becomes a dominant strategy for the exporters if $\gamma \leq f_1(\theta)$. Finally, for all θ belonging to $(0, 1]$, (C, NC) and (NC, C) is the equilibrium if $f_2(\theta) \geq \gamma \geq f_1(\theta)$ holds. Q.E.D.

Proof of Proposition 5.2: First, comparing (NC, NC) and (C, C), we obtain

$$\pi^L(NC, NC) = \pi^L(C, C) \;\Leftrightarrow\; \frac{\tau}{a} = -\frac{4\theta(1-\theta)}{3-4\theta+4\theta^2} \equiv q_1(\theta).$$

Note that $q_1(\theta)$ is non-positive for all θ belonging to $[0, 1]$, and $\pi^L(NC, NC) > \pi^L(C, C)$ holds if $\gamma(= \tau/a) > q_1(\theta)$. Thus, we can immediately find that $\pi^L(NC, NC) \geq \pi^L(C, C)$ for all $(\theta, \gamma) \in [0, 1] \times [0, \xi(\theta)]$.

Next, comparing (NC, NC) and (C, NC), we obtain

$$\pi^L(NC, NC) = \pi^L(C, NC) \;\Leftrightarrow\; \frac{\tau}{a} = -\frac{4\theta(-1+\theta)}{(-3+\theta)(1+\theta)} \equiv q_2(\theta)$$

Note that $q_2(\theta)$ is non-positive for all θ belonging to $[0, 1]$, and $\pi^L(NC, NC) > \pi^L(C, NC)$ holds if $\gamma > q_2(\theta)$. Thus, we can immediately find that $\pi^L(NC, NC) \geq \pi^L(C, NC)$ for all $(\theta, \gamma) \in [0, 1] \times [0, \xi(\theta)]$.

Finally, comparing (C, NC) and (C, C), we obtain

$$\pi^L(C, NC) = \pi^L(C, C) \;\Leftrightarrow\; \frac{\tau}{a} = -\frac{4\theta(-3+3\theta-2\theta^2+2\theta^3)}{(3-4\theta+4\theta^2)(3-6\theta+7\theta^2)} \equiv q_3(\theta)$$

Note that $q_3(\theta)$ is non-positive for all θ belonging to $[0, 1]$, and $\pi^L(C, NC) > \pi^L(C, C)$ holds if $\gamma > q_3(\theta)$. Thus, we can immediately find that $\pi^L(C, NC) \geq \pi^L(C, C)$ for all $(\theta, \gamma) \in [0, 1] \times [0, \xi(\theta)]$. Therefore, $\pi^L(NC, NC) \geq \pi^L(C, NC) = \pi^L(NC, C) \geq \pi^L(C, C)$ holds for all $(\theta, \gamma) \in [0, 1] \times [0, \xi(\theta)]$. Q.E.D.

Proof of Proposition 5.3: Differentiating the equilibrium profit of firm L with respect to θ, we obtain the following equations.

$$\frac{\partial \pi^L}{\partial \theta}(C, C) = \frac{9a^2(-1+2\theta)^3}{4b(3-4\theta+4\theta^2)^3}, \tag{B.1}$$

$$\frac{\partial \pi^L}{\partial \theta}(C, NC) = \frac{\partial \pi^L}{\partial \theta}(NC, C) = \frac{(a+\tau)^2(-9+36\theta-54\theta^2+36\theta^3+7\theta^4)}{8b(3-2\theta+3\theta^2)^3}. \tag{B.2}$$

From equation (B.2), the real roots of equation $-9+36\theta-54\theta^2+36\theta^3+7\theta^4 = 0$ are $-(3+2\sqrt{3}\,) < 0$ and $-3+2\sqrt{3} > 0$. Thus, from equations (B.1) and (B.2), we obtain

$$\frac{\partial \pi^L}{\partial \theta}(C, C) \begin{cases} > 0 & \text{if} \quad \theta > 1/2 \\ \leq 0 & \text{if} \quad \theta \leq 1/2 \end{cases}$$

$$\frac{\partial \pi^L}{\partial \theta}(C, NC) = \frac{\partial \pi^L}{\partial \theta}(NC, C) \begin{cases} > 0 & \text{if} \quad \theta > -3+2\sqrt{3} \\ \leq 0 & \text{if} \quad \theta \leq -3+2\sqrt{3} \end{cases}.$$

Next, differentiating the equilibrium profit of exporters (firms F) with respect to θ, we obtain the following equations.

$$\frac{\partial \pi_j^F}{\partial \theta}(C,C) = \frac{a^2(7-64\theta+96\theta^2-64\theta^3+16\theta^4)}{8b(3-4\theta+4\theta^2)^3}, \tag{B.3}$$

$$\frac{\partial \pi_1^F}{\partial \theta}(C,NC) = \frac{\partial \pi_2^F}{\partial \theta}(NC,C) = \frac{(a+\tau)^2(-7-36\theta+54\theta^2-36\theta^3+9\theta^4)}{8b(3-2\theta+3\theta^2)^3}, \tag{B.4}$$

$$\frac{\partial \pi_1^F}{\partial \theta}(NC,C) = \frac{\partial \pi_2^F}{\partial \theta}(C,NC) = \frac{(a+\tau)(1-\theta^2)\,A}{4b(3-2\theta+3\theta^2)^3}, \tag{B.5}$$

where $A \equiv (7-2\theta+7\theta^2)a-(17-14\theta+17\theta^2)\tau$. From equation (B.3), the real roots of equation $7-64\theta+96\theta^2-64\theta^3+16\theta^4=0$ are $(1/2)(2-\sqrt{3}\,)<1$ and $(1/2)(2+\sqrt{3}\,)>1$. Thus, we obtain

$$\frac{\partial \pi_j^F}{\partial \theta}(C,C)\begin{cases} >0 & \text{if} \quad \theta<(1/2)(2-\sqrt{3}\,) \\ \leq 0 & \text{if} \quad \theta \geq (1/2)(2-\sqrt{3}\,) \end{cases}$$

From equation (B.4), the real roots of equation $-7-36\theta+54\theta^2-36\theta^3+9\theta^4=0$ are $(1/3)(3-2\sqrt{3}\,)<0$ and $(1/3)(3+2\sqrt{3}\,)>1$. Since θ must belong to $[0,1]$, we obtain

$$\frac{\partial \pi_1^F}{\partial \theta}(C,NC) = \frac{\partial \pi_2^F}{\partial \theta}(NC,C) < 0.$$

From equation (B.5), we obtain

$$(7-2\theta+7\theta^2)\,a-(17-14\theta+17\theta^2)\,\tau \geq 0 \Leftrightarrow \frac{7-2\theta+7\theta^2}{17-14\theta+17\theta^2} \geq \frac{\tau}{a}$$

Since $\xi(\theta) \equiv ((7-2\theta+7\theta^2)/(17-14\theta+17\theta^2))$, we obtain

$$\frac{\partial \pi_1^F}{\partial \theta}(NC,C) = \frac{\partial \pi_2^F}{\partial \theta}(C,NC) > 0.$$

Therefore, Proposition 5.3 holds. Q.E.D.

Welfare function: In equilibrium, the welfare of the local country is given by

$$W(NC,NC) = \frac{331a^2}{1152b} + \frac{91a\tau}{288b} - \frac{149\tau^2}{288b}, \tag{B.6}$$

$$W(C,C) = \frac{a^2(331 - 1032\theta + 1896\theta^2 - 1696\theta^3 + 816\theta^4)}{128b(3 - 4\theta + 4\theta^2)^2}, \tag{B.7}$$

$$W(C,NC) = \frac{\begin{bmatrix} (-725 + 1148\theta - 1806\theta^2 + 1052\theta^3 - 645\theta^4)\,\tau^2 \\ + 2(91 - 68\theta + 274\theta^2 - 164\theta^3 + 171\theta^4)\,a\tau \\ + (331 - 516\theta + 946\theta^2 - 612\theta^3 + 411\theta^4)\,a^2 \end{bmatrix}}{128b(3 - 2\theta + 3\theta^2)^2}. \tag{B.8}$$

Proof of Proposition 5.4:

(i) Comparing (B.6) with (B.7), we obtain

$$W(NC,NC) = W(C,C) \;\Leftrightarrow\; \frac{\begin{bmatrix} 91a\tau(3 - 4\theta + 4\theta^2)^2 - 149\tau^2(3 - 4\theta + 4\theta^2)^2 \\ -4a^2\theta(-84 + 239\theta - 292\theta^2 + 128\theta^3) \end{bmatrix}}{288b(3 - 4\theta + 4\theta^2)^2} = 0.$$

This yields the following equations.

$$\gamma_1 = \frac{91(3 - 4\theta + 4\theta^2)^2 + 3\sqrt{-(3 - 4\theta + 4\theta^2)^2 B}}{298(3 - 4\theta + 4\theta^2)^2},$$

$$\gamma_2 = \frac{91(3 - 4\theta + 4\theta^2)^2 - 3\sqrt{-(3 - 4\theta + 4\theta^2)^2 B}}{298(3 - 4\theta + 4\theta^2)^2},$$

where $B \equiv -8281 - 168\theta + 265048\theta^2 - 479048\theta^3 + 191848\theta^4$.

We find that $\gamma_2 < 0$ for all θ. Thus, we can ommit γ_2. Here, γ_1 implies that $W(NC,NC) > W(C,C)$ holds if $\gamma < \gamma_1$ and $W(NC,NC) < W(C,C)$ holds if $\gamma > \gamma_1$. However, we find that $\gamma_1 > \xi(\theta)$ holds for all θ belonging to $[0,1]$. Thus, $W(NC,NC) > W(C,C)$ always holds.

(ii) Comparing (B.7) with (B.8), we obtain

$$
\begin{aligned}
&W(C,C) = W(C,NC) \\
\Leftrightarrow\ & \frac{\left[\begin{array}{l} -\ 2a\tau(3-4\theta+4\theta^2)^2\left(819-15572\theta+15388\theta^2-7088\theta^3+998\theta^4\right) \\ -\ \tau^2(3-4\theta+4\theta^2)^2\left(1161-31800\theta+31422\theta^2-23160\theta^3+4410\theta^4\right) \\ +\ a^2\begin{pmatrix} 26811-1253888\theta+3577860\theta^2-6525000\theta^3+8770670\theta^4 \\ -8411920\theta^5+5959760\theta^6-2731200\theta^7+776160\theta^8 \end{pmatrix} \end{array}\right]}{1152b(3-2\theta+3\theta^2)^2(3-4\theta+4\theta^2)^2} = 0.
\end{aligned}
$$

Solving the above equation with respect to τ, we obtain

$$
\gamma_3 = -\frac{\left(3-4\theta+4\theta^2\right)^2 D - 6\left(9-18\theta+29\theta^2-20\theta^3+12\theta^4\right)\sqrt{E}}{\left(3-4\theta+4\theta^2\right)^2\left(1161-31800\theta+31422\theta^2-23160\theta^3+4410\theta^4\right)},
$$

$$
\gamma_4 = -\frac{\left(3-4\theta+4\theta^2\right)^2 D + 6\left(9-18\theta+29\theta^2-20\theta^3+12\theta^4\right)\sqrt{E}}{\left(3-4\theta+4\theta^2\right)^2\left(1161-31800\theta+31422\theta^2-23160\theta^3+4410\theta^4\right)},
$$

where

$$
\begin{aligned}
D &\equiv 819-15572\theta+15388\theta^2-7088\theta^3+998\theta^4, \\
E &\equiv 114705-6807224\theta+19968874\theta^2-36982360\theta^3+45945210\theta^4-39503920\theta^5 \\
&\quad + 22543400\theta^6-7929440\theta^7+1061280\theta^8.
\end{aligned}
$$

We can find that $\gamma_4 < 0$ for all θ belonging to $[0,1]$. Thus, we can omit γ_4. On the other hand, $\gamma_3 > 0.7\ (> \xi(\theta))$ always holds and γ_3 is a strictly increasing with respect to θ for all θ. The contour γ_3 implies that $W(C,C) > W(C,NC)$ holds if $\gamma < \gamma_3$. Thus, $W(C,C) > W(C,NC)(= W(NC,C))$ always holds. From step (i) and (ii), Proposition 5.4 holds. Q.E.D.

Proof of Proposition 5.5: Differentiating (B.7) and (B.8) with respect to θ, we obtain

$$
\frac{\partial W}{\partial\theta}(C,C) = \frac{a^2(-14+61\theta-90\theta^2+44\theta^3+8\theta^4)}{4b(3-4\theta+4\theta^2)^3}, \tag{B.9}
$$

$$
\frac{\partial W}{\partial\theta}(C,NC) = \frac{\partial W}{\partial\theta}(NC,C) = \frac{\left[\begin{array}{l} (17+5\theta-27\theta^2+31\theta^3-18\theta^4)\,\tau^2 \\ +\,2(5+13\theta-27\theta^2+23\theta^3-6\theta^4)\,a\tau \\ +\,(-7+21\theta-27\theta^2+15\theta^3+6\theta^4)\,a^2 \end{array}\right]}{4b(3-2\theta+3\theta^2)^3}. \tag{B.10}
$$

From equation (B.9), the real roots of equation $-14+61\theta-90\theta^2+44\theta^3+8\theta^4=0$ are

$$-\left[2+\frac{9}{2}\left(\frac{3}{16-\sqrt{13}}\right)^{1/3}+\frac{3^{2/3}(16-\sqrt{13}\,)^{1/3}}{2}\right]<0; \qquad \frac{1}{2}.$$

Thus, we obtain

$$\frac{\partial W}{\partial\theta}(C,C)\begin{cases}\leq 0 & \text{if} \quad \theta\leq 1/2\\ >0 & \text{if} \quad \theta>1/2.\end{cases}$$

From the denominator of equation (B.10), we solve the inequality

$$\begin{aligned}(17+5\theta-27\theta^2+31\theta^3-18\theta^4)\,\tau^2+2(5+13\theta-27\theta^2+23\theta^3-6\theta^4)\,a\tau\\ +(-7+21\theta-27\theta^2+15\theta^3+6\theta^4)\,a^2\geq 0\end{aligned}$$

with respect to τ, and obtain $\tau\leq -a$ or $a\times g(\theta)\leq\tau$. Thus, we obtain

$$\frac{\partial W}{\partial\theta}(C,NC)\begin{cases}<0 & \text{if} \quad \gamma<g(\theta)\\ \geq 0 & \text{if} \quad \gamma\geq g(\theta),\end{cases}$$

where

$$g(\theta)\equiv\frac{-7+21\theta-27\theta^2+15\theta^3+6\theta^4}{-17-5\theta+27\theta^2-31\theta^3+18\theta^4}.$$

Therefore, Proposition 5.5 holds. Q.E.D.

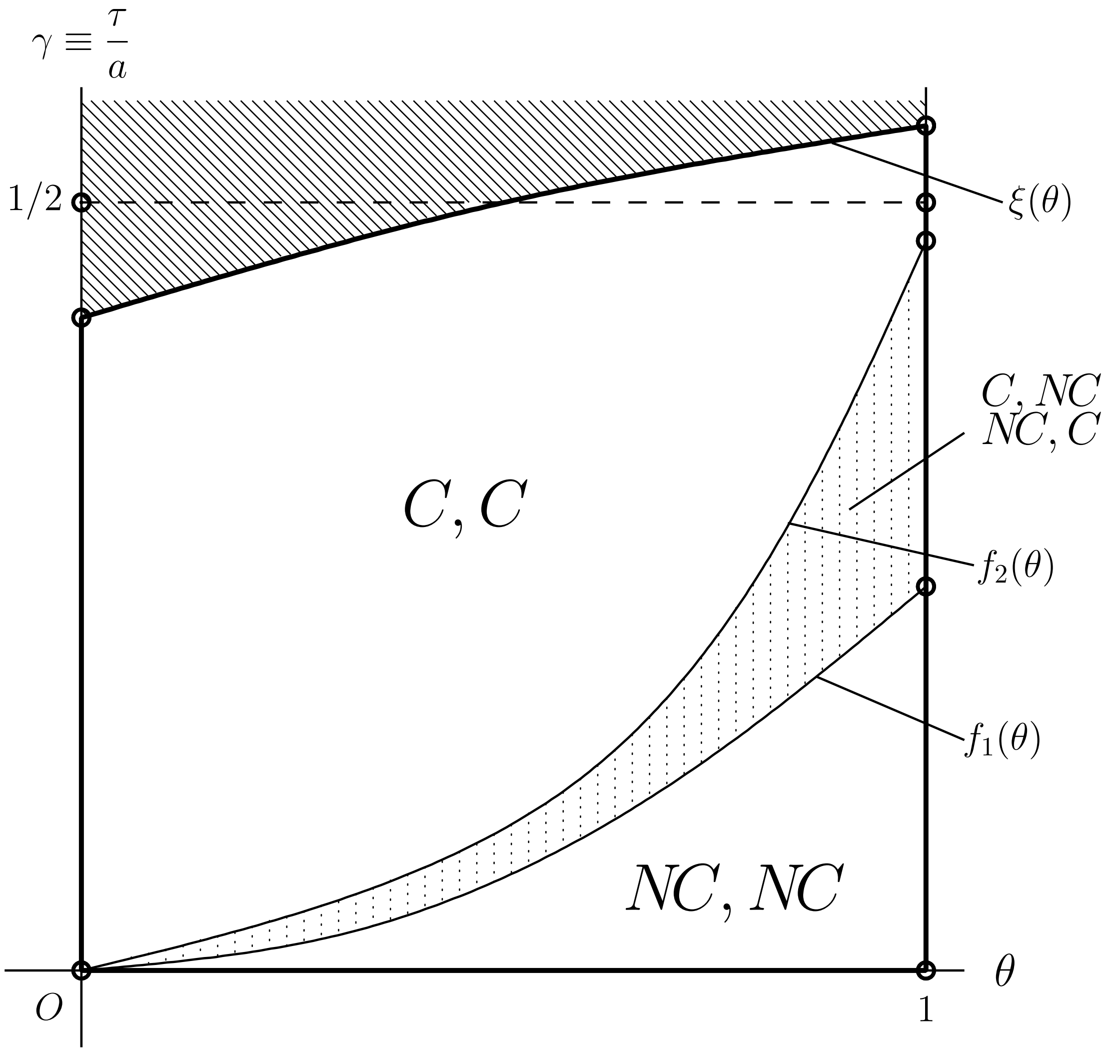


Figure 5.1: Eequilibrium outcomes

Note that $\xi(\theta) \equiv \dfrac{7 - 2\theta + 7\theta^2}{17 - 14\theta + 17\theta^2}$,

$$f_1(\theta) \equiv \frac{4\theta(1 + 3\theta)}{51 - 38\theta + 39\theta^2}, \quad f_2(\theta) \equiv \frac{4\theta(1 + 2\theta - \theta^2 + 4\theta^3)}{(3 - 4\theta + 4\theta^2)(17 - 14\theta + 17\theta^2)}.$$

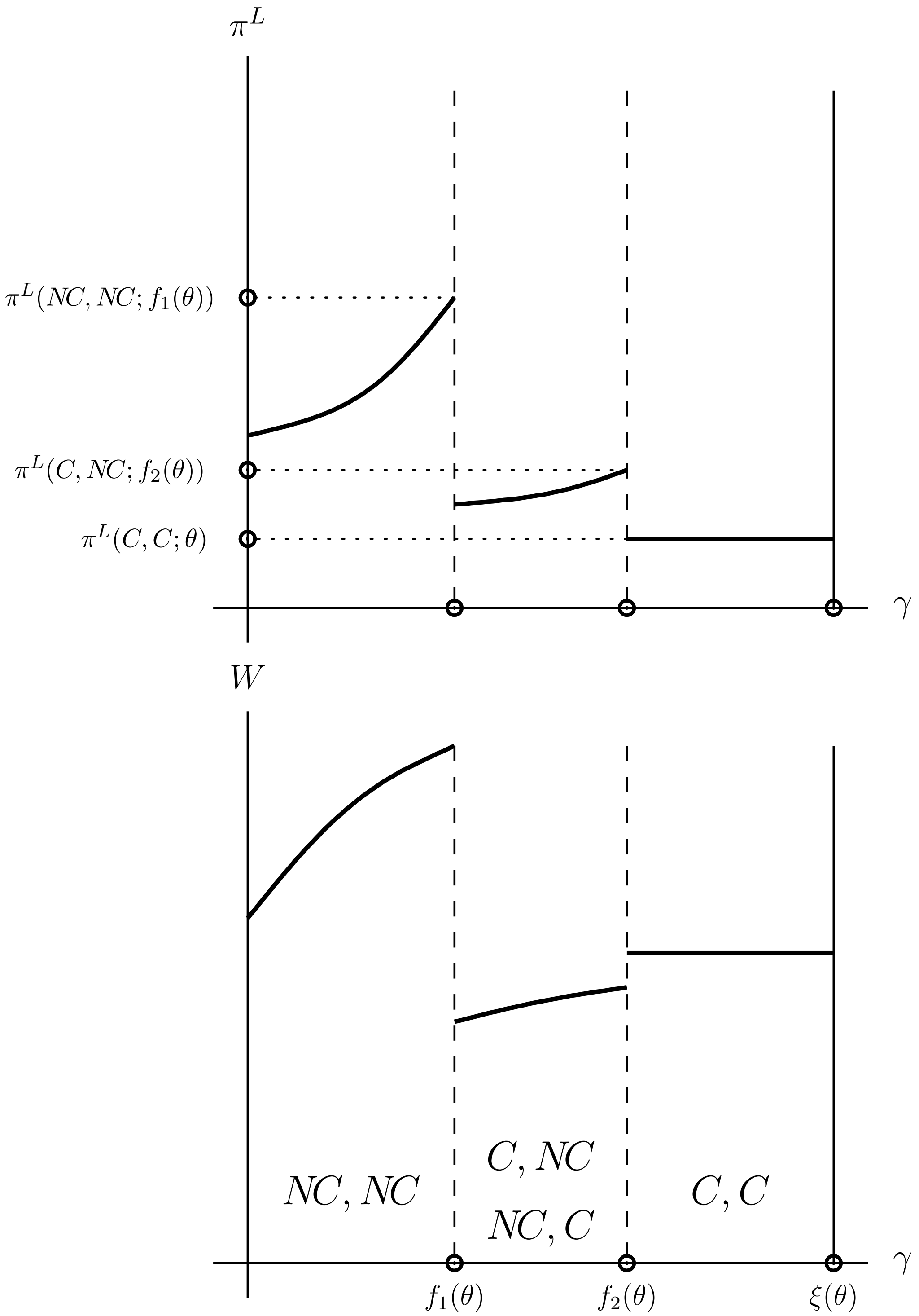


Figure 5.2: The profit of firm L and welfare of local country

Chapter 6

ROO and R&D Rivalry

6.1 Introduction

In an FTA, to distinguish between intra-regional trade and outside trade, ROO is required, and most of the FTAs have introduced and imposed some form of ROO. In general, to enjoy duty-free access to a member country's market within an FTA, final good producers must include a minimum fraction of intermediates or parts produced within the region. This aspect of the ROO causes cost differences between the firms that comply with it and the firms that do not comply, so ROO serves as a protectionist device for the less-efficient countries.

Many works on ROO focus on this protectionist nature, including Krueger (1993); Lopez-de-Silanes, Markusen, and Rutherford (1996); Falvey and Reed (2002); Takauchi (2007, forthcoming; 2008); and Takauchi and Mizuno (2008). However, these studies mainly examine firms' export (or production) activities—they do not consider firms' R&D competition. When the exporting firms engage in cost-reducing R&D activity, ROO considerably affects them because ROO causes cost differences between firms conforming to it and those not conforming to it. As shown by Barros and Nilssen (1999) and Lahiri and Ono (1999), a lower-cost firm undertakes a larger cost-reducing investment than a higher-cost one. As a result, a major firm's market share expands due to cost-reducing R&D competition.[1] Therefore, the welfare implication of the ROO is crucially

[1]Since the study of Spencer and Brander (1983), a series of studies that examine cost-reducing R&D competition and industrial policy (i.e., R&D subsidy) have arisen. For example, Leahy and Neary (1996, 1999) examined the effects of strategic R&D subsidy on firms' activity and each country's welfare. Furthermore, there is a recent study on the initial cost heterogeneity of firms. Ishida, Matsumura, and Matsushima (2008) focused on the competitive effects caused

important when exporting firms engage in cost-reducing R&D activity.

In this chapter, to examine the effects of ROO on cost-reducing R&D competition, we build a simple FTA trade model with ROO. Consider an FTA consisting of two countries: one with a final good market (country M) and the other without it (country E). Outside the FTA is country O. One final good producer is located in each country, and the three producers (firms M, E, and O) engage in cost-reducing R&D competition. The exporting firm in this FTA (firm E) faces ROO and chooses a mixed ratio of intermediate goods produced in this region and in the outside. In both countries M and O, the intermediate good industries produce under perfect competition. However, the intermediate good industry in country M is inefficient as compared to that in country O.

We mainly consider the following three-stage game. In the first stage, the government of country M sets a rate for the external tariff. In the second stage, each firm chooses a volume of cost reduction, respectively. Finally, each firm chooses a quantity of the final good.

Taking into account R&D rivalry, the following interesting results arise. First, an increase in the ROO requirement increases the output, R&D investment, and profit of the exporting firm within the FTA when the efficiency of R&D investment is sufficiently high. This result contradicts conventional wisdom. The reason is that the optimal external tariff rises with an increase in the ROO requirement, and this effect dominates any other effect when the efficiency of R&D investment is sufficiently high.

Second, the government of country M gives an import subsidy to the outside firm if the efficiency of R&D investment is not too high and productivity inside the FTA is sufficiently high. Similar to the logic of Lahiri and Ono (1988, 1995), the efficiency of production is a key factor. If the productivity of the final good producers within the FTA is less efficient, an increase in the ROO requirement reduces imports from the outside firm and harms country M. Thus, country M encourages import from the outside (import subsidy).

Third, under certain conditions, the ROO requirement minimizes the welfare in country M. The productivity of the outside firm is relatively high when the productivity inside the FTA is relatively low. Then, an increase in the ROO requirement raises the external tariff, reduces imports from the outside firm, and harms country M. However, a higher content rate of the ROO implies a

by the initial cost differences among firms.

higher rate of the external tariff. Then, the outside firm is less efficient. In this case, an increase in the ROO requirement improves welfare in country M.

6.2 The model

Consider an FTA consisting of two countries: one with a final good market and the other without it. We call the member country with a final good market country M, and the other country E; outside of the FTA is country O. There are two final good producers in this FTA, one is located in country M (labeled firm M) and the other is located in country E (labeled firm E). Further, a final good exporter is located outside this FTA, which we call it firm O. Firm E faces the ROO and chooses a mixed proportion of intermediate goods produced in countries M and O when exporting the final good to country M's market, because firm E is exempted from the external tariff τ if it procures more than the predetermined proportion of ROO. Let us denote this ROO requirement as δ $(0 \leq \delta \leq 1)$.

In countries M and O, the intermediate goods industries produce under perfect competition. However, the intermediate goods industry in country M is inefficient as compared to that in foreign countries. That is, $k > k^O = 0$, where k (k^O) is the price of the intermediate goods in country M (O). We assume that one unit of the intermediate good is required to produce one unit of the final good. Thus, firm E's initial cost is defined by $c^E \equiv c + \delta k$. On the other hand, firm O's initial cost is defined by $c^O \equiv c + \tau$, because it is subject to the external tariff τ. Further, we define firm M's initial cost as $c^M \equiv c + k$.[2]

The unit production cost of firm i is $c^i - x^i$, $i = M, E, O$, where x^i is the volume of cost reduction, that is, it denotes each firm i's R&D level. Thus, all firms control their input coefficient. Our focus is the initial level of unit cost differences among all firms. Thus, we are not concerned with R&D subsidies or taxes and spillovers. We define R&D cost as $\varphi(\gamma, x^i) \equiv \gamma(x^i)^2$, where γ is a positive constant.

The inverse demand for the product in country M is given by $p = a - Q$, with $Q = q^M + q^E + q^O$, where Q is total sales of the product and q^i denotes

[2] Properly, the procurment cost is $\delta k + (1 - \delta)k^O$. This definition is the same as that used in Lahiri and Ono (1998, 2003) and Kayalica and Lahiri (2003).

firm i's output.[3] The net profit of firms is

$$\pi^i \equiv (p(Q) - (c^i - x^i))\, q^i - \gamma(x^i)^2. \tag{6.1}$$

Let us consider the following three-stage game. Stage 1: The government of country M sets a rate for the external tariff. Stage 2: Each firm independently and simultaneously chooses a volume of cost reduction x^i, respectively. Stage 3: Each firm independently and simultaneously chooses a quantity of the product q^i.

Final stage: In the market competition, each final good producer (firm i) chooses q^i to maximize $(p(Q) - (c^i - x^i))\, q^i$. From equation (6.1), solving the first order condition, we obtain the following equilibrium outputs in the final stage:

$$q^i = \frac{\alpha - 3(y^i - x^i) - \sum_{j\neq i} x^j + \sum_{j\neq i} y^j}{4}, \tag{6.2}$$

where $\alpha \equiv a - c > 0$, $i = M, E, O$, $y^M \equiv k$, $y^E \equiv \delta k$, and $y^O \equiv \tau$.

Second stage: In the R&D investment stage, each firm i chooses x^i to maximize π^i. From (6.1) and (6.2), solving the first order condition, we obtain the equilibrium R&D level for each firm x^i:

$$x^i = \frac{3[(4\gamma - 3)\alpha - 3(4\gamma - 1)y^i + 4\gamma \sum_{j\neq i} y^j]}{(4\gamma - 3)(16\gamma - 3)}. \tag{6.3}$$

Substitutiong (6.3) into (6.2) gives

$$q^i = \frac{4\gamma[(4\gamma - 3)\alpha - 3(4\gamma - 1)y^i + 4\gamma \sum_{j\neq i} y^j]}{(4\gamma - 3)(16\gamma - 3)} = \frac{4}{3}\gamma x^i, \tag{6.4}$$

industry output and final good price are

$$Q = \frac{4\gamma(3\alpha - \sum_i y^i)}{16\gamma - 3} \quad \text{and} \quad p = \frac{(4\gamma - 3)a + 4\gamma(3c + (1+\delta)k + \tau)}{16\gamma - 3}. \tag{6.5}$$

Henceforth we shall use the following assumption:

Assumption 6.1. $\tau < \dfrac{1}{3(4\gamma - 1)}[(4\gamma - 3)\alpha + 4\gamma(1+\delta)k] \equiv \tau_P.$

[3] Assume a representative consumer with quadratic preferences given by $u(Q, z) = aQ - (1/2)Q^2 + z$, where z is consumption of the *numeraire good.*

Assumption 1 requires that the external tariff is at least smaller than the prohibitive tariff level τ_P.

In the second stage, the net profit of each firm $(q^i)^2 - \varphi(\gamma, x^i)$ is given by

$$\pi^i = \gamma(16\gamma - 9)\left[\frac{(4\gamma - 3)\alpha - 3(4\gamma - 1)y^i + 4\gamma\sum_{j\neq i} y^j}{(4\gamma - 3)(16\gamma - 3)}\right]^2,$$
$$= \frac{16\gamma - 9}{16\gamma}(q^i)^2. \tag{6.6}$$

Next, let us derive consumer surplus in country M. Since consumer surplus is given by $CS = (Q^2/2)$, from (6.5) we obtain

$$CS = \frac{8\gamma^2\left(3a - \sum_i c^i\right)^2}{(16\gamma - 3)^2}. \tag{6.7}$$

First stage: In this stage, the government of country M sets a rate for the external tariff τ^*. Social welfare in country M is defined by the sum of consumer surplus CS, firm M's net profit π^M, and tariff revenue τq^O:

$$W \equiv CS + \pi^M + \tau q^O. \tag{6.8}$$

Substituting equations (6.2), (6.6), and (6.7) into equation (6.8) and solving first order condition for the welfare maximization with respect to the external tariff τ, we obtain the following for country M's optimal external tariff.[4]

$$\tau^* = \frac{3(8\gamma - 3)\left[(2\gamma - 1)(4\gamma - 3)\alpha - 2\gamma(4\gamma + 3)k\right] + 4(9 - 51\gamma + 56\gamma^2)\delta}{6(224\gamma^3 - 276\gamma^2 + 90\gamma - 9)}. \tag{6.9}$$

From (6.9) it is easily found that the following property.

$$\frac{\partial\tau^*}{\partial\delta} = \frac{2(9 - 51\gamma + 56\gamma^2)}{3(224\gamma^3 - 276\gamma^2 + 90\gamma - 9)} > 0.$$

Under the optimal external tariff (6.9), each firm's R&D investment is given

[4]The welfare function in country M is depicted in the Appendix. See equations (W.1) and (W.2).

by

$$x^M = \frac{3(4\gamma-1)(4\gamma-3)\alpha + [4\gamma(14\gamma-3)\delta - 9 + 66\gamma - 128\gamma^2]k}{224\gamma^3 - 276\gamma^2 + 90\gamma - 9}, \tag{6.10}$$

$$x^E = \frac{3(4\gamma-1)(4\gamma-3)^2\alpha + (4\gamma b_3 + b_2\delta)k}{(4\gamma-3)(224\gamma^3 - 276\gamma^2 + 90\gamma - 9)}, \tag{6.11}$$

$$x^O = \frac{(4\gamma-3)(3-18\gamma+16\gamma^2)\alpha + 2\gamma(9-56\gamma+64\gamma^2-4\gamma\delta)k}{2(4\gamma-3)(224\gamma^3 - 276\gamma^2 + 90\gamma - 9)}, \tag{6.12}$$

$$X = \frac{3(15-82\gamma+80\gamma^2)\alpha - 2k[(4\gamma-3)(14\gamma-3)\delta + b_3]}{2(224\gamma^3 - 276\gamma^2 + 90\gamma - 9)}, \tag{6.13}$$

where $X = x^M + x^E + x^O$, $b_2 \equiv 27 - 234\gamma + 612\gamma^2 - 448\gamma^3$, and $b_3 \equiv 9 - 45\gamma + 40\gamma^2$. Thus, each equilibrium output is given by $q^M = (4/3)\gamma x^M$, $q^E = (4/3)\gamma x^E$, $q^O = 4\gamma x^O$, and $Q = (4/3)\gamma X$.

Hereafter, we impose the following assumptions.

Assumption 6.2. $\dfrac{k}{\alpha} < \dfrac{3(4\gamma-1)(4\gamma-3)}{(9-66\gamma+128\gamma^2) - 4\gamma(14\gamma-3)\delta} \equiv \xi(\delta,\gamma)$.

Assumption 6.3. *The social welfare in country M is strictly concave with respect to the external tariff, that is,* $\gamma > 0.786001$.

The net profit of firms is $\pi^M = (1/16\gamma)(16\gamma-9)\left(q^M\right)^2$, $\pi^E = (1/16\gamma)(16\gamma-9)\left(q^E\right)^2$, and $\pi^O = (1/4\gamma)(16\gamma-9)\left(q^O\right)^2$.

From (6.10) to (6.13) we establish the following result.

Proposition 6.1. *An increase in the ROO requirement* δ

1. *increases (decreases) the output, R&D investment, and profit of firm M (firm O)*
2. *increases (decreases) the output, R&D investment, and profit of firm E if* $\gamma < (>)\, 0.817104$
3. *always harms consumers and decreases total R&D investment.*

Proof of Proposition 6.1: See Appendix. Q.E.D.

As shown by Lopez-de-Silanes, Markusen, and Rutherford (1996), a tightening of the ROO requirement shifts rent from the firm conforming to the ROO to the firm not conforming to the ROO. Thus, this proposition has an interesting feature. The logic behind this result is as follows. First, a tightening of the ROO requirement (i.e., an increase in δ) shifts rent from firm E to the other firms (firms M and O). However, as previously mentioned, the optimal external tariff rises due to an increase in δ. The volume of increase in the optimal external tariff dominates the volume of increase in δ when the efficiency of the R&D investment is sufficiently high ($\gamma < 0.817104$). Second, the following point is important. Scale of economies works because the firms engage in R&D competition. When the efficiency of R&D investment is not too high (i.e., $\gamma > 0.817104$), the exports of firm E decreases due to an increase in δ because the optimal external tariff does not sufficiently rise due to an increase in δ. That is, it is desirable for the government of country M to concentrate production on the domestic firm when the efficiency of R&D investment is not too high.

6.3 Welfare implication

In this section, we mainly consider the welfare effect of a change in the ROO requirement. First, we verify the shape of the welfare function with respect to the content rate of the ROO.

Lemma 6.1. *Second derivative of the social welfare in country M with respect to δ is always positive.*

Proof of Lemma 6.1: Twice differentiating the welfare function (equation W.2) with respect to δ, we obtain

$$\frac{\partial^2 W}{\partial \delta^2} = \frac{16(k\gamma)^2(9 - 48\gamma + 56\gamma^2)}{3(4\gamma - 3)(224\gamma^3 - 276\gamma^2 + 90\gamma - 9)}.$$

From the numerator of the above equation, solving $(9 - 48\gamma + 56\gamma^2) \geq 0$ with respect to γ, we obtain $\gamma \geq (3/28)(4 + \sqrt{2})$. From the denominator of the above equation, solving $(224\gamma^3 - 276\gamma^2 + 90\gamma - 9) \geq 0$ with respect to γ, we obtain $\gamma \geq 0.786001$. Thus, from the assumption 3, Lemma 1 holds. Q.E.D.

Equation (6.9) yields the following proposition:

Proposition 6.2. *Let the efficiency of R&D investment be sufficiently high (i.e., $\gamma < 1.24099$) and $\alpha > \rho$ holds. Then, the government of country M gives an import subsidy to firm O if $(\delta/\alpha, k/\alpha)$ belongs to $S \equiv \{(\delta/\alpha, k/\alpha) : k/\alpha >$*

$I_S\}$. *Otherwise, the government of country M imposes an import tariff on firm O, where*

$$\rho \equiv \frac{12(-9 + 69\gamma - 158\gamma^2 + 112\gamma^3)}{-81 + 702\gamma - 2052\gamma^2 + 2352\gamma^3 - 896\gamma^4}$$

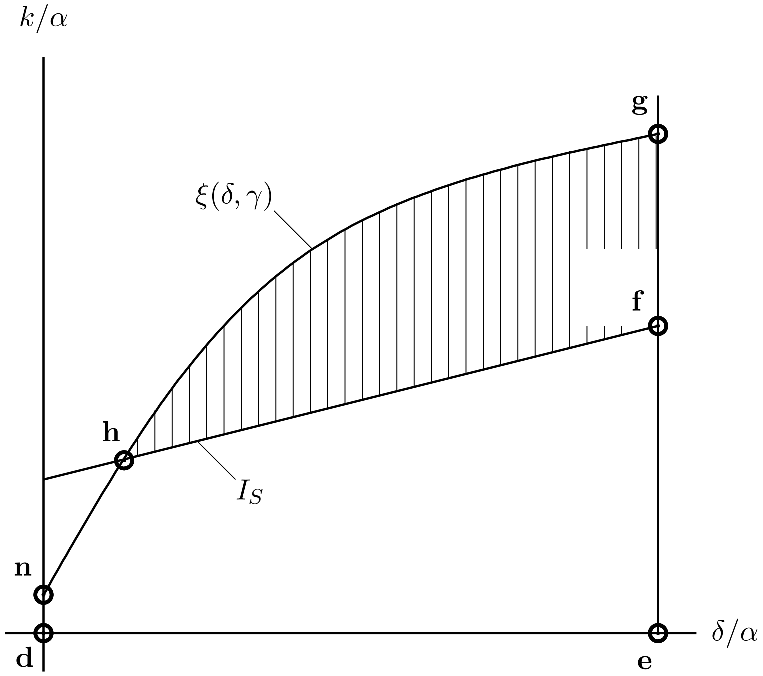
and

$$I_S = \frac{3(2\gamma - 1)(4\gamma - 3)}{2\gamma(4\gamma + 3)} + \frac{2(9 - 51\gamma + 56\gamma^2)}{\gamma(4\gamma + 3)(8\gamma - 3)} \times \frac{\delta}{\alpha}.$$

Proof of Proposition 6.2: In the Appendix. Q.E.D.

Proposition 6.2 says that lower productivity in this region (i.e., a larger k) gives rise to an import subsidy. An increase in the ROO requirement reduces imports from the outside firm and harms country M if the productivity of the final good producers within the FTA is less efficient. Then, the government of country M encourages imports (with an import subsidy) from the outside.

Figure 6.1: Import subsidy or tariff



- Area '**fgh**' is import subsidy
- Area '**defhn**' is import tariff

From Lemma 1 and welfare function in country M (equation W.2) we establish the following result.

Proposition 6.3. *There exists* $0 < \delta_m < 1$*, which minimizes the welfare in country M if and only if* $[3(4\gamma - 3)]/(9 - 78\gamma + 112\gamma^2) < k/\alpha$*, where*

$$\delta_m = \frac{(9 - 78\gamma + 112\gamma^2)k - 3(4\gamma - 3)\alpha}{2(9 - 48\gamma + 56\gamma^2)}.$$

Proof of Proposition 6.3: In the Appendix. Q.E.D.

The above proposition says that the ROO possibly harms welfare of final good importing country within the FTA, which has a less efficient intermediate good industry. This result is similar to the logic of Lahiri and Ono (1988, 1995). That is, the welfare-enhancing (or deteriorating) production substitusion effect of ROO is key factor. The logic behind Proposition 6.3 is as follows. First, we consider the case of $\delta \leq \delta_m$. Relatively large k/α implies that the productivity of firm O is relatively high compared to inside firms. An increase in the content rate of ROO raises the optimal rate of the external tariff τ^* (see equation 6.9) and it reduces exports of firm O (Proposition 6.1). An increase in the content rate of ROO decreases production. That is, it replaces productive firm with less-productive inside firms in the final good production. Hence, the welfare level of the importing country is decreased.

Next, we consider the case of $\delta \geq \delta_m$. In this case, since δ is sufficiently high, τ^* is sufficiently high, too. Hence, opposite to the case of $\delta \leq \delta_m$, firm O is less productive. An increase in δ increases production. The welfare level of the importing country is better due to an increase in δ because an increase in the profit of the domestic firm dominates any other effects.

Futhermore, we can immediately find the following result.

Corollary 6.1.

1. 0% *content rate of ROO is most desirable for country M if*
   $k/\alpha > [3(4\gamma - 3)]/[2\gamma(28\gamma - 15)]$.
2. 100% *content rate of ROO is most desirable for country M if*
   $[3(4\gamma - 3)]/[2\gamma(28\gamma - 15)] > k/\alpha > [3(4\gamma - 3)]/(9 - 78\gamma + 112\gamma^2)$.

6.4 Conclusion of Chapter 6

This chapter focused on the final good producing firms' R&D activity and examined the effects of ROO on the behavior of firms and each country's welfare. To consider the effects of ROO on international R&D competition, in this chapter, we presented a simple three-country, three-firm FTA trade model with ROO.

We mainly considered the following three-stage game. Stage 1: The government of the final good-importing country within the FTA sets a rate for the external tariff. Stage 2: Each firm independently and simultaneously chooses a volume of cost reduction, respectively. Stage 3: Each firm independently and simultaneously chooses a quantity of the final good.

Taking into account firms' cost-reducing R&D competition, we obtain the following interesting results. First, an increase in the ROO requirement increases the output, R&D investment, and profit of the exporting firm within the FTA when the efficiency of R&D investment is sufficiently high. Second, the government of the final good-importing country within the FTA gives an import subsidy to the outside firm if the efficiency of R&D investment is not too high and productivity of firms inside the FTA is sufficiently low. Third, the ROO may minimize the welfare level in the final good-importing country within the FTA when the efficiency of R&D is not too low and productivity of firms inside the FTA is not relatively high.

Appendix of This Chapter

A: Welfare function in country M

Substituting equations (6.4), (6.6), and (6.7) into equation (6.8), we obtain the following welfare function in country M:

$$
\begin{aligned}
W = \gamma & \left[\frac{(88\gamma - 9)(4\gamma - 3)^2(a^2 + c^2) + (8\gamma - 3)(27 - 216\gamma + 304\gamma^2)k^2}{(4\gamma - 3)^2(16\gamma - 3)^2} \right] \\
& - 8k\gamma^2 \left[\frac{(4\gamma + 3)(8\gamma - 3)\tau + k(9 - 108\gamma + 160\gamma^2)\delta - 4(9 - 51\gamma + 56\gamma^2)\delta\tau}{(4\gamma - 3)^2(16\gamma - 3)^2} \right] \\
& + 12\gamma \left[\frac{2k^2\gamma(2\gamma - 1)(8\gamma - 3)\delta^2 - (-9 + 90\gamma - 276\gamma^2 + 224\gamma^3)\tau^2}{(4\gamma - 3)^2(16\gamma - 3)^2} \right] \\
& - 2\gamma \left[\frac{A\alpha + (27 - 300\gamma + 252\gamma^2)ac}{(4\gamma - 3)(16\gamma - 3)^2} \right],
\end{aligned}
\tag{W.1}
$$

where $A \equiv [27 + 32\gamma^2(9 + \delta) - 12\gamma(19 + 3\delta)]k - 6(3 - 14\gamma + 16\gamma^2)\tau$.
Under the optimal external tariff, country M's welfare function W becomes

$$
\begin{aligned}
W = 6\gamma & \left\{ \frac{(6 - 39\gamma + 40\gamma^2)(a^2 + c^2) + \left[9 + 64\gamma^2 - 4\gamma(14 + \delta)\right]ck}{3(224\gamma^3 - 276\gamma^2 + 90\gamma - 9)} \right\} \\
& + \gamma k^2 \left[\frac{18\gamma(39 - 4\delta + 4\delta^2) - 81 + 64\gamma^3(25 - 14\delta + 7\delta^2) - 27\gamma^2(79 - 26\delta + 16\delta^2)}{3(4\gamma - 3)(224\gamma^3 - 276\gamma^2 + 90\gamma - 9)} \right] \\
& - 6\gamma a \left\{ \frac{2(6 - 39\gamma + 40\gamma^2)c + \left[9 + 64\gamma^2 - 4\gamma(14 + \delta)\right]k}{3(224\gamma^3 - 276\gamma^2 + 90\gamma - 9)} \right\}.
\end{aligned}
\tag{W.2}
$$

Derivation of Assumption 6.3. Twice defferentiating welfare function with respect to the external tariff, we obtain

$$
\frac{\partial^2 W}{\partial \tau^2} = \frac{\gamma(216 - 2160\gamma + 6624\gamma^2 - 5376\gamma^3)}{(9 - 60\gamma + 64\gamma^2)^2},
$$

From numerical calculation, solving $216 - 2160\gamma + 6624\gamma^2 - 5376\gamma^3 \leq 0$ with respect to γ yields the following result: $\gamma \geq 0.786001$. Therefore, $(\partial^2 W/\partial \tau^2) < 0$ for all $\gamma > 0.786001$.

B: Proof of Propositions

Proof of Proposition 6.1. First, differentiating equilibrium outputs with respect to δ, we obtain

$$\frac{\partial q^M}{\partial \delta} = \frac{16(14\gamma - 3)\gamma^2 k}{3(224\gamma^3 - 276\gamma^2 + 90\gamma - 9)},$$

$$\frac{\partial q^E}{\partial \delta} = \frac{4\gamma(27 - 234\gamma + 612\gamma^2 - 448\gamma^3)k}{3(4\gamma - 3)(224\gamma^3 - 276\gamma^2 + 90\gamma - 9)},$$

$$\frac{\partial q^O}{\partial \delta} = -\frac{16\gamma^3 k}{(4\gamma - 3)(224\gamma^3 - 276\gamma^2 + 90\gamma - 9)},$$

$$\frac{\partial Q}{\partial \delta} = -\frac{4\gamma(4\gamma - 3)(14\gamma - 3)k}{3(224\gamma^3 - 276\gamma^2 + 90\gamma - 9)}.$$

From the above equations, we obtain: $(\partial q^M/\partial\delta) > 0$ for all $\gamma > 0.786001$, because of $(224\gamma^3 - 276\gamma^2 + 90\gamma - 9) > 0$ for $\gamma > 0.786001$. $(27 - 234\gamma + 612\gamma^2 - 448\gamma^3) > 0$ if $0.314277 < \gamma < 0.817104$ or $\gamma < 0.234691$, and $(27 - 234\gamma + 612\gamma^2 - 448\gamma^3) < 0$ if $0.234691 < \gamma < 0.314277$ or $\gamma > 0.817104$. Thus, $(\partial q^E/\partial\delta) > (<)\ 0$ if $\gamma < (>)\ 0.817104$. Also, we obtain $(\partial q^O/\partial\delta) < 0$ for all $\gamma > 0.786001$, because of $(224\gamma^3 - 276\gamma^2 + 90\gamma - 9) > 0$ for $\gamma > 0.786001$. $(\partial Q/\partial\delta) < 0$ for all $\gamma > 0.786001$, because of $(224\gamma^3 - 276\gamma^2 + 90\gamma - 9) > 0$ for $\gamma > 0.786001$. Second, it is easily found that the following relation holds: $(\partial\pi^i/\partial\delta) = \beta^i q^i(\partial q^i/\partial\delta)$ iff $\mathrm{sign}(\partial\pi^i/\partial\delta) = \mathrm{sign}(\partial q^i/\partial\delta)$ where $\beta^i = (1/8\gamma)(16\gamma - 9)$ for $i = M, E$ and $\beta^i = (1/2\gamma)(16\gamma - 9)$ for $i = O$. This implies that equilibrium final good price rises due to an increase in the content rate of ROO. These imply Proposition 6.1. Q.E.D.

Proof of Proposition 6.2. First, rearranging optimal external tariff τ^* (6.9), the following relation holds:

$$\tau^* \begin{cases} < 0 & \text{if} \quad k/\alpha > I_S((\delta/\alpha), \gamma) \\ \geq 0 & \text{if} \quad k/\alpha \leq I_S((\delta/\alpha), \gamma) \end{cases}$$

where

$$I_S((\delta/\alpha), \gamma) \equiv \frac{3(2\gamma - 1)(4\gamma - 3)}{2\gamma(4\gamma + 3)} + \frac{2(9 - 51\gamma + 56\gamma^2)}{\gamma(4\gamma + 3)(8\gamma - 3)} \times \frac{\delta}{\alpha} > 0.$$

Second, we verify that the area of import subsidy (i.e., negative external tariff) exists (δ/α)-(k/α) plane. When $\delta = 0$, constraint $\xi(\delta, \gamma)$ is $[3(4\gamma - 1)(4\gamma - 3)]/(9 - 66\gamma + 128\gamma^2)$. Thus, we obtain

$$\frac{3(4\gamma - 1)(4\gamma - 3)}{9 - 66\gamma + 128\gamma^2} - I_S\big|_{\delta=0} = -\frac{3(27 - 306\gamma + 1188\gamma^2 - 1776\gamma^3 + 896\gamma^4)}{2\gamma(3 + 4\gamma)(9 - 66\gamma + 128\gamma^2)} \equiv \varphi.$$

Solving $\varphi \geq 0$ with respect to γ, from numerical calculation, we obtain $0.75 \leq \gamma \leq 0.786001$. Thus, $I_S\big|_{\delta=0} > \xi(\delta = 0, \gamma)$ always holds for $\gamma > 0.786001$.
When $\delta = 1$, constraint $\xi(\delta, \gamma)$ is $(4\gamma - 3)/3(2\gamma - 1)$. Thus, we obtain

$$\frac{4\gamma - 3}{3(2\gamma - 1)} - I_S\big|_{\delta=1} = \frac{\alpha(-81 + 702\gamma - 2052\gamma^2 + 2352\gamma^3 - 896\gamma^4) - 12(-9 + 69\gamma - 158\gamma^2 + 112\gamma^3)}{6\alpha\gamma(9 - 30\gamma - 8\gamma^2 + 64\gamma^3)}.$$

Solving the denominator of the above equaton $(9 - 30\gamma - 8\gamma^2 + 64\gamma^3) \geq 0$ with respect to γ, we obtain $\gamma \geq 1/2$. From Assumption $(9 - 30\gamma - 8\gamma^2 + 64\gamma^3) > 0$ always holds. From the numerator of the above equation, $-12(-9+69\gamma-158\gamma^2+112\gamma^3)$ is always negative. And, solving $(-81+702\gamma-2052\gamma^2+2352\gamma^3-896\gamma^4) \geq 0$ with respect to γ, we obtain $0.75 \leq \gamma \leq 1.24099$. Thus, we obtain $\gamma < 1.24099$. We need the following condition:

$$\alpha > \frac{12(-9 + 69\gamma - 158\gamma^2 + 112\gamma^3)}{-81 + 702\gamma - 2052\gamma^2 + 2352\gamma^3 - 896\gamma^4} \equiv \rho.$$

Therefore, the area of *import subsidy* exists if $\gamma < 1.24099$ and $\alpha > \rho$ hold. The above relation implies Proposition 6.2. Q.E.D.

Proof of Proposition 6.3. Under the optimal external tariff policy, differentiating welfare function of country M with respect to δ, we obtain

$$\frac{\partial W}{\partial \delta} = 8k\gamma^2 \times \frac{3(4\gamma - 3)\alpha + [2(9 - 48\gamma + 56\gamma^2)\delta - (9 - 78\gamma + 112\gamma^2)]k}{3(4\gamma - 3)(224\gamma^3 - 276\gamma^2 + 90\gamma - 9)}.$$

$224\gamma^3 - 276\gamma^2 + 90\gamma - 9 > 0$ for $\gamma > 0.786001$. Thus, we consider only the case for which $\gamma > 0.786001$.

When $\delta = 1$,

$$\left.\frac{\partial W}{\partial \delta}\right|_{\delta=1} = \frac{8k\gamma^2\left[3(4\gamma-3)\alpha - 9(2\gamma-1)k\right]}{3(4\gamma-3)(224\gamma^3-276\gamma^2+90\gamma-9)}.$$

We obtain

$$\frac{4\gamma-3}{3(2\gamma-1)} > \frac{k}{\alpha} \Leftrightarrow \left.\frac{\partial W}{\partial \delta}\right|_{\delta=1} > 0.$$

When $\delta = 0$,

$$\left.\frac{\partial W}{\partial \delta}\right|_{\delta=0} = \frac{8k\gamma^2\left[3(4\gamma-3)\alpha - (9-78\gamma+112\gamma^2)k\right]}{3(4\gamma-3)(224\gamma^3-276\gamma^2+90\gamma-9)}.$$

We obtain

$$\frac{3(4\gamma-3)}{9-78\gamma+112\gamma^2} < \frac{k}{\alpha} \Leftrightarrow \left.\frac{\partial W}{\partial \delta}\right|_{\delta=0} < 0.$$

From the fact that $(4\gamma-3)/[3(2\gamma-1)] > [3(4\gamma-3)]/(9-78\gamma+112\gamma^2)$ and Lemma 6.1, the following relation holds: δ_m $(0 < \delta_m < 1)$ minimizes welfare of country M if and only if

$$\frac{3(4\gamma-3)}{9-78\gamma+112\gamma^2} < \frac{k}{\alpha} < \frac{4\gamma-3}{3(2\gamma-1)},$$

where

$$\delta_m = \frac{(9-78\gamma+112\gamma^2)k - 3(4\gamma-3)\alpha}{2(9-48\gamma+56\gamma^2)}.$$

Finally, let us verify that the welfare level is always positive for sufficiently large δ. Plugging δ_m into (W.2), we obtain

$$W|_{\delta=\delta_m} = \gamma \times \frac{4(5\gamma-3)(4\gamma-3)\alpha^2 + (16\gamma-9)\{3(2\gamma-1)k - 2[a-(4\gamma-3)c]\}k}{(4\gamma-3)(9-48\gamma+56\gamma^2)}.$$

If $\gamma \geq 1$, then $\alpha \equiv a - c \geq a - (4\gamma-3)c$. From this and the numerator of the above equation, $3(2\gamma-1)k - 2\alpha \geq 0$ iff $k/\alpha \geq 2/[3(2\gamma-1)]$. Comparing $2/[3(2\gamma-1)]$ with $(4\gamma-3)/[3(2\gamma-1)]$ (the upper limit), we obtain the following relation: $(4\gamma-3)/[3(2\gamma-1)] > 2/[3(2\gamma-1)]$ for all $\gamma > 5/4 = 1.25$. As long as $\gamma > 1.25$, $W|_{\delta=\delta_m} > 0$ obviously holds. Therefore, Proposition 6.3 holds. Q.E.D.

Chapter 7

Conclusion and Future Research

In this thesis, we focused on the protectionist nature of ROO and examined the effects of it on firms' behavior and each country's social welfare under international oligopolistic competition. Specifically, we pointed out three issues in the existing literature on RTA with ROO: first, "policy interaction between ROO and subsidy policy"; second, "exporting firms' strategic choice of compliance with ROO"; and third, "exporting firms' R&D activities in the presence of ROO." Considering these three issues, we obtain distinct results.

In chapter 3, we considered two game types (in the first, the exporting country within an FTA offers production subsidies for its firm, and in the second, the final good importer within the FTA decides a content rate of ROO) in a three-country oligopolistic framework. We obtained the following three results. First, in the first game type, the government of the exporting country within the FTA imposes an export tax on its firm. Second, in the second game type, that government offers a positive production (or export) subsidy for its firm. Third, in both game types, a reduction in the external tariff may increase the profit of the intra-regional exporting firm. To summarize, we demonstrated the relationship between ROO and subsidy policy in the situation of FTA with ROO. Our second result is particularly important. Other studies have overlooked the possibility of subsidization in the exporting country within an FTA.

To advance our research in this chapter (Issue 1), it is necessary to examine the following two assumptions: The first assumption is to employ a specific trade flow in the intermediate good. That is, the final good producer located in the final good-importing country within the FTA is not allowed to procure from a cheaper source of intermediate good (i.e., outside of the FTA). Although this is a useful setting in order to emphasize the protectionist nature of ROO, it is not necessarily a general setting. The second assumption is the number of final good producers. If the number of outside firms is relatively large, the effects of a reduction in the external tariff may possibly changes. Moreover, the effects of a change in the content rate of ROO may possibly change when the number of exporting firms within the FTA is relatively large. These two points are less examined in this chapter.

In chapter 4, we considered the relationship between endogenously determined ROO and the external tariff in a situation of three-country and two-way oligopolistic trade. Our results are summarized into the following three points: First, there is a positive relationship between ROO and the external tariff under a two-way oligopolistic intra-FTA trade model. Second, we demonstrated a condition that is needed to improve member countries' social welfare when an external tariff is changed. Third, we demonstrated how the relationship between the effects of ETR and market structure arises. Our main contributions are summarized into the following three points. First, we treat ROO as an endogenous variable of RTA members. Second, we show that a sufficiently small market size is needed to enhance the welfare in members. Third, we demonstrate the relationship between the effects of external tariff reduction and market structure.

To advance our research in this chapter (Issue 1), it is necessary to examine the assumption that the member countries within the RTA are perfectly symmetric. This assumption is a useful device to omit bargaining process in the decision on the ROO requirement, because the realized content rate of ROO is the same in both members, and the uniform level of the requirement is the ROO requirement in their RTA. However, this device is not necessarily appropriate when we examine an FTA with ROO, because the external tariff rate is generally different among FTA members. To advance our research, it is necessary to consider asymmetric member countries and introduce some bargaining processes in the decision on the ROO requirement (e.g., Nash bargaining solution). This point is less examined in this chapter.

In chapter 5, we focused on the strategic choice of exporting firms that face two alternatives: compliance or non-compliance with ROO. This chapter presents the following three results: First, a heterogeneous regime occurs when the content rate of ROO is not too high compared to the external tariff rate. Second, if either exporter complies with ROO, the welfare level of the final good importer within the RTA is the worst among any other cases. Third, a tightening of ROO may reduce the profits of all final good-producing firms. These results are summarized into the following two contributions: First, in contrast to Demidova and Krishna (2008), we demonstrated that a heterogeneous regime arises among homogeneous exporting firms under a strategic situation. It is demonstrated that productivity asymmetry is not necessarily needed to cause a heterogeneous regime. Second, we demonstrated that a tightening of ROO may reduce the profits of all final good-producing firms. This point crucially differs from Ju and Krishna (2005). Since complying and non-complying firms arise in the preferential trade area, it is more important to consider a conflict between intra-regional firms.

To advance our research in this chapter (Issue 2), it is necessary to examine the assumption that the number of firms located in the exporting country within the RTA is two. This assumption has no importance if we focus on the strategic choice of homogeneous firms. However, the number of firms located in the exporting country within the RTA is an important issue when we consider the proportion of firms that comply with the ROO requirement. To examine an endogenous rate of complying firms, we must relax this assumption (i.e., the number of firms located in the exporter within the RTA is two) and deal with many firms. This point is less examined in this chapter.

In chapter 6, we focused on the final good producers' R&D competition in the presence of ROO. We expanded a standard framework of R&D competition with cost asymmetry (Lahiri and Ono, 1999; Barros and Nilssen, 1999) to the situation of FTA with ROO. This chapter presents the following three results: First, an increase in the ROO requirement increases the output, R&D investment, and profit of the exporting firm within the FTA if the efficiency of R&D is sufficiently high. Second, the government of the final good-importing country within the FTA gives an import subsidy to the outside firm when the efficiency of R&D is not too high and intra firms' productivity is sufficiently low. Third, the ROO requirement may minimize the welfare in the final good importer within the FTA. These results are summarized into the following two points: First, it is demonstrated that the rent-shifting effects of ROO do not necessarily harm exporting firms that comply with ROO. Second, we extended the argument of welfare-enhancing production substitution effects to the situation of FTA with ROO. These points are more important compared to the analyses of the existing literature when we consider the protectionist nature of ROO in an imperfect competitive market.

To advance our research in this chapter (Issue 3), it is necessary to examine the following two assumptions. The first assumption is singular policy decision in the final good-importing country. That is, we assume only "the optimal external tariff policy in the final good importer within the FTA." If we consider the possibility of the other countries' intervention, such as is seen in the analysis in chapter 3, then many results in this chapter may be modified. Consideration of R&D subsidy may be particularly important. R&D subsidy is an important industrial policy. However, this policy is not necessarily examined in the existing literature on R&D competition. The second assumption is to employ a specific trade flow in the intermediate good. This point is same as in chapter 3, and it needs to be relaxed. These two points are less examined in this chapter.

For future research beyond our three issues, here, we comment on two advanced topics on RTA with ROO. First is a political-economy aspect of the RTA with ROO. This aspect is mainly argued by Cadot, de Melo, and Olarreaga (1999), and Duttagupta and Panagariya (2007). They considered the lobbying activity of final good producers within the RTA under a perfect competitive situation. However, it is important to consider lobbying activity for ROO under imperfect competition. When the final good market is oligopolistic, firms pursue expansion of their market share, and may undertake more severe lobbying activity for those governments, compared to the case of perfect competition.

Second is an optimal location decision. In this thesis, we basically assume that final good-producing firms simply have the option of export. Although we introduce cost-reducing R&D competition in chapter 6, we do not examine another important investment activity of firms. Generally speaking, firms may undertake FDI in order to procure a cheaper input and reduce the cost of compliance with ROO. This FDI decision of firms is not sufficiently examined in the existing literature. It is necessary for our future research to take into account this cross-border investment activity of firms.

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