Export, Foreign Direct Investment and Local Content Requirement*

Larry D. Qiu
Hong Kong University of Science and Technology

Zhigang Tao
The University of Hong Kong

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Abstract

Local content requirement (LCR) is a popular government regulation on foreign direct investment (FDI). This paper investigates the design of optimal LCR policy. LCR affects multinationals' international strategies, namely FDI and export. We find that a less efficient or more vertically integrated firm is more likely to adopt the FDI strategy over the export strategy. By taking the endogeneity of a firm's international strategy into account, we characterize conditions under which the host government's optimal LCR policy results in one of the following equilibria: (i) all firms make FDI, (ii) all firms choose export, and (iii) some make FDI and others choose export.

Key Words: Export, FDI, Local content requirement, Tariff, Multinationals.
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Correspondence to: Larry D. Qiu, Department of Economics, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong. Fax number: +(852)2358-2084. Email: larryqiu@ust.hk.

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"There is little chance that companies trying to do business in the developing world will escape this rising tide of local content demands."

Wall Street Journal (31 July 1984).

1. Introduction

The world has become more and more integrated. Among others, the two most important contributors to the world integration are international trade and foreign direct investment (FDI). It is apparent that multinational enterprises (MNEs) play a critical role in these two areas. However, both trade and FDI are subject to various types and degrees of government regulations. While trade policies have been intensively studied in the literature, FDI policies have not. This paper focuses on local content requirement (LCR), which is an FDI policy, and examines its impacts on MNEs' *international strategies*, i.e., export and FDI.

It is commonplace that FDI host countries impose LCR regulations on FDI. As reported by UNIDO (1986, p10), in a sample of 50 countries, 27 (or 54%), mostly developing countries, have LCR policies for the FDI in automotive industry alone in 1980. LCR is also found in many other sectors such as pumps and consumer durables (UNIDO, 1986, pp2-3). Overall, more and more developing countries are introducing LCR to a growing number of sectors. A typical LCR policy requires a firm to use a certain proportion of locally made inputs (e.g., parts and components in the auto industry) in its final goods production. The percentage of local input ranges from 15% to as high as 100%.[1] In most cases, LCR is born in a country at a time when the country is adopting an import substitution policy in a particular industry. LCR is popular also because it is perceived to bring a lot of benefits to the host country such as reducing industry dependence on foreign companies, enhancing technology transfer to local

[1] Detailed information can be found in Table 3 contained in UNIDO (1986). More recently in China, a joint venture in auto production is required to meet 40-50% local content in early periods, and the standard progresses to 80-90% within a few years of operation.

firms, raising employment and labor skill, and improving the country's balance-of-payments.[2] However, designing an appropriate LCR policy is not trivial. For example, it is difficult to predict the extent of protection of the LCR policy[3] and there is often uncertainty associated with the future international structure of the industries concerned (e.g., the relationship between car assemblers and their parts suppliers).[4] In this paper, we examine the design of optimal LCR policy in anticipation of the policy's impact on MNEs' decisions.

MNEs from the same industry may take different international strategies to enter the same market. We argue that other things being equal, firms who differ in production cost or in the degree of vertical integration may choose different international strategies *if* the host country has an LCR policy in the industry concerned. Consider a case in which there are two firms, 1 and 2, and firstly suppose firm 1's production cost is lower than firm 2's. If they make FDI, both firms' costs will increase since they have to use the more expensive local components. However, the relative cost increase for firm 1 is higher than that for firm 2 as firm 1's initial cost is lower.[5] In the jargon of international business, the location advantage of FDI for firm 1 is lower than that for firm 2. Then, for a certain range of tariff we will see firm 1 choosing export and firm 2 making FDI. Second, suppose firm 1's vertical integration is lower than firm 2's. Then with FDI, both will produce some parts in the host country. To satisfy LCR, firm 2 still has to purchase some local components, but less than firm 1 does. Consequently, the cost increase for firm 1 is higher than that for firm 2, giving firm 1 smaller location advantage than firm 2. Therefore, for a certain range of tariff we will see firm 1 choosing export and firm 2 making FDI.

The endogeneity of MNEs' international strategies complicates the design of optimal LCR policy. In designing the policy, the host government realizes the following policy effects. FDI brings to the host country some benefits as discussed before and LCR enlarges these benefits. However, LCR also discourages FDI as it reduces the location advantage of FDI. Moreover, LCR raises FDI-firms' costs and thus lowers consumer surplus. Finally, the host country loses tariff revenue if the MNEs choose FDI over export. We characterize conditions under which the host government's optimal LCR policy results in one of the following equilibria: (i) all firms make FDI, (ii) all firms choose export, and (iii) some make FDI and others choose export.

[2] For more discussion see UNIDO (1986, pp6-7).

[3] This is one of the most important conclusions obtained by Grossman (1981).

[4] UNIDO (1986, pp13-14) has more discussion on this.

[5] The following hypothetical example roughly illustrates this point. Suppose that without FDI, firm 1 spends \$100 and firm 2 \$200 on components. The LCR policy requires that a firm must use at least 50% of the local parts which costs \$200. As a result, with FDI, firm 1's cost becomes \$250, a 150% increase, and firm 2's cost becomes \$300, a 50% increase.

Although LCR is an important policy towards FDI, it has received little attention in the literature. Grossman (1981) systematically analyzes the effects of content protection on resource reallocation, with a particular focus on the intermediate goods. He finds that conclusion about the degree of protection which LCR gives to the domestic intermediate goods is hard to make as the degree depends on the substitution possibilities in production, the supply conditions in the domestic intermediate good industry, and the market structure for that good. Most recently, Lahiri and One (1998) focus on the welfare implication of FDI and investigate the host country's optimal policy combination, which includes a profit tax/subsidy and an LCR on FDI. They characterize the optimal LCR policy, which depends on the number of domestic firms, the number of foreign MNEs, and the firms' costs. They find that it is optimal to tax the profits of the foreign MNEs if and only if the local costs is higher than twice the foreign costs.[6]

Although our study also deals with LCR, it explores issues that are different from those in the literature. Like us, Lahiri and Ono, whose 1998 study is the only exception in the literature, also investigate the optimal LCR. However, we have a different focus. They emphasize the optimal profit tax in combination with LCR, while we stress questions of when and why the optimal LCR should induce all firms to export, all firms to take FDI, or some to export and others to take FDI.

To the best of our knowledge, none of the existing studies explains why and how LCR affects MNEs' FDI/Export decisions differently.[7] Researchers in international business and international trade have attempted to explain why MNEs invest abroad, instead of exporting their products or licensing their technologies to foreign countries.[8] According to the well-known OLI framework,[9] an MNE will choose FDI over export and licensing if there are ownership advantage, location advantage and internalization advantage. Because these factors vary from

[6] In between Grossman (1981) and Lahiri and Ono (1998) there are also some other studies related to LCR, which include Davidson, Matusz and Kreinin (1985), Hollander (1987), Krishna and Itoh (1988), Richardson (1991, 1993), Chao and Yu (1993), and Lopez-de-Silanes, Markusen and Rutherford (1996). However, none of them considers asymmetric international strategies and optimal LCR policy. See Belderbos and Sleuwaegen (1997) for a very brief survey.

[7] Grossman (1981) assumes competitive final good market and Lahiri and Ono (1998) assume identical foreign MNEs. Hence, their models necessarily exclude this issue.

[8] The literature of MNEs and FDI is very large and still growing. Early contributions are made by researchers from the field of international business, including Hymer (1976), Dunning (1977, 1981) and Caves (1982). International economists also contribute to this literature, particularly with formal economic models. They include Helpman (1984), Markusen (1984), Ethier (1986), Horstmann and Markusen (1987, 1992, 1995), Brainard (1993) and Ethier and Markusen (1996). Markusen (1995) has a nice survey of the literature, paying particular attention to research and models produced by international economists.

[9] OLI stands for ownership, location and internalization. This framework was proposed by Dunning (1977, 1981).

country to country and from industry to industry, we can easily observe that different countries attract different amounts of FDI, and different industries of the same country receive various levels of FDI. It is equally transparent that MNEs from different countries or different industries have different incentives to make FDI.[10] In this paper, we explain why MNEs in the *same* industry take *different* international strategies (i.e., FDI and export) to enter the *same* market.[11] As discussed above, we identify two possibilities that give rise to the asymmetric strategies. We show that other things being equal, firms that differ in production cost or degree of vertical integration will realize different levels of FDI location advantage and thus may adopt different international strategies.[12]

The rest of the paper is organized as follows. In section 2, we lay out the model and analyze asymmetric MNEs' responses to LCR. In section 3, we investigate the optimal LCR policy under various situations. In section 4, we give our concluding remarks.

2. The Choice between FDI and Export

2.1. Cost difference

[10]In their empirical study, Mody and Srinivasan (1998) find that the Japanese MNEs and the U.S. MNEs behave differently in their FDIs. Feinberg, Keane and Bognanno (1998) find that the U.S. MNEs that have invested in Canada respond to Canadian tariff changes differently.

[11]There are lots of examples of this sort. To illustrate, let us look at China's auto industry. In 1979, China began its economic reform and opened up its door for both foreign trade and investment. Before 1979, the domestic auto industry was able to survive under extremely high protection. But its technology and efficiency were many decades behind those in advanced countries. While trade protection remained high in the 1980s, foreign capital started to flow into this industry. FDI in auto assembly started in 1983, with AMC Jeep Corporation investing in a joint venture named Beijing Jeep to produce jeeps. (AMC was later purchased by Chrysler Corporation in 1987.) In 1984, Volkswagen AG invested in a joint venture called Shanghai Volkswagen Automotive to produce passenger cars. In the early years (before 1994), the door was open for all foreign investors, but the world's leading auto-makers took different strategies towards this market: While Chrysler (U.S.), Volkswagen (Germany) and Citroen-Peugeot (France) invested quickly and heavily in the country, others such as GM (U.S.), Ford (U.S.), Toyota (Japan) and Honda (Japan) relied on export to compete in this market. GM, Ford, Toyota and Honda had their investments in motorcycle, minivan, or parts and components, but not in passenger car production. Recently, they all had changed their mind and have been waiting eagerly for the Chinese government's approval for new investment in this sector, but only GM and Honda got a deal. This clear, interesting pattern of international strategies deserves a close look. In particular, it begs the question of why firms in the same industry enter the same market via different strategies, some using FDI and others using export.

[12]Internalization advantage is used to explain the choice of FDI over licensing. Ownership advantage is a necessary, but not sufficient, condition for choosing FDI over export. Since we only compare FDI and export strategies and we know that all foreign auto-makers have ownership advantage, we can just focus on the location advantage.

There are two multinational enterprises, henceforth referred to as firm 1 and firm 2. They produce a homogeneous product and consider entry to the market of another country, called the host country. Each firm can enter the host country's market via export or FDI.[13] To focus on these firms' choices of international entry strategy, we assume away any local firm of the host country.[14] Demand in the host market is characterized by $P = P(q_1 + q_2)$, where q_i is the quantity produced by firm i (where $i = 1, 2$) and $P(\cdot)$ has the usual properties.

Generally, in modern manufacturing industries such as the automobile industry, a final product is assembled from a set of parts and components. Thus the production cost includes the cost of parts and components and that of the assembly. Since separation of these two types of cost will not change any of our results, we only consider the cost of parts and components so as to focus on the implications of the LCR policy. For simplicity, we assume that there is no fixed cost of production and each firm's marginal cost of production (denoted by c_i) is constant.

Before entering the host market, each firm has two ways to obtain parts and components in its home market. One is to purchase the parts and components from its domestic parts suppliers (market transaction),[15] and the other is to have internal production of parts and components (vertical integration). These two ways will be shown to have rather different implications for a firm's FDI decision when an LCR policy is imposed. We consider the case of market transaction in this subsection and the case of vertical integration in subsection 2.2.

If firm i chooses to export, then it faces a specific tariff, t, imposed by the host government.[16] This is equivalent to adding t to the unit cost of firm i.

If firm i makes FDI, then it must comply with the LCR policy imposed by the host government. An LCR policy specifies that in the final good production a certain fraction, denoted by $\lambda \in [0, 1]$, of input must be locally made.[17] Moreover, with the satisfaction of LCR, there is no

[13] We exclude the consideration of licensing. Among the papers on LCR, Grossman (1981) does not analyze entry decisions and Lahiri and Ono (1998) do not consider export and licensing.

[14] In the case of Volkswagen's FDI in China, "competition from other domestic car makers has yet to become the major threat to VW's business in China. More than domestic competition, VW feels it is imports that are having the biggest impact on sales, especially Japanese and South Korean cars." (EIU, 1996, p3). In 1995, the Chinese market had 322,000 domestically made cars (more than 90% are made by FDI joint ventures) and 158,000 imported cars (EIU, 1997, p2). Furthermore, including host country's firms will not affect the results of this section, but will complicate the analysis in section 3.

[15] The two multinational enterprises may or may not come from the same country. Even if both firms purchase parts and components from the same market, they normally do not have the same set of parts suppliers and therefore their production costs could still be different.

[16] Here tariff represents the costs associated with export. In general, export costs also consist of transportation cost and others caused by non-tariff barriers.

[17] In practice, failing to meet the LCR results in punitive tariffs levied on the firms' imports of parts and components. To have a better focus, we simply assume that the punitive tariffs are so high that a firm will never violate the LCR if it chooses FDI.

tariff on the import of the remaining parts and components. Let $\bar{c}$ be the unit cost of production if a firm uses all local parts and components in production. For LCR to be meaningful, assume that $\bar{c}$ is higher than c_1 and c_2.[18] Then, with the LCR policy, a firm that chooses the FDI strategy will only use the local parts and components up to λ and import the rest from its home market. Thus, the unit cost of production for firm i is $\lambda\bar{c} + (1-\lambda)c_i$.[19]

For ease of exposition, we introduce a variable, z_i, to capture firm i's international strategy with $z_i = 0$ representing export and $z_i = 1$ for FDI. Then, based on the above discussion on costs, we obtain the unit cost function of firm i as[20]

$$C_i \equiv \lambda z_i \bar{c} + (1 - \lambda z_i)c_i + (1 - z_i)t, \;\; \lambda \in [0,1], \; z_i = \{0, 1\}.$$

Accordingly, the profit function of firm i is $\pi_i = (P - C_i)q_i$.

Firm 1 and firm 2 play a two-stage game: at the first stage they choose the international strategies while at the second stage they compete in the market by choosing their levels of output. In the first stage of the game, there are four possible outcomes: (E, E), (E, I), (I, E) and (I, I), where E denotes export, I denotes FDI, and the first (second) component of a combination represents the international strategy of firm 1 (firm 2). We follow the backward induction principle by first considering the quantity competition between the two firms given their international strategies and then investigating the equilibrium international strategies.

Given the international strategies in the first stage, i.e. (z_1, z_2), the firms engage in a Cournot competition in the second stage. The equilibrium output levels are determined by the following first-order conditions:

$$P'q_i + P - C_i = 0, \quad i = 1, \; 2. \tag{1}$$

We assume downward sloping reaction curves and satisfaction of the stability conditions, which

[18] Both Grossman (1981) and Lahiri and Ono (1998) make this assumption without necessarily giving any justification. But perhaps it is more natural to consider that the locally produced parts and components are of lower quality than what firm 1 and firm 2 can obtain from their own markets. In this case, we say that the quality-adjusted unit cost of local parts and components is higher than c_1 and c_2. Woodard and Zhu (1994) provide an example in which local parts suppliers license foreign technology and import foreign materials to improve their product quality, of course, at higher costs.

[19] Lahiri and Ono (1998) also use this cost structure under LCR. However, Grossman (1981) distinguishes between LCR defined in physical term and that defined in value term since he wants to examine their different impacts on the up-stream industry. Nevertheless, determining local content in value term is nebulous as figures can be manipulated by exaggerating the value of local parts and components. Grossman (1981) avoids this by assuming exogenous prices for both intermediate and final products.

[20] While export involves some transport cost, FDI requires a fixed set-up cost. However, the effects of these costs on a firm's choice of international strategy are obvious: transport cost discourages export and FDI fixed cost discourages FDI. To focus on more important issues, we omit these two costs in our model.

are

$$P''q_i + 2P' < 0, \quad P''q_i + P' < 0, \text{ and}$$

$$A \equiv (P''q_1 + 2P')(P''q_2 + 2P') - (P''q_1 + P')(P''q_2 + P') > 0.$$

Although z_i is a discrete variable, for analytical convenience we treat it as a continuous one in the following analysis. By differentiating the first-order condition (1) with respect to z_1, we have

$$(P''q_1 + 2P')\frac{\partial q_1}{\partial z_1} + (P''q_1 + P')\frac{\partial q_2}{\partial z_1} = \frac{\partial C_1}{\partial z_1},$$

$$(P''q_2 + P')\frac{\partial q_1}{\partial z_1} + (P''q_2 + 2P')\frac{\partial q_2}{\partial z_1} = 0.$$

Similarly we differentiate the first-order condition with respect to z_2 to get another equation system. Solving these equation systems together, we obtain

$$\frac{\partial q_i}{\partial z_j} = -\frac{\partial C_j}{\partial z_j}(P''q_i + P')/A, \quad i \neq j. \tag{2}$$

Then using the first-order condition and (2), we obtain

$$\frac{\partial \pi_i}{\partial z_i} = -q_i \left[1 + \frac{P'(P''q_j + P')}{A}\right] \frac{\partial C_i}{\partial z_i}.$$

Thus,

$$\text{sgn}\left(\frac{\partial \pi_i}{\partial z_i}\right) = -\text{sgn}\left(\frac{\partial C_i}{\partial z_i}\right), \tag{3}$$

where

$$\frac{\partial C_i}{\partial z_i} = \lambda(\bar{c} - c_i) - t. \tag{4}$$

Recall that firm i's unit cost is $\lambda\bar{c} + (1-\lambda)c_i$ in the case of FDI and $c_i + t$ in the case of export. The difference between the two unit costs is $\lambda(\bar{c} - c_i) - t$. Thus the right-hand side of (4) represents the extra cost of production under FDI as compared with export. If this extra cost is negative, then it is optimal for firm i to choose FDI (or $z_i = 1$). Otherwise, it is optimal for firm i to choose export (or $z_i = 0$).[21] The above analysis leads to the following result:

Proposition 1 : *Firm i's optimal decision is $z_i = 0$ $(= 1)$ if $\lambda(\bar{c} - c_i) - t \geq$ $(<)$ 0. If $c_1 < c_2$ and given that t is not too big, then as λ decreases from one to zero, sequentially we will observe the following equilibrium international strategy combinations: (E, E), (E, I), (I, I).*

[21] Assuming that a firm will choose export when it is indifferent between export and FDI.

If there is only one firm contemplating entry to a host country's market, it is clear that its choice between export and FDI depends upon their relative cost. However, it is interesting to note that, even when there are two firms, one firm's international strategy is independent of the other firm's. While this result is obtained under several simplified assumptions, the intuitive appeal of this result is quite strong.

Given the cost parameters (i.e., $\bar{c}, c_1$ and c_2), the equilibrium outcome is determined by the interplay of the tariff policy and the LCR policy. Given an LCR, a firm is more likely to choose FDI over export if the tariff is higher. This tariff-jumping motive for FDI has been well-known in the literature. Let us focus on the impact of the LCR policy, given a positive but not too large t. In the absence of LCR, (I, I) is the only equilibrium. This is because, by choosing FDI, each firm avoids the cost of export but does not incur any cost of FDI. For a similar reason, (I, I) is still the equilibrium so long as λ is small. If, however, λ becomes large, FDI cost is higher than export cost for both firms and (E, E) turns out to be the equilibrium. Formally, we can see that $\lambda(\bar{c} - c_i) - t$ is negative for small λ but positive for large λ. More interestingly, for intermediate λ, asymmetric strategies could be the equilibrium. Note that the firms face the same export cost (i.e., tariff) but different FDI costs. With the LCR policy in place, both firms must use the same proportion of locally produced, high cost parts and components. But relatively speaking, the resulting cost increase for firm 1 is higher than that for firm 2 since without the LCR firm 1's cost is lower. Thus, the LCR policy adversely affects firm 1 more than firm 2. This leads to the asymmetric strategies, (E, I), in equilibrium. Formally, this occurs when $t/(\bar{c} - c_1) < \lambda \leq t/(\bar{c} - c_2)$, in which $\lambda(\bar{c} - c_1) - t > 0$ but $\lambda(\bar{c} - c_2) - t < 0$.

In summary, the two firms' choices of international strategy depend on the interplay between their costs of production and the host government's tariff and LCR policies. Although facing the same set of policies, the firms may adopt different strategies because they have different costs of production. Lowering the LCR induces firms to carry out FDI. However, the firm that first switches from export to FDI is the high-cost firm, which may or may not be desirable from the host country's point of view.

2.2. Difference in degree of vertical integration

In this subsection, we consider an alternative case in which before entering the host market each firm produces a certain fraction, denoted by $v_i \in [0, 1]$, of parts and components for its final good production and purchases the rest from its domestic suppliers. Our objective is to show that the difference in the degree of vertical integration between the two firms also affects their international strategies. It is not impossible that different degrees of vertical integration may result in different costs of production, but we rule out this case because we have already investigated the relationship between cost difference and optimal international strategy in subsection 2.1. To isolate the effect of vertical integration on international strategy, we assume $c_1 = c_2 \equiv c < \overline{c}$ in this subsection.

With (partial) vertical integration, each firm can satisfy the LCR in two ways. It can produce parts and components in the host country, or it can buy them from local parts suppliers.[22] For simplicity, we assume that a firm with production of parts and components in its home market can replicate the production in the host market at the same cost. This implies that, for firm i to meet the LCR in the host country, it prefers producing parts and components in the host country over purchasing local parts and components.[23] If the firm's degree of vertical integration is higher than the LCR, then it will not purchase any local parts and components. Clearly, it is more interesting to focus on the case in which each firm's vertical integration is not as high as that required by the policy, i.e., $v_i < \lambda$. Then, for firm i to meet the LCR, it will produce v_i in the host market, buy $(\lambda - v_i)$ from the local suppliers, and import the remaining from home. Thus, firm i's unit cost of production can be expressed as:

$$C_i = z_i v_i c + z_i(\lambda - v_i)\bar{c} + (1 - \lambda z_i)c + (1 - z_i)t, \quad \lambda \in [0, 1],\ v_i \in [0, \lambda)\ z_i = \{0, 1\},$$

where as before $z_i = 0$ represents export and $z_i = 1$ represents FDI.

As in subsection 2.1, the two firms engage in a two-stage game: first choosing the international strategies and then playing a quantity-competition game. The analysis is also similar: the equilibrium quantities of production are determined by (1), and the firms' equilibrium choices of international strategy are characterized by (3). The only difference between the analysis here and that in subsection 2.1 lies in the firms' costs: equation (4) is replaced by

$$\frac{\partial C_i}{\partial z_i} = (\lambda - v_i)(\bar{c} - c) - t. \tag{5}$$

Immediately, we have:

Proposition 2 : *Firm i's optimal decision is* $z_i = 0$ $(= 1)$ *if* $(\lambda - v_i)(\bar{c} - c) - t \geq$ $(<)$ 0. *If* $v_1 < v_2$ *and given that* t *is not too big, then as* λ *decreases from one to zero, sequentially we will observe the following equilibrium international strategy combinations: (E, E), (E, I), (I, I).*

[22] In most countries, an LCR policy requires a multinational enterprise to use a certain percentage of parts and components produced *locally*, regardless whether the production is carried out by local producers or the multinational enterprise itself.

[23] Volkswagen's China joint venture, Shanghai Volkswagen, produces engines by itself.

The intuition is the same as that behind Proposition 1. By making FDI, firm i avoids paying a tariff t but its production cost increases from c to $v_i c + (\lambda - v_i)\bar{c} + (1-\lambda)c$, that is, a net increase of $(\lambda - v_i)(\bar{c} - c)$. Thus, given that t is not too big, both firms choose FDI for sufficiently low λ, and they both choose export for sufficiently high λ. However, for the intermediate range of λ, $v_1 + t/(\bar{c} - c) \leq \lambda < v_2 + t/(\bar{c} - c)$, the two firms choose different international strategies. The driving force for the asymmetric international strategies is the difference in the degree of vertical integration between the two firms, as opposed to the cost difference in the case of subsection 2.1. Specifically, although the two firms face the same export cost (i.e., tariff), they incur different FDI costs, $(\lambda - v_1)(\bar{c} - c)$ for firm 1 and $(\lambda - v_2)(\bar{c} - c)$ for firm 2, where the former is higher than the latter. Intuitively, as firm 2 has a higher degree of vertical integration, it can produce a higher percentage of parts and components in the host country thereby alleviating the adverse effect of the LCR policy. Thus, as the host country lowers the LCR, the more vertically integrated firm switches from export to FDI before the less vertically integrated firm does.

3. Optimal LCR Policy

In the preceding section, we have analyzed how, in the presence of the tariff and LCR policies, firms choose between export and FDI to enter another market. In this section, we investigate how the host government should set its LCR policy to maximize the host country's social welfare. We focus on the LCR policy rather than the tariff policy because the former is much less understood than the latter. Recall from Propositions 1 and 2 that, given that t is not too big, the following three scenarios arise sequentially as the LCR decreases from one to zero: (1) both firms choose export, (2) firm 1 chooses export and firm 2 carries out FDI, and (3) both firms carry out FDI. Note that the firms' entry strategies affect the host country's welfare, in three ways. First, they determine the equilibrium price of the final product and consequently the host country's consumer surplus. Second, they affect the host government's tariff revenue. Third, they affect the benefit that the host country receives from inward FDI. The host country benefits more with the imposition of LCR policy. For example, with the LCR policy, FDI generates employment in the host country and creates demand for locally produced parts and components thereby benefiting the upstream industry in the host country. This positive externality, which is associated with FDI exclusively, is called the FDI benefit.[24] We use the term $\lambda s(z_1 q_1 + z_2 q_2)$ to capture this benefit, where the non-negative parameter s

[24]Lahiri and Ono (1998) also include this FDI benefit in the host country's welfare function.

measures the degree of the externality. Intuitively, the magnitude of the FDI benefit depends positively on the total production by the two firms in the host country and the level of the LCR policy.

In summary, we have the following welfare as the host government's objective function:

$$W = \lambda s(z_1 q_1 + z_2 q_2) + CS + t[(1 - z_1)q_1 + (1 - z_2)q_2], \tag{6}$$

where $CS = \int_0^{q_1+q_2} [P(Q) - P(q_1 + q_2)]\mathrm{d}Q$ is the consumer surplus.[25] The host government chooses λ to maximize W. To derive the optimal LCR policy, we need to know how λ affects the firms' entry strategies, which has been studied in section 2 and summarized in Propositions 1 and 2. We also need to know how λ affects the equilibrium outputs and consequently the three terms in (6). For simplicity of analysis, we assume a linear demand curve, $P = a - b(q_1 + q_2)$, where a and b are positive constants with a being sufficiently large.[26] Then, using the first-order condition (1), we can derive the Cournot equilibrium outputs and the consumer surplus:

$$q_1 = \frac{a - 2C_1 + C_2}{3b}, \quad q_2 = \frac{a - 2C_2 + C_1}{3b}, \quad \text{and} \quad CS = \frac{b(q_1 + q_2)^2}{2}. \tag{7}$$

Differentiating the first-order condition (1) with respect to λ yields

$$-2b\frac{\partial q_1}{\partial \lambda} - b\frac{\partial q_2}{\partial \lambda} = \frac{\partial C_1}{\partial \lambda}, \quad \text{and} \quad -b\frac{\partial q_1}{\partial \lambda} - 2b\frac{\partial q_2}{\partial \lambda} = \frac{\partial C_2}{\partial \lambda}. \tag{8}$$

It follows that

$$\frac{\partial q_1}{\partial \lambda} = \frac{1}{3b}\left(-2\frac{\partial C_1}{\partial \lambda} + \frac{\partial C_2}{\partial \lambda}\right), \quad \text{and} \quad \frac{\partial q_2}{\partial \lambda} = \frac{1}{3b}\left(-2\frac{\partial C_2}{\partial \lambda} + \frac{\partial C_1}{\partial \lambda}\right). \tag{9}$$

Note that the welfare function W is not continuous in λ as z_i switches from 1 to 0. Therefore we cannot use the first-order approach to derive the optimal LCR policy. Nevertheless, what we would like to know is not the exact level of the optimal LCR but rather the firms' entry strategies at the optimal LCR. It turns out that such a characterization of the optimal LCR can be obtained with the following strategy of analysis. Denote the optimal LCR (i.e., the λ that maximizes W in (6)) by λ^{opt}, and denote the λ that maximizes the sum of the FDI benefit and the consumer surplus (i.e., the first and second terms of W in (6)) by λ^*. The first step of our analysis is to examine the relationship between λ^* and λ^{opt}. This allows us to see clearly

[25] Note that profits are not included in the welfare function as there is no domestic producer of the final product. As pointed out before, t is a term representing all the costs associated with export. In the case of transportation cost, there is no revenue generated to the host country.

[26] It is not uncommon in the literature that specific demand function is assumed for welfare analysis. See for example, Dixit (1988) and Markusen (1998).

how the tariff revenue (the third term of W in (6)) influences the optimal LCR. The second step is to characterize λ^* in terms of the firms' entry strategies under the optimal LCR policy.[27] We undertake this analysis for the case where the two firms have different costs of production in subsection 3.1 below, and for the case where the two firms have different degrees of vertical integration in subsection 3.2.

As for the first step, the impact of the tariff revenue on the optimal LCR is rather straightforward to analyze. For sufficiently small λ such that both firms choose FDI (scenario 1), there is no tariff revenue. For the intermediate range of λ under which firm 1 chooses export and firm 2 carries out FDI (scenario 2), the tariff revenue jumps from zero to tq_1. Furthermore, within this range of λ, firm 1's output can be shown to increase in λ, because firm 1's unit cost of production is constant with respect to λ but that of firm 2 increases in λ. It follows that in scenario 2 the tariff revenue increases in λ. Finally, for sufficiently large λ, both firms choose export (scenario 3) and the tariff revenue becomes $t(q_1 + q_2)$, which is constant with respect to λ as both firms's costs of production are independent of λ. However, this constant tariff revenue in scenario 3 is always higher than that for scenario 2. This is because tq_1 continously increases in λ as firm 2 switches its strategy from FDI to export. To summarize, the tariff revenue weakly increases in λ.

The tariff revenue as a monotonically increasing function of λ directly implies the following weak inequality: $\lambda^{opt} \geq \lambda^*$. Therefore, if we are able to know what the firms' international strategies would be at λ^*, we will have some idea about them at λ^{opt}. For example, one of the results derived in the rest of the paper is that for sufficiently large s and when the firms are sufficiently different, λ^* leads to scenario 2. Then, we immediately know that λ^{opt} will either keep the equilibrium entry strategies as in scenario 2, or move them to scenario 3, but scenario 1 is never an equilibrium. Other implications based on the results derived below can be similarly drawn.

Next, we shall focus on step 2, i.e., the characterization of λ^*.

3.1. The case of cost difference

In this subsection, we characterize λ^* (the λ that maximizes the sum of the FDI benefit and consumer surplus) in the framework of subsection 2.1 where the two firms have different costs

[27] An alternative sequential approach is to first study the effect of the consumer surplus on the optimal LCR and then characterize the λ that maximizes the sum of the FDI benefit and the tariff revenue. Sequential approaches are adopted because the joint maximization of the FDI benefit, consumer surplus and tariff revenue is too complicated to yield any clear-cut result.

of production ($c_1 < c_2$). Recall from Proposition 1 that firm i engages in FDI if and only if $\lambda(\bar{c} - c_i) < t$. Define two critical points $\lambda_i \equiv t/(\bar{c} - c_i),\ i = 1, 2$. Then, for $\lambda < \lambda_1$, both firm 1 and firm 2 engage in FDI (scenario 1); for $\lambda_1 < \lambda < \lambda_2$, firm 1 chooses export while firm 2 has FDI (scenario 2); for $\lambda \geq \lambda_2$, both firms choose export (scenario 3). Therefore,

$$C_i = \begin{cases} \lambda\bar{c} + (1-\lambda)c_i & \text{for } \lambda < \lambda_i, \\ c_i + t & \text{otherwise.} \end{cases} \tag{10}$$

$$\frac{\partial C_i}{\partial \lambda} = \begin{cases} \bar{c} - c_i & \text{for } \lambda < \lambda_i, \\ 0 & \text{otherwise.} \end{cases} \tag{11}$$

To make our analysis interesting, we confine to the case where all three scenarios are possible. In doing so, we require that $\lambda_2 < 1$, i.e.,

Condition 1: $t < \bar{c} - c_2$.

Differentiating CS with respect to λ yields:

$$\frac{\partial CS}{\partial \lambda} = b(q_1 + q_2)\left(\frac{\partial q_1}{\partial \lambda} + \frac{\partial q_2}{\partial \lambda}\right) = -\frac{1}{3}(q_1 + q_2)\left(\frac{\partial C_1}{\partial \lambda} + \frac{\partial C_2}{\partial \lambda}\right). \tag{12}$$

From (11), we know that firm i's cost increases in λ within $[0, \lambda_i)$ and becomes constant for $\lambda \geq \lambda_i$. It immediately follows from (12) that the consumer surplus decreases in λ over $[0, \lambda_2)$ but is constant over $[\lambda_2, 1]$. Intuitively, because at least one firm's cost increases in λ within $[0, \lambda_2)$ but both firms' costs become constant over $[\lambda_2, 1]$, the total output $(q_1 + q_2)$ (and subsequently the consumer surplus) decreases in λ over $[0, \lambda_2)$ but remains constant afterwards. Therefore, if the host government is only concerned about the consumer surplus, it should set the LCR as low as possible.

However, a low level of LCR may result in a low FDI benefit. Recall that the FDI benefit, $\lambda s(z_1 q_1 + z_2 q_2)$, depends on two endogenous variables: the level of the LCR and the resulted FDI output. It is neither monotonic in λ nor continuous in λ as z_i switches from 0 to 1.

Note for $\lambda \geq \lambda_2$, there is no FDI benefit and the consumer surplus is lower than that for $\lambda < \lambda_2$ as discussed above. Therefore, to maximize the sum of the FDI benefit and consumer surplus, the LCR should not be set too high such that neither firm engages in FDI. Thus, λ^* will be either in the range of $[0, \lambda_1)$, or $[\lambda_1, \lambda_2)$. Before plunging into detailed analysis, we discuss our strategy for characterizing λ^*. Note that the functional form of the welfare that is constituted by the FDI benefit and consumer surplus is different between the two regions, $[0, \lambda_1)$ and $[\lambda_1, \lambda_2)$. That is, there are two different functions defined on different domains. This makes it difficult to characterize λ^*. However, by extending and examining these two functions over the entire interval of [0, 1], we find some interesting properties, which significantly simplifies our analysis. Specifically, define

$$U_1(\lambda; s) \equiv \lambda s(q_1 + q_2) + \frac{1}{2}b(q_1 + q_2)^2,$$

where $\lambda \in [0, 1]$ but q_1 and q_2 are the equilibrium outputs when both firms choose FDI, which are obtained using $C_i = \lambda\bar{c} + (1 - \lambda)c_i$ in (7). Next, define,

$$U_2(\lambda; s) \equiv \lambda s q_2 + \frac{1}{2}b(q_1 + q_2)^2,$$

where $\lambda \in [0, 1]$ but q_1 and q_2 are the equilibrium outputs when firm 1 chooses export but firm 2 chooses FDI, which are obtained using $C_1 = c_1 + t$ and $C_2 = \lambda\bar{c} + (1 - \lambda)c_2$ in (7).

Let $\lambda_i^e(s) = \text{argmax } U_i(\lambda; s)$, where superscript e stands for "efficiency" (or cost difference case). It can be shown that

$$\lambda_1^e(s) = \frac{(2a - c_1 - c_2)}{(2\bar{c} - c_1 - c_2)} \frac{(3s - \bar{c} + c_1 + c_2)}{(6s - 2\bar{c} + c_1 + c_2)},$$

$$\lambda_2^e(s) = \frac{3s(a - 2c_2 + c_1 + t) - (\bar{c} - c_2)(2a - c_1 - c_2 - t)}{(\bar{c} - c_2)(12s - \bar{c} + c_2)}.$$

To ensure that both λ_1^e and λ_2^e are positive, the following condition on s is imposed.

Condition 2: $s > (2\bar{c} - c_1 - c_2)/3$.

It can also be easily checked that both λ_1^e and λ_2^e increase in s. The intuition is that when s increases, the positive marginal effect of increasing λ on the FDI benefit is higher. This calls for raising the LCR to balance the negative marginal effect of increasing λ on consumer surplus.

More importantly, we can derive two regularities for $U_1(\lambda; s)$ and $U_2(\lambda; s)$. We summarize the results related to these two functions in Lemma 1 below.

Lemma 1 : (i). *$\partial\lambda_i^e/\partial s > 0$, where i=1,2.*

(ii). *For any given s, $U_1(\lambda; s) > U_2(\lambda; s)$ over the entire range of $\lambda \in [0, 1]$.*

(iii). *For any given λ and $s' > s$, $U_i(\lambda; s') > U_i(\lambda; s)$, where i=1,2.*

Proof: The proof of (i) is straightforward. For (ii), given any s, $U_1(\lambda; s) - U_2(\lambda; s) = \lambda q_1 > 0$. Finally, for (iii), note that q_1 and q_2 are not affected by s. Thus, s shifts up U_i. □

Based on Lemma 1, we are able to draw Figure 1 to show the relative position of the two functions graphically. Note that the sum of the FDI benefit and consumer surplus is equal to $U_1(\lambda; s)$ if $\lambda < \lambda_1$ and $U_2(\lambda; s)$ if $\lambda_1 \leq \lambda < \lambda_2$. Using the second and third results of Lemma 1, with reference to Figure 1, we can conclude that λ^* is equal to λ_1^e if $\lambda_1^e < \lambda_1$.

<Figure 1 is about here>

Recall that λ_1^e increases in s under Condition 2. We can find conditions for $\lambda_1^e < \lambda_1$. The result is stated in Proposition 3 below.

Proposition 3 (**The case for small** s): *Suppose both Condition 1 and Condition 2 are satisfied. If s is small, then $\lambda^* = \lambda_1^e < \lambda_1$, which induces both firms to engage in FDI.*

Proof: See Appendix A. □

The intuition for Proposition 3 is as follows. Between the FDI benefit and consumer surplus, the host government will be concerned mostly with the consumer surplus for small s. The consumer surplus is highest when both firms choose FDI. Therefore, a low level of LCR is adopted to induce the two firms to take FDI.

Proposition 3 characterizes λ^* for the case where $\lambda_1^e < \lambda_1$ (the case of small s). Next, we examine the case where $\lambda_1^e \geq \lambda_1$. From Figure 1, it is clear that $U_1(\lambda_1)$ is the upper bound for $U_1(\lambda)$ in the range of $[0, \lambda_1)$. Meanwhile, the maximum $U_2(\lambda)$ in the range of $[\lambda_1, \lambda_2)$ is $U_2(\lambda_2)$ if $\lambda_2^e \geq \lambda_2$, and $U_2(\lambda_2^e)$ if $\lambda_2^e < \lambda_2$. Before analyzing these two subcases, we first investigate the condition for λ_2^e to be higher or lower than λ_2. Assuming a is large, we can show that $\lambda_2^e \geq \lambda_2$ if and only if Condition 3 holds.[28]

Condition 3:

$$s \geq \frac{(\bar{c} - c_2)(2a - c_1 - c_2 - 2t)}{3(a + c_1 - 2c_2 - 3t)}.$$

Condition 3 implies Condition 2.

For the case where $\lambda_1^e \geq \lambda_1$ and $\lambda_2^e \geq \lambda_2$, we need to compare $U_1(\lambda_1)$ with $U_2(\lambda_2)$ in order to characterize λ^*. To achieve this end, we first define $\Delta(c_2) \equiv U_1(\lambda_1) - U_2(\lambda_2)$ and examine its property. The results are summarized in the following lemma.

Lemma 2 : *Suppose c_2 can take any value in $[c_1, \bar{c}]$. Then $\Delta(c_2)$ is concave in c_2, with $\Delta(c_2 = c_1) > 0$ and $\Delta(c_2 = \bar{c}) < 0$. Moreover, There exists a unique $c^* \in (c_1, \bar{c})$ such that $\Delta(c_2) > 0$ for $c_2 < c^*$, $\Delta(c_2) = 0$ for $c_2 = c^*$, and $\Delta(c_2) < 0$ for $c_2 > c^*$.*

Proof: See Appendix B. □

Lemma 2 shows that the comparison of $U_1(\lambda_1)$ with $U_2(\lambda_2)$ depends on c_2. We have $U_1(\lambda_1) > U_2(\lambda_2)$ for c_2 close to c_1 but $U_1(\lambda_1) < U_2(\lambda_2)$ for c_2 close to $\bar{c}$. However, under Condition 1, c_2

[28] The lower bound of s in Condition 3 is obtained by setting $\lambda_2^e = \lambda_2$. The inequality in Condition 3 comes from the fact that $\lambda_2^e(s)$ is increasing in s.

is not allowed to take a value close to $\bar{c}$. At maximum, $c_2 = \bar{c} - t$. It is then obvious from the proof of Lemma 2 that the critical point c^* exists, in the sense that $c_1 < c^* < \bar{c} - t$, if and only if $\Delta(c_2 = \bar{c} - t) < 0$. The following lemma characterizes the necessary and sufficient conditions for $\Delta(c_2 = \bar{c} - t) < 0$.

Lemma 3 :
(i). *Given c_1, $\bar{c}$ and s, the necessary condition for $\Delta(c_2 = \bar{c} - t) < 0$ is that t is small.*
(ii). *Given c_1 and $\bar{c}$, a sufficient condition for $\Delta(c_2 = \bar{c} - t) < 0$ is that t is small and s is large.*

Proof: See Appendix C. □

Based on Lemma 2 and Lemma 3, we immediately obtain the following results:

Proposition 4 (**The case for large** s): *Suppose Condition 1 and Condition 3 are satisfied.*
(i). *For large t, $\lambda^* = \lambda_1 - \epsilon$, which induces both firms to take FDI.*
(ii). *For sufficiently small t, $\lambda^* = \lambda_1 - \epsilon$, which induces both firms to take FDI, if c_2 is close to c_1 (i.e., when the two firms have similar unit costs); and $\lambda^* = \lambda_2 - \epsilon$, which induces firm 1 to export and firm 2 to take FDI, if c_2 is not close to c_1 (i.e., when the two firms have very different costs).*

Lemma 3(ii) gives the sufficient conditions (s is large and t is small) under which the critical c^* is below $\bar{c} - t$. In that case, $U_1(\lambda_1)$ could be higher or lower than $U_2(\lambda_2)$, depending on c_2 (refer to Proposition 4(ii)). When t is sufficiently large, from Lemma 3(i) we have $\Delta(c_2 = \bar{c} - t) > 0$, which means $U_1(\lambda_1)$ is higher than $U_2(\lambda_2)$ for all $c_2 \in (c_1, \bar{c} - t)$ (refer to Proposition 4(i)).

The intuition for Proposition 4 is given as follows. Between the FDI benefit and consumer surplus, the host government concerns mostly about the FDI benefit for sufficiently large s. However, when the tariff is high, the host government also worries about the consumer surplus, which could decrease dramatically if any of the two firms switches its strategy from FDI to export. Thus the host government can balance the FDI benefit and consumer surplus by encouraging both firms to choose FDI. This explains part (i) of Proposition 4.

When the tariff is low, the consumer surplus would not become much lower if one of the firms switches its strategy from FDI to export. Meanwhile, by setting a higher LCR so that only one firm chooses FDI, the host country may obtain a higher FDI benefit. This is because the FDI benefit depends on not only the FDI output but also the level of the LCR. This consideration is especially relevant when the two firms' costs are far apart, in which case a very low λ has to be used to induce both firms to choose FDI. This explains part (ii) of Proposition 4.

Proposition 4 is for the case where $\lambda_1^e \geq \lambda_1$ and $\lambda_2^e \geq \lambda_2$, which is essentially the case of large s. For the alternative case where $\lambda_1^e \geq \lambda_1$ and $\lambda_2^e < \lambda_2$ (the intermediate range of s), we need to compare $U_1(\lambda_1)$ and $U_2(\lambda_2^e)$ to determine if λ^* is equal to $\lambda_1 - \epsilon$ or λ_2^e. Unfortunately the analysis is too complicated to yield any clear-cut result for this range of s. The main reason is that when s is neither large nor small, it is difficult for the host government to balance the FDI benefit and consumer surplus.

3.2. The case of different degrees of vertical integration

In this subsection, we characterize λ^* in the framework of subsection 2.2 where firm 1 and firm 2 differ in the degree of vertical integration ($v_1 < v_2$). We shall use the same demand and welfare functions as in subsection 3.1.

Recall from Proposition 2 that firm i engages in FDI if and only if $(\lambda - v_i)(\bar{c} - c) < t$, where $i = 1, 2$. To save notations, redefine $\lambda_i \equiv t/(\bar{c} - c) + v_i$. As $v_1 < v_2$, we have $\lambda_1 < \lambda_2$. To ensure $\lambda_2 < 1$, we impose a condition on t

Condition 4: $t < (1 - v_2)(\bar{c} - c)$.

Depending on the level of λ, there are three pairs of equilibrium entry strategies by the two firms. For $0 \leq \lambda < \lambda_1$, both firms engage in FDI (scenario 1); for $\lambda_1 \leq \lambda < \lambda_2$, firm 1 chooses export while firm 2 has FDI (scenario 2); and for $1 \geq \lambda \geq \lambda_2$, both firms choose export (scenario 3). It follows that

$$C_i = \begin{cases} (\lambda - v_i)\bar{c} + (1 - \lambda + v_i)c & \text{for } \lambda < \lambda_i, \\ c + t & \text{otherwise.} \end{cases} \tag{13}$$

$$\frac{\partial C_i}{\partial \lambda} = \begin{cases} \bar{c} - c & \text{for } \lambda < \lambda_i, \\ 0 & \text{otherwise.} \end{cases} \tag{14}$$

The analysis for characterizing λ^* in this case is similar to that in subsection 3.1. In particular, (7), (8), (9) and (12) hold except that C_i and $\partial C_i/\partial \lambda$ are given by (13) and (14), respectively, instead of (10) and (11). It can be easily seen that λ^* is within the range of either $[0, \lambda_1)$ or $[\lambda_1, \lambda_2)$. To determine which range λ^* falls into, we make use of the same functions $U_1(\lambda; s)$ and $U_2(\lambda; s)$ as defined in subsection 3.1, with the modification that q_1 and q_2 in $U_1(\lambda; s)$ are determined by $C_1 = (\lambda - v_1)\bar{c} + (1 - \lambda + v_1)c$ and $C_2 = (\lambda - v_2)\bar{c} + (1 - \lambda + v_2)c$, and those in $U_2(\lambda; s)$ by $C_1 = c + t$ and $C_2 = (\lambda - v_2)\bar{c} + (1 - \lambda + v_2)c$. We then derive the optimal λ_i^v that maximizes $U_i(\lambda; s)$, where superscript v stands for "vertical integration":

$$\lambda_1^v = \frac{[3s - 2(\bar{c} - c)][2a - 2c + (v_1 + v_2)(\bar{c} - c)]}{4(\bar{c} - c)[3s - (\bar{c} - c)]},$$

$$\lambda_2^v = \frac{3s[a - c + t + 2v_2(\bar{c} - c)] - (\bar{c} - c)[2a - 2c - t + v_2(\bar{c} - c)]}{(\bar{c} - c)[12s - (\bar{c} - c)]}.$$

To ensure that both λ_1^v and λ_2^v are positive, we impose a condition on s, which is similar to Condition 2 in subsection 3.1.

Condition 5: $s > 2(\bar{c} - c)/3$.

It can be easily checked that Lemma 1 still applies in this framework (with λ_i^e substituted by λ_i^v) and so does Figure 1. As a result, λ^* is in the range of $[0, \lambda_1)$ if $\lambda_1^v < \lambda_1$. Similar to Proposition 3, Proposition 5 below gives the condition for $\lambda_1^v < \lambda_1$.

Proposition 5 (**The case for small** s): *Suppose both Condition 4 and Condition 5 are satisfied. If s is small, then $\lambda^* = \lambda_1^v < \lambda_1$, which induces both firms to engage in FDI.*

Proof: See Appendix D. □

The intuition for Proposition 5 is similar to that for Proposition 3. A small s implies that the host government is concerned mostly with the consumer surplus, which increases when any of the two firms switches its strategy from export to FDI. Thus, the host government sets a low enough LCR such that both firms choose FDI.

Proposition 5 characterizes λ^* for the case where $\lambda_1^v < \lambda_1$. Now we turn to the case where $\lambda_1^v \geq \lambda_1$, which can be further divided into two subcases: $\lambda_2^v \geq \lambda_2$ and $\lambda_2^v < \lambda_2$. We can show that $\lambda_2^v \geq \lambda_2$ if and only if Condition 6 holds.

Condition 6:

$$s \geq \frac{2(\bar{c} - c)(a - c - t)}{3[a - c - 3t - 2v_2(\bar{c} - c)]}.$$

Condition 6 implies Condition 5. With the help of Figure 1, we know that given $\lambda_1^v \geq \lambda_1$ and $\lambda_2^v \geq \lambda_2$, $\sup_{\lambda \in [0, \lambda_1)} U_1(\lambda) = U_1(\lambda_1)$ and $\sup_{\lambda \in [\lambda_1, \lambda_2)} U_2(\lambda) = U_2(\lambda_2)$. Thus to find out λ^*, we need to compare $U_1(\lambda_1)$ and $U_2(\lambda_2)$. Similar to our analysis in subsection 3.1, we define $\Delta(v_2) \equiv U_1(\lambda_1) - U_2(\lambda_2)$. Lemma 4 below summarizes the properties of $\Delta(v_2)$.

Lemma 4 : *Suppose v_2 can take any value in $[0, 1]$. Then, $\Delta(v_2)$ is convex in v_2, with $\Delta(v_2 = v_1) > 0$ and for sufficiently large s, $\Delta(v_2 = 1) < 0$. Thus, for sufficiently large s, there exists a unique $v^* \in (v_1, 1)$ such that $\Delta(v_2) > 0$ for $v_2 < v^*$, $\Delta(v_2) = 0$ for $v_2 = v^*$, and $\Delta(v_2) < 0$ for $v_2 > v^*$.*

Proof: See Appendix E. □

However, given t, $\bar{c}$ and c, v_2 is not allowed to take a value too close to 1 under Condition 4. At maximum, $v_2 = 1 - t/(\bar{c} - c)$. It is then obvious from the proof of Lemma 4 that the critical point v^* exists if and only if $\Delta(v_2 = 1 - t/(\bar{c} - c)) < 0$.

Lemma 5 :
(i). *The necessary condition for* $\Delta(v_2 = 1 - t/(\bar{c} - c)) < 0$ *is* $(v_2 - v_1) > 1/2$.
(ii). *The sufficient condition for* $\Delta(v_2 = 1 - t/(\bar{c} - c)) < 0$ *is that* $(v_2 - v_1) > 1/2$, t *is small, and* s *is large.*

Proof: See Appendix F. □

Based on Lemma 4 and Lemma 5, we immediately obtain the following results:

Proposition 6 (**The case for large** s): *Suppose Condition 4 and Condition 6 are satisfied.*
(i). *If* $(v_2 - v_1) \leq 1/2$, *then,* $\lambda^* = \lambda_1 - \epsilon$, *which induces both firms to take FDI.*
(ii). *Suppose* $(v_2 - v_1) > 1/2$, t *is small, and* s *is large. Then,* $\lambda^* = \lambda_2 - \epsilon$, *which induces firm 1 to export and firm 2 to take FDI, if* v_2 *is large.*

If the necessary condition in Lemma 5(i) is violated as in the case of Proposition 6(i), we have $\Delta(v_2 = 1-t/(\bar{c}-c)) > 0$, or equivalently $U_1(\lambda_1)$ is higher than $U_2(\lambda_2)$ for all $v_2 \in (v_1, 1-t/(\bar{c}-c))$. This explains the result of Proposition 6(i). Lemma 5(ii) gives the sufficient condition under which the critical v^* in Lemma 4 is within $(v_1, 1 - t/(\bar{c} - c))$. It follows from Lemma 4 that $U_1(\lambda_1) > U_2(\lambda_2)$ if v_2 is close to v_1 and $U_1(\lambda_1) < U_2(\lambda_2)$ if v_1 and v_2 are far apart. Note, however, that the same sufficient condition (i.e., $v_2 - v_1 > 1/2$) requires v_1 and v_2 to be far apart. Thus, most likely, we have $U_1(\lambda_1) < U_2(\lambda_2)$ in this case. This explains the result of Proposition 6(ii).

Intuitively, the host government is concerned mostly with the FDI benefit for sufficiently large s. The FDI benefit depends on the level of the LCR and the FDI output, which in turn depends on the number of firms choosing FDI. As shown earlier, however, the FDI output weakly decreases in λ. Thus, the host government could either maintain a high LCR (i.e., $\lambda_2 - \epsilon$) under which only one firm chooses FDI or set a low LCR (i.e., $\lambda_1 - \epsilon$) such that both firms choose FDI. When the two firms have similar degrees of vertical integration as in the case of Proposition 6(i), the host government can obtain a substantial increase in the FDI output with a slight decrease in the LCR. As a result, it is optimal for the host government to choose the low LCR.

However, when the two firms have rather different degrees of vertical integration as in the case of Proposition 6(ii), the host government has to lower down the LCR substantially in order to increase the FDI output. It is thus optimal for the host government to choose the high LCR.

Proposition 6 is for the case where $\lambda_1^v \geq \lambda_1$ and $\lambda_2^v \geq \lambda_2$, which is essentially the case of large s. If Condition 5 is satisfied but Condition 6 is not, we have the case where $\lambda_1^v \geq \lambda_1$ but $\lambda_2^v < \lambda_2$, under which we need to compare $U_1(\lambda_1)$ with $U_2(\lambda_2^v)$ to figure out the optimal LCR. It turns out that the comparison is too complicated to yield any clear-cut result.

4. Concluding Remarks

This paper contributes to the FDI literature by offering a partial explanation for how multinationals in the same industry may adopt different international strategies, namely foreign direct investment and export. We emphasize the role of the LCR policy adopted by the host government towards FDI. We find that a firm with lower production efficiency or higher degree of vertical integration is more likely to adopt the FDI strategy over the export strategy. The paper also characterizes conditions under which the host government's optimal LCR policy results in one of the following equilibria: (i) all firms make FDI, (ii) all firms choose export, and (iii) some make FDI and others choose export.

As this paper is the first one to address the issue on MNEs' asymmetric international strategies and to derive optimal LCR policy under this framework, it inevitably makes many simplified assumptions. Some of them may reduce the generality of the results obtained in the present paper. They also suggest directions for future research. First, instead of assuming that the foreign MNEs have different costs or degrees of vertical integration, we may examine entry strategy in the case where their products have various qualities. Second, we should also reexamine the welfare and so the optimal LCR policy with a general demand function.

Appendix

A. Proof of Proposition 3:

On the one hand, $\lim_{s\to\infty}\lambda_1^e = (2a - c_1 - c_2)/2(2\bar{c} - c_1 - c_2)$, which is greater than 1 if and only if $2a - 4\bar{c} + c_1 + c_2 > 0$. This inequality holds for large a. Thus, $\lim_{s\to\infty}\lambda_1^e > 1$. On the other hand, $\lambda_1^e = 0$ as s approaches its lower bound, $(2\bar{c} - c_1 - c_2)/3$, as specified in Condition 2. Recall that λ_1^e is monotonically increasing in s. Hence, given any $t > 0$, there exists a unique s_1^e, which satisfies Condition 2, such that $\lambda^* = \lambda_1^e < \lambda_1$ if and only if $s < s_1^e$. □

B. Proof of Lemma 2:

Define $g(c_2) = \lambda_1 s[q_1(\lambda_1) + q_2(\lambda_1)] - \lambda_2 s q_2(\lambda_2)$, $f(c_2) = \frac{1}{2}b[q_1(\lambda_1) + q_2(\lambda_1)]^2 - \frac{1}{2}b[q_1(\lambda_2) + q_2(\lambda_2)]^2$. Then $\Delta(c_2) = f(c_2) + g(c_2)$. Let us first examine the properties of $g(c_2)$. Note by definition and from the equilibrium outputs, we have

$$g(c_2) = \frac{s}{3b(\bar{c} - c_1)^2}[(\bar{c} - c_1)(2a - c_1 - c_2 - t) - t(\bar{c} - c_2)] - \frac{s(a + c_1 - 2c_2 - t)}{3b(\bar{c} - c_2)}.$$

Thus, under Condition 2,

$$g'(c_2) = -\frac{s(\bar{c} - c_1 - t)}{3b(\bar{c} - c_1)^2} - \frac{s(a - 2\bar{c} + c_1 - t)}{3b(\bar{c} - c_2)^2} < 0,$$

where a prime stands for the first derivative. Moreover, $g''(c_2) = -2s(a - 2\bar{c} + c_1 - t)/3b(\bar{c} - c_2)^3 < 0$, where double prime stands for the second derivative, and finally, $\lim_{c_2 \to \bar{c}} g(c_2) = -\infty$.

Now we examine the properties of $f(c_2)$. Similar to $g(c_2)$, we can first explicitly express $f(c_2)$ as the function of c_2 using the equilibrium outputs, then take derivative. We have, under Condition 2,

$$f'(c_2) = \frac{t}{9b(\bar{c} - c_1)^2}[(\bar{c} - c_1)(2a - \bar{c} - c_2 - t) + t(\bar{c} - c_2)(\bar{c} - c_1 - t)] > 0;$$

$f''(c_2) = -t[(\bar{c} - c_1) + t(\bar{c} - c_1 - t)]/9b(\bar{c} - c_1)^2 < 0$; and $\lim_{c_2 \to \bar{c}} f(c_2)$ is positive and finite.

Although we don't know the monotonicity of $\Delta(c_2)$, it is concave since $\Delta''(c_2) = g''(c_2) + f''(c_2) < 0$. Moreover, we can calculate Δ at the first point, $\lim_{c_2 \to c_1} \Delta(c_2) = \lim_{c_2 \to c_1} f(c_2) + \lim_{c_2 \to c_1} g(c_2) = -\infty$. The existence and uniqueness of c^* of the proposition follows. □

C. Proof of Lemma 3:

By the definition of Δ and using the corresponding equilibrium outputs of the two firms, we can explicitly calculate $\Delta(c_2 = \bar{c} - t)$, which after collecting terms can be expressed as

$$\frac{s}{3b(\bar{c} - c_1)^2}\Phi_1 + \frac{1}{18b(\bar{c} - c_1)^2}\Phi_2,$$

where $\Phi_2 \equiv [(\bar{c} - c_1)(2a - c_1 - \bar{c}) - t^2]^2 - (\bar{c} - c_1)^2(2a - \bar{c} - c_1 - t)^2 = t[(\bar{c} - c_1)(2a - c_1 - \bar{c}) - t^2 + (\bar{c} - c_1)(2a - \bar{c} - c_1 - t)](\bar{c} - c_1 - t) > 0$, and $\Phi_1 \equiv t(\bar{c} - c_1)(2a - c_1 - \bar{c}) - t^3 - (\bar{c} - c_1)^2(a - 2\bar{c} + c_1 + t) =$

$-(\bar{c}-c_1)(\bar{c}-c_1-2t)a - t(\bar{c}+c_1) + (\bar{c}-c_1)(2\bar{c}-c_1-t)$. Obviously, the necessary condition for $\Delta(c_2 = \bar{c}-t) < 0$ is $\Phi_1 < 0$, a necessary condition of which is that t is small. On the other hand, $\Delta(c_2 = \bar{c}-t)$ decreases in s when Φ_1 is negative. Note that the second term in the above expression of $\Delta(c_2 = \bar{c}-t)$ is independent of s. Thus, with $\Phi_1 < 0$ and sufficiently large s, $\Delta(c_2 = \bar{c}-t)$ becomes negative. Finally, when t is sufficiently small, $\Phi_1 < 0$. This proves the sufficient condition for $\Delta(c_2 = \bar{c}-t) < 0$. □

D. Proof of Proposition 5:

We have $\lim_{s\to\infty}\lambda_1^v = [2a-2c+(v_1+v_2)(\bar{c}-c)]/4(\bar{c}-c)$, which is greater than 1. On the other hand, as s approaches its lower bound, $2(\bar{c}-c)/3$, which is specified in Condition 5, $\lambda_1^v = 0$. Recall that λ_1^v is monotonically increasing in s. Hence, given any t satisfying Condition 4, there exists a unique s_1^v, which satisfies Condition 5, such that $\lambda^* = \lambda_1^v < \lambda_1$ if and only if $s < s_1^v$. □

E. Proof of Lemma 4:

Let us define $g(v_2)$ and $f(v_2)$ the same way as we define $g(c_2)$ and $f(c_2)$ in Appendix A, respectively. Then $\Delta(v_2) = f(v_2) + g(v_2)$. Using the equilibrium outputs in various cases, we have

$$f(v_2) = \frac{1}{18b}[2a-2c-2t+(v_2-v_1)(\bar{c}-c)]^2 - \frac{1}{18b}(2a-2c-2t)^2,$$

$$g(v_2) = s\left(\frac{t}{\bar{c}-c}+v_1\right)\frac{2a-2c-2t+(v_2-v_1)(\bar{c}-c)}{3b} - s\left(\frac{t}{\bar{c}-c}+v_2\right)\frac{a-c-t}{3b}.$$

Then,

$$f'(v_2) = \frac{(\bar{c}-c)}{9b}[2a-2c-2t+(v_2-v_1)(\bar{c}-c)] > 0,$$

$$g'(v_2) = -\frac{s}{3b}[a-c-2t-v_1(\bar{c}-c)] < 0.$$

Note that $f'(v_2)$ is independent of s but $|g'(v_2)|$ is increasing in s. Hence, for sufficiently large s, $\Delta(v_2)$ decreases in v_2 and $\Delta(v_2 = 1) < 0$. On the other hand, direct computation gives $f(v_2 = v_1) = 0$ and $g(v_2 = v_1) = \lambda_1 s q_1(\lambda) > 0$. Thus, $\Delta(v_2 = 1) > 0$.

Finally, for convexity, note $f''(v_2) > 0$, and $g''(v_2) = 0$. Therefore, $\Delta''(v_2) > 0$. The existence of v^* and the result of the proposition follow. □

F. Proof of Lemma 5:

Using $f(v_2)$ and $g(v_2)$ derived in Appendix C, we can show that

$$\Delta(v_2 = 1 - t/(\bar{c} - c)) = \frac{s}{3b(\bar{c} - c_1)}\Phi_3 + \frac{1}{18b}\Phi_4,$$

where $\Phi_4 = [4a - 4c - 5t + (1 - v_1)(\bar{c} - c)][-t + (1 - v_1)(\bar{c} - c)] > 0$ under Condition 4, and $\Phi_3 = (\bar{c} - c)[1 - 2(v_2 - v_1)](a - c - t) + [t + v_1(\bar{c} - c)][-t + (1 - v_1)(\bar{c} - c)]$, in which the second term is positive under Condition 4 and the first term is negative if and only if $(v_2 - v_1) > 1/2$. Thus, the necessary condition for $\Delta(v_2 = 1 - t/(\bar{c} - c)) < 0$ is $\Phi_3 < 0$ which requires $(v_2 - v_1) > 1/2$. On the other hand, if $(v_2 - v_1) > 1/2$, a is large and t is small, then $\Phi_3 < 0$. Then, letting s increase, eventually we will have $\Delta(v_2 = 1 - t/(\bar{c} - c)) < 0$. □

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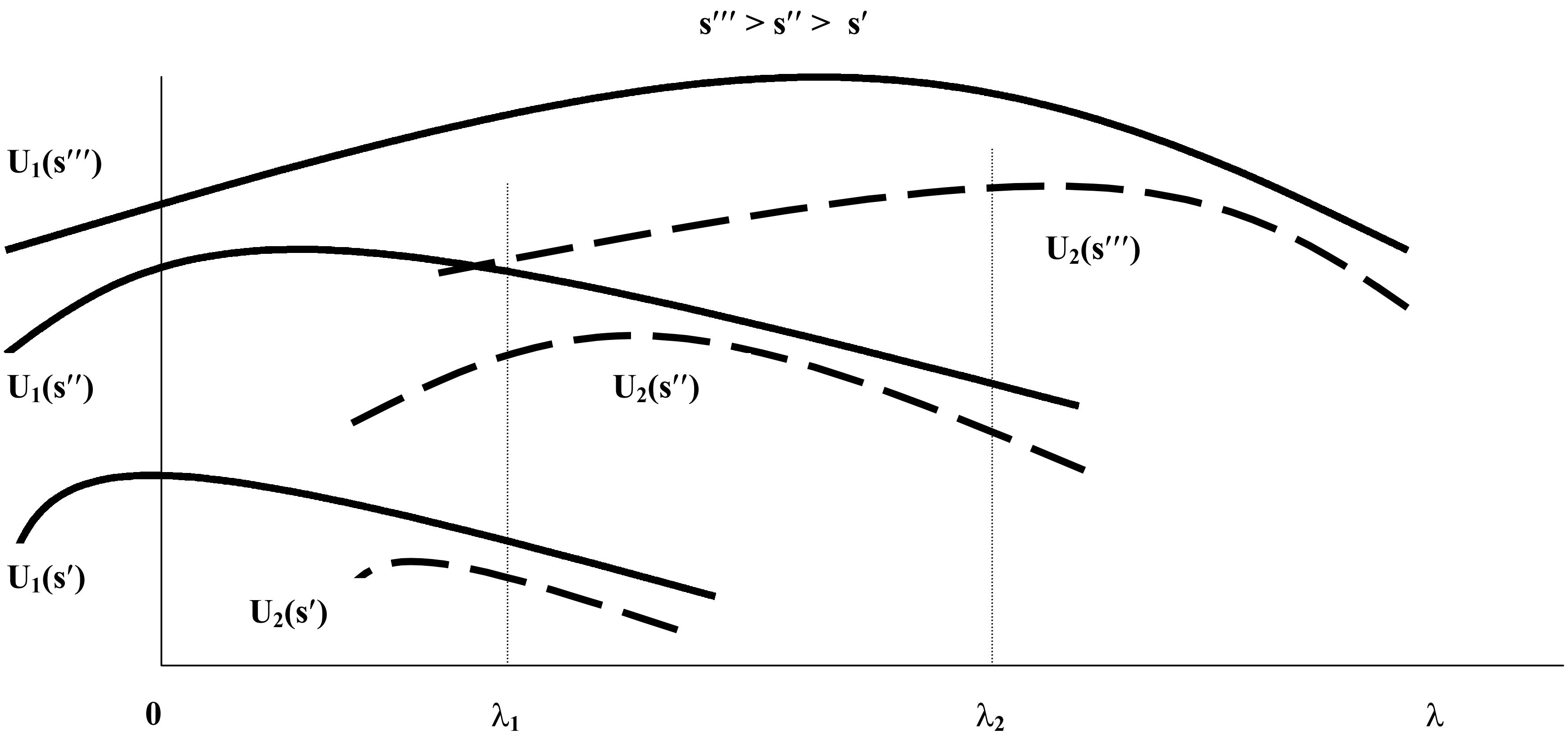

Figure 1: Comparison of $U_1(s)$ and $U_2(s)$