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Comparing Sectoral FDI Incentives: Comparative Advantages and Market Opportunities

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In this paper we closely examine the implications of comparative advantage for foreign direct investment (FDI) incentives. Particularly, we find that the host country's comparative advantage sector is more attractive to inward FDI than its comparative disadvantage sector. This finding is supported by empirical evidence. However, such a cross-sector FDI comparison has not been studied, theoretically and explicitly, in the literature. This paper contributes to the literature by filling this gap. We have also obtained some other results such as how the degrees of comparative advantage and absolute advantage affect FDI incentives, and whether a multinational corporation (MNC) should allow its foreign subsidiary to be run independently.

Key Words: Foreign direct investment (FDI); Multinational corporation (MNC); Comparative advantage; Absolute advantage; Market opportunity; FDI incentives.
JEL Classification Numbers: F12, F13, F21, F23.

1. INTRODUCTION

Multinational corporations (MNCs) and foreign direct investment (FDI) have become more and more important in the world economy. Since the mid-1980s, FDI has grown twice as fast as international trade and about

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two-thirds of world trade has been conducted by MNCs.[1] Moreover, in the last few years, total sales (local and cross border) of foreign affiliates of MNCs have exceeded the value of world trade in goods and services combined.[2] These facts sufficiently signal the danger of leaving out FDI in studies of international trade and trade policy.

What determines the location of FDI has been one of the most important issues in international business literature and recent international trade literature. This is a twofold issue involving country location and sector location. The present paper focuses on sector location. In particular, we ask which sectors in a host country are more attractive to inward FDI. While there are many important factors affecting an MNC's FDI decision in any particular industry, we are interested in something common to all firms within the same industry.

To illustrate, let us take China as a host country and the United States as a source country,[3] and concentrate on two manufacturing sectors grouped according to the United Nations' single-digit SITC (Revision 2) code: SITC 7 (defined as "machinery and transport equipment") and SITC 8 (defined as "miscellaneous manufactured articles"). Examples of products from these sectors are road vehicles (SITC 78), which belong to SITC 7, and apparel and clothing (SITC 84), which belong to SITC 8. There should be no doubt that China has comparative advantage (and maybe also absolute advantage) in SITC 8, and the U.S. has both comparative and absolute advantage in SITC 7.[4] To make a meaningful cross-sector comparison for FDI, we need to adjust a sector's FDI measure. In so doing, we calculate the FDI/Capital ratio for each sector, where the numerator is China's inward

[1]See UNCTAD (1995). The growing linkage between trade and investment has attracted the attention of many important international organizations such as WTO, UNCTAD, OECD and the World Bank. In the first meeting of the WTO Working Group on the Relationship between Trade and Investment, held jointly with the above-mentioned organizations on 2-3 June 1997, it was pointed out that "there was a growing inseparability of trade and investment decisions of businesses as shown by the substantial share of intra-firm transactions in world trade. Foreign direct investments were aimed not only at gaining local market share but also at benefitting from lower production costs. This closer integration of trade and investment called for greater coherence in both national trade and investment policies and international trade and investment arrangements" (WTO *Focus*, No. 20, 1997, p2).

[2]WTO *Focus*, No. 20, 1997.

[3]Currently, the U.S. is both the largest host and the largest source country of FDI in the world, and China is the second largest host country. In 1995, the realized amount of the FDI inflow to China from the U.S. reached $3 billion, or 8.2 percent of China's total inward FDI.

[4]According to our calculation based on 1994's import and export data from the United Nations' *International Trade Statistics Yearbook*, the revealed comparative advantage (RCA) indices of China are 0.43 for SITC 7 and 2.87 for SITC 8, and those of the U.S. are 1.17 for SITC 7 and 0.78 for SITC 8. The RCA index greater than unity indicates comparative advantage, and less than unity implies comparative disadvantage.

FDI from the U.S., on a cumulative basis from 1992 to 1995, and the denominator is the sector's total capital investment in China, in 1995.[5] Figure 1 depicts the two ratios, one for SITC 7 and one for SITC 8, and clearly shows that in the *relative* sense, SITC 8 attracts more FDI from the U.S. to China than SITC 7.[6] Hence, we hypothesize that a host country's comparative advantage sector is more attractive to inward FDI than its comparative disadvantage sector.

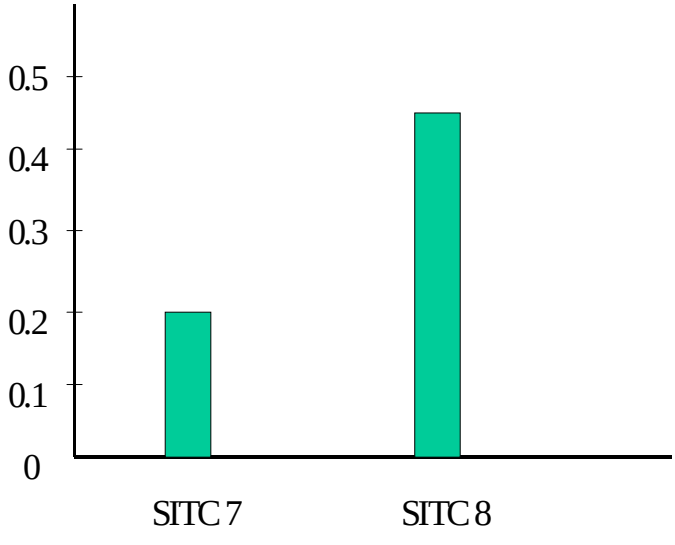

FIG. 1. U.S. FDI in China

This paper attempts to provide a theoretical analysis of the aforementioned issue: The implications of comparative advantage for FDI. As a first step, we only consider the type of comparative advantage as defined in the

[5]Our calculation of FDI is based on the "Statement of Sino-Foreign Joint Ventures" in various issues of *Almanac of China's Foreign Economic Relations and Trade*. The FDI figures reported in the Statement represent only part of the total FDI inflow to China. The sectoral capital investment figures are calculated based on Table 5-14 "Capital Construction Investment and Newly Increased Fixed Assets by Sector (1995)" in *China's Statistical Yearbook 1996*.

[6]If FDI is unadjusted, then when using the same data set we find that total FDI in SITC 7 from the U.S. to China is more than that in SITC 8. This is not surprising at all. However, such a comparison based on *total* FDI does not help explain the FDI attractiveness, for at least two obvious reasons. First, the sectoral classification *per se* affects the comparison in a way that a larger sector tends to have more FDI, *ceteris paribus*. Second, SITC 7 is more capital intensive relative to SITC 8 and therefore it is natural to see more capital flow to the former sector. Obviously, a $1 million investment in the auto industry means little, but the same amount in the textile industry means a lot.

Ricardian model. Based on a set of well-known stylized facts (see Section 3), we construct a minimal trade-cum-FDI model with two countries, the FDI host country and the FDI source country. There are two sectors, called auto and textile, in each country. In the model, the source county has comparative in auto production, and the host country has comparative advantage in textile production. By defining an MNC's *FDI incentive* as the firm's profit difference between making FDI and not making FDI, we are mainly concerned with in which sector firms from the source country have stronger FDI incentives. We find that the source country's auto firms have *weaker* FDI incentives than its textile firms. That is, the host country's comparative advantage sector is more attractive to inward FDI, consistent with Figure 1.

The above result is found in a theoretical model in which comparative advantage is defined in Ricardian sense, but it is also supported by many empirical studies, in which comparative advantage is more generally defined. Using evidence from the U.K. and South Korea, Maskus and Webster (1995) show that the host country's comparative advantage of the factor proportions type is an important determinant of inward FDI to these two countries. Specifically, sectors using the host country's abundant factors more intensively attract relatively more inward FDI. As in Figure 1, Maskus and Webster also make FDI adjustment and use the FDI to gross investment ratio rather than total FDI as the FDI measure.[7] Similar results have also been obtained by Ray (1989), Milner and Pentecost (1994) and Peng (1995) in their studies, which use unadjusted total FDI.[8]

Then what explains this pattern of FDI incentives? To undertake FDI, a typical MNC may have many motivations, which, as explained by international business literature and recent international trade literature, include "jumping over tariffs" and taking the "ownership, location and internalization advantages". Obviously, if these factors vary across sectors, firms in different sectors will have various degrees of FDI incentive. Alternatively,

[7]The conclusion obtained by Maskus and Webster is similar to that derived in a much earlier empirical study by Baldwin (1979). Baldwin uses the U.S. outward FDI to total domestic investment ratio as the FDI measure and finds that the "U.S. firms investing abroad in manufacturing apparently are attracted by the relative abundance of unskilled labor and bias their activities towards labor-intensive industries" (p47).

[8]Ray (1989) uses data on inward FDI in the U.S. from 1979 to 1985 and finds those investments concentrated in the R&D and technology intensive sectors, which are along the line of the host country's comparative and absolute advantage. Milner and Pentecost (1994) study the U.S. outward FDI to the U.K.'s manufacturing sector and find that FDI is higher, *ceteris paribus*, in the industrial groups of the U.K.'s comparative advantage products. Moreover, the FDI is higher, *ceteris paribus*, in the industrial groups with lower market competition. Peng (1995) surveys the empirical studies on FDI flows from Japan and Europe to the U.S. and concludes that "there is a positive relationship between the international competitiveness of a nation's particular industry and the amount of inward foreign direct investment this industry receives" (p35).

we provide a new theory in this paper to explain the cross-sector differences in FDI incentives. Our theory emphasizes the sectoral differences in market opportunity and export opportunity, which are driven by comparative advantage. Based on the stylized facts, we focus on interindustry trade and assume that trade patterns follow the principle of comparative advantage.[9] Thus, the host country only exports textiles and the source country only exports autos. Such a pattern of trade determines the market structure of each sector. In particular, both the local producers and foreign exporters are competing in the host country's auto market, however, the host country's textile market is only served by the local producers. As a result, when choosing FDI, the source country's auto firms and textile firms face different market opportunities. To see this, note if an auto firm from the source country makes FDI, it establishes in the host country a subsidiary that competes in the host country's market not only against other local producers but also against its parent company's exports. That is, via FDI the MNC enters a market that is not a new one. On the contrary, in the textile sector, if a firm from the source country establishes its subsidiary in the host country, it enters a market which it has not touched before. In addition, the subsidiary has the opportunity to export as it is now located in the country that has comparative advantage in the sector. Therefore, our theory explains cross-sector difference in FDI incentives by comparative advantage, through the cross-sector difference in market opportunity.

Besides comparing sectoral FDI incentives in the present study, we have also examined how FDI incentives are affected by factors such as the degrees of comparative advantage and competitiveness. The paper also provides an answer and explanation to whether an MNC should allow its foreign subsidiary to be run independently.

The rest of the paper is organized as follows. Section 2 briefly reviews the related literature. Section 3 lays out the model. Section 4 contains the analysis and the results. Finally, Section 5 concludes the paper.

2. RELATED LITERATURE

In the preceding section, we have reviewed some empirical work on the relationship between comparative advantage and FDI incentives. Let us turn our discussion to the related theoretical work.

The literature on FDI mainly focuses on the question of why MNCs invest abroad, instead of concentrating their efforts on production in their home countries and exporting their products or licensing their technology to

[9] As a consequence, the model is more applicable to North-South trade and investment. In the literature of development economics and international trade, North stands for developed countries and South for developing countries.

foreign countries. The most familiar framework used to answer questions related to this issue is the "OLI" (Ownership, Location and Internalisation) or "eclectic" paradigm (Dunning, 1977 and 1981). According to this paradigm, to offset some obvious disadvantages of foreign production and to compete successfully in a foreign market, an MNC must have an ownership advantage over its overseas competitors such as a patent, blueprint or trademark. If it chooses FDI over exportation, it must have also a location advantage such as being closer to consumers or minimizing transportation costs. Finally, there must be an internalization advantage associated with the MNC, in the sense that the product is better produced by itself than licensed to a foreign firm.

The "OLI" idea has recently been formally modelled by international economists. Markusen (1995) contains a comprehensive survey of the literature on the theory of MNC with particular attention paid to research and models produced by international economists. Earlier papers by Helpman (1984) and Markusen (1984), and more recent studies by Brainard (1993a) and Horstmann and Markusen (1992) are examples of using both ownership advantage and location advantage to explain the existence and behavior of MNCs. Along the line of internalisation advantages are papers by Ethier (1986), Horstmann and Markusen (1987, 1995) and Ethier and Markusen (1996).

In the literature, there is also another line of research that concerns MNCs' entry strategies once FDI has been chosen over exports and license (e.g., Porter, 1986; Brainard, 1993b and 1997; Anand, Ainuddin and Makino, 1997). Generally speaking, MNCs choose one of two strategies: multi-domestic strategy and global strategy. The multi-domestic strategy emphasizes local market penetration by utilizing the MNC's ownership advantages. It corresponds to horizontal FDI in which the MNC shifts its production to foreign countries and produces the same types of products in different countries. In contrast, the global strategy stresses production efficiency by integrating production and marketing activities on a worldwide basis to exploit the host countries' location advantages such as abundant natural resources endowment and low-cost labor force. This strategy corresponds to vertical FDI in which the MNC places its production in different countries, according to the production stage.

The existing literature, in either international business or international trade, provides no direct answers to which sectors are more attractive for FDI, however. It implies though inconclusively a few. For example, the ownership advantage argument and the multi-domestic strategy are clearly consistent with the view that FDI comes from the source country's comparative and absolute advantage sectors. On the contrary, the location advantage argument and especially the global strategy seem to imply that FDI

flows to the host country's comparative and absolute advantage sectors.[10] The present paper contributes to the literature by explicitly comparing FDI in different sectors to uncover the relation between FDI incentives and comparative advantages. In so doing, we have constructed a model that allows us to make such a comparison. We have also provided a theory to explain the results.

3. THE MODEL

Let us first briefly review some familiar evidence, or stylized facts (SF, in short).

SF1: North-South FDI has become increasingly important in recent years. Developed countries are the major source of FDI.[11] While a large percentage of FDI moves among developed countries, developing countries' share of the world FDI inflows increased from less than 20 percent in 1990 to 35 percent in 1995.[12]

SF2: Most of the FDIs are made by MNCs that engage in imperfectly competitive markets. Generally, there are two motives behind MNCs' FDI in developing countries: to penetrate the developing countries' markets and to exploit their abundant resources.

SF3: On the trade side, due to differences in technologies and endowment between developed and developing countries, North-South trade is dominated by interindustry trade, as opposed to intraindustry trade.

SF4: While international trade has a long history, FDI has faced more restrictions in the past and begun to surge only recently.

We now construct a model that builds on the above stylized facts. That is, we take them as the exogenous features of the model, rather than the endogenous results derived from the model. Consequently, our model and so the results are more applicable to North-South trade and FDI.[13] There are two countries, H (H stands for host) and M (for multinational), and two sectors, A (for autos) and T (for textiles). In view of SF2, we assume that

[10] In trade literature, Mundell (1957) shows that capital flows to substitute exports in the Heckscher-Ohlin type of trade. This implies that FDI flows to the host country's comparative disadvantage sectors. But Markusen (1983) argues that trade and capital flows are complementary, meaning that FDI flows to the host country's comparative advantage sectors.

[11] For example, Hummels and Stern (1994) report that in 1985, 97 percent of FDI originated from developed countries.

[12] See WTO (1996).

[13] Some macro and micro facts summarized in Markusen (1995) only fit North-North FDI and so do not apply here.

each country has just one firm in each sector.[14] For convenience, we call the auto firm and the textile firm of country M (H) the MA-firm (HA-firm) and the MT-firm (HT-firm), respectively.

Our study focuses on sectors A and T, but there are also many other sectors in each economy. Labor can freely move across sectors within a country and so the wage rate in each country is determined by the demand and supply of labor in the whole economy. The implication is that we take a partial equilibrium approach by assuming that a country's wage rate is not affected by the changes of labor demand in sectors A and T. Moreover, assume that the wage rate in M is unity and that in H is $w \leq 1$, reflecting that H is relatively labor abundant.

We now describe the technologies and production costs of all the firms in the absence of FDI. For simplicity, assume that labor is the only variable cost in both the textile production and the auto production. Textile production requires a simple technology that is available in both countries. Let c denote the labor requirement for each unit of textile production, then, the labor cost of producing one unit of textiles by the HT-firm is wc and that by the MT-firm is c. To sharpen our focus that the two sectors in country H differ only in comparative advantages, assume that the labor requirement for each unit of auto production by the HA-firm is also c. However, the MA-firm has higher labor productivity or superior technology than the HA-firm. Specifically, the labor requirement for each auto production by the MA-firm is equal to βc, where $\beta \in [0, w)$. Thus, labor cost of each auto to the HA-firm is wc and that to the MA-firm is βc. With these technologies and wage rates, country H has both absolute advantage and comparative advantage in textile production, and country M has both absolute advantage and comparative advantage in auto production.

According to SF3, we confine the model to interindustry trade. With the above comparative advantages, the traditional trade theory predicts the following pattern of interindustry trade: country H exports (imports) textiles (autos) and country M exports (imports) autos (textiles).[15] We also assume that the trade pattern will not be altered by FDI. As for the

[14] In our working paper version (Qiu, 1998), we extend the model to the case where there are many firms in each sector of each country and have found the main results of the paper unaltered.

[15] In addition to having the model compatible with the stylized facts highlighted at the beginning of this section, we have other reasons for why we should emphasize interindustry trade. First, this is a study of FDI patterns, not international trade patterns. Second, it is not clear whether FDI may be caused by intraindustry trade. Based on FDI in the U.S. during 1979-85, "there is no evidence that the existence of intra-industry trade within a manufacturing sector serves as an inducement for future foreign direct investment in that industry" (Ray, 1989, p70). Third, by simply assuming that there is no demand in M for autos produced in H (maybe due to low quality) and no demand in H for textile produced in M (maybe due to high tariffs), interindustry trade will prevail as the trade pattern between the two countries.

pattern of FDI, assume that only country M's firms may make FDI in country H, following SF1. In addition, there is no cross-sector investment, i.e., the MA-firm (MT-firm) never makes FDI in the textile (auto) sector.[16] For simplicity, we assume away any transportation cost and tariffs because incorporating with any reasonable levels of these factors will not alter our results.[17] However, if the MA-firm or the MT-firm chooses to invest in country H, the investment requires an amount of fixed capital equal to k (e.g., plant setup cost).[18]

For simplicity, assume that in the same sector, the two countries produce homogenous products. Changing to a differentiated product setting will not alter the results qualitatively. Since we will not examine the role of demand in affecting FDI incentives, we also assume the same linear demand functions in all product markets. Specifically, the inverse demand in each market is $P = D - Q$, where P is the price of and Q is the total demand for the respective product in the respective market. The constant D is assumed to be sufficiently large to at least ensure a positive supply by each firm. In all markets, whenever there is competition, firms compete in the Cournot fashion (i.e., by choosing quantities). It turns out that we must assume $D - 3c > 0$.

Finally, we make use SF4 to close the model. Specifically, we consider two regimes in time sequence. Initially, there is no FDI and so the two countries engage in trade only. This is called the *trade regime*. It is then followed by the *trade-FDI regime* in which both trade and FDI can take place.

4. ANALYSIS AND RESULTS

In this section, we first analyze the two regimes separately. In the trade-FDI regime, we will derive the MT-firm's and the MA-firm's optimal (equilibrium) global strategies. Then, based on the equilibrium outcomes of the two regimes, we compute the FDI incentives and prove our results.

[16] Thus, this study precludes cross-sector investment, which is a very important topic in future studies. When investing abroad, an MNC will face an economic environment different from its home's and it could be motivated to invest in other business.

[17] In our working paper version (Qiu, 1998), we allow for tariffs, export subsidies and FDI taxes. While the main results are not altered qualitatively, we are able to derive the optimal policies there. However, we have dropped out the policy variables in this paper to have a sharper focus and clearer presentation.

[18] Domestic production also requires fixed capital investments. However, given that the four firms are already producing to the markets, these investments are sunk. Hence, these fixed costs can be ignored in the analysis.

4.1. Trade Regime

To characterize the market structure in each sector of each country, it is important to recall that we consider interindustry trade only. There are four segmented markets: the M's textile market and H's auto market are characterized by duopoly, while the M's auto market and H's textile market are monopoly (See Figure 2).

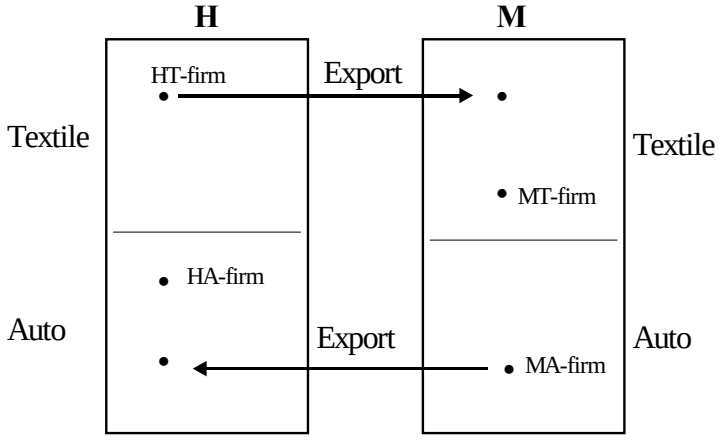

FIG. 2. Trade Regime

Throughout the paper, we shall use asterisk, $*$, to denote export, subscript a and t to denote sector, superscript h and m to denote country, and superscript s to denote subsidiary. Consider the two monopoly markets first. It is easily derived that the MA-firm's profit in the M's market is equal to $(D-\beta c)^2/4$ and the HT-firm's profit in the H's market is equal to $(D-wc)^2/4$. Now consider the M's textile market. Let q_t^m be the amount of textiles produced by the MT-firm, and q_t^{h*} the amount of textiles sold by the HT-firm to this market. Then, the MT-firm's profit from this market is $\pi_t^m = [D-(q_t^m+q_t^{h*})]q_t^m - cq_t^m$ and the HT-firm's profit from this market is $\pi_t^{h*} = [D-(q_t^m+q_t^{h*})]q_t^{h*} - wcq_t^{h*}$. We shall use subscript o to denote the trade-regime equilibrium. The equilibrium of this market can be easily derived:

$$q_{to}^m = \frac{D-(2-w)c}{3} \quad \text{and} \quad \pi_{to}^m = (q_{to}^m)^2, \tag{1}$$

$$q_{to}^{h*} = \frac{D+(1-2w)c}{3} \quad \text{and} \quad \pi_{to}^{h*} = (q_{to}^{h*})^2. \tag{2}$$

Similarly, in the H's auto market, we have

$$q_{ao}^{m*} = \frac{D - 2\beta c + wc}{3} \quad \text{and} \quad \pi_{ao}^{m*} = (q_{ao}^{m*})^2, \tag{3}$$

$$q_{ao}^{h} = \frac{D - 2wc + \beta c}{3} \quad \text{and} \quad \pi_{ao}^{h} = (q_{ao}^{h})^2,$$

where q_{ao}^{m*} and π_{ao}^{m*} are the MA-firm's output sold to this market and profit derived from this market, respectively, and q_{ao}^{h} and π_{ao}^{h} are the HA-firm's output and profit, respectively.

4.2. Trade-FDI Regime

Given the above equilibrium in the trade-regime, now the MA- firm and the MT-firm have the opportunity to make FDI in country H. When it makes FDI, a firm establishes a subsidiary in H and the subsidiary hires country H's labor but uses its own technology to produce the product. We should keep in mind that FDI will not alter the direction of trade. We analyze the two sectors in sequence.

4.2.1. The textile sector

When the MT-firm has the opportunity to set up a subsidiary in H (i.e., make FDI), called the MT-subsidiary, it will make such investment if and only if by doing so it can raise its global profit, which is the sum of the profits derived from all markets, domestic and foreign. However, even if it has decided to invest abroad, the MT-firm still has other two decisions to make. First, should it allow the subsidiary to export its product back to the home market and so compete against the MT-firm's original plant in the headquarter, called the MT-headquarter? Second, if it allows that, should the export level be independently chosen by the subsidiary, or set by the MT-firm? The MT-firm will choose the strategy which leads to a higher global profit.

To derive the optimal strategy and the equilibrium outcome, we formalize the MT-firm's decision-making process in a three-stage game. In the first stage, the firm chooses between FDI and non-FDI. If it chooses FDI, then it goes to the second stage to pick one of the three strategies:

Strategy I: No export by the subsidiary;

Strategy II: Export by the subsidiary with the export level chosen by the MT-firm, in coordination with the headquarter's output, so as to maximize the firm's joint profit in the M's market; and

Strategy III: Export by the subsidiary with the export level chosen independently by the subsidiary so as to maximize the subsidiary's own profit,

while the headquarter's output is chosen independently by the headquarter to maximize its profit.

Finally, in the third stage, production takes place and the firms compete in all markets. If, however, the MT-firm chooses non-FDI in the first stage, we move directly to the third stage and the equilibrium will be just the same as (1) and (2) in the trade regime. In particular, the MT-firm's total profit is simply equal to π_{to}^m as given in (1). For illustration at this point and for further discussion in the future, let us depict in the upper part of Figure 3 the trade and FDI flows and the resulting market structure when the MT-firm chooses Strategy III.

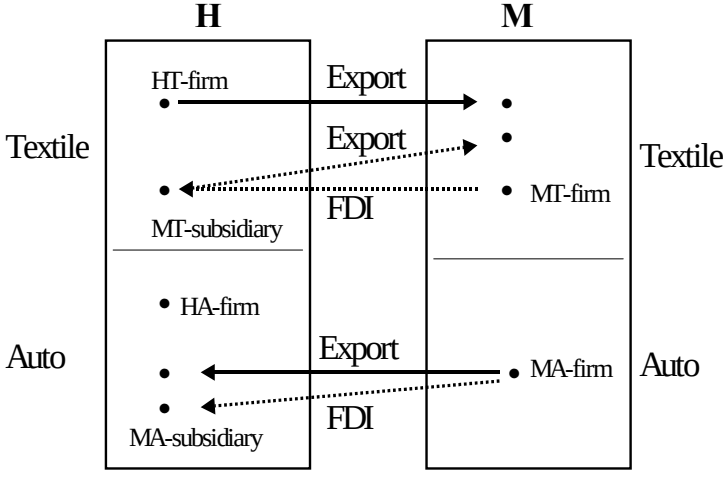

FIG. 3. Trade-FDI Regime

To derive the equilibrium, we should use backward induction and so analyze the game starting from the third stage. Suppose the MT-firm makes FDI and adopts strategy III. In this case, there are three independent competitors in the M's textile market and two in the H's textile market (see Figure 3). First, consider the M's textile market, where the three competitors are the MT-headquarter, the MT-subsidiary and the HT-firm. Let q_t^{ms*} and π_t^{ms*} denote the MT-subsidiary's export level and profit from export, respectively. Then, $\pi_t^{ms*} = (D-Q)q_t^{ms*} - wcq_t^{ms*}$. In equilibrium, the MT-headquarter's output and profit are

$$q_t^m = \frac{D-(3-2w)c}{4} \quad \text{and} \quad \pi_t^m = (q_t^m)^2. \tag{4}$$

The MT-subsidiary and the HT-firm have identical exports to this market and profits derived from this market:

$$q_t^{ms*} = q_t^{h*} = \frac{D + (1-2w)c}{4} \quad \text{and} \quad \pi_t^{ms*} = (q_t^{ms*})^2 = \pi_t^{h*} = (q_t^{h*})^2. \quad (5)$$

Turning to the H's textile market where the MT-subsidiary and the HT-firm are competing. Let q_t^{ms} denote the MT-subsidiary's supply to this market. Then, the MT-subsidiary's profit is $\pi_t^{ms} = (D-Q)q_t^{ms} - wcq_t^{ms}$. The duopoly equilibrium in this market is

$$q_t^{ms} = q_t^h = \frac{D-wc}{3}, \quad \text{and} \quad \pi_t^{ms} = (q_t^{ms})^2 = \pi_t^h = (q_t^h)^2. \quad (6)$$

To summarize, the MT-firm's global profit with FDI and strategy III is

$$\Pi_t^m = \pi_t^m + \pi_t^{ms} + \pi_t^{ms*} - k,$$

where the three profits on the RHS are given in (4), (5) and (6).

We now turn to strategy I. When the MT-subsidiary does not export from H to M, the M's textile market is just the same as that in the trade regime and so the market equilibrium is as given by (1) and (2). Thus, the MT-firm's global profit is $\Pi_t^m(1) = \pi_{to}^m + \pi_t^{ms} - k$, where π_{to}^m and π_t^{ms} are as given in (1) and (6), respectively. A simple calculation leads to $\Pi_t^m - \Pi_t^m(1) = q_t^{ms*}(D + 13c - 14wc)/18 > 0$. Strategy I is dominated by strategy III. Therefore, if it is possible, the MT-firm can increase its global profit by allowing its subsidiary to export.[19]

Finally, we compare strategies II and III. Since the marginal costs of the two plants of the MT-firm, i.e., the MT-headquarter and the MT-subsidiary, are constant, it is easily seen that when the MT-firm chooses the output level for each plant coordinately (i.e., with strategy II), there will be only one plant producing and selling to the M's market if the two plants' marginal costs are not equal. The MT-headquarter does not produce if $w < 1$ and the MT-subsidiary does not export if $w > 1$. If $w = 1$, the

[19] In reality, whether the subsidiary of an MNC will export its products to the home country or a third market is affected by many factors. Normally, if the MNC's purpose is to exploit cheap labor and natural resources in the host country, its subsidiary tends to export all or part of its products. Based on various issues of the *Almanac of China's Economy*, the share of China's export arising from foreign invested enterprises has been increasing continuously from 0.3 percent in 1984 to 28.7 percent in 1994. Most of these exporting FDI firms have the above feature of investments. If, however, the MNC is seeking market entry to the host country through FDI, there is a high tendency not to export. A good example of this is the investments in some developing countries by western countries' car makers.

division of production between the two plants is arbitrary and let us assume that in this case the MT-headquarter does not produce. Because $w \leq 1$, strategy II is equivalent to the following strategy:

Strategy II′: Export by the subsidiary with the export level chosen independently by the subsidiary so as to maximize the subsidiary's own profit, while the MT-firm stops the headquarter's production.

Thus, with strategy II or strategy II′, the MT-firm's profit from the M's market is simply the duopoly profit with the MT-subsidiary alone competing against the HT-firm in this market, which is equal to π_t^{ms} as given in Equation (6).

Letting $\Pi_t^m(2)$ denote the MT-firm's global profit with strategy II or strategy II′, we have

$$\Pi_t^m(2) = 2\pi_t^{ms} - k.$$

Then, the profit difference between strategies III and II is $\Pi_t^m - \Pi_t^m(2) = q_t^m(D + 14wc - 15c)/18$. Define

$$\tilde{w} \equiv -(D - 15c)/14c,$$

which may be positive or negative, but $\tilde{w} < 6/7$ since $D - 3c > 0$. Thus, $\text{sign}(\Pi_t^m - \Pi_t^m(2)) = \text{sign}(D + 14wc - 15c)$, or $\Pi_t^m - \Pi_t^m(2) > 0$ if and only if $w > \tilde{w}$. The condition is automatically satisfied if $w \geq 6/7$, or if $D > 15c$. However, the condition fails if $D < 15c$ and $w < \tilde{w}$. The intuition behind the necessary and sufficient condition for $\Pi_t^m - \Pi_t^m(2) > 0$ is as follows. With strategy III, the MT-firm has two independent plants (the MT-subsidiary and the MT-headquarter) in the M's market to compete against the HT-firm. If the two plants' costs are not too different (i.e., w is large) or demand is very strong (i.e., $D > 15c$), then it is worth for the MT-firm to keep the two independently run plants so as to get a larger market share over its competitor. This is a well known result in industrial organization literature.[20] However, if one plant is relatively very inefficient, it is optimal to close it, i.e., to adopt strategy II′. This occurs when c is large and w is small (i.e., $c > D/15$ and $w < \tilde{w}$) because then the MT-headquarter, whose cost is c, is very inefficient relatively to the MT-subsidiary, whose cost is wc. As a byproduct, we have shown here an example of the product-cycle phenomenon.

[20] See Baye, Crocker and Ju (1996) and the references therein. They only consider symmetric plants, corresponding to our special case, $w = 1$.

The above analysis, which has been summarized in Lemma 1 below, shows that if it is worth making FDI, it is optimal to let the subsidiary make its production and sales decision independently. While it is commonly argued that high plant set-up costs prevent a firm from breaking up to too many plants, it is questionable whether a firm is able to commit to allowing its plants to run independently. FDI is one feasible mechanism. Furthermore, this strategy has been also observed in the real world.[21] It should be emphasized that the main results of the paper will not change if Strategy III is ruled out.

LEMMA 1. *Suppose it is worth for the MT-firm to make FDI in country H. Then, the MT-firm's optimal global strategy is to let its subsidiary be run independently. The MT-subsidiary sells its products to both the H's market and the M's market. The MT-headquarter produces and sells to the local (i.e., the M's) market if and only if* $w \geq \tilde{w}$.

Will FDI raise the MT-firm's global profit? To answer the question, we analyze the first stage of the game. Let us define the MT-firm's *FDI incentive* as the profit difference between FDI strategy and non-FDI strategy:

$$\Delta_t = \begin{cases} \Pi_t^m - \pi_{to}^m, & \text{if } w \geq \tilde{w} \\ \Pi_t^m(2) - \pi_{to}^m, & \text{if } w < \tilde{w}. \end{cases}$$

Note, Δ_t is continuous everywhere in w, even at $w = \tilde{w}$. The MT-firm will make FDI if and only if by doing so its total profit can increase, i.e., $\Delta_t > 0$.

Clearly, as k increases, Δ_t decreases. In addition, we are able to find the necessary and sufficient condition on k such that the HT-firm always makes FDI, regardless of the wage rate, and the necessary and sufficient condition on k such that the HT-firm never makes FDI, regardless of the wage rate (see Proposition 1(ii)). Let us introduce the following notations to be used for these results:

$$k_1 \equiv \frac{1}{8}(D-c)^2, \quad k_2 \equiv \frac{1}{72}(9D^2+14Dc+13c^2) \text{ and } k_2' \equiv \frac{1}{9}(D^2+4Dc-4c^2).$$

The impact of lowering w is less obvious. First of all, a lower w raises the MT-subsidiary's profit as its production cost is reduced. Mathematically,

[21] According to the study by Edington (1995) on Japanese MNCs in Canada, "Canadian subsidiaries were relatively autonomous from their Japanese headquarters in most areas of decision making" including pricing policy and production volumes. The subsidiaries depend on their headquarters mainly for research and design facilities.

we have $\partial\pi_t^{ms}/\partial w < 0$ from (6), and $\partial\pi_t^{ms*}/\partial w < 0$ from (5). However, in the case of strategy III, this benefit to the MT-firm is at least partly offset by the profit reduction to the MT-headquarter as it faces more efficient competitors, $\partial\pi_t^m/\partial w > 0$ from (4). This implies that Π_t^m may or may not increase as a result of lowering w. Nevertheless, such a profit loss also exists in the non-FDI case, since $\partial\pi_{to}^m/\partial w > 0$. This discussion seems to suggest that a reduction in w will raise the FDI incentive. In the case of strategy II′, the countervailing profit reduction to the MT-headquarter disappears and therefore the wage impact becomes clearer. The following proposition confirms this intuition.

PROPOSITION 1. *(i). As w decreases, the MT-firm's FDI incentive increases:*

$$-\frac{\partial\Delta_t}{\partial w} > 0.^{22}$$

(ii). $\Delta_t > 0$ for all $w \in [0,\ 1]$ if and only if $k < k_1$. Moreover, $\Delta_t < 0$ for all $w \in [0,\ 1]$ if and only if $k > k_2$ when $D \geq 15c$, or if and only if $k > k_2'$ when $D < 15c$.

Proof. See A1 in Appendix. ▌

4.2.2. The auto sector

As in the case of textiles, we consider the following three-stage game when the MA-firm is in the trade-FDI regime. In the first stage, it chooses between FDI and non-FDI. If FDI is chosen, it establishes a subsidiary in country H, called the MA-subsidiary. Then, in the second stage, the MA-firm must choose one of the following three strategies:

Strategy I: Stop exporting to the H's market from the headquarter, letting the subsidiary there supply the market;

Strategy II: Continue to export to the H's market, with both the headquarter's export level and the subsidiary's output level being chosen coordinately by the MA- firm to maximize the firm's global profit; and

Strategy III: Continue to export to the H's market but let the subsidiary choose its output level independently to maximize the subsidiary's own profit, while the headquarter chooses the export level independently to maximize the export profit. Let us called this the *independent multiple-entry strategy.*

[22] Δ_t may not be differentiable at $w = \tilde{w}$.

Finally, in the third stage, production takes place and firms compete in the market. If the MA-firm chooses non-FDI in the first stage, we then move to the third stage which is identical to the case of the trade regime. Note, it is never optimal to let the subsidiary sell its products back to the home market, even if in that market there is demand for those products, because the MA-headquarter is a monopolist there. It is therefore clear that we can ignore the M's auto market in our analysis.

The lower part of Figure 3 illustrates the trade and FDI flows and the resulting market structure under strategy III. We now examine the third stage of the game first, supposing the MA- firm chooses FDI in the first stage. If in the second stage the firm adopts strategy III, then there are three independent players in the market, the MA-headquarter (exporter), the MA-subsidiary, and the HA-firm. Their profits are, respectively, $\pi_a^{m*} = (D-Q)q_a^{m*} - \beta c q_a^{m*}$, $\pi_a^m = (D-Q)q_a^{ms} - \beta w c q_a^{ms}$, and $\pi_a^h = (D-Q)q_a^h - wcq_a^h$. The equilibrium quantities and profits from this market are, respectively,

$$q_a^{m*} = \frac{1}{4}(D - 3\beta c + \beta wc + wc), \qquad \pi_a^{m*} = (q_a^{m*})^2, \tag{7}$$

$$q_a^{ms} = \frac{1}{4}(D + \beta c - 3\beta wc + wc), \qquad \pi_a^{ms} = (q_a^{ms})^2, \tag{8}$$

$$q_a^{h} = \frac{1}{4}(D + \beta c + \beta wc - 3wc), \qquad \pi_a^{h} = (q_a^{h})^2. \tag{9}$$

Thus, the MA-firm's global profit with FDI and strategy III is (omitting profit in the M's market):

$$\Pi_a^m = \pi_a^{m*} + \pi_a^{ms} - k,$$

where the two profits on the RHS are as given in (7) and (8).

We now turn to the case where the MA-firm chooses strategy I in the second stage. Then, the H's auto market is a duopoly in the third stage whose equilibrium can be easily derived. In particular, the MA-firm's global profit (simply the subsidiary's profit) is

$$\Pi_a^m(1) = \frac{1}{9}(D - 2\beta wc + wc)^2 - k,$$

and hence the profit difference between strategies III and I is

$$\Pi_a^m - \Pi_a^m(1) = \frac{q_a^{m*}}{18}(D - 15\beta c + 13\beta wc + wc). \tag{10}$$

Before we determine the sign of the above profit difference, let us examine strategy II first. Note, the MA-headquarter has constant marginal cost βc to produce for export, but the MA-subsidiary has even lower constant marginal cost βwc to produce the same product. Note also, the fixed FDI cost k has been sunk in the first stage of the game when the MA-firm sets up the subsidiary. Thus, if the MA-firm jointly sets the levels of export and the subsidiary's output, the subsidiary is the only one to produce. That is, strategy II turns out to be the same as strategy I. Lemma 2 shows that strategies I and II are dominated by strategy III.

LEMMA 2. *Suppose it is worth for the MA-firm to make FDI in country H. Then, the independent multiple-entry strategy (strategy III) is the MA-firm's optimal strategy. That is, the MA-firm enters the foreign market via both export and FDI, letting the export level and its subsidiary's output be chosen independently.*

Proof. See A2 in Appendix. ▌

It is worth reiterating that the main results of the paper will remain unchanged if Strategy III is ruled out.

Finally, we analyze the first stage of the game. Note, with the non-FDI decision, the MA-firm's global profit is simply equal to that in the trade regime, π_{ao}^{m*} as in (3). Hence, the MA-firm's *FDI incentive* is

$$\Delta_a \equiv \Pi_a^m - \pi_{ao}^{m*}.$$

The MA-firm chooses FDI if and only if $\Delta_a > 0$. Obviously, other things being held constant, as k increases, Δ_a decreases. In particular, corresponding to Proposition 1(ii), we can derive the necessary and sufficient conditions on k such that FDI occurs or does not occur for all levels of wage rate. To sharpen our focus, we consider only the case of $\beta = 0$, i.e., when the MA-firm has the largest absolute advantage over the HA-firm. The result is reported in Proposition 2(iii).

It is also clear that an increase in w, *ceteris paribus*, helps the MA-headquarter's export because its competitors become less competitive. This is true regardless of whether or not the MA-firm makes FDI. That is, $\partial\pi_a^{m*}/\partial w > 0$ and $\partial\pi_{ao}^{m*}/\partial w > 0$. However, the wage effect on the MA-subsidiary's profit is less clear at first glance. On the one hand, the subsidiary is hurt directly by the wage increase. On the other hand, it gains because one of its competitors (the HA-firm) becomes less competitive. In fact, $\partial\pi_a^{ms}/\partial w = cq_a^{ms}(1 - 3\beta)/2$, which is positive, zero or negative, if

β is less than, equal to or greater than $1/3$.[23] The intuition is simple. A one-percent increase in w raises the HA-firm's cost by $0.01wc$, and the MA-subsidiary's cost by $0.01\beta wc$. If β is sufficiently small, the positive effect on the MA-subsidiary outweighs the negative effect, and vice versa. The following proposition describes the overall effect of wage increase (decrease) on the FDI incentive.

Another interesting issue is the effect of β on the MA- firm's FDI incentive. That is, we want to know whether the FDI incentive becomes stronger as an MNC's absolute advantage over its competitor gets bigger? Since absolute advantage is about the technology difference, to obtain a clear result, we set $w = 1$ to let β capture the effective cost difference between the two countries. The impacts of various parameters on the MA-firm's FDI incentive are summarized in the following proposition. Let us first introduce some useful notations:

$$k_3 \equiv \frac{D^2}{72} \text{ and } k_4 \equiv \frac{(D+c)^2}{72}.$$

PROPOSITION 2. *(i). As wage in H decreases, the MA-firm's FDI incentive increases if β is large, but decreases if β is small. Specifically, there exists $\tilde{\beta} \in (0,\ 1)$ such that*

$$-\frac{\partial \Delta_a}{\partial w} > 0, \ \text{if } \beta > \tilde{\beta}, \quad \text{and} \quad -\frac{\partial \Delta_a}{\partial w} < 0, \ \text{if } \beta < \tilde{\beta}.$$

(ii). Setting $w = 1$. Then, with a more advanced technology (i.e., a smaller β), the MA-firm has stronger FDI incentive:

$$-\frac{\partial \Delta_a}{\partial \beta} > 0.$$

(iii). Setting $\beta = 0$. Then, $\Delta_a > 0$ for all $w \in [0,\ 1]$ if and only if $k < k_3$. Moreover, $\Delta_a < 0$ for all $w \in [0,\ 1]$ if and only if $k > k_4$.

Proof. See A3 in Appendix. ∎

4.2.3. Comparison

We are ready now to compare the FDI incentives in the two sectors. First, let us examine the role of FDI cost. Based on Proposition 1(ii)

[23] The critical value, one-third, is related to the number of competitors in the market.

and Proposition 2(iii), it is easy to find that the conditions on k are more stringent in the case of auto sector than the textile sector, in the sense that $k_3 < k_1$, $k_2 > k_4$ and $k_2' > k_4$. Moreover, we have the following ranking: $k_3 < k_4 < k_1 < k_2$ for $D - 15c \geq 0$, and $k_3 < k_4 < k_1 < k_2'$ for $D - 15c < 0$. The ranking has an important implication for the sequence of entry via FDI by the MT-firm and the MA-firm. Let us focus our discussion on the case where $D - 15c \geq 0$. When $k > k_2$, there is no FDI in either sector. As k drops to the range, $[k_1,\ k_2]$, the MT-firm makes FDI at some levels of w, but the MA-firm does not at any w. As k continues to drop and falls into (k_4, k_1), the MT-firm makes FDI at all levels of w, but the MA-firm still does not do FDI at any w. Only when k reduces to the range $[k_3,\ k_4)$ does the MA-firm make FDI at some levels of w. The MT-firm surely makes FDI at any w. When k is sufficiently low, $k < k_3$, FDI occurs in both sectors at all levels of w. We summarize the above result in Proposition 3.

PROPOSITION 3. *Letting $\beta = 0$. When the FDI cost is very high ($k > k_2$), neither the MT-firm nor the MA-firm does FDI in country H at any level of wage rate. As the FDI cost drops but still remains at some high level ($k_4 < k \leq k_2$), the MT- firm starts to make FDI, but the MA-firm does not. Only when the FDI cost has dropped to a significantly low level ($k \leq k_4$) will the MA-firm start to make FDI.*

In comparing the two sectors, we are also concerned about how differently their FDI incentives are affected by the wage rate changes, and most importantly, whether $(\Delta_t - \Delta_a)$ is positive or negative. Proposition 4 states the results.

PROPOSITION 4. *(i). As the host country's wage rate decreases, the MT-firm's FDI incentive increases more than the MA-firm's FDI incentive:*

$$-\frac{\partial \Delta_t}{\partial w} > -\frac{\partial \Delta_a}{\partial w}, \quad \textit{for all } w \textit{ and } \beta.$$

(ii). The MT-firm always has stronger FDI incentive than the MA-firm:

$$\Delta_t > \Delta_a \quad \textit{for all } w \textit{ and } \beta.$$

Proof. See A4 in Appendix. ∎

The intuition behind Proposition 4(i) is simple. Recall from Proposition 1(i) and Proposition 2(i), a reduction of country H's wage rate encourages FDI to this country in every sector (except for the auto sector when β is small). Because from country M's point of view, labor is a more important cost component in textile production than in auto production, the wage reduction encourages the textile sector's FDI more than the auto sector's FDI, as shown by Proposition 4(i).

The difficulty is in understanding why $\Delta_t > \Delta_a$, part (ii) of Proposition 4. Since country H has both comparative and absolute advantages in its textile sector, we wonder whether this sector's relative attractiveness to inward FDI is due to its comparative advantage or to its absolute advantage or to both. The proposition gives no indication to an answer. However, it is not difficult to get the answer indirectly as we have found that the result holds when wages in the two countries are equalized (i.e., when $w = 1$), which is a special case of the proposition, or even when the wage rate in country H is slightly higher than that in country M (i.e., $w > 1$), which can be shown by going over the proof again. In these cases, H does not have absolute advantage or it may even have absolute disadvantage in the textile sector. This leads us to conclude that *the textile sector is more attractive to FDI because the host country has comparative advantage in this sector.*[24]

Having established the link of FDI incentives to comparative advantage, the question becomes why comparative advantage matters. The reason is the following. Comparative advantage determines the pattern of trade, which in turn distinguishes the textile and auto sectors in their market opportunity and export opportunity for FDI. This is apparent by comparing Figure 3 to Figure 2. Specifically, when making FDI, there is virtually no new market opened to the MA-firm. The MA-firm has already been in the H's market via export in the trade regime. On the contrary, with FDI, the MT- firm enters a new market which the firm has not been able to touch in the trade regime. Moreover, it also exports from its production base in country H. A better market and export opportunity in H's textile sector makes this sector more attractive to inward FDI compared to the auto sec-

[24]There are a few empirical studies analyzing the determinants of export-oriented foreign direct investment by U.S. MNCs. It is found that primarily such offshore production is to exploit international differences in factor prices. Specifically, such production is positively related to a measure of labor intensity and negatively related to a measure of capital intensity. In particular, a low wage rate is an important determinant. See Kumar (1994) and the references cited therein. In the present study, the textile sector is more attractive to FDI because country H has comparative advantage in this sector and the MT-subsidiary is also export-oriented. Thus, our result is consistent with this empirical finding.

tor. In a nutshell, our explanation emphasizes that comparative advantage leads to different market opportunities opened for FDI in different sectors, which results in discrepancy in cross-sector FDI incentives.[25]

Proposition 4 compares FDI incentives. However, it does not imply that in reality we should observe more FDI in the textile sector than in the auto sector. When comparing the actual FDI, differences between the two sectors in demand, cost and capital structures also matter. For instance, if the plant setup cost, k, is higher in the auto sector than in the textile sector, we may observe FDI in both sectors, but the amount is less in the latter sector than in the former. Because we aim at pointing out other important FDI factors which are less obvious than those such as demand, cost and capital structures, our model has abstracted from these realistic sectoral differences. Hence one should apply the results to the real world with cautions.

5. CONCLUDING REMARKS

Although there have been some empirical studies showing that more FDIs tend to flow to the host country's comparative advantage sectors, the theoretical literature of international trade and FDI does not give any explicit and clear answer to the question that relates comparative advantage to FDI's sector location. We have constructed a theoretical model that allows us to analyze this issue. Our result is consistent with the findings of those empirical works.

In particular, we define FDI incentive and show that the host country's comparative advantage sector is more attractive to inward FDI than is its comparative disadvantage sector. Our theory emphasizes the differences between the two sectors in their market and export opportunities, which are determined by comparative advantages. We have also obtained results on how comparative advantage and absolute advantage affect a sector's FDI incentive, and what is the MNCs' optimal entry strategy via FDI.

In this trade-cum-FDI model, there are many other interesting issues that we have not been able to analyze in this study. For example, when an MNC makes investment abroad, it faces an economic environment different from home. Will it still invest in the same industry or make cross-industry

[25] Besides market and export opportunities, one may think that cross-sector difference in labor intensity is also a reason for the more FDI-attractiveness in the textile sector because it uses more labor than the auto sector and so benefits more from FDI. This intuition applies only for $w < 1$. But our comparison result holds for $w = 1$ and even for a w slightly greater than 1.

investment? What is the role of the host country's comparative advantage and absolute advantage in determining an MNC's cross-industry investment?

APPENDIX

A1. Proof of Proposition 1:

(i) Suppose $w \geq \tilde{w}$. Then, using (1) and (4) – (6), we obtain

$$-\frac{\partial \Delta_t}{\partial w} = -\frac{c}{3}[3q_t^m - 2q_t^{ms} - 3q_t^{ms*} - 2q_{to}^m] = \frac{c}{9}[4(D - wc) + 5(1 - w)c] > 0.$$

If $w < \tilde{w}$, then $-\partial \Delta_t / \partial w = 2c(q_{to}^m + 2q_t^{ms})/3 > 0$.

(ii). The proof of this part is based on the above monotonicity of Δ_t over $w \in [0, 1]$. First, $\Delta_t(w = 1) = k_1 - k$. Hence, $\Delta_t > 0 \ \forall \ w$ iff $k < k_1$. Second, suppose $D - 15c \geq 0$. Then, $\Delta_t(w = 0) = k_2 - k$ and so $\Delta_t < 0 \ \forall \ w$ iff $k > k_2$. Finally, if $D - 15c < 0$, then $\Delta_t(w = 0) = k_2' - k$. Thus, $\Delta_t < 0 \ \forall \ w$ iff $k > k_2'$. ∎

A2. Proof of Lemma 2:

Based on (10), define $X(\beta) = D - 15\beta c + 13\beta wc + wc$. Then, for any given w, $X' = -15c + 13wc < 0$ for all $\beta \leq w$. However, $X(\beta = w) = D - 14wc + 13w^2 c$, which is a convex function of w and reaches minimum at $w = 7/13$. Suppose $D - 49c/13 > 0$, which is a condition slightly stronger than $D - 3c > 0$. Then, $X(\beta = w) \geq X(\beta = w = 7/13) = D - 49c/13 > 0$. Thus, $X(\beta) > 0$ for all $\beta < w$. Note that the above analysis is valid for all $w \leq 1$. Hence, $\Pi_a^m - \Pi_a^m(1) > 0$ for all β. ∎

A3. Proof of Proposition 2:

We prove (i) first. Use the equilibrium profits and quantities in (3), (7) and (8) to obtain

$$-\frac{\partial \Delta_a}{\partial w} = -\frac{c}{6}[3(1 + \beta)q_a^{m*} + 3(1 - 3\beta)q_a^{ms} - 4q_{ao}^{m*}] = -\frac{c}{36}\Phi(\beta),$$

where $\Phi(\beta) \equiv 9c(3 - 5w)\beta^2 + (9D - 7c + 18wc)\beta - (D + wc)$. Note $\Phi' = 18c(3 - 5w)\beta + 9D - 7c + 18wc$, which is obviously positive if $(3 - 5w) > 0$. If $3 - 5w < 0$, then $\Phi' > 18c(3 - 5w) + 9D - 7c + 18wc = 9D + 47c - 72wc \geq 9D + 47c - 72c = 9D - 25c > 0$, because $D - 3c > 0$. Thus, $\Phi(\beta)$ strictly increases in β. Since $\Phi(\beta = 0) = -D - wc < 0$ and $\Phi(\beta = 1) = 8D + 20c - 28wc > 8D + 20c - 28c = 8(D - c) > 0$, there exists a unique $\tilde{\beta}$ such that the result holds.

We now prove (ii). We have $\partial \Delta_a / \partial \beta = (c/6)[-3(3 - w)q_a^{m*} + 3(1 - 3w)q_a^{ms} + 8q_{ao}^{m*}]$. By setting $w = 1$ and taking a second derivative, we obtain

$\partial^2\Delta_a/\partial\beta^2 = c^2/18 > 0$. However, at $\beta = 1$, $\partial\Delta_a/\partial\beta = -(D_a - c)/2 < 0$. Thus, the inequality holds for all $\beta < 1$.

Finally, we prove (iii). At $\beta = 0$, we have $\Delta_a = (D + wc)^2/72 - k$, which is an increasing function of w. Thus, the results in (iii) follow because $\Delta_a(w = 1) = (D + wc)^2/72 - k$ and $\Delta_a(w = 0) = D^2/72 - k$. ∎

A4. Proof of Proposition 4:

(i). Suppose $w \geq \tilde{w}$ and define $Y_1(w) \equiv 9(1+\beta)(D-3\beta c+\beta wc+wc)+9(1-3\beta)(D+\beta c-3\beta wc+wc)-16(D-2\beta c+wc)+72(1-w)c+16(D-wc)+16(D-2c+wc)$. Then, using the equilibrium profits and quantities derived in the preceding subsections, we can show that

$$\frac{\partial(\Delta_a - \Delta_t)}{\partial w} = \frac{c}{72}Y_1(w) \quad \text{and}$$
$$Y_1'(w) = -c[88 - 9(1+\beta)^2 - 9(1-3\beta)^2] < 0 \ \ \forall\, \beta \in [0,1].$$

That is, $Y_1(w)$ is a decreasing function of w. Note $Y_1(w = 1) = 2[(17 - 9\beta)D - (15 + 11\beta - 18\beta^2)c] > 2[8D - (15 + 11\beta - 18\beta^2)c]$. However, at $\beta = 11/36$, $(15 + 11\beta - 18\beta^2)$ reaches its maximum, which is equal to 16.68. Thus, $Y_1(w = 1) > 2(8D - 17c) > 0$ because $D > 3c$. Hence, $\partial(\Delta_a - \Delta_t)/\partial w > 0$ for all β and w.

We now turn to the case $w < \tilde{w}$ and have

$$\frac{\partial(\Delta_a - \Delta_t)}{\partial w} = \frac{c}{36}\Phi_1(\beta) \quad \text{where} \quad \Phi_1(\beta) = \Phi(\beta) + 8(3D - 2c - wc),$$

where $\Phi(\beta)$ is defined in A3 and $\Phi' > 0$ as shown in A3. Thus, $\Phi_1' > 0$. Note $\Phi_1(\beta = 0) = 23D - 16c - 9wc > 0$ because $D > 3c$. Therefore, the inequality $\partial(\Delta_a - \Delta_t)/\partial w > 0$ holds for all β and w.

(ii). Suppose $w \geq \tilde{w}$. Given the monotonicity result in (i), if $(\Delta_t - \Delta_a) > 0$ at $w = 1$, then the same inequality holds for all w (≤ 1). Setting $w = 1$, we obtain

$$(\Delta_t - \Delta_a) = \frac{1}{36}Y_2, \ \text{ where } Y_2 = 4D^2 + [7\beta(1-\beta) + (1+3\beta)(4-3\beta)]c^2 - Y_3(\beta)Dc,$$

where $Y_3(\beta) = (1 + 3\beta) + 4(4 - 3\beta) - 7(1 - \beta)$. Note, $[7\beta(1 - \beta) + (1 + 3\beta)(4-3\beta)]$ is a concave function of β and within [0, 1], it reaches minimum at $\beta = 0$ and $\beta = 1$. The minimum value is 4. Thus, we have $Y_2 > 4D^2 + 4c^2 - Y_3(\beta)Dc = 4(D-3c)^2 + 24Dc - 32c^2 - Y_3(\beta)Dc > 4(D-3c)^2 + 11(D - 3c)c + [13 - Y_3(\beta)]Dc$. Note $[13 - Y_3(\beta)]$ is an increasing function of β and equals to 3 at $\beta = 0$, that is, it is strictly greater than 0 for all $\beta \in [0,\ 1]$. Hence, $Y_2 > 0$ since we also have $D - 3c > 0$.

Now turn to $w < \tilde{w}$, in which case $\Pi_t^m(2)$ should be used to replace Π_t^m in calculating Δ_t. Suppose even if $w < \tilde{w}$ we still use Π_t^m to construct the FDI incentive, denoted by $\overline{\Delta}_t$. The above analysis has indicated that $\overline{\Delta}_t > \Delta_a$ for all $w \in [0, 1]$. As $\Pi_t^m(2) > \Pi_t^m$, we have $\Delta_t > \overline{\Delta}_t > \Delta_a$ for all $w \in [0, \tilde{w})$. ▌

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