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Three Essays on International Trade

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To my beloved parents, Jaimin Lee and Hyosun Koh,

and my heavenly grandmother

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Three Essays on International Trade

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This dissertation consists of three essays in international trade. The first chapter analyzes integration strategies of Korean firms that involve producing final products and providing post-production services for serving geographically separate foreign markets: high-income and low-income countries. I present a model in which heterogeneous firms must provide services for products through their subsidiaries in host countries, but can produce output in different locations. The model shows that the firm's equilibrium decision depends on its own productivity level and economic variables that affect production location and providing services. Using plant- and firm-level data of Korean firms, the empirical analysis provides the results that support the model's predictions.

The second chapter analyzes the effects of regional economic integrations on investment patterns among Korean multinational firms. Using Korea's middle-income status, we develop a model in which heterogeneous firms in a middle-income country decide on the optimal FDI strategies for serving different regions: a developed (EEA) and a developing (AFTA) trade integrated regions. Following reduced trade costs between countries inside the trade integrated region, our model predicts that integrating into a regional economic zone affects firms with low productivity

levels to enter the region via complex FDI strategies. Depending on the size of the region, however, complex FDI strategies differ such that firms investing in developed region tend to undertake local and export sales to the third country, whereas firms investing in developing region are more likely to engage in not only local and export sales to the third country, but also export sales to the parent country. The empirical analysis confirms the effect of different regional economic integrations on the strategy of firms with different productivity levels.

The last chapter examines the conditions under which technology spillovers through workers' movement occur between foreign affiliates in the host country and determine whether such spillovers can affect the exporters' decisions to switch their strategies to serve foreign markets via FDI. Developing a simple two-period duopoly model, I find that the occurrence of technology spillovers is dependent on firm and host country characteristics such that spillovers are more likely to arise when firms have similar technology capabilities and in countries that incur low cost of training local workers. Under these circumstances, exporters are more likely to switch to FDI for serving foreign markets. However, I find that transport costs of goods have ambiguous effect on the occurrence of spillovers and thus, do not play a marginal role in exporters' decision.

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Chapter 1

Post-Production Services and Optimal Integration Strategies for the Multinational Firm

1.1 Introduction

Recent literature on international trade has examined the role of product quality as a determinant of trade patterns (Schott (2004); Hallak (2006); Crinò and Epfiani (2009)). These studies have concentrated on testing Linder's theory (1961), who was the first to argue that rich (poor) countries have a comparative advantage in producing high-quality (low-quality) goods and have relatively higher demand for these goods.[1] For example, Hallak (2006) provides support for the Linder's theory by developing an empirical framework to identify the effect of quality on the demand-side by studying the relationship between a country's income and its aggregate demand for quality. On the other hand, showing a positive correlation between export unit values and exporter per capita income and capital endowments, Schott (2004) supported Linder's (1961) theory predicting the impact of quality on the supply-side. These works have contributed to the trade literature by examining product quality to explain bilateral trade between countries with similar income levels. Notably, however, these studies have been restricted to developed countries and cannot adequately explain trade between heterogeneous countries, particularly outward foreign direct investment (FDI) flows from developing countries to developed

[1] Based on the assumption that the consumer's preference for the quality is non-homothetic with respect to per capita income, these literature have found that countries with similar incomes per capita exhibit large volumes of bilateral trade. See Murphy et al. (1989) and Matsuyama (2000) on the role of non-homothetic preferences on product quality in international trade.

countries.

To study firms' strategies to serve global markets, this paper uses micro-level data from Korea, a developing country that have undergone remarkable growth in outward FDI in last few decades. As noted, developed countries have superior technology and rich endowments to produce and upgrade product quality to serve foreign markets. What kind of measures, then, can multinational firms in developing countries take to enter foreign markets and compete against high-quality products? In this work, I start to explore the idea that improving post-production services for products may be a tactical strategy for such firms.

Much evidence exists to support the fact that providing post-production services is a crucial strategic decision for firms, specifically firms in emerging countries seeking to extend foreign market share. For example, Hyundai Motors, one of the largest multinational firms in Korea, is known worldwide for its post-production services. By providing high-quality service that is distinguishable from other foreign automobile makers producing high-quality vehicles, Hyundai has shown steady growth in its market share worldwide. Computer Aided System Corporation (CAS), a small Korean multinational firm that manufactures electronic scales is also known for leading market share in Eastern Europe by providing superior post-production services.[2] Although recent evidence indicates that the quality of services can be a comparative advantage for firms serving foreign markets, traditional theories of international trade have neglected to study the role service quality plays in firms' strategic decisions.

[2]Post-production services provided by Korean firms mostly involve repair and maintenance services after production. For example, Hyundai offers America's best warranty, which provides free repair and maintenance services for 10 years or 100,000 miles and 24/7 roadside assistance, whereas CAS provides services by establishing numerous service centers and hiring service agents to provide maintenance service everyday (Dong-A Business Review, 2009).

Recently, the literature has incorporated post-production services into firms' decisions to serve foreign markets, specifically examining what determines a firm's choice of providing services through outsourcing or providing services themselves through FDI. To analyze the distribution of final products (an important example of post-production services), recent theoretical work has developed international duopoly models to formalize the role of distribution costs as a determinant of firms' choices on providing services in foreign markets (Qiu (2010); Ishikawa et al. (2010)). These models share two important features. First, domestic and foreign firms compete in the domestic market to provide services. Second, firms' FDI decisions depend not only on distribution costs, but also on plant setup costs. With high distribution costs, foreign firms prefer engaging in FDI; however, conditional on plant setup costs, foreign firms will either merge with domestic firms (cross-border M&A) or establish their own (greenfield FDI).[3]

In contrast to studying one aspect of firms' business activities to serve global markets, this paper studies the optimal strategies of multinational firms in a middle-income country to integrate production and post-production services in different locations. Then, I examine how firms provide services through different types of service managers for serving different foreign markets: high-income and low-income countries.[4] To organize the discussions of firms' decisions to produce and provide services of products in foreign markets, I introduce service quality differences into

[3]In a related work, Nocke and Yeaple (2007) stress the importance of marketing and distribution costs in affecting firms' foreign market entry modes. Developing a general equilibrium model with heterogeneous firms, they show that the source of firm heterogeneity in mobile (technology) and immobile (marketing) capabilities plays a key role in firms' decisions to choose between cross-border M&A and greenfield FDI.

[4]My approach to studying firms that provide post-production services through service managers are consistent with findings from the strategic management literature, which emphasizes the importance of service managers providing services through regular visits, routine conversations, promotions with buyers (Parasuraman et al. (1985); Anand and Delios (2002); Rouleau (2005)).

the heterogeneous firms trade model developed by Grossman et al. (2006), that analyze a complementary strategy of heterogeneous firms that choose different organizational forms to integrate producing intermediate goods and conducting assembly operations in one or more locations.

I develop a modification of the Grossman et al.'s framework to explain strategies of multinational firms on integrating production and post-production services. I introduce a one-stage production model in which firms investing in and serving the North can save transport costs, whereas producing domestically and shipping to the North conserves production and plant setup costs. Alternatively, investing in and serving the South saves both production and transport costs and shipping products from the home country conserves the plant setup cost.

After production, firms either hire local managers or bring home service managers to provide services. Local service managers provide services effectively in their local market, whereas home service managers have disadvantages in exerting their abilities abroad, including limited local market knowledge or cultural barriers. Firms, therefore, choose service managers with high-abilities to provide services by considering the degree to which the managers are internationally mobile. The model shows that the decision a firm makes regarding production location depends on industry characteristics, such as fixed investment costs of setting up the plant, transport costs, and the firm's productivity level. On the other hand, the firm's decision to provide services depends on country characteristics, particularly the manager's ability and the degree of international mobility.

Given that firms' optimal strategies to serve foreign markets are likely to differ based on the market size relative to the home country, I estimate the firm's strategy model separately for firms serving high-income countries and firms serving low-income countries. The empirical findings are consistent with the predictions

of the theoretical model. For firms that enter high-income countries, their choice of strategies depends on the transport cost, which is a crucial element for firms' production location decisions and, their productivity levels. For firms investing in low-income countries, their choice of strategies depends on the degree to which home service managers are international mobile, which plays an important role in firms' decisions to provide services.

This paper makes notable departures from recent trade literature on post-production services and firms' integration strategies. In contrast to recent theoretical work on post-production services (Ishikawa et al. (2010)), this paper focuses on three concepts. First, I focus on maintenance and repair services as the firm's primary activity when providing post-production services in global markets. Second, firms must provide these services by establishing their own facilities abroad. Hence, rather than studying firms' choice between outsourcing and FDI, this paper examines the determinants that affect firms' choice of international organization forms in different locations. Third, service managers provide post-production services in the company. These managers exert their abilities, which differ across countries, to demonstrate the service quality of final products.

On the other hand, in contrast to Grossman et al. (2006), this paper examines two additional phenomena. First, I study firms' integration strategies to produce final outputs and provide post-production services on their own. In the model, I incorporate firm heterogeneity as a determinant of horizontal and service FDI. Second, I study the decisions that firms headquartered in a middle-income country make to serve geographically separate foreign markets. Dividing the present study into two cases in which firms serve each type of foreign market, this paper aims to examine the determinants of firms' optimal strategies when facing different markets.

This paper makes two main contributions to the trade and FDI literatures.

First, by adding the firm's decision to provide post-production services to its production location decision for serving foreign markets, I introduce a new pattern of FDI – service FDI – in equilibrium. Second, in the line with Aw and Lee (2008), I introduce firms in a middle-income country that seek to serve global markets. In contrast to their model, which focuses on the effects of firm heterogeneity on Taiwanese firms' production location choices between high- and low-income countries, I concentrate on Korean firms' integration strategies related to post-production services when serving high- and low-income countries separately. This provides implications for how firms choose an optimal integration strategy when they serve the market from the perspective of a rich country and from the perspective of a poor country. To my knowledge, this concept has not been studied. Given Korean's income status, one of my goals is to provide insights into different forms of FDI that firms in a developing country can choose if they seek to serve developed countries.

The remainder of this paper is organized as follows. Section 2 presents recent FDI activities among Korean firms and describes the plant-level data used for the empirical estimation. Section 3 develops a model illustrating firms' choices for different integration strategies. Section 4 describes how I construct the variables from the data set for the econometric analysis. Section 5 contains the empirical results of testing predictions from the model, and Section 6 concludes and proposes future work.

1.2 Data Facts

This section presents recent activities of Korean multinational firms worldwide using plant-level data from 2002 through 2009. This plant-level data includes the full list of Korean worldwide investments during the sample period. All foreign affiliates abroad in which Korean firms hold at least a 10% ownership share are in-

cluded in the sample. The data was obtained from the Overseas Direct Investment Statistics from the Export-Import Bank of Korea. While the Export-Import Bank of Korea has collected data officially on Korean affiliates abroad since 2002, these figures are restricted from the public by the Ministry of Strategy and Finance of Korea for confidentiality reasons.

This plant-level data are very useful in that they provide information on individual foreign affiliates that are disaggregated by industry sectors and destination country in a given year. The most interesting feature of the data is that they not only provide information on affiliates' balance sheets, but also on total sales divided by: (*i*) sales made from the local market, (*ii*) sales made from exporting back to the parent country, and (*iii*) sales made from exporting to third countries.[5] With information on affiliate sales, it is possible to distinguish plants based on whether they engage in horizontal, vertical, or export-platform FDI.

The data also provide information on the employment of each foreign affiliate, divided by the worker's nationality and occupation. Decomposed into employees from home country and host country, the data provide occupations, which are divided into top managers, middle managers, service managers, and production workers.[6] The data therefore show how Korean firms with different forms of FDI do business with various types of managers and production workers worldwide.

Table 1.1 presents the distribution of Korean multinational firms in manufacturing industries that engage in specific FDI type to serve foreign markets (third

[5]In particular, sales made by each foreign affiliates can be divided within each category into sales to other foreign affiliates of Korean firms or foreign joint ventures and sales to unaffiliated customers.

[6]According to the data, top managers are defined as managers delegated from headquarters to appoint the overall performance of affiliates, whereas middle managers are defined as managers in charge of supervising production workers and, specifically, in charge of contracting with local production workers and sales of the products. Service managers are defined as managers outside the production line who are in charge of after-service of the products.

Table 1.1: New Korean facilities between 2002 and 2009

	High-income countries		Low-income countries	
	Horizontal FDI	Service FDI	Horizontal FDI	Service FDI
% of local employees	0.952	0.881	0.969	0.911
production	0.719	0	0.867	0
service	***0.273***	***0.976***	***0.131***	***0.935***
% of Korean employees	0.048	0.119	0.031	0.089
production	0.121	0	0.206	0
service	***0.169***	***0.009***	***0.46***	***0.714***
Production location				
% of firms in specific FDI type	52.9	47.1	85.7	14.3
Post-production services				
% of firms (local service managers)	94.2	97.6	49.1	46.9
% of firms (Korean service managers)	1.7	0.8	45.5	48.3
affiliate size	133.53	48.53	296.14	105.21
# of entry firms	442		1198	

Note: High-income and low-income countries are divided according to GNI per capita, calculated using the World Bank Atlas Method, with respect to the income-level of Korea in a given year.

row) and the employee demographic in their local subsidiaries that were established during the sample period (first two rows). Firms are divided based on the purpose of investment and by income-level of destination countries relative Korea in order to show how they use their subsidiaries and organize employees to serve different foreign markets.

In the table, horizontal FDI is defined as a firms's investment in a foreign production facility that is designed to serve consumers in the foreign market. In plant-level data, it involves firms that use their facilities to make sales only from the local market by producing output through local production workers. On the other hand, service FDI is defined as firm's investment in a foreign service facility that is designed to provide post-production services of products in the foreign market. In the dataset, it involves firms that use facilities to make sales only from the local

market with products that are produced and shipped from Korea.[7] In contrast to firms that undertake horizontal FDI, these firms do not include any of production workers, but only with service managers.

The table shows that when Korean firms invest in foreign production facilities to serve local markets, they include not only production workers to produce outputs, but also service managers to provide post-production services. In particular, the table shows that firms have different approach to service management in different markets. When serving high-income countries, most of Korean firms tend to employ service managers from host countries, whereas firms in low-income countries are more likely to either employ service managers from host countries or send managers from headquarters to provide services in local markets.

The most distinguishable feature of Korean multinational firms from the table is that there exist large number of firms that invest in subsidiaries that make sales from the local market without producing goods in their host countries; in particular, the table shows that nearly half of new facilities established in high-income countries are not designed to be involved in production facilities, but rather in service facilities (third row). These stylized facts are consistent with the theoretical model which introduces a service FDI strategy for heterogeneous firms.

[7]Plant-level data provide information on an affiliate's imports from the local market, Korea, and third countries, which can be divided within each category into imports from other Korean affiliates or from unaffiliated suppliers. Investigating imports made from affiliates that are designed to provide post-production services, I find that in both high- and low-income countries, new affiliates import products mostly from their headquarters in Korea. (On average, 98.6% of imports were from headquarters for affiliates in high-income countries whereas 94.9% account for affiliates' imports made from headquarters that are located in low-income countries.)

1.3 Theoretical Framework

This section develops a simple model in which firms serving global markets face decisions regarding where to integrate production and services and how to provide services through different types of service managers. To capture the fact that many Korean multinational firms choose various strategies based on different markets, I divide the analysis into two cases to study the determinants of firms' choices when they enter high- and low-income countries separately.

Firms in the Home produce final outputs and provide their services in foreign markets: North (n) or South (s). Each firm produces a differentiated variety. Consumers in all countries have a Dixit-Stiglitz preference over differentiated goods:

$$U = \left[\int_0^n q(\omega)^{1-\rho} x(\omega)^{\rho} d\omega\right]^{1/\rho} \qquad 0 < \rho < 1 \tag{1.1}$$

where n is mass of varieties available to consumers, indexed by ω; $x(\omega)$ is consumption of variety; and $q(\omega)$ is service quality of variety ω, as perceived by the consumer; and ρ is a measure of substitutability. Each variety is therefore a Cobb-Douglas bundle of physical quantity and perceived service quality.[8] Consumers maximize utility function subject to budget constraints

$$y = \int_0^n p(\omega) x(\omega) d\omega \tag{1.2}$$

where y is the exogenously given per capita income. Solving consumer's maximization problem yields the following demand for variety ω

$$x(w) = q(w)\frac{p(w)^{-\sigma}}{P^{1-\sigma}} R \tag{1.3}$$

[8]Perceived service quality is defined as the consumer's assessment of the overall excellence or superiority of the service (Zeithaml, 1998). Incorporating perceived service quality into the utility function implies that consumers rely on their expectation of services that will be provided by each variety and choose the brand that will fulfill their expectation.

where $\sigma = 1/1 - \rho > 1$ is the elasticity of substitution between varieties; $R = Ny$ is a national income with N as exogenously given population of a country; and P is the ideal price index of the country.[9] To capture the role of service managers, I assume that consumer's perceived service-quality takes the following form:

$$q = \lambda\alpha(z) \qquad \alpha(z) > 0, \quad \alpha'(z) > 0 \tag{1.4}$$

where $\lambda \in (1, \infty)$ is the true service quality of variety and $\alpha(z)$ is a function capturing the exogenous skill-level (z) of service managers.[10] This form therefore indicates that consumer's perceived service-quality is affected by true service quality of the product and the manager's ability to demonstrate its quality to consumers.[11]

On the production side, a continuum of firms exist in the home country that differ in their productivity levels indexed by θ.[12] A firm uses only labor to produce variety ω. Firm technology is represented by the constant marginal cost of production, is assumed to be mobile internationally, and can be replicated by its own foreign affiliate. The unit variable cost of firm with productivity level θ that serves foreign markets by producing in country k is denoted by C_k:

$$C_k = w_k t/\theta \tag{1.5}$$

[9] $P = \left[\int_0^n q(w)p(w)^{1-\sigma}dw\right]^{\frac{1}{1-\sigma}}$. Although P is endogenous to the industry, firms treat it as exogenous because their size is negligible relative to the size of the industry.

[10] λ implies inner service value of the product, for example, a 10-year service warranty for an automobile. Alternatively, I assume that the skill-level of service managers implies the manager's ability to demonstrate and perform the service value of the product, such as communication skills or other specific skills related to providing product maintenance and repair services. The value of service quality differs from the physical product quality studied by prior research (Hallak (2006); Johnson (2010)).

[11] By assuming that the managerial ability, rather than per capita income, affects the consumer's preference for the service quality of products, I do not address the effect of differences in the income distribution on demands. See Fajgelbaum et al. (2011) and Crinò and Epfiani (2009) for the analysis of the effect of product quality on the pattern of trade between countries based on non-homotheticity of preferences.

[12] This paper assumes that after entering to the industry, a firm draws a labor per unit output coefficient θ from a known distribution $G(\theta)$ and that firms serving foreign buyers have efficient technology to serve domestic market.

where w_k is the wage-level of production workers in country k and $t \geq 1$ is the melting-iceberg transport cost of shipping products to the destination market. As in Melitz (2003), the marginal cost is inversely related to firm productivity level and is independent of service quality. Each country differs in factor prices. The average hourly wage in Korea is sandwiched between that in developed countries and developing countries. These stylized facts are consistent with the basic assumption of the model that wage-level is highest in the North and lowest in the South such that $w_n > w_h > w_s$.[13] In addition to variable costs, multinational firms entering a foreign country via FDI incur the fixed investment costs of setting up plants.

To produce final outputs, firms face two choices for locating their plants. Firms can produce outputs at home and ship them to the destination market. This strategy incurs transport costs of shipping the products ($t > 1$), but saves the fixed cost of establishing facilities in the foreign country. On the other hand, firms can establish production facilities in the host country to serve local markets. This strategy would impose a fixed cost of FDI (f), but conserve transport costs of shipping products from the headquarters ($t = 1$).[14]

If cost differences across countries are the main factor that affects firms' decisions to choose between different production locations, proximity to consumers is a crucial element for firms needing to provide post-production services. To provide services of post-production outputs, therefore, all firms must establish service facil-

[13] According to LABORSTA, average wage rate per hour for manufacturing between 2002 and 2009 is $16.81 in developed countries (higher-income countries relative to Korea in data set), $11.29 in Korea, and $6.88 in developing countries (lower-income countries relative to Korea in data set).

[14] Since my primary interest is to study firms' strategies to serve countries that are richer or poorer relative to the home country by using two-country model, I exclude the possibility of firms producing outputs in third countries; for example, possibility of firms producing outputs in the South (North) and ship them to their service facilities in the North (South) to serve local markets, with the limited data for the empirical analysis. In the Appendix, however, I discuss for this possibility.

ities in the destination market which incur the fixed costs of setting up plants (s). Firms then hire local managers or bring service managers from headquarters, whose decision depends on the managerial ability to provide services which is assumed to be exogenous and differs across countries. Following the idea from Nocke and Yeaple (2007), service managerial ability takes the following form:

$$\alpha(z) \quad = \quad \max \ \{z_k, \delta z_h\} \ \text{ for } \ k = n, s \tag{1.6}$$

where $\delta \in (0, 1)$ is the degree of international mobility of managers, capturing the idea that service managers are more effective in their home country than abroad.[15]

Given the fact that tertiary education enrollment, which is used to proxy manager's ability in trade literature (Antràs et al. (2008)), in Korea lies between that of developed countries and developing countries, I assume that managerial ability is highest in the North, lowest in the South and intermediate in Home, i.e. $z_n > z_h > z_s > 1$. Figure 1.3 in the Appendix shows the relationship between the country's per capita income and service managerial ability, which is measured by the percentage of agents in the relevant age range enrolled in tertiary education. Managerial ability differences are also consistent with empirical findings that studied the role of managers in the company as international skill transfer from developed to developing countries (Fosfuri et al. (2001); Head and Rice (2002)).

When firms provide services through different types of managers, each firm bears a fixed cost of managing service managers, which can be interpreted as a fixed coordination cost in Nocke and Yeaple (2007). Because the service manager's role is to demonstrate the service quality of post-production outputs, the cost of managing

[15]Indeed, Maurin et al. (2002) provided empirical evidence suggesting that domestic firms have an advantage over foreign firms in marketing activities in their own country. By assuming that managerial ability to provide service takes the following form, firms will either hire or send high-ability managers to provide services in the destination market.

these service managers are not proportional to the products that the company sell. This is the term "distribution cost" used by Qiu (2010). Instead, I assume that the management cost is proportional to the managers' abilities, which are given exogenously in the model.[16]

1.3.1 The international organization of production and post-production services

In this subsection, I will derive firm's profit from serving the foreign market as a function of its productivity level and economic factors that affect firm's decision on locating production and providing post-production services. Then I turn to the equilibrium analysis in profit functions of different strategies firms can choose to serve consumers in high-income and low-income countries, respectively.

Within an industry, profit of a firm i that serves country k is as follows:

$$\Pi_{ik} = p_{ik}x_{ik} - C_{ik}x_{ik} - F_{j,k} \tag{1.7}$$

where $F_{j,k}$ is the firm's fixed entry costs consisting of plant setup cost, denoted by subscript $j = H, S$ (H, for horizontal FDI; S, for service FDI) and the cost of managing service managers, denoted by subscript $k = n, h, s$. Solving for the firm's profit maximization problem, the optimal price is a constant mark-up ($\sigma/\sigma - 1 = 1/\rho$) over marginal cost:[17]

$$p_{ik} = \frac{C_{ik}}{\rho} \tag{1.8}$$

[16]For expositional simplicity, this paper assumes that fixed managing cost takes the following functional form, $w(z)$ where $w(z) > 0$, $w'(z) > 0$, and z is the service manager's ability which is heterogeneous across countries.

[17]Note that marginal cost of production, $C_{ik} = w_k$ if firm i serves market k from its local subsidiary. Alternatively, $C_{ik} = w_h t$ if this firm produces in the home country then exports to market k.

Using country's demand level and optimal price, the profit of firm i producing variety to serve country k can be written as a function of firm productivity level and service quality

$$\Pi_{ik} = B_k(\overline{w}_k)^{1-\sigma}\theta^{\sigma-1}q_{ik} - F_{j,k} \tag{1.9}$$

where $B_k = (1-\rho)R_k/(\rho P)^{1-\sigma}$. If firm i produces and serves country k via FDI, then $\overline{w}_k = w_k$. If firm i serves country k by producing in the home country and export, then $\overline{w}_k = w_h t$.

After producing variety, each firm engages in providing post-production services. Here, I endogenize service quality to study its relationship with firm productivity. This captures the idea that upgrading service quality after production requires more activities such as fixed cost of opening additional service shops.[18] In particular, following Crinò and Epfiani (2009), I assume that upgrading the service quality of the product (λ) requires a fixed cost equal to $\frac{1}{\eta}\lambda^{\eta}$, where $\eta > 0$ is the elasticity of the fixed cost to service quality of the product. Firms therefore solve the following problem:

$$\max_{\lambda} \; B_k(\overline{w}_k)^{1-\sigma}\theta^{\sigma-1}\alpha(z)\lambda - \frac{1}{\eta}\lambda^{\eta} - F_{j,k}$$

Solving this problem yields optimal service quality, λ^*:

$$\lambda^* = \left[\overline{\lambda}\theta^{\sigma-1}\right]^{\frac{1}{\eta-1}}, \qquad \overline{\lambda} = B_k(\overline{w}_k)^{1-\sigma}\alpha(z) \tag{1.10}$$

where $\eta > 1$ by the second-order condition for a maximum. Optimal service quality implies that, holding other factors constant, more productive firms choose higher

[18] Recently, studies have analyzed product quality as a source of firm heterogeneity by assuming that product quality is endogenous (Johnson (2010); Hallak and Sivadasan (2009). This paper follows their idea by assuming that each firm chooses the level of service quality which incurs the fixed costs of upgrading. For example, firms can establish an additional service shop or hire additional managers for maintenance and repair services.

service quality in all destination markets to which they provide services. The intuition for this result is that only the more productive firms are profitable enough to pay the additional fixed cost of upgrading service quality. Using optimal service quality (λ^*) into firm's profit yields:

$$\Pi_{ik} = \frac{\eta-1}{\eta}[B_k(\overline{w}_k)^{1-\sigma}\alpha(z)]^{\frac{\eta}{\eta-1}}\theta^{\frac{\eta(\sigma-1)}{\eta-1}} - F_{j,k} \quad (1.11)$$

$$= \frac{\eta-1}{\eta}(\overline{\lambda}\theta^{\sigma-1})^{\frac{\eta}{\eta-1}} - F_{j,k} \quad (1.12)$$

Equations (1.11) and (1.12) imply that firm's profit will differ depending not only on the firms' productivity level, but also on the industry and country characteristics; in particular, marginal costs of production and service managers' abilities.

Profit function therefore suggests that when making decisions to serve foreign markets, firms have four strategies from which to choose. Firms can engage in horizontal FDI with either home or local service managers, implying that firms integrate production processes and providing services in a single location by establishing manufacturing and service facilities. This integration strategy would impose the highest fixed costs of establishing plants ($f + s$) and managing different service managers, but conserve the transport costs. Alternatively, firms can undertake service FDI with either of home or local service managers, indicating that firms produce in the home country and export products to a service facility established in the destination market. This integration strategy imposes fixed costs of setting up a service facility (s) and managing different types of service managers, and the transport costs.

In the following, I will analyze the firms' optional strategies when they serve consumers in high-income countries and in low-income countries, respectively. For

each market, I will examine the determinants of firms' choices among different strategies that maximize the profit.

1.3.1.1 Firms serving high-income countries

When firms enter the North, the profit functions of 4 strategies are as follows:

$$\Pi_n^{HH} = \frac{\eta-1}{\eta}(B_n \delta z_h w_n^{1-\sigma})^{\frac{\eta}{\eta-1}} \theta^{\frac{\eta(\sigma-1)}{\eta-1}} - F_{H,h} \tag{1.13}$$

$$\Pi_n^{HL} = \frac{\eta-1}{\eta}(B_n z_n w_n^{1-\sigma})^{\frac{\eta}{\eta-1}} \theta^{\frac{\eta(\sigma-1)}{\eta-1}} - F_{H,n} \tag{1.14}$$

$$\Pi_n^{SH} = \frac{\eta-1}{\eta}(B_n \delta z_h (w_h t)^{1-\sigma})^{\frac{\eta}{\eta-1}} \theta^{\frac{\eta(\sigma-1)}{\eta-1}} - F_{S,h} \tag{1.15}$$

$$\Pi_n^{SL} = \frac{\eta-1}{\eta}(B_n z_n (w_h t)^{1-\sigma})^{\frac{\eta}{\eta-1}} \theta^{\frac{\eta(\sigma-1)}{\eta-1}} - F_{S,n} \tag{1.16}$$

The first and second strategies (Equations (1.13) and (1.14)) represent horizontal FDI with home service managers and with local service managers to provide services, respectively. These strategies illustrate the market-access incentives for a firm serving the North. A firm integrates production and services in the host country to conserve on transport costs than production costs. The third and fourth strategies (Equations (1.15) and (1.16)) represent service FDI with home service managers and with local service managers, respectively. In contrast to horizontal FDI, relatively low production costs in the Home and low plant setup costs are key motivations for these firms to undertake service FDI. All of these strategies are consistent with the stylized facts from Table 1.1.

Now, I compare the profits attainable for a firm with the measure of productivity, θ, from different strategies listed above. Given that $z_n > z_h > z_s$ and $\delta \in (0,1)$, it is straightforward to find that the profit from providing services through local managers dominates the profit from sending home managers under the same type of FDI strategy. That is, I can eliminate firms' strategies on providing ser-

vices by sending home service managers and only consider strategies that involve local service managers to provide services. With two possible integration strategies: horizontal FDI and service FDI (Π_n^{HL}, Π_n^{SL}), which integration strategy to choose depends not only on the firm's productivity level, but also on the relative magnitudes of transport costs, fixed costs and relative wage.

Taking strategies underlying Equation (1.14) and (1.16), it is straightforward to see that as long as transport cost is larger than the wage differentials between the North and the Home, such that $t > w_n/w_h$, horizontal FDI strategy is more profitable than service FDI strategy at every productivity level, θ, in the absence of fixed investment costs. Depending on the productivity level and fixed plant setup costs, it follows that:

$$0 < \frac{d\Pi_n^{SL}(\theta)}{d\theta} < \frac{d\Pi_n^{HL}(\theta)}{d\theta}, \tag{1.17}$$

and

$$\Pi_n^{HL}(0) < \Pi_n^{SL}(0) < 0 \tag{1.18}$$

Therefore, there exist (unique) thresholds θ_n^1 and θ_n^2 such that firms with productivity $\theta \in (0, \theta_n^1)$ will not enter the foreign market via FDI; firms with productivity $\theta \in (\theta_n^1, \theta_n^2)$ engage in service FDI with local managers; and firms with productivity $\theta > \theta_n^2$ engage in horizontal FDI with local managers.[19] This result is consistent with Helpman et al. (2004) model that more productive firms can afford to pay higher fixed investment costs to produce a high volume of products in the host country, whereas less productive firms export. Our model indicates, however,

[19]Because all profit functions are continuous with respect to firm productivity level (θ), I can also use the intermediate value theorem to prove that there exist unique threshold $\overline{\theta}$ that cuts off two profit functions. Further, in the Appendix, Figure 1.4 depicts the operating profits attainable from possible integration strategies, for different levels of productivity, in different locations.

that more productive firms pay higher fixed costs to upgrade service quality, whereas less productive firms also participate in upgrading the service quality of products that are imported from headquarters by establishing service facilities in the host country.

On the other hand, as long as transport cost is smaller than the wage differential between the North and the Home, such that $(t \in (1, w_n/w_h))$, it is clear that choosing service FDI strategy is more profitable than choosing horizontal FDI strategy at every productivity level. In particular, it follows that:

$$0 < \frac{d\Pi_n^{HL}(\theta)}{d\theta} < \frac{d\Pi_n^{SL}(\theta)}{d\theta}, \tag{1.19}$$

and

$$\Pi_n^{HL}(0) < \Pi_n^{SL}(0) < 0 \tag{1.20}$$

In this case, a unique threshold θ_n^3 exists such that firms with productivity $\theta \in (0, \theta_n^3)$ will not enter the foreign market via FDI, whereas firms with productivity $\theta > \theta_n^3$ engage in service FDI with local managers. In other words, when serving countries that incur relatively low transport cost, firms will either not enter the market or engage in service FDI, and will never choose to undertake horizontal FDI. In contrast to prior trade literature that focused on examining FDI flows between Northern countries or from North to South, this model proposes that if FDI flows from South to North, then firms' activities are affected largely by the transport cost.

Given the same FDI strategy, with large managerial ability differentials between the North and the Home, firms find it more profitable to provide services with local service managers when serving high-income countries. However, if transport costs are sufficiently high, the most productive firms will choose horizontal FDI strategy, whereas less productive firms will choose service FDI strategy and the

least productive firms will not enter the market via FDI. Alternatively, if transport costs are sufficiently low, firms at every productivity level will not choose horizontal FDI strategy. Instead, more productive firms will undertake service FDI strategy, whereas less productive firms will not enter the market.

1.3.1.2 Firms serving low-income countries

When firms enter the South, the profit functions of 4 strategies are as follows:

$$\Pi_s^{HH} = \frac{\eta-1}{\eta}(B_s\delta z_h w_s^{1-\sigma})^{\frac{\eta}{\eta-1}}\theta^{\frac{\eta(\sigma-1)}{\eta-1}} - F_{H,h} \tag{1.21}$$

$$\Pi_s^{HL} = \frac{\eta-1}{\eta}(B_s z_s w_s^{1-\sigma})^{\frac{\eta}{\eta-1}}\theta^{\frac{\eta(\sigma-1)}{\eta-1}} - F_{H,s} \tag{1.22}$$

$$\Pi_s^{SH} = \frac{\eta-1}{\eta}(B_s\delta z_h (w_h t)^{1-\sigma})^{\frac{\eta}{\eta-1}}\theta^{\frac{\eta(\sigma-1)}{\eta-1}} - F_{S,h} \tag{1.23}$$

$$\Pi_s^{SL} = \frac{\eta-1}{\eta}(B_s z_s (w_h t)^{1-\sigma})^{\frac{\eta}{\eta-1}}\theta^{\frac{\eta(\sigma-1)}{\eta-1}} - F_{S,s} \tag{1.24}$$

Consistent with previous subsection, first two strategies (Equations (1.21) and (1.22)) indicate integrating production and service in the South with different types of service managers, whereas last two strategies (Equations (1.23) and (1.24)) indicate integrating business activities in different locations and involving different types of managers in the service department.

Comparing the profits attainable for a firm with different productivity levels from different strategies, in contrast to serving high-income countries, firms have to make a decision on providing services with different types of managers. In particular, depending on the degree of international mobility, it is clear that as long as the degree of international mobility is higher than the managerial ability differential between the South and Home, such that ($\delta \in (z_s/z_h, 1)$), firms will find it more profitable to send home service managers than hiring local service managers within the same type of FDI strategy. Alternatively, as long as the degree of international mobility

is lower than the managerial ability differential between South and Home, such that ($\delta \in (0, z_s/z_h)$), the profit from providing services through local service managers dominates the profit from sending home managers under the same FDI strategy. For each country, therefore, which FDI strategy to choose depends on the firm's productivity level and the fixed plant setup costs.

Given that $w_n > w_h > w_s$ and $t > 1$, it is straightforward to see that firms are more profitable to choose horizontal FDI strategy than service FDI strategy at every productivity level, θ, in the absence of fixed costs. Depending on plant setup costs, it can be seen that the most productive firms will bear high fixed costs of establishing manufacturing and service facilities in the South and produce varieties with low marginal cost, whereas less productive firms will export products to their service facilities abroad. Figure 1.5 in the Appendix depict the profits attainable for firms with different levels of productivity in countries with a low degree of international mobility (Fig. 1.5a) and in countries with a high degree of international mobility (Fig. 1.5b).

Figure 1.5 shows that in both types of countries, more productive firms will undertake horizontal FDI strategy, whereas less productive firms will choose service FDI strategy and the least productive firms will not enter the foreign market via FDI. It is the measure of service managerial ability that affects firms to choose between different strategies. In particular, the model shows that depending on the degree of mobility between countries, firms will provide services with local service managers in locations with low mobility, whereas send home service managers in countries with high mobility from Home.

To summarize, firms with different productivity level will choose different strategies to serve global markets, where more productive firms will choose FDI whereas less productive firms stay Home. Among FDI firms, their optimal strate-

gies, however, differ depending on which market they are targeting to. In particular, when firms serve the North, the model predicts that their strategies are concerned primarily with integrating production and service in different locations, such that transport costs and their own productivity level play an important role in firms' decision. Alternatively, when firms enter the South, the model predicts that firms' strategies are concerned primarily with providing services. Depending on the degree to which home service managers are mobile between countries, firms choose different strategies to serve different foreign markets. In each location, based on the plant setup costs, firms choose optimal integration strategies on the basis of their productivity level. The sorting of strategies by firms' productivity levels and industry and country characteristics provides the building block for the empirical specification presented in next sections.

1.4 Data

The theoretical framework presented in the previous section suggests that multinational firms choose different strategies when they serve different foreign markets. The sorting of firms doing business in high-income or low-income country based on their productivity level depends on industry and country characteristics: in particular, transport costs and the degree of international mobility. The following analysis illustrates the impact of these economic factors on firms' optimal strategies by using a sample of Korean multinational firms.

1.4.1 Data Analysis

To test predictions of firms' optimal strategies in different foreign markets based on the model, this paper requires data that vary across industry sectors and countries. Specifically, data must fall into the following categories: showing cross-

border activities of foreign affiliates and representing characteristics of parent firms, industry sectors, and host countries. As noted in Section 1.2, this paper uses plant-level data from Korean multinational firms from 2002 through 2009. This dataset provides information on individual foreign affiliates doing business in host countries including each company's balance sheet, date of establishment, sales and imports from different markets, ownership, and composition of employments.

Since data specify the owner of each affiliate through its unique firm identification number, I also use parent firm-level data for the analysis, which was obtained from the Financial Supervisory Service of Korea and the Korea Information System (KIS) database of the Korea Investor's Service Co., Ltd. This data include all Korean firms registered as a corporation in different industries and contain detailed information of interest, including balance sheets, profit and loss statements, sales from domestic production and exports, total output, status on FDI, and the composition of employment. Each firm is classified by the Korean Standard Industrial Classifications (KSIC), which are defined by the Korea National Statistical Office. Because firm-level data itself do not provide information on firms' foreign affiliates, this paper merges firm-level data from KIS with plant-level data from the Export-Import Bank of Korea.

The theoretical model studies firm strategies to enter foreign markets by integrating production processes and post-production services. For the econometric analysis, therefore, I will consider firms in the manufacturing industry using the three-digit KSIC level. Then, among firms in the manufacturing industry, I will use observations of firms that established foreign affiliates abroad between 2002 and 2009. In a related work that studied serving foreign markets through FDI, a substantial body of work exists that examine firms' incentives to form cross-border mergers and acquisitions with local firms or foreign firm's affiliates as their entry

mode. However, because my model focuses on firms' integration strategies of entry, observations only include firms that invest independently in their affiliates abroad.[20]

Further, because my primary interest is to study the strategy firms take to serve local consumers, FDI firms that established affiliates abroad to make sales by exporting products back to headquarters or to third countries are excluded. To examine Korean firm activities in different foreign markets, I decompose destination countries by developed and developing countries (relative to Korea) based on their income-level measured by real gross domestic product (GDP) per capita from World Development Indicators, 2010. After eliminating observations to make the sample size consistent with the model, the number of firms discovered for analysis is 1,516, with 372 observations from high-income countries and 1,144 from low-income countries.[21]

1.4.2 Variables

In this section, I discuss the definition of strategies used in the empirical setting and provide detailed information on the variables for the econometric analysis. Dependent variables are firm strategies to integrate production and service in different locations and provide post-production services with different types of service managers in the host country. Because this paper only observes each firm's

[20]Plant-level data contain information on whether a foreign affiliate is established through independent investment by parent firms, through joint venture with other firms, or through purchasing from other firms, as well as parent firms' share of equity investment. To make observations consistent with the model, I include firms that enter foreign markets through independent FDI or firms that have 100% equity investment in their foreign affiliates abroad.

[21]Results using the entire sample of new FDI firms between 2002 and 2009 are very similar to those reported in Section 1.5 because horizontal investments dominate the sample. Among FDI firms during the sample period, horizontal FDI account for 86% of the observations, whereas vertical FDI account for 4%, export-platform FDI for 2%, and complex FDI (which denotes firm activity of engaging in multiple types of FDI), account for 8% of the sample. Results using the entire sample are available on request.

strategy through the composition of employments in subsidiaries, rather than its profits from different types of FDI, I construct binary variables to capture firms' decisions on production location and providing services. Then, binary choice model will be used to estimate the probability that a firm chooses a specific strategy type.

To capture firms' decisions on integrating production and service abroad, I construct a dummy variable, *manu*, which is equal to 1 if firm's affiliate makes sales from the local market by producing outputs through local production workers, whereas zero if affiliate makes sales from the local market without employing any local production workers, but only imports products from the headquarters. On the other hand is firm activity to provide post-production services through different types of managers. In particular, a dummy variable, *local*, is equal to 1 if firm's affiliate only includes local managers in the service department and zero otherwise.

Because observations include firms that engage in horizontal FDI or service FDI, a binary variable capturing firm's integration decision, *manu*, takes a value 1 if firms engage in horizontal FDI and zero if undertake service FDI. Firms' decisions to provide services, however, are complicated. In particular, the dataset indicates that most of subsidiaries either include local managers or none to provide services in high-income countries, whereas they include either of local and Korean managers or none in low-income countries. The binary variable, *local*, therefore, takes a value of 1 if the affiliate includes only local managers to provide services, otherwise zero in the regression for high-income countries. In contrast, I reduce the sample size to firms that include either local or Korean service managers and construct the same binary variable, *local*, which is equal to 1 if the affiliate employs only local service managers and zero if it employs only Korean service managers in the specification for low-income countries.[22]

[22]This result is a loss of only 4.9% of firms investing in low-income countries. Further, according

The key explanatory variables used for the analysis are firm productivity level, transport cost, and the degree to which service managers are internationally mobile. To measure firm productivity, this paper uses labor productivity rather than total factor productivity. This is because the theoretical model assumes labor includes only input to produce the final outputs, with information on capital flow or stock not available in the dataset.[23] For industry characteristics, the model predicts that the transport cost plays a key role in the firm's decision to choose between different integration strategies when entering high-income countries. Because data on transport cost are difficult to obtain, prior trade literature has turned to indirect measures of transport cost using proxies such as distance measured by using the great circle distance between national capitals of the home and destination country and ad-valorem shipping costs calculated as trade partners' CIF/FOB ratio.[24]

When using distance as a proxy for transport cost, however, it also proxies for the technology transfer between trading countries. For example, Keller (2002) examined the geographic distance between countries as a determinant of technology diffusion between countries. He found evidence that knowledge spillover is localized geographically such that productivity effects decline with the geographic distance between sender and recipient countries. Alternatively, the value of using CIF/FOB ratio as a proxy for transport cost has been questioned. Indeed, Hummels and Lu-

to plant-level data, top and middle managers in the organization are not directly related to the production process or providing service, which are the main interests of the paper. Therefore, the composition of top and middle managers varies for each affiliate in constructing the dependent variables; still, all affiliates include either or both top and middle managers.

[23]Following Aw and Lee (2008), I compute labor productivity as $[(lnQ - \overline{ln}Q) - (lnL - \overline{ln}L)]$ where $\overline{ln}Q$ and $\overline{ln}L$ are the industry mean levels of the log of total revenue plus net inventory change and log of total employment.

[24]According to the IMF Direction of Trade Statistics, exporters report trade flows exclusive of freight and insurance (Free On Board), whereas importers report flows inclusive of freight and insurance (Cost, Insurance, and Freights). With the data, many researchers measured trade costs by comparing the difference of the valuation of the same flow reported by both exporter and importer (Brainard (1997); Helpman et al. (2004); Hummels and Lugovskyy (2006))

govskyy (2006) used data from IMF Direction of Statistics to investigate whether CIF/FOB ratio is usable by comparing their levels and variation to directly measured transport costs for the U.S. and New Zealand. In their study, they found that CIF/FOB ratios between countries are not useful to measure cross-commodity variation.

Instead of using data constructed from the matched partner technique, this paper follows Tekin-koru (2009) on calculating tariff rate as a measure of transport costs by using data from UNCTAD-TRAINS assembled by the Ultimate Trade Barrier Catalog. The data include information on tariff rates and trade data using the six-digit HS industry level for 103 countries. Here, I compute unweighted averages using the five-digit SITC industry level and map these figures into the three-digit KSIC industry level by using Trade Statistics provided by the Korea International Trade Association.[25]

The key explanatory variables also include the degree to which service managers are internationally mobile from the home to the destination country. In the model, the degree of mobility plays an important role in firms' strategies to provide post-production services when serving low-income countries. Because this paper is the first to empirically analyze firms' decisions on integrating post-production services in host countries, to best of my knowledge, no empirical works have estimated the determinants of firm's choice between hiring local managers and sending home service managers.

In the theoretical model, the degree of international mobility indicates a country's barrier that hinders the ability of managers from the home country to provide services in the foreign market. Because the model focuses on managers pro-

[25]I also compute weighted averages using the five-digit SITC industry level, but do not report their results due to the reduced number of observations in regressions.

viding post-production services to final consumers rather than examining their role as problem solvers between production workers and top management or technology transfer to production workers, both of which are related to goods trade inside the organization (Garicano (2000); Antràs et al. (2008)), I proxy the degree of international mobility as being a cultural differences between home and host countries (Rauch (1999); Keller (2002, 2004)).[26] I therefore measure the degree of international mobility by a common language between countries, represented by a dummy variable, which is 1 if countries share a common language. Suggested by Rauch (1999), I construct a common language dummy variable by assigning countries to language groups on the basis of Ethnologue. However, because the Korean language is not spoken outside Korea, I assume English to be a common language. Thus, I construct a dummy variable, *language*, which is 1 if at least 10% of the population of the host country speaks English at home.[27] Hence, I expect that countries speaking a common language strongly facilitate firms to send home managers, whereas countries with a different language positively affect firms to employ local managers to provide services in local markets.

For controls, this paper includes variables representing other firm and country characteristics. The controls used in the regression are inspired both from the theoretical model and the broader FDI literature. To capture firm characteristics that affect the decision to choose an optimal strategy, I add firm-specific assets. First, I use firm's R&D intensity, computed as the firm's total R&D expenditures divided by total sales at the end of the fiscal year before investing abroad, as a proxy

[26]These studies have focused on the cultural differences between countries as one of measurements for knowledge transfers and proposed that country characteristics such as language and religion are important elements in diffusing international technology that is not necessary related to goods trade. Although my model is not related to technology diffusions, it is consistent with their work on studying the role of service managers who are not related to goods trade.

[27]Data obtained from Ethnologue's 16^{th} edition and the CIA's World Factbook shows that, on average, 18% of Korea's populace speaks English at home during the sample period.

for firm-specific assets, some of which can be provided to its foreign affiliates. Multinational firms can reduce their production costs by using high technology, which can be transferred to their plants. Highly R&D intensive firms, therefore, depend more on their own creation and production technology and are more likely to enter foreign markets through horizontal FDI.

Second, I add firm's non-mobile assets that are specific to the host country as control variables. In particular, I use firm's international experience, which is measured by the number of previous foreign affiliates of a multinational firm worldwide (*experience*), and the total employment of those firms (*size*).[28] Broad international experience increases previous knowledge of local markets, connection to bureaucracy, and business culture which facilitate multinational firms to invest abroad (Caves (2007); Tekin-koru (2009)). Therefore, this previous knowledge may influence the firm's decision not only on production processes, but also on providing services using different types of managers. I expect positive signs on all of strategies, even though the strength of this effect on each strategy is ambiguous.

To capture the effects of country characteristics, I measure market size using the country's GDP and infrastructure using telephone mainlines per one million people (*telephone*). Furthermore, because the theoretical model assumes that the service managers' abilities across countries play a key role in affecting the firm's decision on providing services in the local market, following the idea from Antràs et al. (2008) on measuring managers' abilities, I proxy service managerial ability as the percentage of agents in the relevant age range enrolled in tertiary education. All of the country-level data are obtained from the International Financial Statistics of IMF, the World Development Indicators from The World Bank, and LABORSTA

[28]Firm size is not only an indicator that captures a firm's international experience and its capabilities to overcome investment barriers, but also distinguishes the size effect from firm productivity.

from International Labour Organization.

Year dummies and industry sector dummies control for year- and industry-specific fixed effects. Because there exist number of firms that established multiple facilities during sample period, I also control for these firms in the specification. Further, I allow for clustering host countries to account for the possible correlated shocks that might affect all foreign affiliates in the same host country. Table 1.4 in the Appendix depicts descriptive statistics of the variables used in regression, where variables representing country characteristics are divided into two sets, namely, high- and low-income countries.

1.5 Empirical Results

1.5.1 Estimation method

Dependent variables for firm strategies are binary and include firms' decisions on production location and providing post-production services through different types of managers, which can be interrelated as strategies to serve foreign markets. For the econometric analysis, therefore, I first divide firms into two sets based on income-level of their host countries relative to Korea. For each set, I specify bivariate probit model to test whether the firms' strategies are related and identify the determinants of firms' decisions on locating production and providing services.

The bivariate probit model provides a test for a positive correlation between firm's decision to locate production facilities in a host country and to provide services through local service managers conditional on the vector of covariates including the explanatory and control variables mentioned in the previous section. Then, I calculate the marginal effects for the joint probability of whether to integrate production and service in a single location or in multiple locations and whether to provide

post-production services through local managers are chosen simultaneously.[29]

In particular, when the bivariate probit is used, firm i's decisions are:

$$y^*_{i,manu} = x_i^{'}\beta_{manu} + \mu_{manu} \quad (1.25)$$

$$y^*_{i,local} = x_i^{'}\beta_{local} + \mu_{local} \quad (1.26)$$

where $y^*_{i,j}$ are unobservable and related to the binary dependent variables $y_{i,j}$ by the following rule

$$y_{i,j} = 1 \text{ if } y^*_{i,j} > 0 \quad (1.27)$$

$$= 0 \text{ if } y^*_{i,j} \leq 0 \quad (1.28)$$

whereas $x_i^{'}$ is a vector of explanatory variables that account for firm and country characteristics and β_j is a vector of unknown coefficients that are specific to the jth strategy for $j = \{manu, local\}$.

To estimate bivariate probit models, I use a bivariate standard normal distribution function $\Phi(.;\rho)$ by assuming that the mean of error terms (μ_j) is zero and variance-covariance matrix V has values of 1 on the leading diagonal and correlations ρ as off-diagonal elements for all j. The correlation coefficient (ρ) denotes the extent to which the error terms are covary and its sign indicates if firms' decisions on integrating production and service in the host country and choosing local service managers are influenced by unobservable factors whose effects operate in the same direction. If error terms between the two probit models are not correlated such that $Cov[\mu_{manu}, \mu_{local}] = 0$, firms' decisions could be estimated separately through univariate probit models.

[29]Because the theoretical model indicates that firm strategies to serve foreign markets involve producing and providing services of products, the main interest in the empirical analysis is to examine the economic factors that affect the likelihood of firms choosing joint strategies. In the appendix, however, I also report the marginal effects for the success probability of each strategy.

Given the bivariate standard distribution, the joint probability that firm i's decisions are simultaneously chosen is defined as:[30]

$$Pr(y_{i,manu} = 1, y_{i,local} = 1) \quad = \quad \Phi(x_i^{'}\beta_{manu}, x_i^{'}\beta_{local}; \rho) \tag{1.29}$$

if $\rho = 0$, then the probability of joint strategies is just the product of marginal probabilities of each strategy.

Furthermore, because the model predicts that firms choosing strategies on the basis of their productivity level depends on the scale of transport cost and the degree of international mobility when serving different markets, the interaction effects of these two determinants play a crucial role in the empirical analysis. Debates continue, however, on interpreting interaction terms in non-linear models such as probit models.[31] On the other hand, Ai and Norton (2003) and Greene (2010) both discussed the marginal effects of interaction terms in probit models. These studies showed that for non-linear models, the total interaction effect may have a different sign and statistical significance from those determined by a t-test on the estimated coefficient of the interaction term alone. To present the practical importance of interaction terms, they proposed presenting graphical evidence to supplement probit regression results, for the purpose of providing further insight into the statistical and economic significance of the interaction.

[30] Joint probability can also be defined as $\int_{-\infty}^{\mu_{i,manu}} \int_{-\infty}^{\mu_{i,local}} \phi(x_i^{'}\beta_{manu}, x_i^{'}\beta_{local}; \rho) d\mu_{i,manu} d\mu_{i,manu}$, where $\phi(.)$ is joint probability density function for two standard-normally distributed error terms.

[31] Arguments exist between whether to interpret interaction terms from estimated probit coefficients or marginal effects. For example, Frant (1991) and Nagler (1991) argued that interpreting marginal effects is not straightforward. Because the functional form of a non-linear model implies that all explanatory variables have non-linear effects on the probability of success, these works have argued that marginal effects can produce interaction effects based on the distributional assumption, which results in artificial predictions by calculating the cross-derivative of the expected value of the dependent variable. On the other hand, Meyer (1995) argued that the marginal effects should be discussed on interpreting interaction terms because the estimated coefficients only allow the research to state the significance and the sign of an effect, but not on its extent.

This paper therefore shows the results of the estimated bivariate probit coefficients of interaction terms and calculates average marginal effects of firm productivity level on the success probability of firms' joint strategies on choosing production locations and providing services, conditional on industry and country characteristics. Then, I present figures that provide evidence concerning the statistical and economic significance of the total interaction effects between firm productivity and industry and country characteristics.

1.5.2 Empirical results

Table 1.2: Bivariate probit, high-income countries

Firm strategies	Estimates		Marginal effects on joint probability	
	manu	*local*	*HL*	*SL*
tariff	0.438	0.117	0.058	-0.022
	(0.324)	(0.364)	(0.065)	(0.058)
productivity	-0.256	0.546	0.057	0.109
	(0.522)	(0.585)	(0.042)	(0.136)
R&D intensity	-0.507	-0.043	-0.053	0.039
	(0.394)	(0.446)	(0.071)	(0.081)
experience	0.307**	0.14	0.491*	-0.064
	(0.141)	(0.107)	(0.263)	(0.126)
firm size	-0.114	-0.095	-0.024	-0.004
	(0.102)	(0.062)	(0.018)	(0.004)
language	0.599	0.373	0.095	0.011
	(0.962)	(1.02)	(0.158)	(0.135)
GDP	0.013	0.085	0.013	0.012
	(0.083)	(0.064)	(0.011)	(0.013)
telephone	-0.133	0.207	0.018	0.045
	(0.265)	(0.27)	(0.036)	(0.061)
education	0.008	-0.042	-0.005	-0.007
	(0.014)	(0.03)	(0.003)	(0.005)
tariff*productivity	0.167	-0.279		
	(0.283)	(0.347)		
language*productivity	-0.568	0.775		
	(0.934)	(0.964)		
tariff*language	-0.152	-0.15		
	(0.442)	(0.485)		
constant	−3.23*	-1.44		
	(1.89)	(2.03)		
Observations	351			
Log-likelihood	-315.53			
Success probability			0.109	0.122
ρ	-0.055			
	(0.059)			
LR-test of $\rho = 0$	$\chi^2(1) = 0.862$			

Note: Robust standard errors are in the parenthesis. ∗ ∗ ∗,∗∗,∗ denote significance at the 1,5,10 percent, respectively; regression includes a time, country, firm and industry fixed effects. Testing firms that only include Korean managers are not available due to the small number of observations.

I begin with the maximum likelihood estimates of the bivariate probit models using samples from high-income countries, which are reported in Table 1.2. The table displays coefficient estimates in the first two columns and the average marginal effects of the explanatory variables on the success probability of joint strategies –

horizontal FDI with local managers ($y_{i,manu} = 1$ and $y_{i,local} = 1$) and service FDI with local managers ($y_{i,manu} = 0$ and $y_{i,local} = 1$) – in the last two columns.

The correlation coefficient (ρ) in Table 1.2 implies that no interrelationship exists between firms' decisions related to integrating business activities in the host country and providing service through local service managers. Examining the determinants for different firm strategies, the coefficient estimates on the tariff rate are statistically insignificant, as shown in the first and second columns. This indicates that the transport cost from the home to the destination market, as measured by the tariff rate, do not effect firms' decisions to locate production facilities in a host country and provide services with local managers, independently.

It is interesting to see that productivity is not a significant determinant of firms' decisions to locate production abroad. This is inconsistent with prior empirical studies that have emphasized the importance of firm productivity in affecting firms' decisions to serve foreign markets such that more productive firms are more likely to undertake FDI, whereas less productive firms tend to export from the home country. A possible explanation for this inconsistency is that although service FDI in this paper involves firm exports, the firm incurs fixed investment costs to enter foreign countries. This suggests that firm productivity does not affect firms' production location decisions independently between FDI firms. Furthermore, the model predicts that the effect of productivity on the firm's choice between integration strategies is conditional on the transport costs. Insignificant coefficients of firm productivity, therefore, suggest analyzing its impact on firms' integration strategies conditional on the tariff rates.

To gain further insights into the effects of productivity and tariff rate on firms' choices, I estimate their interaction effects. The interaction term between firm productivity and tariff rate in the first column of Table 1.2 is positive yet

insignificant. As noted, however, one must be cautious in interpreting the interaction terms from coefficient estimates and marginal effects. In the following analysis, suggested by Greene (2010), I estimate and present the development of the marginal effect of firm productivity on the joint probability that firms will choose different strategies, conditional on different tariff rates.[32]

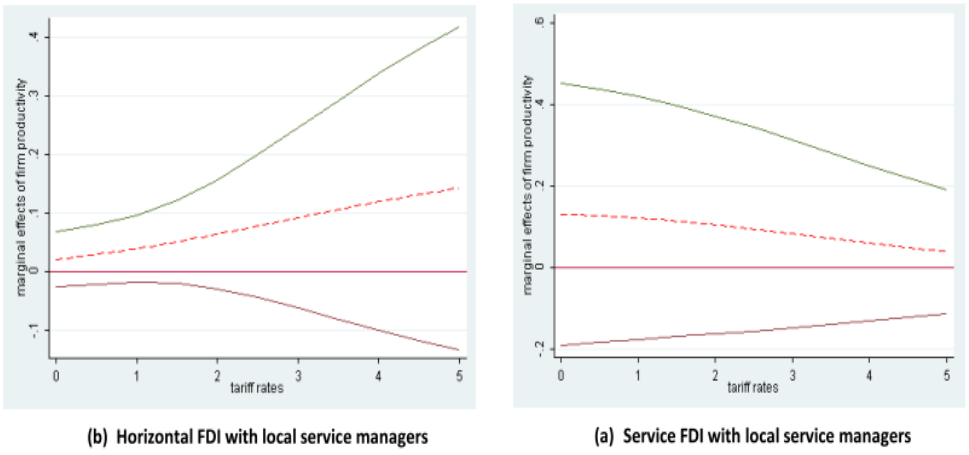


Figure 1.1: Interaction effects on the joint probability of firm strategies in high-income countries

Table 1.5 in the Appendix shows the estimates of the average marginal effect of productivity on the joint probability of choosing different strategies based on different tariff rate levels. Figure 1.1, in contrast, presents the development of marginal effects conditional on tariff rates. Examining a firm's strategy to choose horizontal

[32]To examine the interaction effects between the level of firm productivity and the degree of international mobility, I have also computed the marginal effects of firm productivity on the joint probability of firms' choosing different strategies, conditional on whether the host country shares a common language. The results are reported in the last two columns of Table 1.7 in the Appendix. This table shows that the marginal effects of firm productivity level are widely insignificant for countries that either share a common language or not.

FDI with local service managers, Figure 1.1a illustrates that the marginal effect of firm productivity corresponds to upward direction in tariff rates.[33] Basically, this implies that productivity level becomes more effective in enhancing the probability that a firm will choose horizontal FDI and employ local managers when tariff rates are higher. The marginal effect gains statistical significance in the high range of the tariff rates, implying that the positive effect is realized in countries with a higher level of tariff rates. The first three columns of Table 1.5 show that the magnitude gradually increases as the tariff rate increases and holds the statistical significance at the 5% level in the high range of the tariff rates.

Turning to firm strategy on integrating business activities in multiple locations, Figure 1.1b shows that the marginal effect of firm productivity follows a downward direction in tariff rates. This implies that productivity level is more effective in increasing the probability of a firm engaging in service FDI and employing local managers when the tariff rate is lower. The last three columns of Table 1.5 indicate that the magnitude of marginal effects decreases as the tariff rate increases. The statistical significance of the marginal effect holds in the low range of tariff rates, whereas the effects are widely insignificant in the high range of tariff rates.

Most of the other covariates exhibit their expected signs, although some exhibit insignificant effects on both of firm strategies to integrate business activities in a host country and provide services with local managers. In particular, firm's experience, measured as the number of previous foreign affiliates of a multinational firm worldwide, has significant impact on its production location decision. A positive coefficient estimate in the first column of Table 1.2 indicates that firms with more market experience have a higher chance of entering high-income countries through horizontal FDI. Calculating the average marginal effects shows that firms' experience

[33]Note: 95% level of confidence interval.

significantly increases the odds in favor of choosing horizontal FDI with local service managers.

Turning to other coefficient estimates, it is interesting to discover that the degree of international mobility, measured as a common language, and manager's ability proxied by tertiary education level have no effects on firms' service strategies. These results indicate that providing services through different types of managers is not a firm's primary concern when serving developed countries.

The results in Table 1.2 suggest that firms' decisions on integrating business activities in a host country and providing service through local managers are independent as strategies. To gain further insights into the effect of economic factors on firms' decisions to serve high-income countries, Table 1.6 in the Appendix display the results from using univariate probit model. The table reports the probit estimate coefficients in the first two columns and the average marginal effects of the explanatory variables on the success probability of each strategy – integrating production and service in the host country (*manu*) and providing services through local managers (*local*) – in the last two columns.

As expected, the results do not differ significantly from the results of the bivariate probit shown in Table 1.2. The coefficient estimates of the univariate probit reveal that the tariff rate and firm productivity level do not have significant effects on firms' production location decisions, whereas firms' experiences have significant effects on the probability that they will choose a horizontal FDI strategy to serve high-income countries. I also estimated the interaction effect between firm productivity and the tariff rate on the likelihood of firms choosing each strategy by calculating the average marginal effects of productivity conditional on tariff rates. In contrast to the bivariate probit specification, the results showed that the marginal effects of firm productivity on firms' decisions of locating production sites

and providing services were widely insignificant in every range of the tariff rates.

Table 1.3: Bivariate probit, low-income countries

Firm strategies	Estimates		Marginal effects on joint probability			
	manu	*local*	HL	HH	SL	SH
tariff	0.156	0.114	0.012	-0.019	0.006	0.0005
	(0.119)	(0.082)	(0.014)	(0.012)	(0.005)	(0.001)
productivity	0.238^{***}	-0.006	0.007	0.002	-0.008^{***}	-0.002^{**}
	(0.052)	(0.04)	(0.006)	(0.006)	(0.003)	(0.001)
R&D intensity	0.545^{**}	-0.088^{**}	0.005^{*}	0.017^{***}	-0.02^{*}	-0.003
	(0.273)	(0.035)	(0.003)	(0.006)	(0.011)	(0.002)
firm size	-0.298^{***}	-0.026	-0.015^{**}	0.002	0.01^{***}	0.002^{**}
	(0.045)	(0.037)	(0.007)	(0.005)	(0.003)	(0.0008)
language	-0.31	-0.106	-0.069	0.072	-0.068	0.009
	(0.208)	(0.564)	(0.051)	(0.051)	(0.051)	(0.009)
education	0.303	-0.07	-0.0001	0.013	-0.011	-0.002
	(0.778)	(0.309)	(0.058)	(0.049)	(0.029)	(0.005)
telephone	0.112^{***}	0.167^{***}	0.031^{***}	0.026^{***}	-0.003^{***}	-0.002^{***}
	(0.032)	(0.018)	(0.003)	(0.003)	(0.001)	(0.0005)
GDP	-0.567	-0.057	-0.029	0.005	0.02	0.004
	(0.504)	(0.113)	(0.024)	(0.018)	(0.014)	(0.003)
experience	-0.002	0.086^{**}	0.013^{*}	-0.013^{**}	0.004^{***}	-0.0003
	(0.044)	(0.038)	(0.007)	(0.005)	(0.001)	(0.0005)
language*prod	0.117^{***}	0.009				
	(0.041)	(0.158)				
tariff*prod	-0.197	0.225				
	(0.807)	(0.188)				
tariff*lang	0.526^{**}	-0.156^{*}				
	(0.221)	(0.085)				
constant	-1.84^{***}	1.71				
	(0.325)	(2.22)				
Observations	966					
Success probability			0.895	0.087	0.014	0.003
ρ	0.161^{***}					
	(0.054)					
LR-test of $\rho = 0$	$\chi^2(1) = 8.65$					

Note: Robust standard errors are in the parenthesis. $***$,$**$,$*$ denote significance at the 1,5,10 percent, respectively; regression includes a time, country, firm and industry fixed effects.

Table 1.3 reports the results of estimating bivariate probit models using samples from low-income countries. Consistent with the previous specification, the table reports bivariate probit estimate coefficients in the first two columns and the average marginal effects of explanatory variables on the success probability of joint strategies – horizontal FDI with local managers ($y_{i,manu} = 1$ and $y_{i,local} = 1$),

horizontal FDI with home managers ($y_{i,manu} = 1$ and $y_{i,local} = 0$), service FDI with local managers ($y_{i,manu} = 0$ and $y_{i,local} = 1$), and service FDI with home managers ($y_{i,manu} = 0$ and $y_{i,local} = 0$) – in the last four columns.[34]

In contrast to the previous specification, the correlation coefficient (ρ) is positive and significant at the 1% level to reject that $\rho = 0$, indicating that a complementary relationship exists between firms' decisions to integrate business activities in a host country and provide services through local managers when serving low-income countries. The coefficient estimate of the tariff rate is positive as shown in the first column of Table 1.3, implying that firms tend to expand production horizontally in countries that incur high transport costs. Statistically insignificant estimated coefficients, however, indicate that transport cost has no effect on firms' choosing different integration strategies to enter low-income countries.[35]

Firm productivity level has a positive and significant influence on the likelihood that firms will integrate production and service in host countries, whereas it has a negative yet insignificant effect on the likelihood that firms will provide post-production services with local managers. This result indicates firms that are relatively more productive are more likely to engage in horizontal FDI, whereas firms that are less productive tend to engage in service FDI.

[34]Note that I am testing with the sample of firms that include either type of service managers in the organization. Observations used in regression account for 95.1% of firms serving low-income countries via FDI.

[35]Because the theoretical model predicts that the marginal cost of producing in low-income countries is smaller than producing and shipping from home, due to the low factor prices, I added the wage-level of local production workers in each regression where data are obtained from ILO (Results are excluded for brevity and because of reduced number of observations in regressions). Specifying firms' production location decisions, having negative and significant coefficient estimates on wages and insignificant coefficient on tariff rate suggest that, in general, firms that integrate all of their business activities in low-income countries are influenced significantly by factor prices such that firms are likely to integrate production and services in countries with low wages. Alternatively, the results for specifying firms' decisions on providing post-production services are similar to ones reported in the second column of Table 1.3 by showing insignificant coefficients on both tariff rate and wage level.

Calculating the average marginal effect shows that an infinitesimal increase in productivity level significantly reduces the probability of engaging in service FDI by 0.8% for firms that provide services with local managers and by 0.2% for firms that send Korean managers to provide service. Although the marginal effects of productivity level on firms' strategy to choose service FDI with either type of manager is relatively small in terms of absolute magnitude, this is nevertheless economically meaningful compared to the success probability evaluated at the sample means.

Language, a proxy for the degree of international mobility, is negative yet statistically insignificant as reported in the second column of Table 1.3. Calculating the marginal effects of language on the success probability of joint strategies shows that locating facilities in an English-speaking country reduces the probability of firms hiring local managers, whereas it increases the probability of sending home managers through both types of FDI. Statistically insignificant effects, however, point out that language is not a determinant of a firm's decision to locate production in different locations or employ different types of service managers.

To gain further insights regarding the effects of firm productivity level and the degree of international mobility on firms' choices in low-income countries, I estimate their interaction effects. Consistent with the previous specification for high-income countries, I follow Greene (2010) by estimating the marginal effects of productivity on the joint probability of choosing different strategies conditional on whether the host country shares a common language. These results are reported in the first two columns of Table 1.7 in the Appendix and depicted in Figure 1.2.[36]

[36]To examine the interaction effects between firm productivity level and tariff rates, I also estimated the marginal effects of firm productivity on the joint probabilities of firms' choosing different strategies based on different tariff rate levels (data not shown but available on request). The results showed that the marginal effects of firm productivity on joint probabilities were widely insignificant in all ranges of the tariff rates.

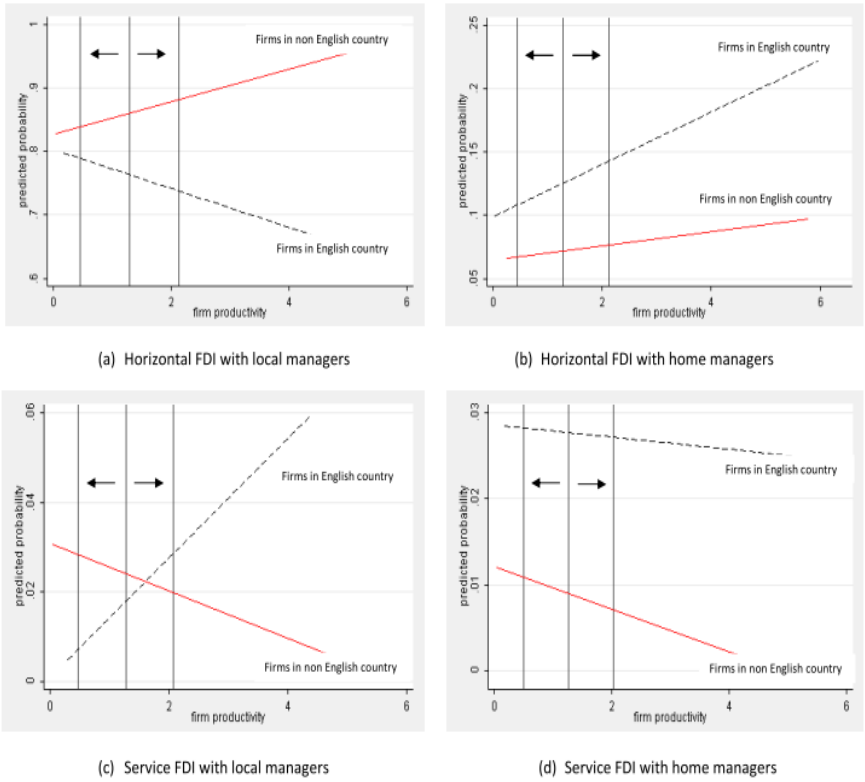


Figure 1.2: Interaction effects on the joint probability of firm strategies in low-income countries

Analyzing firm integration strategies that provide services through local managers, Figures 1.2a and 1.2c show several implications. First, the figure shows the regression line for firms investing in countries that do not share a common language lies above the corresponding line for firms investing in countries that do share a common language. This is consistent with the results that establishing facilities in countries that do not share a common language make it more likely that firms will provide services using local managers. Figure 1.2c, however, indicates that beyond a certain level of productivity, these firms are likely to provide services through local

managers in countries that share a common language.

Furthermore, each section of the figure shows regression lines with different slopes. In particular, the line for firms that invest in countries that do not share a common language has a positive slope in Figure 1.2a, whereas it has a negative slope in Figure 1.2c. In other words, these results indicate that productivity level becomes more important for firms that engage in horizontal FDI with local service managers, whereas it becomes less important for firms that undertake service FDI with local service managers in countries that do not share a common language.

Finally, increasing a firm's productivity level from one standard deviation below to one standard deviation above the mean from Figure 1.2a increases the joint estimated probability of engaging in horizontal FDI and including local managers in countries that do not share a common language by approximately 7%. Similarly, it reduces the probability of firms engaging in horizontal FDI with local managers in countries that share a common language by approximately 5%, in which the differences between the two lines are statistically significant at the 5% level. Alternatively, decreasing firm productivity level from the mean to one standard deviation below the mean from Figure 1.2c increases the estimated probability of firms engaging in service FDI with local managers in countries that do not share a common language by approximately 0.5%. Similarly, it reduces the probability of firms choosing the same strategy in countries that share a common language by approximately 1%, in which the difference between the lines is statistically significant at the 10% level.

Estimations of the average marginal effects of firm productivity on the joint probability of firms' choosing different integration strategies conditional on a language are reported in first two columns of Table 1.7. I find that in non-English-speaking countries, firm productivity increases the probability of undertaking horizontal FDI with local managers by 0.4% at the 1% significance level. Alternatively,

it reduces the probability of firms engaging in service FDI with local managers by 0.5% at the 1% significance level.[37]

The analysis of choosing different integration strategies for firms that provide services through Korean service managers is consistent with the results from the previous specification of firms that employ local service managers. Figures 1.2b and 1.2d show that firms engaging in both types of FDI are more likely to provide services through Korean managers when they enter a country that shares a common language. Furthermore, in countries that share a common language, firm productivity level becomes important for firms that integrate production and services in their home locations, whereas it is less important for firms that choose to integrate in multiple locations.

Increasing firm productivity level from one standard deviation below to one standard deviation above the mean in English-speaking countries (Fig. 1.2b) significantly increases the firms' propensity to provide services with home managers through horizontal FDI; indeed, it is higher than the increased probability of firms undertaking horizontal FDI in non- English-speaking countries. Although decreasing firm productivity level from one standard deviation above to one standard deviation below the mean in non-English- and in English-speaking countries (Fig. 1.2d) increases the probability of firms to engage in service FDI by sending home service managers, the difference between the two increases are statistically insignificant.

Computing for the average marginal effects of firm productivity on the joint estimated probability of firms' choosing different strategies (HH, SH), conditional on whether the host country shares a common language, the second column of

[37] Conditional marginal effects of firm productivity are computed at the mean levels of other firm and country characteristics. For more details on computing conditional marginal effects of interaction terms, see Christofides et al. (1997) and Norton et al. (2004).

Table 1.7 shows that firm productivity increases the probability of firms choosing horizontal FDI with home service managers by 0.6% at the 10% significance level in English-speaking countries. Alternatively, firm productivity level reduces the odds in favor of firms undertaking service FDI with home managers by 0.5% at the 1% significance level.

Turning to other coefficient estimates in Table 1.3, firm size has a significant impact on firms' integration strategies, whereas firms' experience has a significant effect on firms' post-production service strategies. In particular, larger size increases the probability of firms choosing service FDI with either type of service managers, whereas firms with more international experience are more likely to provide services with local managers through both types of FDI in low-income countries. On the other hand, firms' R&D intensity and the host country's infrastructure have significant effects on both firms' production and service strategies. Calculating their average marginal effects show that firms have a high propensity to undertake horizontal FDI with either type of service managers if they are highly R&D intensive or in countries with a rich infrastructure. Consistent with previous specifications for firms serving high-income countries, managerial ability measured as tertiary education level of the host country has no effect on firms' strategies to provide services with different types of managers in low-income countries.

Table 1.8 in the Appendix reports the univariate probit estimates of firm and country characteristics on firms' decisions to choose locations for the production process and different types of managers to provide services. The results do not differ significantly from the results of the bivariate probit shown in Table 1.3. For example, the coefficient estimates on the univariate probit reveal that the firm productivity level and its size have significant effects on firms' production location decision, such that firms with higher productivity levels and smaller size are more likely to choose

horizontal FDI in a host country. Alternatively, firm experience has positive and significant impacts on the strategy to provide services through local managers.

Computing the average marginal effects of firm productivity on the probability of firms choosing each strategy, conditional on a language, the results showed no interaction effects between these factors. The marginal effects of productivity level on each strategy were widely insignificant for countries that either share a common language or not. In contrast to the results from Table 1.3, however, the coefficient estimate on the tariff rate shows that it has a positive and significant impact on the probability of firms choosing horizontal FDI, in the absence of their decision to provide services through different types of managers.

Overall, the empirical results from testing firms in low-income countries suggest that firms' decisions on locating production facilities in a host country and providing services through local managers are complementary. Supplementing the graphical analysis with the bivariate probit regression provides evidence that firm productivity level has a significant effect on the joint probability of choosing different strategies when interacted with a language. In particular, in countries that share a common language, firms that are more productive are more likely to undertake horizontal FDI with home service managers, whereas firms that are less productive tend to engage in service FDI with home service managers. Alternatively, in countries that do not share a common language, horizontal FDI with local service managers is more likely to be chosen by firms that are more efficient. Service FDI with local service managers, on the other hand, tends to be performed by firms that are less efficient. All of these results support the predictions from the theoretical model.

1.6 Conclusion and Future Work

In this paper, I examine integration strategies of Korean firms that involve producing final outputs and providing post-production services to serve foreign markets. In the theoretical model, consumers in all countries perceive the service quality of products based on the inner value of service and the ability of managers that demonstrate the products' service value. On the other hand, heterogeneous firms must provide services for products through their subsidiaries abroad, but can produce output in either their home or host country.

The model shows that the equilibrium decision of a firm depends on its productivity and other economic factors that affect decisions on integrating business activities and providing services. By adding service quality differences into the heterogeneous firms trade model, I introduce that a new pattern of FDI – service FDI – appears as one of the available strategies firms can use to serve global markets. To my knowledge, this has not been studied before.

Using Korea's middle-income status, I examine two scenarios separately; that is, when firms choose optimal strategies to serve high- and low-income countries. Then, I estimate a model of firms' strategies using a rich set of plant- and parent firm-level data of Korean multinational firms from 2002 through 2009. The empirical results indicate that firms' optimal strategies are affected not only by its productivity level, but also by different factors for each scenario. In particular, the results show that firms entering high-income countries are concerned primarily with the transport cost, a crucial element for firms' integration strategies. Alternatively, firms serving low-income countries are affected mostly by the degree to which service managers are internationally mobile between countries, which plays an important role in firms' post-production service strategies.

The main goal of this paper was to study firm's optimal integration strategies to serve foreign markets by incorporating decisions on providing services after production. As such, a range of questions including other options in the firms' decision are not addressed in this paper. I have not considered various possibilities to serve foreign markets that are important for a full account of firm strategies, such as outsourcing providing service to foreign firms through contracting or cross-border mergers and acquisitions, or possibility of investing in physical product quality. Furthermore, given this paper's focus on studying firm activities to serve foreign markets with different sizes, the analysis was also limited to comparing firm integration strategies to serve between high-income and low-income countries relative to the home country.

In the present study, one of primary interests is to examine the effect of service managers in providing post-production services. The basic premise of the model, therefore, is that the preference for the service quality of products by a consumer in all countries is affected by the managers' abilities. Put differently, this assumption implies that consumer's preference is homothetic with respect to per capita income. Indeed, previous trade literature have analyzed the non-homotheticity of demand for physical product quality and found that the relative demand for high-quality products is higher in high-income countries. For future research, therefore, it would be interesting to study how the non-homotheticity of demand for service quality affects firms' strategies to serve global markets. This would involve extending the model. Furthermore, including both service and product qualities in consumers' preferences would yield various implications on multinational firm activities when serving global markets. These questions are left for future research.

1.7 Chapter Appendix

In this appendix, I will discuss firms' optimal strategies to serve different foreign markets when they can also produce varieties in third countries. For simplicity, I assume that there exist a third country with different market size where firms can only use it as an export-platform.[38] Here, I will study the effects of third production location on firms' optimal strategies to serve high-income and low-income countries, respectively. For expositional simplicity, I assume that transport costs and fixed investment costs of setting up plants are symmetric across countries.

For firms that serve high-income countries, they can produce varieties in the South and ship them to the service facilities located in the North. This integration strategy would impose transport costs and fixed investment costs of setting up plants in multiple locations, but conserve the production cost. In this case, the profits from choosing possible strategies to serve the North are:

$$\Pi_n^{HH} = \frac{\eta-1}{\eta}(B_n\delta z_h w_n^{1-\sigma})^{\frac{\eta}{\eta-1}}\theta^{\frac{\eta(\sigma-1)}{\eta-1}} - F_{H,h} \tag{1.30}$$

$$\Pi_n^{HL} = \frac{\eta-1}{\eta}(B_n z_n w_n^{1-\sigma})^{\frac{\eta}{\eta-1}}\theta^{\frac{\eta(\sigma-1)}{\eta-1}} - F_{H,n} \tag{1.31}$$

$$\Pi_n^{SH} = \frac{\eta-1}{\eta}(B_n\delta z_h (w_h t)^{1-\sigma})^{\frac{\eta}{\eta-1}}\theta^{\frac{\eta(\sigma-1)}{\eta-1}} - F_{S,h} \tag{1.32}$$

$$\Pi_n^{SL} = \frac{\eta-1}{\eta}(B_n z_n (w_h t)^{1-\sigma})^{\frac{\eta}{\eta-1}}\theta^{\frac{\eta(\sigma-1)}{\eta-1}} - F_{S,n} \tag{1.33}$$

$$\Pi_n^{CH} = \frac{\eta-1}{\eta}(B_n\delta z_h (w_s t)^{1-\sigma})^{\frac{\eta}{\eta-1}}\theta^{\frac{\eta(\sigma-1)}{\eta-1}} - F_{C,h} \tag{1.34}$$

$$\Pi_n^{CL} = \frac{\eta-1}{\eta}(B_n z_n (w_s t)^{1-\sigma})^{\frac{\eta}{\eta-1}}\theta^{\frac{\eta(\sigma-1)}{\eta-1}} - F_{C,n} \tag{1.35}$$

[38] To make it consistent with the main theme of the paper, I assume that a third country is not a target market for multinational firms. Allowing a third country to be firms' another target market is consistent with Aw and Lee (2008) who develop three-country model consisting of low-income, middle-income and high-income countries to study how firms in a middle-income country make production location decisions to serve global markets.

where equations (1.30) to (1.33) represent firm profits made from engaging in horizontal FDI and service FDI with including different types of service managers, which are consistent with profit functions in Section 1.3.1.1. On the other hand, equations (1.34) and (1.35) represent firm profits made from undertaking complex FDI with home and local service managers, respectively. Complex FDI indicates firm's integration strategy to produce varieties in the South by investing in production facility and ship products to service facility in the North to provide post-production services in the local market.

Under the assumption on managerial abilities across countries, it can also be seen that between firms that choose complex FDI strategy, the profit made from providing services through local managers dominates the profit made from sending home managers to the North. Therefore, among three possible integration strategies to serve the North ($\Pi_n^{HL}, \Pi_n^{SL}, \Pi_n^{CL}$), which integration strategy to choose depends not only on firm productivity level but also on the transport costs.

Figure 1.6 shows the profits attainable for firms with different levels of productivity, θ: in case of high transport cost ($t > w_n/w_s$) in Figure 1.6a and low transport cost ($t \in (1, w_n/w_s)$) in Figure 1.6b. Both figures depict profit functions reflected underlying equations (1.31), (1.33), and (1.35). The steeper Π_n^{CL} relative to Π_n^{SL} from both figures reflect lower marginal cost of production involved for firms that produce in the South than produce in the home country. This implies that more productive firms are affordable to pay higher fixed costs and take advantage of higher returns generated by the lower production cost in the South.

However, Figure 1.6a shows that due to the high transport cost, the profit from engaging in horizontal FDI dominates the profit from undertaking complex FDI for firms in the all range of productivity levels. Consistent with the results from prior section, more productive firms will integrate business activities in the

North, whereas less productive firms undertake service FDI, and all firms will provide services by employing local service managers. It is never profitable to integrate business activities in different locations. Alternatively, if transport costs are relatively low, Figure 1.6b shows that firms are never profitable to engage in horizontal FDI, which is also consistent with the results from the prior section. More productive firms are now in the position to overcome the highest fixed costs and produce a large volume of varieties with the lowest unit cost of production in the South and ship to the North, whereas less productive firms undertake service FDI.

To summarize, when firms have an option to establish production facilities in the South and use them as an export-platform to the North, they would only choose this alternative integration strategy when transport cost is low. In this case, the model shows that more productive firms will bear high fixed costs of establishing facilities in multiple locations and produce varieties with low marginal cost. However, if the transport cost is relatively high, firms will find that it is never profitable to choose an alternative option.

Now, suppose that firms have an option to produce varieties in the North and ship to their service facilities in the South to serve local markets. With same fixed investment costs for establishing production and service facilities in foreign countries, producing in the South always incurs lower marginal cost than producing in the North and ship to the South. Therefore, between firms that choose the same type of service managers, it is never profitable to undertake complex FDI strategy. Instead, consistent with the results from Section 1.3.1.2, more productive firms will integrate business activities in the South, whereas less productive firms will produce and export products from the home country.

Figure 1.3: Relationship between country's per capita income and education level in 2009

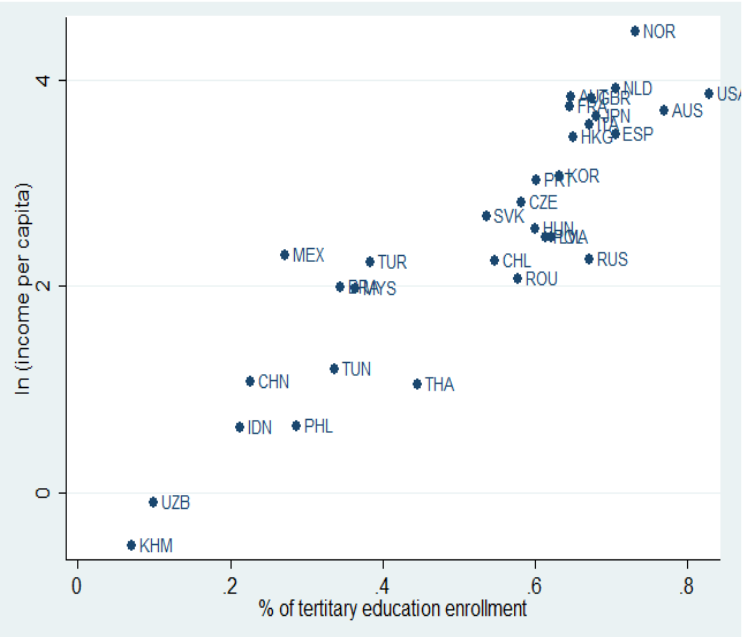


Table 1.4: Descriptive Statistics of new FDI-firms in 2009

	Variable	Mean	SD
	productivity	0.182	0.788
	R&D intensity	0.254	0.29
	Firm size	3857.63	11726.87
	Firm experience	1.89	3.16
High-income countries	Tariff rates	1.67	0.704
	Language	0.523	0.328
	Managerial ability	0.728	0.147
	GDP	7.665	5.905
Low-income countries	Tariff rates	5.56	1.82
	Language	0.684	0.565
	Managerial ability	0.251	0.118
	GDP	2.571	1.413

Note: GDP is in US billion dollars.

Table 1.5: Marginal effect of firm productivity level on firm integration strategies and the level of tariff rates, high-income countries

HL			*SL*		
tariff rate level	marginal effects of firm productivity	95% Confidence interval	tariff rate level	marginal effects firm productivity	95% Confidence interval
0	0.021 (0.023)	-0.025/0.067	0	0.131** (0.066)	-0.191/0.452
1	0.039 (0.029)	-0.018/0.097	1	0.121* (0.063)	-0.176/0.419
2	0.064 (0.047)	-0.028/0.157	2	0.104* (0.059)	-0.163/0.371
3	0.092* (0.048)	-0.061/0.245	3	0.082 (0.051)	-0.148/0.312
4	0.119** (0.058)	-0.099/0.338	4	0.059 (0.042)	-0.132/0.25
5	0.142** (0.067)	-0.132/0.417	5	0.038 (0.035)	-0.113/0.19

Note: Standard errors using delta method are in the parenthesis. $***$,**,* denote significance at the 1,5,10 percent, respectively.

Table 1.6: Univariate probit, high-income countries

Firm strategies	Estimates		Marginal effects	
	manu	*local*	*manu*	*local*
tariff	0.427	0.122	0.171	0.042
	(0.333)	(0.368)	(0.133)	(0.129)
productivity	-0.255	0.536	-0.101	0.187
	(0.521)	(0.576)	(0.208)	(0.198)
R&D intensity	-0.507	-0.044	-0.202	-0.015
	(0.393)	(0.444)	(0.156)	(0.155)
experience	0.306**	0.142	0.122**	0.497
	(0.142)	(0.104)	(0.056)	(0.362)
firm size	-0.114	-0.094	-0.045	-0.032
	(0.101)	(0.063)	(0.04)	(0.022)
language	0.585	0.381	0.228	0.127
	(0.976)	(1.04)	(0.365)	(0.324)
education	0.007	-0.042	0.003	-0.014
	(0.014)	(0.03)	(0.005)	(0.01)
GDP	0.012	0.084	0.004	0.029
	(0.082)	(0.062)	(0.033)	(0.021)
telephone	-0.134	0.207	-0.053	0.072
	(0.264)	(0.271)	(0.105)	(0.095)
tariff*productivity	0.166	-0.312		
	(0.282)	(0.35)		
language*productivity	-0.565	0.128		
	(0.929)	(0.073)		
tariff*language	-0.142	0.108		
	(0.449)	(0.316)		
constant	−3.13*	-0.67		
	(1.77)	(0.431)		
observations	351	354		
pseudo R^2	0.1531	0.1267		
Log L	165.45	-150.21		
success probability			0.502	0.811

Note: Robust standard errors are in parenthesis. ∗ ∗ ∗, ∗∗, ∗ denote significance at the 1,5,10 percent, respectively; all regressions include a constant, time, country, firm and industry fixed effects. Testing firms that only include Korean managers are not available due to small number of observations.

Table 1.7: Conditional marginal effects of firm productivity level

Conditional marginal effects	Low-income countries		High-income countries	
	language = 0	*language = 1*	*language = 0*	*language = 1*
$\frac{\partial \text{HL}}{\partial \text{productivity}}$	0.004***	0.064	0.027	0.073
	(0.001)	(0.097)	(0.046)	(0.059)
$\frac{\partial \text{HH}}{\partial \text{productivity}}$	0.002	0.006*		
	(0.006)	(0.003)		
$\frac{\partial \text{SL}}{\partial \text{productivity}}$	−0.0054***	-0.065	0.104	0.106
	(0.002)	(0.098)	(0.171)	(0.126)
$\frac{\partial \text{SH}}{\partial \text{productivity}}$	-0.001	−0.005***		
	(0.0006)	(0.001)		
Observations	947		349	

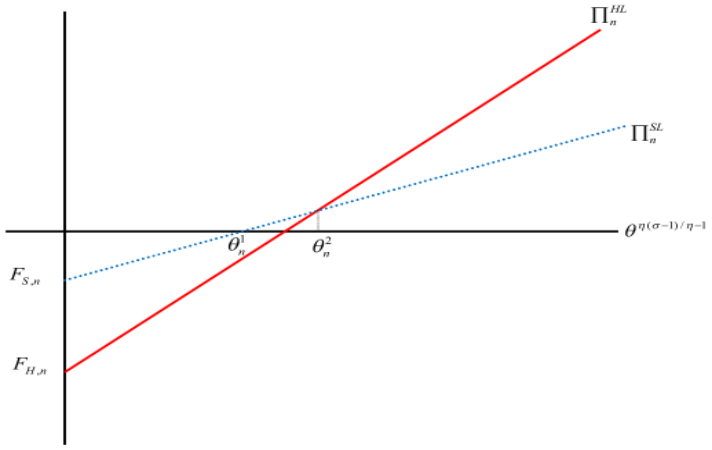
Note: Conditional marginal effects of firm productivity are computed at the mean levels of firm and country characteristics. Estimation of marginal effects on joint probabilities of firms' choosing different integration strategies with Korean service managers when serving high-income countries are excluded due to small number of observations.

Table 1.8: Univariate probit, low-income countries

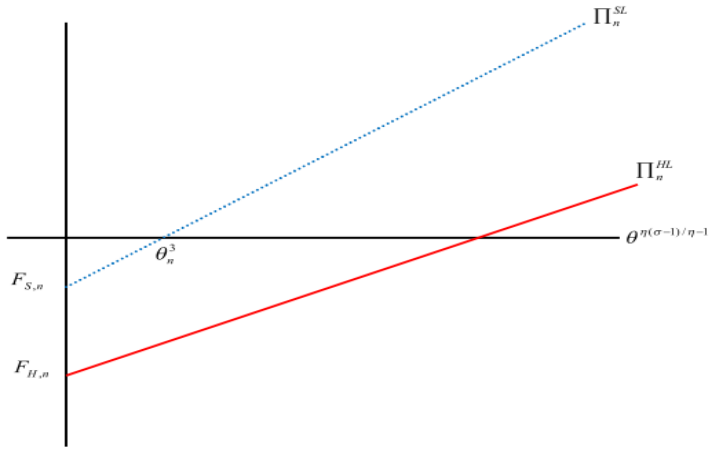
Firm strategies	Estimates		Marginal effects	
	manu	*local*	*manu*	*local*
tariff	0.151***	0.114	0.01***	0.02
	(0.051)	(0.082)	(0.003)	(0.014)
productivity	0.28***	-0.005	0.019***	-0.001
	(0.084)	(0.04)	(0.004)	(0.007)
R&D intensity	0.643***	−0.088**	0.045***	−0.015**
	(0.207)	(0.035)	(0.014)	(0.006)
firm size	−0.303***	-0.027	−0.021***	-0.004
	(0.045)	(0.037)	(0.002)	(0.006)
experience	0.036	0.084**	0.002	0.014**
	(0.03)	(0.038)	(0.002)	(0.006)
language	-0.443	-0.113	-0.045	-0.021
	(0.645)	(0.563)	(0.088)	(0.113)
education	-0.045	-0.065	-0.003	-0.011
	(0.359)	(0.313)	(0.025)	(0.055)
GDP	-0.043	-0.059	-0.003	-0.01
	(0.15)	(0.114)	(0.01)	(0.02)
telephone	0.152***	0.168***	0.011***	0.029***
	(0.022)	(0.018)	(0.001)	(0.003)
tariff*productivity	0.154	0.22		
	(0.263)	(0.188)		
language*productivity	−0.965***	0.07		
	(0.174)	(0.157)		
tariff*language	0.162**	−0.157*		
	(0.076)	(0.084)		
constant	4.89***	1.78		
	(1.507)	(2.23)		
observations	1032	966		
pseudo R^2	0.1720	0.072		
Log L	-238.35	-298.28		
success probability			0.968	0.897

Note: Robust standard errors are in parenthesis. $***$, $**$, $*$ denote significance at the 1,5,10 percent, respectively; all regressions include a constant, time, country, firm and industry fixed effects.

Figure 1.4: Profits from different integration strategies serving high-income countries

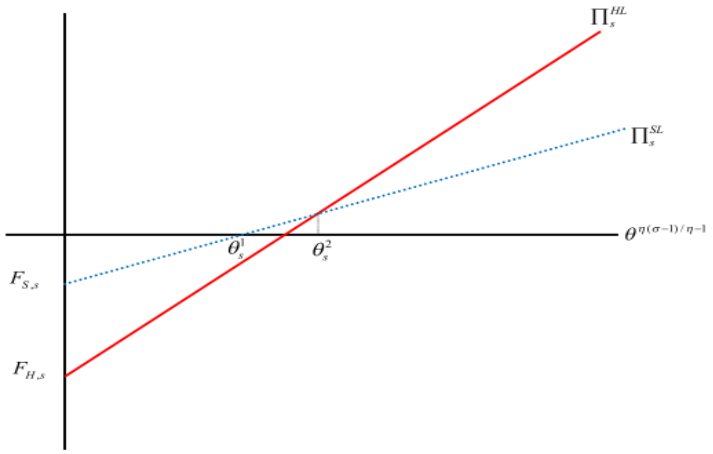


(a) Profit function, high transport cost in high-income countries

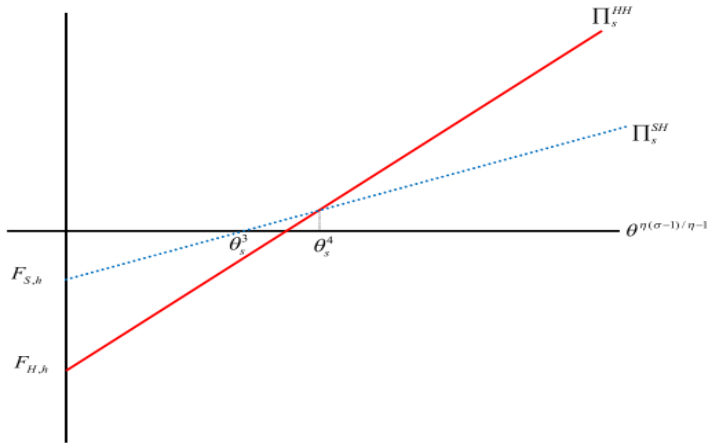


(b) Profit function, low transport cost in high-income countries

Figure 1.5: Profits from different integration strategies serving low-income countries

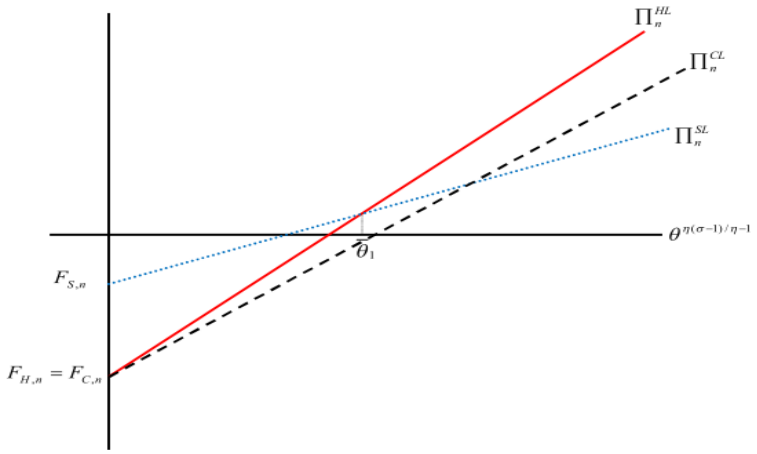


(a) Profit function, with low mobility in low-income countries

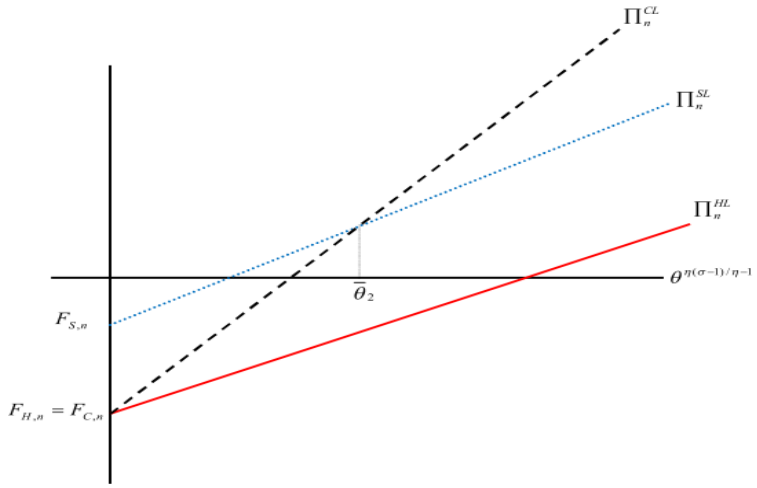


(b) Profit function, with high mobility in low-income countries

Figure 1.6: Profits from different integration with complex FDI strategy serving high-income countries



(a) Profit function, high transport cost in high-income countries



(b) Profit function, low transport cost in high-income countries

Chapter 2

Regional Economic Integration and Multinational Firm Strategies in Middle-Income Countries

2.1 Introduction

Regional economic integration impacts the structure of foreign direct investment (FDI) flows of multinational firms inside and outside the region. By taking advantage of low trade barriers such as common external tariff on goods shipped within the region, firms are likely to establish facilities in the host country and use them as an export platform. For example, using U.S. affiliates data, Ekholm et al. (2007) showed that 40% of total sales made by affiliates located in member countries of North American Free Trade Agreement (NAFTA) account for the export sales to U.S. compared to 12% of total sales that account for export sales to the U.S. from other countries, whereas Feinberg and Keane (2006) also found the same evidence by showing that 19% of U.S. affiliates in Canada only engage in export sales to the U.S.

This paper examines the effect of regional economic integration on patterns of foreign direct investment of firms based in Korea. Due to the limited data, prior works studying the effect of regional economic integration on multinational firm activity have been restricted to maintain focus on FDI flows of firms in developed countries like the U.S. or Japan. Using Korea's middle-income status, our empirical analysis focuses on the factors that affect the decision of firms in middle-income countries to choose a production location inside the different trade integrated regions, a region with high-income countries (European Economic Area), and a region

with low-income countries (ASEAN Free Trade Area) and studies the patterns of FDI in each region. Therefore, we attempt to show that, when entering trade integrated region, firms make decisions depending on the aggregate size of the region and present a theoretical model to explain the factors that affect different firm activities in these regions.

Previously, relatively few papers have studied the relationship between free trade agreements and firms' FDI activities. These works focus on the export-platform FDI made by firms outside the region as a response to regional trade agreements (Chen (2009); Antràs and Foley (2009)). For example, Antràs and Foley (2009) develop the Helpman et al. (2004) model with three countries consisting of large and two symmetric small countries to show that the formation of free trade agreement between small countries (ASEAN) leads an increase in the number of firms locating plants inside the region and their share of export sales to third countries. However, rather than analyzing firm activities in response to the formation of a free trade agreement between countries, we focus on the factors that affect firms' different FDI strategies inside different trade integrated regions.

In our related work that studies the decision of firms in middle-income countries, Aw and Lee (2008) examine how firm productivity affects the production location decision of Taiwanese multinationals. Their paper is the first to consider the location decision of firms from middle-income country to serve two different income-level countries, the U.S. and China. Using the firm-level data of Taiwanese multinationals; they find that the most productive firms serve both countries through local subsidiaries followed by a firm investing in a rich country (U.S.), whereas the less productive firm serves a poor country (China), and the least productive firm exports.

In this paper, however, rather than focusing on horizontal FDI investments

in different income-level countries, we modify the Aw and Lee's framework by considering two free trade areas that are different in terms of income-level of member countries and analyze two scenarios in which a firm makes production location decisions to serve a free trade area with high-income countries and a region consisting of low-income countries.

We first study the case in which a firm makes a decision on locating a production site in each of free trade areas, assuming that the member countries are symmetric. From this case, we argue that the firms' production location choices vary depending on their productivity level such that more productive firms invest in free trade areas by locating plants in multi-locations to serve local markets followed by firms entering the region through locating plants in a single location not only to engage in local sales but also export sales (complex FDI). In particular, we show that the main feature of the free trade area, which is low trade barriers within the region, plays am important role in less productive firms' decision to enter and engage in complex FDI.

Then, our model presents that the firms' complex FDI differ depending on the aggregate size of trade integrated regions such that firms engaging in complex FDI inside high-income regions involve serving local market and third countries through exports, whereas complex FDI inside low-income region include serving local market and exports to not only third countries but also to the parent country.

Given that the firm's pattern of FDI inside the trade integrated region are likely to differ based on its aggregate size, using the firm- and plant-level data of Korean firms, we estimate the model separately for firms investing in EEA and firms investing in AFTA between 2002 and 2008. For each region, we specify a probit model to identify the determinants of firms' investment patterns and find the results that are consistent with our theoretical prediction.

This paper makes two main contributions to the trade literature. First, we extend Aw and Lee (2008) by developing a three-country model that accounts for interdependence between the host country, where production takes place, and the final consumption countries within trade-integrated region. By introducing trade-integrated regions into Aw and Lee's framework, we allow firms with different productivity levels to choose different patterns of FDI based on the regional characteristics. In contrast to Aw and Lee (2008), we introduce the strategy of engaging in multiple types of FDI in a single location.

Second, apart from prior empirical studies, which focus on analyzing investment patterns of firms from North to South countries, we introduce firms in a middle-income country that can invest in the North as well as in the South. In particular, developing a one-stage production model, we focus on analyzing production location choices and activities of firms from Korea inside EEA and AFTA. This model enables us to use unique information in a plant-level data set on the destination of outward FDI among Korean multinational firms. By analyzing Korean firms, our goal is to gain insights into different FDI strategies that firms can choose if they seek to enter developed or developing trade integrated region.

This paper proceeds as follows. Section 2.2 presents recent FDI activities among Korean firms worldwide and analyzes their investment patterns inside and outside the trade integrated regions. Section 2.3 develops a theoretical model for firms' production location choices in different regions. Section 2.4 describes the plant- and firm-level data used for the empirical estimation, and the estimation results are presented in Section 2.5. Section 2.7 concludes.

2.2 Data Facts

Table 2.1: Distribution of sales by Korean affiliates (percent) in 2002 and 2008

Year	Location	2002	2008
Share of sales to local market	***EEA***	**0.499**	**0.456**
	Non-EEA countries	0.767	0.935
	AFTA	**0.292**	**0.351**
	Non-AFTA countries	0.855	0.728
Share of sales to Korea	***EEA***	**0.026**	**0.023**
	Non-EEA countries	0.107	0.04
	AFTA	**0.069**	**0.108**
	Non-AFTA countries	0.032	0.073
Share of sales to third countries	***EEA***	**0.474**	**0.521**
	Non-EEA countries	0.126	0.024
	AFTA	**0.639**	**0.542**
	Non-AFTA Countries	0.113	0.199
Number of firms	***EEA***	**59**	**220**
	Non-EEA countries	10	12
	AFTA	**69**	**634**
	Non-AFTA countries	27	63

Table 2.1 provides information on the direction of sales of Korean affiliates inside trade-integrated regions (EEA and AFTA) and other regions in 2002 and 2008.[1] The sample includes 81% of all Korean multinational firms in the manufacturing industry. Affiliates' sales are broken down into local sales in the host country, export sales to the parent country (Korea), and export sales to third countries.

The last row of Table 2.1 demonstrates that the majority of firms locate plants inside trade-integrated regions and that their numbers have dramatically increased in relation to firms investing in other regions. Examining their direction of sales, it is apparent that firms locating plants inside trade integrated regions

[1] In the table, EEA consists of 19 member countries, whereas AFTA includes 9 member countries (Brunei not included). On the other hand, 4 non-EEA European countries account for other European Countries, whereas 11 non-AFTA Asian countries account for Other Asian Countries in Table 2.1. Note that other countries include countries that do not have any free trade agreement relationship with Korea.

tend to have complex patterns of FDI, which indicates that firms engage in multiple types of FDI, whereas firms investing in other regions are more likely to exhibit pure horizontal FDI strategy.

In both trade integrated regions, the table shows that most firms exhibit undertaking complex FDI while having a large share of export sales to third countries. However, it can be seen that firms investing in EEA tend to have a larger share of local sales, whereas firms investing in AFTA tend to have a larger share of export sales to the parent country. This evidence indicates the importance of low trade barriers within the free trade area that promote outsider firms' export sales to third countries and that firms tend to exhibit horizontal motives for FDI in large markets, while they are likely to have vertical motives for FDI in a region with low factor costs. These stylized facts are consistent with our theoretical model which introduces a complex FDI strategies for firms in different regions.

2.3 Model

In this section, we develop a simple partial equilibrium model to analyze the effects of different regional economic integrations on the decision of firms in middle-income country to locate their plants and serve markets within each integrated region. The main purpose of the paper is to study how each regional economic integration among high-income countries and among low-income countries affects the location choice of firms in a middle-income country and their FDI strategies inside the free trade area. Therefore, we build a three-country model by developing the approach of Aw and Lee (2008) and Antràs and Foley (2009) and consider two scenarios to analyze the effect of regional trade integration between high-income countries (EEA, which will be called North) and between low-income countries (AFTA, which will be called South) on the location decision of firms.

The representative consumer in all countries has the same CES utility function.

$$U = \left[\int_{i\in\Omega} q(i)^{\alpha} di\right]^{1/\alpha}, \qquad 0 < \alpha < 1$$

where Ω represents the continuous set of all available varieties and $q(i)$ is a consumption of variety i by the representative consumer. If we maximize utility function with respect to standard budget constraint, it would yield the following demand for variety i:

$$q(i) \quad = \quad \frac{p(i)^{-\varepsilon}}{P^{1-\varepsilon}} E$$

where $\varepsilon = 1/1-\alpha > 1$ is the elasticity of substitution between heterogeneous goods, E is the exogenous expenditure level of the country, and P is the ideal price index of the country, with $p(i)$ being the price of variety i.[2] If we define $A_j = E_j/P_j^{1-\varepsilon}$ to be aggregate demand level of country j, the demand for variety i in country j can be written as follows:

$$q_{ij} \quad = \quad A_j p_i^{-\varepsilon}$$

On the production side, there is a continuum of firms in Home which are indexed by their heterogeneous productivity level φ_i.[3] These firms only use labor to produce final good i. The unit variable cost of production for a firm with productivity φ_i producing in country j is denoted by C_{ij};

$$C_{ij} \quad = \quad \frac{w_j}{\varphi_i}$$

---

[2] $P = \left[\int_{i\in\Omega} p(i)^{1-\varepsilon} di\right]^{\frac{1}{1-\varepsilon}}$

[3] In this paper, we only consider one-stage production by firms. See Grossman et al. (2004) for more details on firm's "complex" FDI strategies when intermediate goods are added in firm's production.

where w_j is wage level of workers in country j. Each country differs in its factor prices such that we assume the wage level of workers to be the largest in the North, followed by Home, and the South has the lowest: $w_N > w_H > w_S$.[4]

When a firm enters the industry in country j via FDI, we assume that it incurs fixed investment cost f_j in every foreign market. On the other hand, when a firm exports products to country j from Home, these goods are subjected to melting-iceberg transport cost $t_j > 1$, whereas goods shipped from foreign affiliates to other countries within the trade-integrated region are subjected to common transport cost τ such that $\tau \in (1, t_j)$. After entry, these firms engage in monopolistic competition.

Taking a demand function as given, the price that maximizes the firm's profit is the unit variable cost over constant price-marginal cost markup:

$$p_i = \frac{C_i}{\alpha}$$

where $1/\alpha$ markup factor.

Therefore, the profit of a firm that serves the local market through its local subsidiary in country j will be as follows:

$$\begin{aligned} \Pi_{ij}^I &= (1-\alpha)A_j(\frac{C_{ij}}{\alpha})^{1-\varepsilon} - f_j \\ &= B_j \Theta_i w_j^{1-\varepsilon} - f_j \end{aligned}$$

where $B_j = (1-\alpha)A_j\alpha^{\varepsilon-1}$ and $\Theta_i = \varphi_i^{\varepsilon-1}$. For expositional simplicity, we define $B_H = B$ such that $B_N = \beta_N B$ and $B_S = \beta_S B$, where $\beta_N > 1 > \beta_S$, which implies that aggregate demand level is the largest in the North, whereas it is the smallest in the South relative to Home.

[4]Following Aw and Lee (2008), we have calculated average hourly wage in EEA, Korea, and ASEAN using the data from LABORSTA. We found that average earnings per hour for manufacturing during sample period was $27.64 in EEA, $13.66 in Korea and $3.89 in ASEAN countries.

On the other hand, if a firm engages in exporting to serve foreign market j, the profit of a firm that produces in home country (h) will be thus:

$$\begin{aligned}\Pi_{ij}^{EX} &= (1-\alpha)A_j(\frac{t_j C_{ih}}{\alpha})^{1-\varepsilon} \\ &= B_j \Theta_i (t_j w_h)^{1-\varepsilon}\end{aligned}$$

whereas the profit of a firm exporting to j from its local subsidiary located in country (k) within trade integrated region will be as follows:

$$\begin{aligned}\Pi_{ij}^{IX} &= (1-\alpha)A_j(\frac{\tau C_{ik}}{\alpha})^{1-\varepsilon} - f_k \\ &= B_j \Theta_i (\tau w_k)^{1-\varepsilon} - f_k\end{aligned}$$

2.3.1 Firms serving a developed trade integrated region (EEA)

In this subsection, our goal is to study the effects of regional economic integration between high-income countries on the location decision of firms in a middle-income country. Here, we consider three countries consisting of two identical Northern countries and Home (N, N, H).

When firms produce goods in Home and export to North, it will cost them $t_N > 1$. For firms that locate production facilities in North, it will cost them fixed investment cost f_N, whereas shipping products within trade integrated region has relatively low transport cost $\tau_N \in (1, t_N)$. For a simple notation, we assume that West and East are symmetric countries inside the Northern region.

Goods selling in each market can be produced from any of three countries. To serve global markets, therefore, this implies that there are 27 possible location combinations that the firm can choose. Here, we denote (x, y, z) as choices set that firms can choose to locate their plants to service Home, West, and East. For example, HWW indicates that firms serve Home domestically while they establish

a plant in West to serve its local market and export to East. Here, we make our first key assumption:

$$1 > \frac{w_H}{w_N} > \frac{\tau_N}{t_N} \tag{2.1}$$

which implies that the variable cost of exports to the destination market is higher from the home country than from a country within the free trade area. Under assumption (2.1), there exist four possible location combinations that firms can choose.

$$\begin{aligned}
\Pi^N_{HHH} &= B\Theta_i[w_H^{1-\varepsilon} + \beta_N(w_H t_N)^{1-\varepsilon} + \beta_N(w_H t_N)^{1-\varepsilon}] \\
\Pi^N_{HWH} = \Pi^N_{HHE} &= B\Theta_i[w_H^{1-\varepsilon} + \beta_N(w_H t_N)^{1-\varepsilon} + \beta_N w_N^{1-\varepsilon}] - f_N \\
\Pi^N_{HWW} = \Pi^N_{HEE} &= B\Theta_i[w_H^{1-\varepsilon} + \beta_N(w_N \tau_N)^{1-\varepsilon} + \beta_N w_N^{1-\varepsilon}] - f_N \\
\Pi^N_{HWE} &= B\Theta_i[w_H^{1-\varepsilon} + \beta_N w_N^{1-\varepsilon} + \beta_N w_N^{1-\varepsilon}] - 2f_N
\end{aligned}$$

All four location combinations indicate that Home is served domestically, whereas serving countries inside the Northern free trade area is different. In particular, location choice $(HHH)^N$ represents that both Northern countries are served by exports from Home, whereas $(HWH)^N = (HHE)^N$ represents that one of Northern countries is served by exports from Home and the other is served by the local subsidiary. Location choice $(HWW)^N = (HEE)^N$ denotes that both Northern countries are served by the local subsidiary in a single location; i.e. the firm locates a plant in one of Northern countries to serve its local market and also export to the third country. $(HWE)^N$ denotes that both Northern countries are served by local subsidiaries in each country; i.e. the firm locates plants in several locations to serve their local market only. We can depict the above four locations in a figure thus:

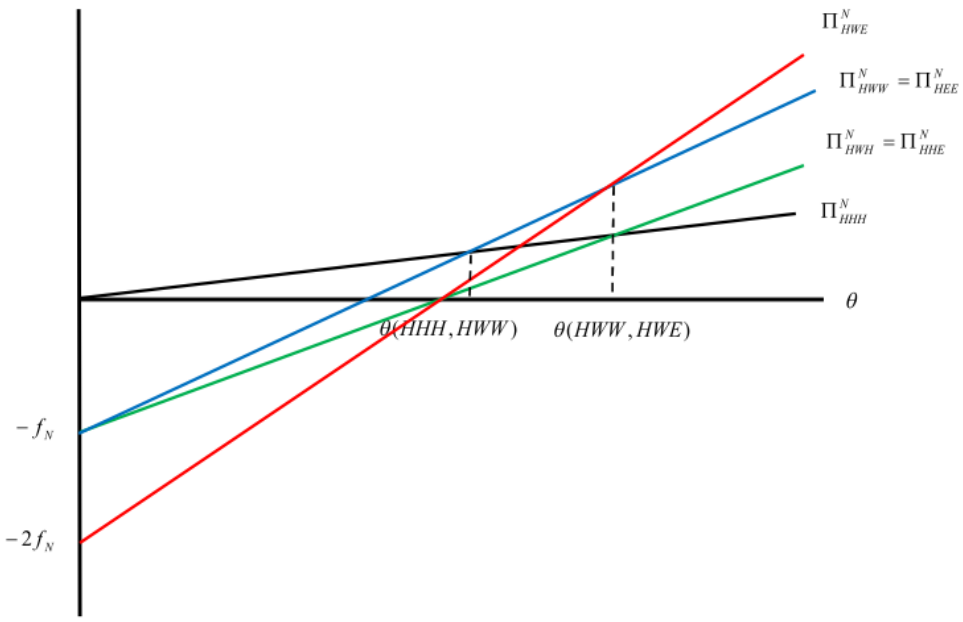


Figure 2.1: Profit functions in case of Home, North, and North

Figure 2.1 shows that the most productive firm serves countries within the Northern free trade area through horizontal FDI in multiple locations, whereas the relatively less productive firm serves the region via complex FDI in a single location – engaging in not only local sales but also export sales to the third country within the region. Alternatively, the least productive firm serves the region through exports from Home. It is interesting to see that location choice $(HWH)^N = (HHE)^N$ is dominated by $(HWW)^N = (HEE)^N$ from the figure. This indicates that firms with an intermediate productivity level (firms with productivity level between $\Theta(HHH, HWW)$ and $\Theta(HWW, HWE)$ in the figure) are never profitable to serve the free trade area through pure horizontal FDI strategy. Instead, low transport cost within the region (τ) encourages these firms to enter and undertake complex FDI strategies. From the data we can see that these loca-

tion combinations and FDI strategies reflect the recent Korean multinational firm activities inside EEA.

2.3.2 Firms serving a developing trade integrated region (AFTA)

In this subsection, our goal is to study the effects of regional economic integration between low-income countries on the location decision of firms in a middle-income country. Here, we consider three countries consisting of two identical Southern countries and Home (S, S, H).

Consistent with the first case in which firms invest in the Northern free trade area, when firms produce goods in Home and export to South, it costs them $t_S > 1$. For firms that locate plants in South, they incur the fixed investment cost f_S, whereas shipping products within the free trade area has the low transport cost $\tau_S \in (1, t_S)$. For a simple notation, we assume that West and East are symmetric member countries inside the Southern free trade area in this subsection. Because firms can produce goods in any of the three countries, we still have 27 possible location combinations that firms can choose to serve global markets.[5] Here, we make our second key assumption.

$$\frac{w_H}{w_S} \quad > \quad t_S \tag{2.2}$$

which implies that relative variable costs of Home to South is greater than the transport cost from Home. This assumption indicates that South has the low factor cost, such that affiliates producing goods in South and exporting back to Home incur lower variable cost than producing domestically. Under assumption (2.2), there now

[5]Consistent with previous subsection, (x, y, z) represent choices set that firms can choose to locate their plants to serve Home, West, and East inside the Southern free trade area.

exist five possible location combinations that firms can choose.

$$
\begin{aligned}
\Pi^S_{HHH} &= B\Theta_i[w_H^{1-\varepsilon} + \beta_S(w_H t_S)^{1-\varepsilon} + \beta_S(w_H t_S)^{1-\varepsilon}] \\
\Pi^S_{WHH} = \Pi^S_{EHH} &= B\Theta_i[(w_S t_S)^{1-\varepsilon} + \beta_S(w_H t_S)^{1-\varepsilon} + \beta_S(w_H t_S)^{1-\varepsilon}] - f_S \\
\Pi^S_{WWH} = \Pi^S_{EHE} &= B\Theta_i[(w_S t_S)^{1-\varepsilon} + \beta_S w_S^{1-\varepsilon} + \beta_S(w_H t_S)^{1-\varepsilon}] - f_S \\
\Pi^S_{WWW} = \Pi^S_{EEE} &= B\Theta_i[(w_S t_S)^{1-\varepsilon} + \beta_S w_S^{1-\varepsilon} + \beta_S(w_S \tau_S)^{1-\varepsilon}] - f_S \\
\Pi^S_{WWE} = \Pi^S_{EWE} &= B\Theta_i[(w_S t_S)^{1-\varepsilon} + \beta_S w_S^{1-\varepsilon} + \beta_S w_S^{1-\varepsilon}] - 2f_S
\end{aligned}
$$

In contrast to the location combinations that firms can choose when they invest in the Northern free trade area, firms now have a vertical motive for FDI by taking advantage of the low factor costs to produce goods in South and ship back to Home. Except for the case in which firms produce domestically, the last four location combinations indicate that Home is now served by the local subsidiary located in South.

In particular, when serving the Southern region, location choice $(WHH)^S$ represents that, while Home is served by exports from South, countries inside the free trade area will be served by exports from Home. $(WWH)^S$ presents that one of Southern countries is served by a local subsidiary while the other country is served by exports from Home. $(WWW)^S$ denotes the choice that the firm locates a plant in a single location inside the region to undertake a complex FDI strategy which involves serving the local market and third country via exports. $(WWE)^S$ indicates that the firm invests in both Southern countries only to engage in local sales.

Figure 2.2 indicates that the most productive firm invests in the Southern free trade area to engage in horizontal FDI in one country and complex FDI in the other, whereas the relatively less productive firm invests in the region by engaging in complex FDI that involves not only serving the local market but also Home and

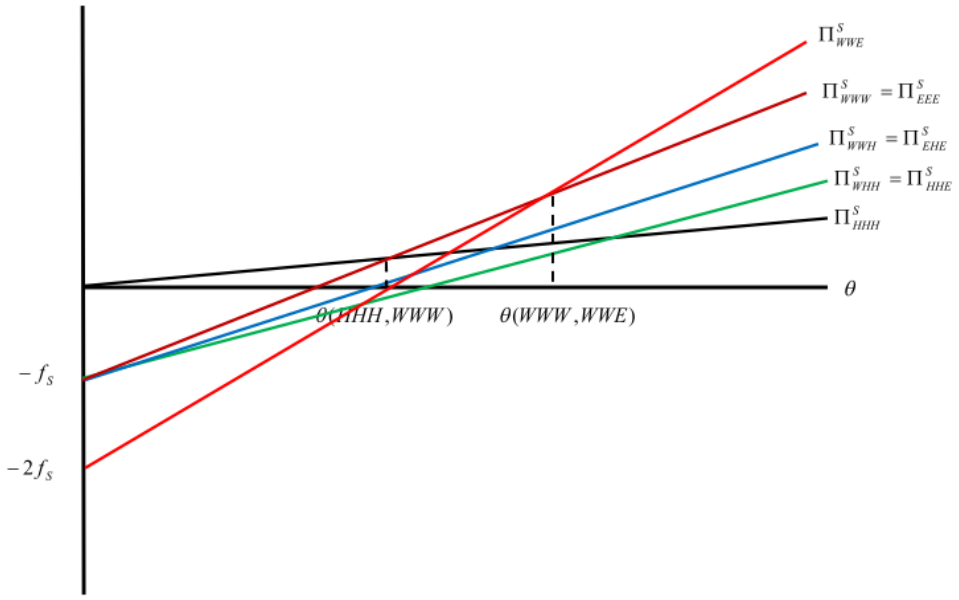


Figure 2.2: Profit functions in case of Home, South, and South

third countries through exports. On the other hand, the least productive firm serves the region through exports from Home. In contrast to Figure 2.1, we can see that firms now locate plants inside the region to engage in export sales to Home due to the low variable costs. For firms that locate plants in multiple locations, therefore, one of the plants will be designed to undertake a complex FDI, whereas the other will be established to engage in a pure horizontal FDI. Alternatively, firms that locate plants in a single location will export not only to Home but also to third countries.

Consistent with the first case, Figure 2.2 shows that firms with an intermediate productivity level (firms with productivity level between $\Theta(HHH, WWW)$ and $\Theta(WWW, WWE)$ from the figure) will not be profitable in locating a plant in

a single location inside the region to serve its local market only or also export to Home (it is apparent that the location choice $(WWW)^S$ dominates $(WWH)^S$ and $(WHH)^S$). Instead, low transport cost within the region encourages these firms to engage in complex FDI that involves not only local sales but also export sales to Home and third countries. These findings also reflect recent Korean multinational firm activities inside AFTA, shown in Table 2.1.

To summarize, we find that, when firms enter the free trade area, regardless of its aggregate size, more productive firms engage in FDI while less productive firms export, which is consistent with the recent FDI literature studying firms' modes of foreign market access (Helpman et al. (2004); Aw and Lee (2008)). In particular, we show that, among FDI firms, more productive firms engage in horizontal FDI by investing in multiple locations inside the region followed by firms engaging in complex FDI by investing in a single location. However, firms' complex FDI strategy differs depending on the size of the region such that firms investing in North are likely to engage in local sales and export sales to third country, whereas firms investing in South tend to focus on export sales to the home country in addition to the third country to conserve production costs.

Our model resembles those of Aw and Lee (2008) by studying FDI strategy of firms in middle-income countries for serving geographically separate markets. Our findings, however, provide an alternative view on firms' FDI strategies such that when entering the trade integrated region, firms are never profitable to use their facilities in the host country only to serve local market. Instead, low transport costs within the region affect firms, specifically relatively less productive firms to undertake complex FDI strategies, which include export sales. In the following sections, we test our findings from the model using data for Korean multinational firms.

2.4 Data

In the previous section, we developed a three-country model to study the effects of the different free trade areas on firms' location choices and FDI strategies. Here, we discussed that the regional economic integration affects firms with a relatively low productivity level to enter the region by engaging in complex FDI, whereby firms locate plants in a single location to engage in not only local sales but also export sales. Moreover, firms' complex FDI strategies differ depending on the income level of countries such that export sales made by affiliates in low-income regions are not only from third countries, but also from the parent country.

To test our predictions from the model, this paper requires plant-level and firm-level data. Here, we use data from the Korean foreign direct investment obtained from the Overseas Direct Investment Statistics from the Export-Import Bank of Korea. This plant-level data include the full list of Korean worldwide investment from 2002 to 2008, for which 2002 is the first year that the Export-Import Bank of Korea officially started to collect data. All foreign affiliates abroad, of which Korean firms hold at least a 10% ownership, are included in the sample, and each foreign affiliate is disaggregated by industry sectors and by its destination countries in a given year.

This plant-level data are very useful in that they provide information on individual foreign affiliates in the host country. In particular, they not only have information on affiliates' balance sheets but also provide total sales disaggregated by (i) sales made from the local market, (ii) sales made from exporting back to the home country, and (iii) sales made from exporting to third countries. In particular, since data enable us to break them down within each of these categories into sales to other foreign affiliates of Korean firms or foreign joint ventures and sales to unaffiliated customers, it is very useful to distinguish plants by whether they engage

in horizontal, vertical, or complex FDI by their sales.

The other source of firm-level data for the analysis is provided by the Financial Supervisory Service of Korea and the Korea Information System database of the Korea Investor's Service Co., Ltd.. This data contain information on firms' balance sheets, profits and loss statements, export status, output (value-added), and the employment divided by production and non-production sectors of all firms that are registered as corporations. These firms are classified by the Korean Standard Industrial Classification (KSIC) set by the Korea National Statistical Office that is closely related to commonly used Standard Industrial Classification (SIC). For the empirical analysis, this paper merges firm-level data from KIS with the plant-level data from the Export-Import Bank of Korea.

2.4.1 Data Analysis

In order to test our predictions on complex FDI strategies of entry firms with an intermediate productivity level, we first divide firms by three-digit KSIC level from each period.[6] From each manufacturing sector, we select firms that establish local subsidiaries worldwide between 2002 and 2008. Since our firm-level data do not provide information on specific destination countries to which firms export and our main goal is to study firms that engage in complex FDI, we test with samples that include firms investing in foreign countries during the sample period. To estimate firm characteristics, which is among the study's main interests, we follow Aw and Lee (2008) on measuring firm labor productivity as the mean levels of revenue plus net inventory change divided by mean levels of total employment.[7]

[6]Note that since our model assumes that labor is the only input to produce goods, we only consider firms in manufacturing industry for the analysis.

[7]Since our data do not provide information on the capital flow or stock, we were not able to proxy total factor productivity as a measure of firm productivity.

For regional characteristics, because we are particularly interested in firm activities inside two different free trade areas, EEA and AFTA, we measure EEA as a binary variable, which is equal to 1 if a firm locates a plant inside EEA, and AFTA, which is equal to 1 if a firm builds a plant inside AFTA countries. Therefore, our main interest is to study how interaction terms between firm productivity and free trade area dummy variables affect firms in their choice between different FDI strategies.

Our econometric analysis includes control variables that represent other firm and host country characteristics. First, we include firm size, which is measured by the total employment of the firm, and R&D intensity, computed as the firm's total R&D expenditure divided by total sales. To estimate country characteristics, we add trade cost, which is measured as a ratio of CIF imports to FOB imports, regarding which data are obtained from IMF Direction of Statistics, and country's income-level, which is measured by GDP per capita, for which data are obtained from the World Development Indicators 2009.

2.5 Empirical Results

The specifications presented in Table 2.2 report the results by estimating the effects of free trade area and its interaction term with firm productivity level on the direction of sales of new Korean affiliates. The sample includes observations from all European regions for the results in first three columns, whereas it includes observations from all Asian regions in last three columns.[8] Each regression includes year-fixed effects and industry-fixed effects to control for the possible

[8]To save space, we do not present the results of running pooled OLS regression with observations from worldwide. In particular, we obtain the results that are approximately same estimate and statistical significance of each coefficient from Table 2.2. Results are available upon request.

time trends and for any unobserved systematic differences across industry sectors. Heteroskedasticity-consistent standard errors that allow for clustering of host countries are computed to explain the possible correlated shocks that might affect all affiliates in the same host country.

Table 2.2: Direction of Sales of New Korean affiliates

	Share of Sales to Local Market	Share of Sales to Korea	Share of Sales to Third Countries	Share of Sales to Local Market	Share of Sales to Korea	Share of Sales to Third Countries
Firm productivity	-0.02	-0.008	0.015	-0.019	-0.006	0.037**
	(0.0155)	(0.005)	(0.01)	(0.018)	(0.005)	(0.016)
EEA	-0.149	-0.04	0.153**			
	(0.092)	(0.047)	(0.069)			
AFTA				−0.111*	−0.07***	0.182***
				(0.057)	(0.026)	(0.057)
Productivity*EEA	0.135**	-0.031	−0.085*			
	(0.059)	(0.025)	(0.046)			
Productivity*AFTA				0.003	-0.003	-0.01
				(0.023)	(0.013)	(0.022)
GDP per capita	0.004***	−0.002***	0.0001	0.003***	-0.001	-0.0001
	(0.001)	(0.0007)	(0.0001)	(0.001)	(0.001)	(0.001)
Trade cost	0.001	-0.0005	0.002	0.001	−0.009***	-0.004
	(0.001)	(0.001)	(0.004)	(0.0007)	(0.003)	(0.004)
R&D intensity	-0.0001	0.0004**	−0.0004**	0.0001	-0.0004	−0.003**
	(0.0004)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.002)
Firm size	−0.023***	−0.013***	0.038***	−0.025***	−0.018***	0.042***
	(0.007)	(0.005)	(0.005)	(0.006)	(0.007)	(0.004)
Constant	0.665***	0.352***	0.003	0.868***	0.394***	−0.14***
	(0.11)	(0.051)	(0.093)	(0.127)	(0.133)	(0.053)
R^2	0.2055	0.1163	0.1819	0.3141	0.203	0.3668
# of observations	159	159	159	1214	1214	1214

Note : Heteroskedasticity-consistent standard error allowing for clustering by host country are in parentheses. * represents significance at 10% level, ** for significance at 5% level, *** for significance at 1% level. European countries include 18 EEA countries and 6 non-EEA countries while Asian countries involve 9 AFTA countries and 25 non-AFTA countries.

The dependent variables in the first and last three columns are the direction of sales of new Korean affiliates – share of sales to the host country, to Korea, and to third countries, respectively. Here, we are particularly interested in finding out whether a single plant inside the free trade area established by the less productive firm exhibits a high share of local and export sales. In this specification, the coefficients on the EEA dummy variable estimate whether new Korean affiliates have distinctive sale patterns inside EEA as opposed to affiliates in other European regions, whereas the AFTA dummy variable estimates the difference in sales patterns for affiliates inside AFTA as opposed to other affiliates outside the region.

The coefficient on the EEA dummy in the first column is negative and significant at the 10% level, implying that new Korean affiliates inside EEA do not tend to have large shares of local sales as opposed to other affiliates in Europe. The insignificant coefficient in the second column indicates that new affiliates inside EEA do not exhibit distinctive export sales to the home country, whereas the positive and significant coefficient in the third column indicates that the new Korean affiliates inside EEA are more likely to engage in export sales to third countries than other affiliates in Europe. Alternatively, coefficient estimates on firm productivity in the first three columns indicate that more productive firms have a large share of export sales to third countries, whereas firm productivity does not tend to influence their affiliates' sales to local market or home country through exports.

The interaction term between firm productivity level and EEA dummy variable in the first column is positive and significant at the 1% level, which indicates that the more productive firms inside EEA tend to have a large share of local sales. The negative and significant coefficient of the interaction term in the third column implies that firms with low productivity level inside EEA region are likely to have a large share of export sales to third countries within the same region. On the other

hand, the results present that there is no significant interaction effects between the firm productivity level and the EEA region on firms' motives to engage in export sales to the parent country.

The negative and significant coefficients on AFTA dummy variables in the fourth and fifth columns imply that firms do not have a large share of local sales, as neither do export sales to the parent country by locating plants inside AFTA as opposed to firms investing in other Asian region. Alternatively, the positive and significant coefficient on AFTA in the last column indicates that firms are more likely to have a large share of export sales to third countries inside AFTA as opposed to other firms. The coefficients on interaction terms between firm productivity level and AFTA in last three columns have expected signs but show that they have statistically insignificant effects on firms' direction of sales.

For other control variables, coefficients on trade cost show that it has a significant influence on firms' export sales back to Korea from the Asian region such that firms have a large share of export sales from Asian countries that incur low trade cost. Meanwhile, trade costs do not have significant effect on firms' sales in local markets, an insight that does not support the proximity-concentration hypothesis studied in traditional trade literature (Brainard (1997); Helpman et al. (2004)), which argues that firms tend to expand production horizontally across borders as trade cost increases. Alternatively, coefficients on the countries' GDP per capita provide evidence that firms' motives to serve the local market through FDI is positively associated with the income-level of the destination country. It is also interesting to see that, in both regions, firms' size has a negative influence on its sales in the local market and Korea via exports, whereas size has a positive impact on firms' export sales to third countries.

For the robustness check, we have retested previous results by adding other

control variables. Because our model predicts that less productive firms enter free trade areas by locating plants in a single location to engage in local and export sales and that more productive firms invest in multiple locations to serve their local markets, we include other dummy variables representing the number of foreign affiliates that a firm locates in each free trade area. In particular, the Multi-EEA dummy is equal to 1 if a firm locates more than two affiliates inside EEA countries, whereas Multi-AFTA is equal to 1 if a firm locates more than two affiliates inside AFTA countries in a given year. Consistent with the previous specification, dependent variables represent the pattern of sales for new Korean affiliates.

In this specification, the coefficients on the Multi-EEA dummy variable estimate whether new Korean affiliates in multiple locations inside EEA have distinctive sales patterns, whereas coefficients on the Multi-AFTA dummy variable estimate the same effect inside AFTA as opposed to other firms investing in non free-trade areas. Therefore, we are interested in finding out whether firms investing inside free trade areas exhibit distinctive local and export sales from a single location when we also consider firms that establish plants in multiple locations inside the same region.

Table 2.4 in the Appendix presents the results with the addition of new variables. Note that we also add new interaction terms *productivity*Multi-EEA* and *productivity*Multi-AFTA* in each region to study how each firm's decision to serve different markets depends on its productivity level and establishing plants in multiple locations inside free trade areas. The estimate and significance of coefficients are approximately the same as those from the previous results. In particular, the coefficients of Multi-EEA and Multi-AFTA are all insignificant in Table 2.4 to estimate firms' decision to engage in local or export sales, implying that establishing plants in multiple locations inside either free trade area do not exhibit distinctive local or export sales as opposed to affiliates outside the region. However, the pos-

itive and significant coefficient of interaction term between firm productivity level and Multi-EEA in the first column provides evidence that, among firms that locate plants in multiple locations inside EEA, more productive firms are more likely to have a large share of local sales in its location, which is consistent with our model.

The results from Table 2.2 and 2.4 provide evidence that support the hypothesis that free trade areas are attractive for firms to locate plants and undertake export sales to third countries than serve its local market, or export back to the home country (AFTA). Among firms that enter EEA, we find that less productive firms are more likely to engage in export sales to third countries by investing in a single location, whereas more productive firms have a large share of local sales by investing in multiple locations. However, our results do not show that firm productivity and its interaction with locating plants in AFTA have significant association with firms' decision to serve different markets in Asia. In particular, we cannot find evidence regarding how the free trade area and productivity level of entering firms affect their decisions to engage in multiple types of FDI simultaneously. Because firms engaging in complex FDI may have different shares of sales made from serving different markets, we should consider using other methodology to examine firms' choice of different FDI strategies and its determinants.

Here, we use a probit model to examine firms' choice of complex FDI strategies:

$$\begin{aligned} E[y \mid x, z] &= Prob(y = 1 \mid x, z) \\ &= \Phi(\beta x + \delta z) \\ &= \Phi(A) \end{aligned}$$

where $\Phi(A)$ is the standard normal cumulative distribution function and x and z denote the set of explanatory variables representing firm and country characteristics,

respectively. Our dependent variable (y) is a binary variable which is equal to 1 if a firm engages in specific FDI strategy through the establishing plant in a single location. In particular, *Complex* is a binary variable equal to 1 if firms' affiliate makes sales from the local market and exports to third countries from a single location. Therefore, it indicates firms' complex FDI strategy that involves serving local market and third countries through exports. *Complexx* is a binary variable equal to 1 if firms' affiliate makes sales from local market and export to home and third countries, implying firms' complex FDI strategy that involves not only engaging in local sales but also exporting sales to home and third countries. Finally, *Purehori* is a binary variable equal to 1 if firms' affiliates make sales only from the local market, and represent the firms' pure horizontal FDI strategy that does not include any of the export sales.

In this specification, we are particularly interested in finding out whether a single plant inside the free trade area established by less productive firms exhibit complex FDI strategy. Consistent with the previous analysis, therefore, the main coefficient of interest is coefficients on the free trade area dummy variables – EEA and AFTA – and their interaction term with firm productivity level. Here, we also add control variables that represent firm and country characteristics and include year and industry-fixed effects. Heteroskedasticity-consistent standard errors that allow for clustering host countries are computed to explain the possible correlated shocks that might affect all affiliates in the same host country.

Table 2.3 reports the results from estimating the effects of free trade areas on firms' different FDI strategies by using a probit model. The first three columns present the results from testing firms that enter the European region, whereas the last three columns show the results of firms investing in the Asian region. Within each region, we present the coefficient estimates of the probit model. We also report

Table 2.3: FDI Strategies of new Korean affiliates

FDI strategies	Complex	Complexx	Purehori	Complex	Complexx	Purehori
EEA	0.587	0.645	-0.088			
	(0.677)	(0.52)	(0.445)			
AFTA				0.361	0.272**	−0.334*
				(0.315)	(0.131)	(0.181)
Firm productivity	−0.199*	-0.011	0.053***	-0.052	-0.025	0.039**
	(0.107)	(0.028)	(0.018)	(0.103)	(0.019)	(0.016)
productivity*EEA	0.257*	0.267	0.129			
	(0.144)	(0.176)	(0.26)			
productivity*AFTA				-0.007	-0.024	0.083*
				(0.122)	(0.069)	(0.05)
R&D intensity	0.033	-0.302	-0.452	0.309	0.29*	−0.481*
	(0.619)	(0.217)	(0.3)	(0.51)	(0.162)	(0.28)
Firm size	0.127***	0.108***	0.07	0.001	0.001***	0.071
	(0.046)	(0.036)	(0.046)	(0.001)	(0.0003)	(0.048)
Trade cost	0.01	-0.045	0.078*	-0.046	-0.132	0.6*
	(0.039)	(0.03)	(0.046)	(0.063)	(0.172)	(0.361)
GDP per capita	0.002	-0.012	0.019***	0.002	-0.0004	0.019***
	(0.008)	(0.042)	(0.006)	(0.006)	(0.011)	(0.006)
Observations	159	159	159	404	688	686
Number of countries		14			21	
R-squared	0.1561	0.1067	0.053	0.089	0.0594	0.0558
Log-Likelihood	-90.49	-148.65	-450.13	-112.73	-170.97	-448.96
Wald chi2 (Prob > chi2)	659.95	91940.67	168.34	165.66	2656.3	182.04
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$\frac{\text{dy}}{\text{d(productivity)}} \mid FTA{=}1$	−0.044*	-0.003	0.021***	-0.011	−0.005*	0.015**
	(0.024)	(0.006)	(0.007)	(0.021)	(0.003)	(0.006)

Note : Heteroskedasticity-consistent standard error allowing for clustering by host country are in parentheses. * represents significance at 10% level, ** for significance at 5% level, *** for significance at 1% level.

the marginal effects of each variable at sample means on the predicted probability of firms to choose different FDI strategies in Table 2.5 in the Appendix. Furthermore, because our main goal is to study interaction effects between firm productivity level and the trade integrated region on the probability of firms choosing different FDI strategies, we estimate these probability effects by computing marginal effects of firm productivity level on the probability of a firm engaging in a specific FDI strategy, conditional on firms that invest in the free trade area, evaluated at the mean values of other explanatory variables.

We first examine the effects of free trade area on firms' decision to engage

in complex FDI strategies in the European region. In the first column, the probit coefficient estimates suggest that less productive firms tend to engage in complex FDI, whereas EEA do not have significant influence on firms' strategy in the European region. However, the probit coefficient of interaction term, *productivity*EEA*, is negative and significant at the 10% level, suggesting that less productive firms are more likely to undertake complex FDI inside EEA. The results are the same when we compute the marginal effects at sample means. Firms with low productivity levels tend to engage in complex FDI, but it cannot be supported that EEA attract firms to undertake complex FDI in their region.

Computing the marginal effects of firm productivity level on the probability of choosing FDI strategy, conditional on firms' investment in EEA, we find that, inside EEA, an infinitesimal increase in firm productivity reduces the probability that these firms undertake complex FDI by 4.4%, which is significant at the 10% level. Alternatively, outside EEA, an infinitesimal increase in firm productivity increases firms' probability to engage in complex FDI by 2%, but it is statistically insignificant. For firms that invest in Asia, probit estimates of all variables are insignificant in the fourth column, implying that firm productivity and AFTA are not determinants of firms' decisions to engage in complex FDI strategies.

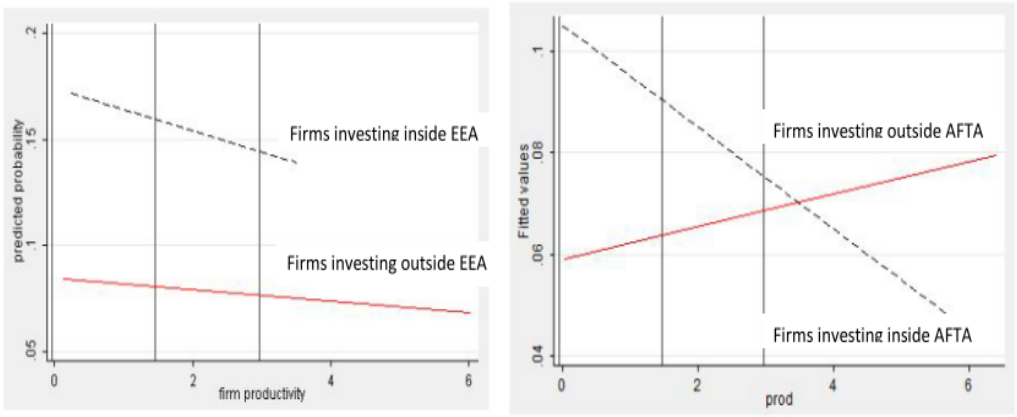
Next, we examine the effects of free trade area on firms' decisions to engage in complex FDI strategies that involve export sales to home country in Asian region, which is our main of interest in testing the prediction of firm activities in developing countries. In the fifth column, the probit coefficient estimates indicate that firms investing in AFTA are more likely to engage in complex FDI as opposed to firms entering non-AFTA. However, the results indicate that firm productivity does not affect firms' complex FDI strategies independently. On the other hand, the insignificant probit coefficient of interaction term between firm productivity and

AFTA does not support our prediction of the model that less productive firms tend to choose complex FDI strategy inside AFTA.

The results do not change much when we compute marginal effects at sample means such that firms that invest inside AFTA are likely to engage in complex FDI. Alternatively, computing the marginal effects of firm productivity levels on the estimated probability of firms to choose complex FDI, conditional on whether firms invest in AFTA, shows that, inside AFTA, an infinitesimal increase in firm productivity reduces the probability that these firms undertake complex FDI by 0.5%. Outside the AFTA, the entry of less productive firms increases the probability of firms engaging in complex FDI by 0.2%, but it is statistically insignificant.

For estimating interaction effects in non-linear models, since the marginal effect of interaction term depends on the levels of the explanatory variables consisting of the interaction term, the coefficient of the interaction term may not correctly reflect the statistical significance and the direction of the marginal effect, with respect to the interaction terms. Ai and Norton (2003) and Greene (2010) show that the total interaction effect can have a different sign and statistical significance from those determined by a t-test on the estimated coefficient of the interaction term alone. To better understand how the marginal effect of firm productivity level to its probability of choosing FDI strategy interacts with the free trade area, a graphical demonstration would supplement probit regression results to provide further insight with respect to the statistical and economic significance of the interaction.

Following Greene (2010), Figure 2.3 plots the relation between firm productivity level, free trade area, and the probability of firms' choosing complex FDI, and their interaction from the model in columns 1 and 5 from Table 2.5. To assess the economic significance of firm productivity level on firm's complex FDI strategy, the vertical lines in Figure 2.3 show how the estimated probability of firms' engagement



(a) Complex strategy in Europe

(b) Complex strategy in Asia

Figure 2.3: Complex strategies of firms investing inside trade integrated regions

in complex FDI outcome varies as firm productivity level moves from one standard deviation below to one standard deviation above the mean.

Figure 2.3 illustrates three important features of the results for the model in columns 1 and 5 from Table 2.5. First, in both regions, the regression line for firms investing inside free trade area lies above the corresponding line for firms investing outside the region, which is consistent with the results that investing in a single location inside free trade area makes firms more likely to engage in complex FDI (However, it can be seen that firms with the highest productivity level tend to prefer outside the AFTA to engage in complex FDI). Second, in the European region, regression lines for firms that invest inside and outside the EEA have a negative slope where the line for firms investing inside EEA is steeper, which is consistent with the positive sign on the interaction term between firm productivity level and EEA in the first column of Table 2.5. Alternatively, in the Asian region,

the regression line for firms investing inside and outside the AFTA have a different slopes, which is consistent with the negative sign on the interaction term in the fifth column. This indicates that higher productivity level assigns less importance to engaging in complex FDI for firms inside AFTA.

Third, decreasing firm productivity level from one standard deviation above to one standard deviation below the mean in Figure 2.3a increases the estimated probability of engaging in complex FDI for firms inside EEA by approximately 2.5%, whereas it increases the estimated probability of complex FDI by approximately 0.5% for firms that invest outside the EEA. These increases of estimated probabilities are economically significant, as is the difference between firms investing inside and outside EEA, both of which support the overall economic significance of the interaction term, $productivity * EEA$. In the Asian region, decreasing firm productivity level from one standard deviation above to one standard deviation below the mean increases the estimated probability of engaging in complex FDI for firms inside AFTA by approximately 3%, whereas it decreases the estimated probability for firms outside AFTA by approximately 1%. Consistent with the results from the European region, these increases and decreases are economically significant, as is the difference between firms investing inside and outside AFTA, which also supports the overall economic significance of the interaction term, $productivity * AFTA$.

For other types of FDI strategies in the European region, the probit coefficient estimates suggest that EEA is not a determinant of firms' choice on either pure horizontal FDI or complex FDI that involves export sales to home. The third column of Table 2.3 implies that more productive firms are more likely to engage in pure horizontal FDI in Europe, whereas firm productivity has no significant effect in interaction with EEA.[9] However, computing the marginal effects of firm pro-

[9]Our graphical analysis on the result of interaction term from column 3 also shows that there is

ductivity level on the estimated probability of engaging in different types of FDI, conditional on firms that locate plants inside EEA, show that an increase of firm productivity level raises the estimated probability of engaging in pure horizontal FDI by 2.1%, which is significant at the 1% level.

In the Asian region, the probit coefficient estimates in column 6 indicate that AFTA and firm productivity independently affect firms' decision to choose pure horizontal FDI such that productive firms or firms entering non-AFTA countries are more likely to serve the local market via horizontal FDI. Alternatively, the results show that firms' decision to choose complex FDI that does not include export sales to the home country is not affected by its productivity or AFTA. The interaction term between the firm productivity level and AFTA is positive and significant in the last column, implying that firms investing inside AFTA tend to engage in pure horizontal FDI.

In our graphical analysis, we find that interaction terms between firm productivity level and AFTA do not have significant effects on the probability of engaging in complex or pure horizontal FDI for both firms inside and outside the AFTA. Furthermore, computing marginal effects of firm productivity level on the estimated probability of engaging in different types of FDI, conditional on firms that locate plants inside AFTA, shows that an increase of firm productivity level decreases the probability of engaging in complex FDI that does not include export sales to the home country by 1.1%, yet statistically insignificant, whereas it significantly increases the probability of engaging in horizontal FDI by 1.5%.

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no interaction effect between firm productivity and EEA. The figure is available upon the request.

2.6 Summary and Conclusion

Regional economic integration affects outsider firms' production location decisions and FDI strategies on serving the global market. In our paper, we have presented a model where firms based in a middle-income country decide on the optimal production locations for serving geographically separate trade integrated regions. The model shows that the equilibrium decision of a firm depends on its own productivity level and other regional characteristics.

In particular, we found that regional economic integration affects relatively less productive firms to enter and undertake complex FDI. Depending on the aggregate size of the region, firms' complex FDI strategy is different such that undertaking complex FDI inside a developed region involves local sales and export sales to third countries, whereas it includes local sales and export sales to not only third country but also the home country inside developing regions. Exploiting the firm- and plant-level data of Korean firms, we specified a probit model to link firms' FDI strategies with their productivity levels and trade integrated region. Our empirical results are consistent with the theoretical predictions.

However, one may question why some firms enter the region with high-income countries, whereas others invest in the region with low-income countries. Since our analysis was limited such that firms have information on their destinations prior to the investment, for future research, it will be interesting to discuss the factor that might affect firms' production location choices when they can choose to invest in either a developed or developing region. For instance, assuming that production requires skilled and unskilled workers and study how the skill-intensity of the production affects firms' decision will be a good start. These questions are left for future research.

2.7 Chapter Appendix

Table 2.4: Direction of Sales of New Korean affiliates with new binary variables

	Share of Sales to Local Market	Share of Sales to Korea	Share of Sales to Third Countries	Share of Sales to Local Market	Share of Sales to Korea	Share of Sales to Third Countries
Firm productivity	-0.009	-0.006	0.114	-0.002	-0.008^{*}	0.026^{*}
	(0.011)	(0.034)	(0.146)	(0.014)	(0.004)	(0.015)
EEA	-0.079	-0.089	0.167^{**}			
	(0.094)	(0.081)	(0.071)			
AFTA				-0.112^{*}	-0.054^{*}	0.168^{***}
				(0.066)	(0.029)	(0.062)
Productivity*EEA	0.1^{*}	-0.036	-0.083^{**}			
	(0.06)	(0.032)	(0.37)			
Productivity*AFTA				0.016	-0.002	-0.0003
				(0.021)	(0.01)	(0.022)
GDP per capita	0.049^{**}	-0.001^{**}	0.0002	0.004^{**}	-0.0008	-0.0001
	(0.022)	(0.0005)	(0.0003)	(0.0017)	(0.001)	(0.001)
Trade cost	0.001	-0.0008	0.002	0.001	-0.005^{**}	-0.002
	(0.001)	(0.0008)	(0.004)	(0.0007)	(0.002)	(0.0025)
R&D intensity	-0.012	0.045^{**}	-0.0003^{**}	0.0002	-0.0004	-0.004^{***}
	(0.036)	(0.022)	(0.00014)	(0.0003)	(0.0003)	(0.0008)
Firm size	-0.027^{***}	-0.074^{*}	0.042^{***}	-0.029^{***}	-0.014^{**}	0.044^{***}
	(0.007)	(0.044)	(0.009)	(0.008)	(0.005)	(0.01)
Multi-EEA	0.048	-0.043	-0.013			
	(0.037)	(0.086)	(0.026)			
Multi-AFTA				0.016	-0.093	0.01
				(0.178)	(0.072)	(0.049)
Productivity*Multi-EEA	0.294^{***}	-0.091	-0.024			
	(0.066)	(0.069)	(0.039)			
Productivity*Multi-AFTA				0.133	-0.041	0.177
				(0.097)	(0.053)	(0.137)
Constant	0.654^{***}	0.31^{***}	0.07	0.855^{***}	0.375^{***}	-0.182^{**}
	(0.101)	(0.147)	(0.105)	(0.146)	(0.055)	(0.079)
R^2	0.1864	0.1626	0.2316	0.3086	0.2155	0.3706
# of observations	159	159	159	1214	1214	1214

Note : Heteroskedasticity-consistent standard error allowing for clustering by host country are in parentheses. * represents significance at 10% level, ** for significance at 5% level, *** for significance at 1% level. European countries include 18 EEA countries and 6 non-EEA countries while Asian countries involve 9 AFTA countries and 25 non-AFTA countries.

Table 2.5: FDI strategies of entry firms, average marginal effects at sample means

	Complex	Complexx	Purehori	Complex	Complexx	Purehori
EEA	0.093	0.103	-0.035			
	(0.141)	(0.097)	(0.177)			
AFTA				0.061	0.04*	−0.131*
				(0.064)	(0.022)	(0.07)
Firm productivity	−0.022*	-0.001	0.021***	-0.007	−0.003*	0.016***
	(0.012)	(0.003)	(0.007)	(0.014)	(0.002)	(0.006)
productivity*EEA	0.029*	0.039	0.051			
	(0.016)	(0.028)	(0.104)			
productivity*AFTA				-0.001	−0.009***	0.033*
				(0.017)	(0.003)	(0.02)
R&D intensity	0.004	−0.032*	−0.18*	0.043	0.036*	−0.192*
	(0.071)	(0.023)	(0.119)	(0.073)	(0.021)	(0.111)
Firm size	0.014***	0.012***	0.028*	0.0001	0.01***	0.028*
	(0.005)	(0.003)	(0.018)	(0.0001)	(0.005)	(0.019)
Trade cost	0.001	−0.005*	0.031*	-0.006	0.017	0.227*
	(0.004)	(0.003)	(0.018)	(0.009)	(0.023)	(0.126)
GDP per capita	0.0001	0.001	0.008***	0.0002	-0.0001	0.008***
	(0.0001)	(0.005)	(0.002)	(0.001)	(0.001)	(0.03)
predicted probability	0.057	0.052	0.504	0.074	0.065	0.505

Chapter 3

Technology Spillover Through Worker's Mobility and Exporters' Choice

3.1 Introduction

Over the last few decades, multinational firms have come to play an increasingly important role in international trade, accounting for two-thirds of world trade by the year 2000. Whereas in the past, firms used to export goods to destination countries, their pattern of international economic activity has now changed. By taking advantage of proximity to consumers, firms today invest directly in their own local subsidiaries to produce goods and increase local market share.

Meanwhile, many host countries attract more multinational firms to engage in foreign direct investment (FDI) by providing generous investment or tax incentives. While their expected benefits include financial development and creation of new jobs, one of the reasons for attracting FDI is the possibility of acquiring new technology, which may spill over from multinational firms to the host country and allow domestic firms to improve their performance in the market.

It has long been thought that multinational firms have access to some type of firm-specific asset, and then change it to production technology or a marketing technique, which can subsequently be transferred to their foreign affiliates (Mansfield and Romeo (1980)). By attracting various multinational firms to build plants in countries, host governments expect that some of this firm-specific asset will be transferred to domestic firms, thus allowing them to improve worker productivity

or skills. This potential mechanism may be important for developing countries to catch up with industrialized nations, and is one piece of evidence indicating that FDI might benefit a host economy.

There has been a substantial body of work investigating different forms of technology spillovers from multinational firms in their host countries. First, there are both backward and forward linkages between foreign affiliates and domestic firms (Rodriguez-Clare (1996); Smarzynska Javorcik (2004)). These studies show that when multinational firms source intermediate inputs in a low-wage country and if the demand for inputs is high enough, then multinational firms create higher net backward linkages that push undeveloped domestic firms (or suppliers) out of the bad equilibrium and thus gain relatively more. In other words, positive "vertical" spillovers occur from multinational firms to their domestic suppliers. This outcome might also be related to what is called *competition effect*, whereby domestic firms face competition with other suppliers from local to foreign, and have to be more efficient – improving their own performance to survive in the intermediate goods market. Second, there are demonstration effects, in which domestic firms learn by imitating from technological innovations introduced by multinational firms, that result in an increase of productivity (Mansfield and Romeo (1980)). Third, spillovers, which have been studied recently, arise through labor movements where foreign affiliates train local workers who will later join domestic firms, bringing along some or all of the multinationals' firm-specific knowledge, such as technological and managerial (Fosfuri et al. (2001); Markusen and Trofimenko (2009); Poole (2008)).

In this paper, I am particularly interested in the last form of technology spillovers, specifically the theoretical study by Fosfuri et al. (2001), which presents a two-stage duopoly model between multinational and domestic firms to study the conditions under which technology spillovers occur in the host country. They built

a model in which multinational and domestic firms compete for the services of local workers who have been previously trained by multinational firms. In their work, technology spillovers arise when monopoly profit made by multinational firms if they use the technology by themselves is less than the aggregate profit made by multinational and domestic firms if they both use the technology.[1]

Other empirical studies have focused on examining the effect of workers' movement on the performance of domestic firms. Using detailed firm-level data of Ghanaian manufacturing firms, Gorg and Strobl (2005) find that domestic firms whose owners once worked in multinational firms in the same industry are more productive than similar domestic firms. Exploiting a sample of Chinese manufacturing firms, Hale and Long (2006) also established evidence of productivity spillovers from multinational firms by showing a positive and significant correlation between the percentage of managers who once worked in multinational firms and a firm's total factor productivity.

In summary, considering technology spillovers through workers' mobility between multinational and domestic firms, the aforementioned studies present the findings that once trained workers are hired by domestic firms, they make a contribution to the company by raising its productivity level and as a result, FDI might benefit the development of the host economy.

This paper starts, however, by asking the question: What if trained workers are not hired by domestic firms but instead are hired to other foreign affiliates, so that technology spillovers occur between multinational firms in the host country?[2]

[1] In their model, a multinational firm has a firm-specific technology which can be used it as a monopolist in the foreign market. Only after local firm appropriates technology by hiring trained worker, it can enter the market and create duopoly structure.

[2] In fact, other studies investigate whether all domestic firms acquire technology spillovers from multinational firms, by arguing that infrastructure must be built up by firms to implement foreign

Because the empirical results of the aforementioned literature validate the idea that domestic firms benefit from technology spillovers by an increase in productivity level from hiring trained workers, it is reasonable to think that some technology- or productivity-laggard firms may try to benefit from spillovers by entering the host market through FDI.

Examining the factors to explain different patterns of firm entry into foreign markets, traditional trade studies have focused on the trade costs. This is known as the proximity-concentration trade-off which explains why firms invest abroad when the profits from avoiding trade costs outweigh the costs of supporting additional capacity in foreign markets (Brainard (1997)). Recent studies have sought to incorporate heterogeneous firms into the proximity-concentration trade-off. Specifically, Helpman et al. (2004) build a simple multi-country and multi-sector model that stresses the important role of within-sector firm productivity differences in explaining the structure of international trade and investment. Exploiting U.S. exports and affiliate sales data, they find that the more productive firms engage in foreign activities – and that of those firms servicing foreign markets, only the most productive ones engage in FDI while the less productive ones service through exports.

Apart from aforementioned trade literature on firm's choice of entry through FDI or exports, this paper explores the incentive of exporters to choose between exports and FDI when servicing foreign markets. Excluding domestic firms from the model, my main goal in this research is to study the conditions under which such exporters switch to FDI when servicing foreign markets. To answer the question, this

technologies. More specifically, these studies set out to test the hypothesis that the incidence of externalities is dependent on a domestic firm's absorptive capacity and find out the relationship between technology spillovers and absorptive capacity (e.g., Girma and Wakelin (2001)). These studies show that technology spillovers are present when technology gaps are moderate, and that firms in developing countries lack the necessary absorptive capacity to integrate new information into the production process.

paper focuses specifically on whether the existence of technology spillovers in a host country can be a determinant factor for exporters to switch their strategies to FDI. To the best of my knowledge, this work is the first approach to consider technology spillovers through labor mobility between multinational firms through their local subsidiaries in the host country, and substantiates the position that technology spillover through workers' mobility in a host country does not always benefit the host economy.

To investigate whether the existence of technology spillovers affects the decisions of exporters to service foreign markets via FDI, this paper builds a two-period duopoly model along the lines of Fosfuri et al. (2001). In the model, FDI firms and exporting firms compete for the service of local workers who have been trained by FDI firms in the host country. Assuming that hiring previously trained workers would result in an increase of profit by the recipient firm, exporting firms will switch to FDI only if they hire trained workers. Alternatively, to protect intangible asset, FDI firms will manage to keep trained workers by offering higher wages or may choose to export rather than invest in host countries in the first place.

By introducing a simple parametric model, this paper finds that technology spillover arise dependent on firm- and country-specific characteristics. First, this paper shows that spillovers are likely to occur when the products are rather imperfect substitutes. In other words, exporting firm has a higher chance of hiring previously trained workers when product market competition is relatively weak. Second, I find that spillovers are likely to occur as firms have similarity in the technological capabilities. Third, spillovers may occur in host countries where costs of training local workers are low, such as in countries with higher educational level of local workers. However, this paper finds that transport costs have ambiguous effect on the occurrence of technology spillovers and thus, to exporters' decision.

This paper proceeds as follows: Section 3.2 sets up a simple duopoly model and derives comparative statics on how economic variables affect the occurrence of technology spillover and discuss the obtained results. Section 3.3 concludes the paper.

3.2 Model

For simplicity, this paper adopts a parametric model introduced by Singh and Vives (1984). The utility function of a foreign representative consumer across differentiated varieties has the following form:

$$u(x_f, x_e) = x_f + ax_e - \frac{1}{2}(x_f^2 + x_e^2 + 2gx_f x_e)$$

where x_i denotes the consumption of variety produced by firm i ($i = \{f, e\}$) and the parameter a indicates an asymmetry between the two varieties. The parameter g is a measure of substitutability between goods, where $1/g^2$ is a measure of the degree of product differentiation.[3] Maximizing the utility function subject to standard budget constraint generates the following inverse demand:

$$\begin{aligned} p_f &= 1 - x_f - gx_e \\ p_e &= a - x_e - gx_f \end{aligned}$$

Each differentiated variety is produced by separate firms at the constant marginal cost (c). In the home country, there are two firms that serve foreign markets through FDI or exports. If a firm chooses to export from the home country, it has to bear the unit export cost denoted by τ ($\tau \in (0, 1)$). On the other hand, if

[3]Two varieties are symmetric if $a = 1$. If $a > 1$, firm e has a cost advantage with respect to firm f, whereas it has a cost disadvantage if $a < 1$. On the other hand, the varieties can be defined as complements, independent, or substitutes if $g < 0$, $g = 0$, or $g > 0$ respectively. For example, varieties are perfect substitutes when $g = 1$. In this paper, for simplicity, I assume that $g > 0$.

a firm chooses to serve the market by establishing a local subsidiary, it can conserve on the export cost but will have to incur a one-time fixed cost of employing FDI (F), which includes all costs associated with forming a business activity in the foreign country.

Prior to the production, I assume that a firm f is endowed with new technology which can be used to serve foreign markets through FDI.[4] The only possible channel to transfer technology to its local subsidiaries is by training a local worker in the host country (on-the-job-training). At period $t = 0$, a firm f can decide to serve the foreign market through FDI with the new technology or exports. If a firm chooses to engage in FDI, it builds a foreign affiliate in the host country by bearing fixed costs F. Firm then hires the local worker and train her by sending a staff of supervisors from the headquarters, which incurs the cost of training the worker T. This worker is hired from a pool of identical untrained worker and is paid the reservation wage w which is normalized to zero. When hiring, I assume that a firm makes one-period contract. Since new technology is relevant only for the FDI, this knowledge will not be transferred in the host country if a firm decides to export from the home country. On the other hand, a firm e does not possess new technology and it will serve the foreign market through exports.

After training, the local worker acquires all the knowledge and information of firm's specific assets. At the first period, production takes place and the profit of

[4]In the model, new technology can be thought of as payoff relevant information, such as new managerial technique. Here, I assume that this technology is exogenously given and cannot be transferred between firms in the home country.

firm f if it undertakes FDI will be:[5]

$$\Pi^{I}_{f,1} = \left[\frac{2(1-c)-g(a-\tau c)}{4-g^2}\right]^2$$

On the other hand, firm e will make use of production facilities and export from the home country. The profit will be:[6]

$$\Pi^{EX}_{e,1} = \left[\frac{2(a-\tau c)-g(1-c)}{4-g^2}\right]^2$$

In the second period, informed worker's contract is expired. Perceiving the status of informed worker, firm e realizes that it could appropriate the technology by switching to FDI and hires her. From the findings of previous empirical studies on spillovers by workers' movement, I assume that if trained worker is hired by a firm, then the recipient firm increases its profit by θ.[7] Therefore, a firm e will switch to FDI only if it can hire a trained worker from firm f, whereas firm f would like to retain its trained worker within the company to avoid the dissipation of its knowledge-based asset.

If firm e decides to enter the foreign market by switching to FDI in the second period, it will compete for the previously trained worker against firm f. Drawing from Fosfuri et al. (2001), I assume that each firm simultaneously and independently makes a take-it-or-leave-it offer to trained worker. The firm with

[5] As mentioned earlier, firm f may choose to export in the first period. In this case, the profit will be: $\Pi^{EX}_{f,1} = \left[\frac{2(1-\tau c)-g(a-\tau c)}{4-g^2}\right]^2$. For simplicity, however, I assume that the profit from engaging in FDI always dominates the profit from exports within the period, such that $\Pi^{I}_{f,t} > \Pi^{EX}_{f,t}$ for $t = \{1, 2\}$.

[6] Note that I denote by $\Pi^{k}_{i,t}$ the profit earned by firm $i = \{f, e\}$ in period $t = \{1, 2\}$ where $k = \{I, EX\}$ (I stands for FDI and EX for exports).

[7] Gorg and Strobl (2005) and Hale and Long (2006) provide an evidence of increased profit through an increase in firm's productivity after the informed manager is hired by domestic firms. Since this technology is limited to FDI activities, firm will not hire informed local manager and take her back to the headquarters for exports.

the highest willingness to pay for trained worker hires her by paying exactly the maximum willingness to pay of the competitor. The willingness to pay for trained worker by each firm depends on the outside options. Here, I assume that if firm f loses a trained worker, it has to call back the staff from its headquarters to instruct other local workers, which incurs additional training costs T. On the other hand, if firm e does not hire trained worker in the second period, it does not have any other possibility for acquiring technology. Consequently, it does not have an incentive, an increase in profit, to switch to FDI. To find the equilibrium solutions, I first identify the outcome of the hiring process in the second period.

Firm f's maximum willingness to pay for trained worker is:

$$V_f^{max} = \Pi_{f,2}^{I(r)} - \Pi_{f,2}^{I(l)}$$

which implies the difference between the profit it would earn if it kept trained worker ($I(r)$) and the profit it would earn if it lost trained worker to the competitor ($I(l)$).[8] On the other hand, the maximum offer of firm e is given by:

$$V_e^{max} = \Pi_{e,2}^{I} - \Pi_{e,2}^{EX}$$

which is the difference between the profit it would earn from doing FDI if it hires the trained worker and the profit it would earn from exports if it does not hire her.

Hence, firm e will switch from exports to FDI only if $V_e^{max} > V_f^{max}$, or when technology spillovers occur. In this case, firm e will set up a local subsidiary in the host country by bearing the fixed costs of doing FDI, and start the business by employing a trained worker. Conversely, firm f will have to hire new untrained

[8]Note that since firm f would never prefer to export even if it loses the trained worker to firm e (due to the assumption that the profit from FDI dominates the profit from exports in the second period), its maximum willingness to pay will be the difference of profit from FDI when it retains the worker and when it loses her.

employees, a process that will incur additional training costs. For simple notation, I assume that foreign market size is constant during periods and discount factor is 1. Under this circumstances, the profit realized by firm f and e will be:

$$\begin{aligned}\Pi_{f,2}^{I(l)} &= \left[\frac{2(1-c)-g(a-c)}{4-g^2}\right]^2 - T \\ \Pi_{e,2}^{I} &= \left[\frac{2(a-c)-(1-c)g}{4-g^2}\theta\right]^2 - F\end{aligned}$$

However, if $V_f^{max} > V_e^{max}$, then there will be no technology spillovers and firm f will retain informed worker, whereas firm e remains in exports. In this case, the profit of firm f and e will be:

$$\begin{aligned}\Pi_{f,2}^{I(r)} &= \left[\frac{2(1-c)-g(a-\tau c)}{4-g^2}\right]^2 \\ \Pi_{e,2}^{I} &= \left[\frac{2(a-\tau c)-(1-c)g}{4-g^2}\right]^2\end{aligned}$$

Solving the model by backward induction, there are two possible equilibrium situations in this game. First, technology spillovers will arise under conditions:

$$\frac{4c(\tau-1)(2a-c(1+\tau)-(1-c)g}{(4-g^2)^2} > T+F \tag{3.1}$$

$$\frac{4c(\tau-1)(2-c(1+\tau)-g(a-\tau c)}{(4-g^2)^2} > T \tag{3.2}$$

Condition (3.1) implies the result of the hiring process in which firm e has a higher maximum willingness to pay for the trained worker and hires her. Condition (3.2) indicates that firm f still prefers to engage in FDI rather than exports in the first period even if it expects to lose trained worker to the competitor.

Second, technology spillovers will not occur under conditions:

$$\frac{4c(\tau-1)(2a-c(1+\tau)-(1-c)g)}{(4-g^2)^2} \leq T+F \tag{3.3}$$

$$\frac{4c(\tau-1)((2+g)(a-1)+gc(\tau-1))}{(4-g^2)^2} \leq F \tag{3.4}$$

Condition (3.3) implies that firm f retains a trained worker by offering higher maximum willingness to pay for her and condition (3.4) indicates that firm f prefers to engaging in FDI to exporting when it anticipates that it would retain the trained worker by paying the wage V_e^{max}.[9]

To simplify the presentation, I fix the values of all parameters but a and g and analyze the solution in the plane (a, g). Figure 3.1 illustrates the equilibrium outcomes for the benchmark case.[10] Curves (1), (2) and (3) define the equilibrium outcomes and corresponds to the conditions (3.1), (3.2) and (3.4).

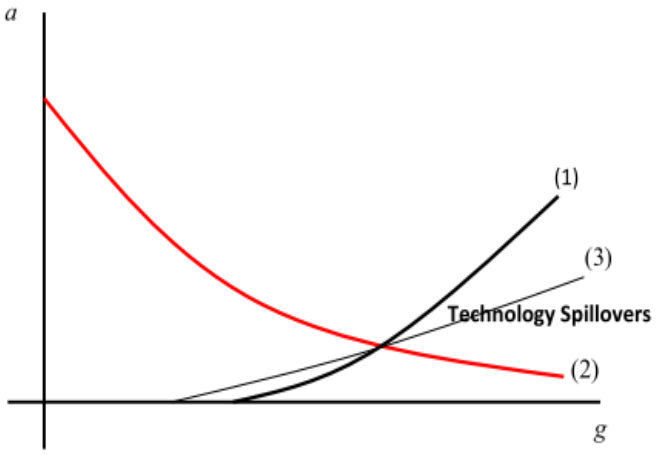

Figure 3.1: Equilibrium Outcomes

From Figure 3.1, it can be pointed out that under holding other parameters constant, firm e can anticipate the occurrence of technology spillovers when the products are rather imperfect substitutes (high values of g). In other words, firm e

[9]The sufficient condition for the technology spillovers to occur is that firm f must engage in FDI and train local workers in the first period. Hence, if condition (3.2) or (3.4) does not hold, there will be no technology spillovers in the game.

[10]For simplicity, parameters are fixed as $F = 1/8$, $T = 1/16$, $c = 1/2$, $\tau = 0.4$, and $\theta = 2$.

is more likely to hire the trained worker and switch to FDI when product market competition is weak. Alternatively, technology spillovers are likely to arise in the host country when firms have similar technological levels or when they are more symmetric. When a is very large, firm f expects that technology spillovers will arise in the second period if it engages in FDI and will choose to export in the first period to protect its intangible asset. On the other hand, when a is very small, firm e's maximum willingness to pay for trained worker decreases and technology spillovers do not occur.

3.2.1 Comparative Statics

In this subsection, I proceed to comparative statics based on the benchmark case illustrated in Figure 3.1. The goal is to have more insights into the effects of economic variables on the occurrence of technology spillovers in the host country.

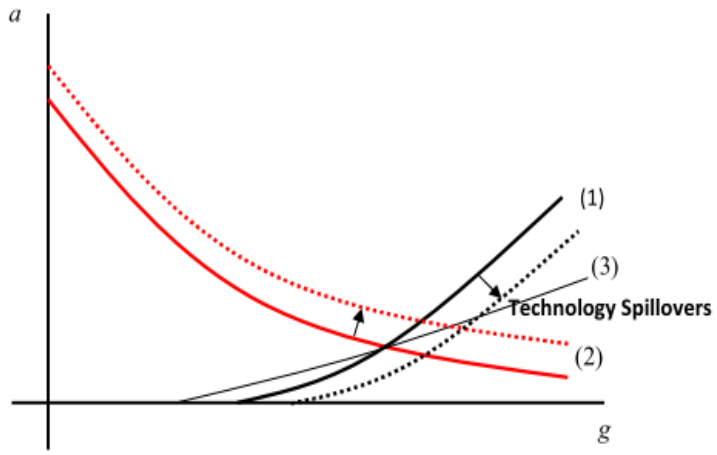

Figure 3.2: The effect of an increase in training cost (T)

Figure 3.2 shows the effect of an increase in training costs T (T rises from

1/16 to 1/8). When training costs increase the FDI firm (f) offers more for the trained worker because it is more costly to bring a new staff of supervisors from the headquarters when it loses the trained worker. Furthermore, an increase in training costs makes an export more favorable option to serve the foreign market than FDI. These effects shift curves (1) and (2) and make spillovers less likely to occur. Hence, exporters have more incentive to switch to FDI in countries with low training costs, such as countries that have a higher level of education in workforce.[11]

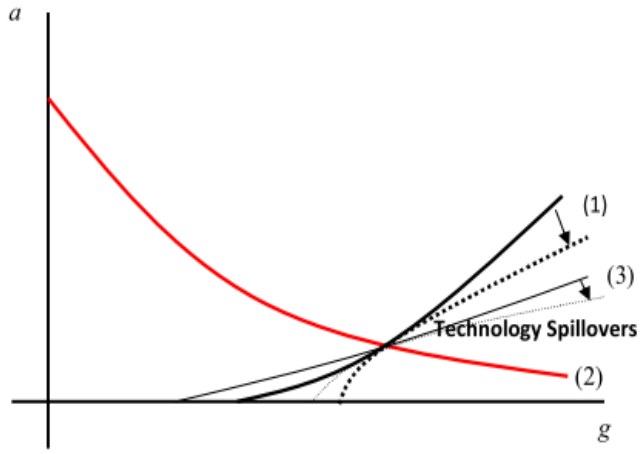

Figure 3.3: The effect of an increase in fixed cost of FDI (F)

Figure 3.3 illustrates the changes when fixed cost of FDI increase (F rises from 1/8 to 1/4). When the cost of FDI, such as the cost of forming a local subsidiary, increases, exporters (firm e) find it more costly to switch to FDI and offer less for the trained worker. Since F is one-time fixed cost of doing FDI, changes in F do not affect firm f's decision of choosing FDI or export in the game, instead

[11]Firms might also expect to have low training costs in countries where borrowing rate is low. In most cases, this rate can be considered to be an indicator of the cost of firms' investment in training local employees in the economy (Maloney (1999))

it has higher chance of retaining trained worker due to the low wage it would have to pay for her. These results shift curve (1) and (3) downwards and decrease the region where technology spillover arises. Therefore, we can anticipate exporters to switch to FDI in countries that incur low costs of doing FDI, such as countries that have generous environment for the investment.

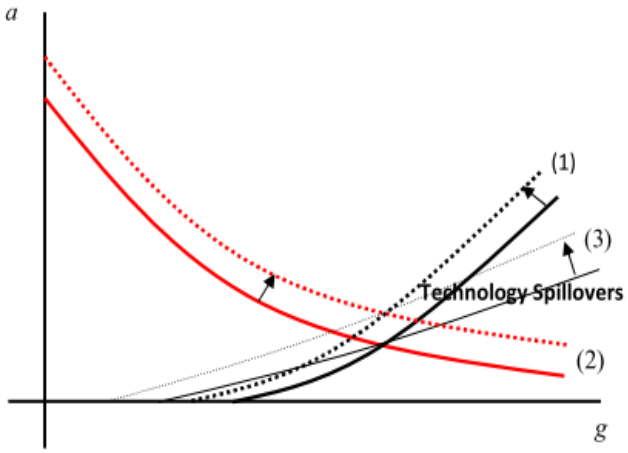

Figure 3.4: The effect of an increase in transport cost (τ)

Finally, Figure 3.4 shows the effects of an increase in transport cost (τ increases from 0.4 to 0.6). When transport cost increases, exporters anticipate to acquire technology spillovers by offering more for the trained worker because it is more costly to export from the home country. On the other hand, an increase in transport cost makes FDI firm less favorable to resort to exports and more favorable to engage in FDI, however, it also raises the wage that must be paid to the trained worker for FDI firm (f) if firm retains the worker, which reduces the profitability of engaging in FDI. These effects shift all curves in different directions and make it ambiguous whether such spillovers are likely to occur. Hence, changes in export cost do not have significant effect on exporters' decision to switch to FDI.

This result is not consistent with previous trade literature in confirming the predictions of the proximity-concentration trade-off: Firms substitute FDI sales for exports when the cost of foreign trade are relatively high (Brainard (1997); Helpman et al. (2004)). Instead, this model implies that when technology spillover is taken into consideration between multinational firms, changes in transport cost not only affect exporters but also FDI firms such that it causes ambiguous effect on exporter's decision to switch to FDI.

Analyzing a simple parametric model allows us to gain more insights into the occurrence of technology spillovers in the host country and how it is affected by specific economic factors. In particular, the model shows that spillovers are likely to arise between FDI and exporting firms when they are more similar in the technological levels and when they produce varieties that are rather imperfect substitutes. In countries that provide generous investment or higher education level for the local workforce, exporting firms have a higher chance of hiring the trained worker from FDI firms and switch to FDI. However, I find that the change in transport cost has an ambiguous effect on the occurrence of technology spillovers.

3.3 Summary and Conclusion

To date, a large body of literature has accumulated to explain the different forms of technology spillovers from foreign to domestic firms. Specifically, theoretical and empirical studies examining technology spillovers through workers' mobility have stressed its effect between multinational and domestic firms by showing that domestic firms benefit from spillovers through an increase in productivity level if they hire previously trained workers from multinational firms.

Stemming from the idea that there are technology spillovers between multinational firms through their foreign affiliates, my main goal was to investigate the

conditions under which such spillovers occur between firms, and analyze how it affects the decisions of exporters to switch to FDI. Extending Fosfuri et al.'s framework by considering the competition between multinational firms, this paper examined how specific economic variables affect the occurrence of technology spillovers through workers' mobility. In particular, consistent with Fosfuri et al. (2001), I found that such spillovers are affected by firm and host country characteristics such that spillovers are more likely to arise when firms have similar technological levels and exporters are more likely to switch to FDI in countries where costs of training local workers are low. However, the model showed that the transport cost do not play a marginal role in the occurrence of technology spillovers and thus in exporters' decision.

Much opportunity for future research remains. From the idea of the existence of technology spillovers through labor mobility between foreign firms, this paper contributes to the literature that investigate not all domestic firms benefit from technology spillovers in their countries. While this paper focuses exclusively on spillovers between multinational firms and excludes domestic firms from the model, I hope to explore how the existence of technology spillovers might affect the decision of exporters to enter local markets through FDI when domestic firms are present. In this case, there will be competition for the services of trained workers among (a) multinational firms that had previously trained workers, (b) other foreign firms seeking to enter the local market by FDI to benefit from hiring informed workers, and (c) a domestic firm that looks forward to the benefit from spillovers. These questions are left for future research.

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