FOREIGN DIRECT INVESTMENT AND INTELLECTUAL PROPERTY RIGHTS: EVIDENCE FROM THE KNOWLEDGE-CAPITAL MODEL

by

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LIST OF ACRONYMS

BEA – Bureau of Economic Analysis

CEEC – Central and Eastern European countries

CD – Cross-sectional Dependence

EU – European Union

E.E.C. – European Economic Community

EFW – Economic Freedom of the World

ERT – European Round Table

FDI – Foreign Direct Investment

FE – Fixed Effects

GDP – Gross Domestic Product

GATT – General Agreement on Tariffs and Trade

IPR – Intellectual Property Rights

KC – Knowledge Capital

MNEs – Multinational Enterprises

NAFTA – North American Free Trade Agreement

OLS – Ordinary Least Squares

OECD – Organization for Economic Co-operation and Development
PCD – Physical Capital Difference
RE – Random Effects
R&D – Research and Development
SD – Skilled Labor Difference
TNC – Transnational Corporations
TRIPS – Trade Related Aspects of Intellectual Property Rights
UNCTAD – United Nations Conference on Trade and Development
U.S. – United States
WDI – World Development Indicator
WTO – World Trade Organization
ABSTRACT

This thesis analyzes the relationship between FDI and IPR protection based on a panel data of U.S. affiliates sales in 50 countries from 2000 to 2008. Although many studies have investigated the effect of IPR protection on FDI, few of them have estimated whether the effect will vary by the type of FDI or the type of product sectors.

In this thesis, these two problems are addressed respectively. First of all, a recently developed knowledge-capital (KC) model is adopted. The knowledge-capital model allows for the simultaneous existence of both horizontal FDI motivation and vertical FDI motivation. By incorporating the IPR protection into the KC model, how IPR protection will influence FDI and how the influence will vary by the type of FDI are estimated.

In addition, both aggregated and disaggregated data are used in this thesis although most of the existing studies only focused on aggregated data. Data from total manufacturing are applied to represent the aggregated level while data from seven manufacturing sub-sectors are used to conduct the disaggregated analysis. It is expected that IPR protection will influence multinational activities differently based on the type of sectors. Particularly, stronger IPR protection could have more effect on technology-intensive industry.

To better capture the cross-sectional and time-series variations in the data, panel data regression methods including fixed effects estimation, random effects estimation and Hausman-Taylor instrumental variable estimation are used to
analyze the data.

According to the empirical results, the basic predictions of the knowledge-capital model are affirmed that horizontal FDI will be stimulated by larger market size, greater similarities in market size and relative factor endowments, lower investment cost and higher host-country trade cost, while vertical FDI will be encouraged by larger market size, larger difference in market size and relative factor endowments and lower host-country trade cost. The results also indicate that the effects of basic FDI determinants in the knowledge-capital model will vary by the type of FDI.

In terms of IPR protection, it shows statistical significance in most of the cases. However, stronger IPR protection could increase FDI with a market expansion effect in some sectors while decrease FDI with a market power effect in other sectors. Therefore, IPR protection plays a crucial role in FDI decisions but its effect is ambiguous.

Furthermore, the results indicate that the effect of IPR protection on FDI will vary by the type of FDI and the type of sectors. The strengthening of IPR protection will have a stronger effect on horizontal FDI relative to vertical FDI and tighter IPR protection will also have more effects on FDI in the technology-intensive sectors.
Chapter 1

INTRODUCTION

1.1 The Context of the Study

In recent decades, foreign direct investment (FDI), as a form of capital flow and investment of foreign assets, has undergone a prominent evolution not only in volume but also in composition. Despite two notable declines in the 2000s, global FDI flows have shown increasing tendency since 1970s. As a way of transferring capital, technology and other resources, the importance of FDI has been highlighted as a driving force of economic development.

As a result of dramatic privatization of economic activity and liberalization of financial markets, FDI has become a crucial source of external financial resource and capital flows for development. During 1991 to 1998, the share of FDI in total capital flows to developing countries increased from 28% to 56%. Different from other types of capital flows, FDI involves actual investment besides providing capital resources. The investment of the foreign affiliates could simultaneously bring advanced goods and services to the host country, enhance the productive capacity in the recipient country, promote the development of related industries, and stimulate favorable environment and infrastructure for other
investment, leading to the crowd-in and agglomeration effects which will attract more foreign and domestic investment and achieve the economies of scale (UNCTAD, 1991, 1999, 2000).

Another important reason for attracting FDI into host countries, particularly to developing countries, is that FDI could improve the technological competence in host countries. First, multinational firms could transfer more advanced and productive technology to host country through two channels. One is to transfer technology within their production system and achieve technology internalization. The other is to externalize the technology in local firms by licensing and strategic alliance. Second, after interaction with local firms through competition, collaboration, human capital exchange and imitation and so on, advanced technology could be diffused to local firms. Furthermore, FDI will enhance the innovation capability in host countries as a complement to local R&D and technology improvement (UNCTAD, 1995, 1999, 2000).

With regard to employment in the recipient countries, FDI could raise the quantity as well as the quality of the employment. Particularly, along with the technology transfer and technology dissemination, multinational firms could improve local human capital by training and imitation, which will have a positive influence on FDI as well (Noorbakhsh, Paloni and Youssef, 2001; UNCTAD, 2000). In addition, the expansion of FDI will utilize the comparative advantage in host countries and enhance their trade competitiveness (UNCTAD, 1999, 2000).
The dramatic rise of global FDI in volume and importance is accompanied with increasing studies on the determinants of FDI, such as market size, market growth, trade openness, wage cost, infrastructure and political risk (Wheeler and Mody, 1992; Loree and Guisinger, 1995; Cheng and Kwan, 2000). However, few academic studies have paid attention to the influence of intellectual property rights (IPR) protection on FDI. Even in the limited existing studies, the effect of IPR on FDI appears to be ambiguous. According to Markusen (2004), multinational firms tended to engage in industries and sectors requiring more R&D investment and more skilled- and technology-intensive inputs. Specifically, knowledge-based assets were highly valued by multinational firms and intangible assets, such as marketing, advertising, finance, management, reputation and trademarks, accounted for a larger part of business operation in multinational firms. Therefore, strong IPR protection system will prevent the intangible assets of multinationals from unauthorized usage and stimulate their investment among multiple countries (Nunnenkamp and Spatz, 2004).

1.2 The Objectives and Contributions

In this study, the importance of some traditional and non-traditional determinants of FDI is investigated using an updated dataset ranging from 2000 to 2008. Particularly, how FDI is influenced by IPR protection is focused. To further study the relationship between FDI and IPR, a recently developed knowledge-
capital (KC) model and a specific sector-level analysis is incorporated. As a result, whether the effects of IPR protection and other determinants will vary by the type of FDI and by the sectors will be discussed.

To sum up, the contributions of this study to previous literature could be summarized in several ways.

First, a knowledge-capital model is used when analyzing the determinants of FDI, to overcome the shortcomings of using separate models for different types of FDI in previous studies. There are two main types of FDI. One is horizontal FDI, where multinational firms tend to duplicate the same production and service activities in multiple countries and serve the local market. The other is vertical FDI, where multinational firms separate their production into different stages and locate them in different countries. The main advantage of the knowledge-capital model is to jointly analyze both horizontal and vertical FDI in a single model, which allows for assessing how the effects of FDI determinants will vary by FDI types.

Second, how IPR protection will act differently according to FDI types has not been adequately addressed in existing empirical analysis of IPR protection. It is expected that an improvement in IPR protection will have more effect on horizontal FDI than vertical FDI, based on the assumption of the knowledge-capital model that horizontal FDI are more skilled-labor-intensive than vertical FDI.
Third, a disaggregated sector-level analysis is conducted in this study, while most of the previous studies analyzing FDI and IPR protection focused on aggregated FDI. According to Lee and Mansfield (1996), IPR protection tended to have a greater influence on FDI containing more technology-intensive components. For each sector, the technical composition of FDI will vary for two reasons. On the one hand, each sector is predicted to be dominated by different types of FDI. Considering the assumption that horizontal FDI is more skilled-labor-intensive, the sectors display horizontal nature will be more technology-intensive. On the other hand, various sectors will involve different factor intensities and R&D inputs based on the nature of their products. Therefore, a sectoral analysis will help to study whether the influence of IPR protection on FDI would vary across the sectors. Specifically, data from seven individual product sectors in manufacturing industry are used to better investigate the different influences of IPR protection on various kinds of products in this study.

Moreover, in order to capture both the cross-sectional and time-series natures of the data, a panel data method is applied in this study. Fixed effects (FE) and random effects (RE) estimations are conducted to solve the problem of unobserved heterogeneity. Furthermore, the potential endogeneity issue is addressed via the application of the Hausman-Taylor Instrumental Variable estimation.
1.3 The Organization of the Study

The remainder of this study is organized as follows. Section 2 will present the historical developments and causal connections of the two main subjects in this study: FDI and IPR protection. Section 3 will provide a literature review concerning the theoretical and empirical relationship between FDI and IPR protection. Model specification, variable description, methodology and data source will be discussed in section 4. Section 5 contains the empirical results and final conclusion is provided in section 6.
Chapter 2

BACKGROUND

2.1 The Development of Foreign Direct Investment

2.1.1 Global Trend of Foreign Direct Investment

After a steady but slow growth in the early 1980s, global flows of foreign direct investment had increased at an unparalleled rate since the mid-1980s. Table 2.1 presents the global FDI flows and FDI flows by groups of economies in recent four decades. It is shown that global FDI flows have grown significantly from $13,346 million in 1970 to $1,114,189 million in 2009. Between 1985 and 1990, the average annual growth rate of FDI flows reached 34% which was significantly larger in comparison to the growth rate of nominal GDP (12%) and merchandise exports (13%). This dramatic growth of FDI flows could be attributed to the strong economic recovery and economic growth after the recession of the early 1980s. Although rising at a lower rate, FDI continued its growth in 1990 with an expansion of 35,000 transnational corporations (TNCs) and 150,000 foreign affiliates. However, a reduction followed in 1991 because of the decreasing growth of FDI outflows from Japan and United Kingdom which were two main FDI source countries (UNCTAD, 1991, 1992).
Table 2.1 Inward and Outward Foreign Direct Investment Flows, Global and by Groups of Economies (Millions of Dollars)

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<tr>
<td>World</td>
<td>13,346</td>
<td>54,076</td>
<td>207,697</td>
<td>1,401,466</td>
<td>1,114,189</td>
</tr>
<tr>
<td>Developing</td>
<td>3,854</td>
<td>7,477</td>
<td>35,096</td>
<td>256,465</td>
<td>478,349</td>
</tr>
<tr>
<td>Developed</td>
<td>9,491</td>
<td>46,576</td>
<td>172,526</td>
<td>1,137,976</td>
<td>565,892</td>
</tr>
<tr>
<td>United States</td>
<td>1,260</td>
<td>16,918</td>
<td>48,422</td>
<td>313,997</td>
<td>129,883</td>
</tr>
</tbody>
</table>


Since 1994, a blooming period of FDI started with a 9% growth rate of FDI inflows in 1994 and 40% in 1995. Considerable growth of FDI was followed in the succeeding years until reaching an unprecedented level in 2000. In 2000, FDI inflows reached $1.3 trillion and FDI stock expanded to $6 trillion and 820,000 foreign affiliates were owned by more than 60,000 TNCs. These arresting expansions could be well explained by the extensive liberalization of related policy, prominent technical progress and advanced management and coordination (UNCTAD, 1996, 1997, 2001).

A notable decline in FDI flows followed in 2001 due to the recession of economic growth and the concussion of stock market. In that year, FDI inflows dropped by 51% and FDI outflows decreased by 55%. The decline continued until 2004 with a moderate increase of FDI inflows and an 18% increase of FDI outflows. As a main contributor to the recovery in 2004, FDI inflows to developing countries got to $233 billion. Stronger economic growth, better
country investment environment, larger-scale restructuring of business and more comprehensive privatization were concluded to be the reasons for recovery. In 2007, global FDI inflows reached a peak value of $1,833 billion which surpassed the previous record in 2000. The number of TNCs reached a new height of 79,000 and the number of foreign affiliates enlarged to 790,000 with total affiliate sales of $31 trillion (UNCTAD, 2002, 2005, 2008).

2.1.2 Regional Trend of Foreign Direct Investment

Figure 2.1 shows the global FDI inflows by groups of economies for recent three decades. In the 1980s, developed countries were dominant in both global FDI inflows and outflows. With regard to FDI inflows, developed countries accounted for global shares of 75% and 81% in 1980-1984 and 1985-1989 respectively. Although increasing trends of FDI inflows were shown in developed as well as developing countries, there was still a big gap between the actual values in these two regions. For example, the value of FDI inflows to developed countries were $163 billion in 1989 while it only reached $30 billion in developing countries. Among the developing countries, Latin America and Asia became the two main FDI recipients. For FDI outflows, three developed countries, the United Kingdom, the United States and Japan, contributed over 90% of the global FDI outflows (UNCTAD, 1991).
Represented by the triad of European Union (EU), the United States and Japan, developed countries still accounted for the majority of global FDI flows in the 1990s. From 1998 to 2000, the triad was responsible for 75% of global FDI inflows and 85% of FDI outflows. As two main performers of FDI flows in 1980s, the United States and Japan turned to be less important relative to the EU for the EU’s shares of FDI inflows and outflows both increased while those of the United States and Japan had decreased. In the 1990s, the importance of developing countries, particularly of Asia and Latin America, in global FDI flows started to grow. North-East Asia became the largest contributor with $80 billion of FDI inflows into Hong Kong, China and the Republic of South Korea. Specifically, China became the largest FDI recipient among developing countries with $64
billion of FDI inflows in 2000. This striking increase was mainly stimulated by the FDI-friendly environment created by the domestic government such as improvements in trade openness, higher level of infrastructure and less investment barriers (UNCTAD, 2001).

From 2001 to 2007, global FDI flows experienced short decline in the first three years and turned to increase in the succeeding years. For developed countries, the share of FDI inflows rose at a steady rate and reached $1,248 billion in 2007, and FDI outflows increased by 56%. Therefore, FDI inflows and outflows of developed countries still accounted for a bulk of global FDI flows. With regard to developing countries, their FDI inflows spread to their highest level of $500 billion in 2007. Among the developing economies, South, East and South-East Asia and Oceania still played crucial roles with FDI inflows of $249 billion and outflows of $150 billion in 2007, which were both their highest levels. Particularly, China and Hong Kong sustained their FDI bloom and continued to be the two largest FDI recipients in developing countries. Latin America and the Caribbean maintained its growth in FDI inflows and reached $126 billion in 2007. FDI flows into Africa increased slowly and still accounted for a relatively small proportion of global FDI inflows (UNCTAD, 2008).

2.1.3 Sectoral Trend of Foreign Direct Investment

Along with the rapid expansion, FDI is allocated in different industrial
sectors which are generally categorized to be primary sector (e.g. agriculture, mining, forestry), secondary sector (e.g. automobile production, textile production, chemical and engineering industries) and tertiary sector (retail and wholesale sales, transportation and distribution, entertainment, banking). Primary sector extracts and utilizes the natural resources to produce raw materials and basic foods. Secondary sector includes all activities of manufacturing, processing and construction, which is aimed to provide the finished goods. Tertiary sector is referred to be the service sector which supplies variety of services from general population to business. Among these sectors, obvious shifts exist even though the absolute values of FDI in all three sectors were increasing. Before the 1960s, FDI was mainly concentrated in primary sector which was incented by the abundance of natural resources. Following the market liberalization and globalization, multinational firms tended to use the comparative advantage and operate their production and distribution globally. Therefore, the focus of FDI transferred to manufacturing sector during the 1960s and 1970s. Since the 1980s, there were more FDI emerging in service sector and technology-intensive manufacturing due to the development of globalization and the technological progress (UNCTAD, 1993, 1999).

FDI in primary sector was prosperous during 1950s for it aimed at taking advantage of the abundant natural resources in host countries. Since the 1960s, however, the share of primary sector in total FDI had declined. By 1970,
the share of primary sector was only 22.7% compared to 45.2% in secondary sector and 31.4% in tertiary sector. Particularly during 1980s and 1990s, the share of primary sector in total outward FDI stock for main developed countries experienced rapid decrease due to the excessive stock of petroleum and mining products in the 1980s. After 2000, FDI in primary sector began to recover due to the increase of mining and petroleum activities. From 2004 to 2006, the share of primary sector in global FDI inflows reached 13% which was parallel with its record in 1990 (UNCTAD, 1993, 1999, 2006, 2008).

During the 1970s, the focus of FDI transferred from primary sector to manufacturing sector. Along with the prevailing tendency of service during 1980s, the share of manufacturing in FDI declined at a slow rate and lasted to decrease in recent years. However, it still accounted for a significant part of global FDI. In 1990, the proportion of manufacturing in outward FDI from developed countries was around 40% and over 30% of global inward FDI stock was attributed to manufacturing in 2006. Although FDI in manufacturing total was decreasing, there was an intra transfer from resource- and labor-intensive sectors to capital- and technology-intensive sectors within manufacturing total (UNCTAD, 1993, 1999, 2008).

Since the 1980s, the role of service in global FDI has been highlighted in both developed and developing countries. In 2005, the service sector had attracted the largest bulk of FDI into these two regions, accounting for 62% and
58% of the inward FDI stock in developed countries and developing countries respectively. Finance and trade services were the two dominant engines in the service sector which contributes two thirds of the service FDI stock in developed countries. In addition, the share of other services such as infrastructure also began to increase since 1990s. The expansion of FDI in service was mainly caused by the liberalization of investment in service, the technological progress, the development of globalization and the existence of nontradable services (UNCTAD, 1993, 1999, 2007, 2008).

2.1.4 Determinants and Motives of Foreign Direct Investment

As indicated by UNCTAD (1998), the determinants of FDI are based on the comprehensive consideration of the motive of investment, the type of investment, the sector of investment and the size of investor. There are three different kinds of motives for FDI: resource-seeking, market-seeking and efficiency-seeking.

Market-seeking is the most important motive for FDI, which is targeted to exploit larger markets and gain easier access into global markets based on a horizontal integration. Driven by this motive, the main determinants of FDI are traditional market-related determinants, such as GDP, market growth, income per capita and population. Additionally, when there are strong trade barriers, the cost of market access through international trade will increase. Therefore, FDI will
be stimulated to take place of international trade as a way of accessing large markets (UNCTAD, 1998).

Efficiency-seeking FDI rose with the globalization and also accounts for a significant share of global FDI flows. To make use of the comparative advantage, multinational firms tend to locate their affiliates in countries with lower setup and production cost. Therefore, low-cost inputs and operation environment such as unskilled labor, low corporation tax and convenient transportation will enhance the efficiency-seeking FDI. Furthermore, extensive globalization and rapid technology innovation also generate innovative-assets-seeking FDI to utilize the advanced technology and innovative resources (UNCTAD, 1998, 2006).

Natural-resource-seeking FDI from countries with poor resource endowments is mainly encouraged by abundant and relatively cheap raw materials (UNCTAD, 1998). For example, Rahman, Rahman and Elasayed (2010) studied the Japanese foreign direct investment to Australia and pointed that the investment strategy of the Japanese multinational firms was a combination of resource-seeking and market-seeking motives. Particularly, for agribusiness or mining sectors where Australia owned both absolute and comparative advantages, FDI from Japanese multinational firms would be strongly attracted by the adequate and cheap natural resources in Australia.

Generally, the determinants of FDI could be divided into three categories: economic determinants, political determinants and host country
characteristics. Among economic determinants, there are traditional market-related determinants like market size, market growth and national income. Infrastructure, level of industrialization, domestic investment and historical FDI are treated as agglomeration determinants in that these determinants would encourage the cluster of firms. When more firms concentrated into a region, there will be more competitive suppliers, more comprehensive cooperation and greater specialization and division of production, which will ultimately leads to the economics of scale. In addition, economic determinants include trade openness, wage cost and human capital. In terms of political determinants, investment policy, tax policy, fiscal and financial incentive policy, FDI-related international agreements and privatization policy all play important roles in attracting FDI. In addition, distance, culture proximity, macroeconomic and social stability are treated as host country characteristics. The expansion of FDI is generally a result of the combinations of different motives and determinants (UNCTAD, 1998, 2006).

2.2 The Development of Intellectual Property Rights

Intellectual property rights (IPR) refers to a series of exclusive rights that are granted to a number of distinct types of creations of the mind. Protected by the rules and laws which are corresponding to the rights, the owners of the intellectual property could make exclusive use of the intangible assets. Generally, the types of intellectual property include patents, trademarks, copyrights, industrial
design and trade secrets (Maskus, 2000).

In recent years, IPR protection has experienced remarkable improvement. In 1867, the constitution of North German Confederation granted legal rights over the protection of intellectual property to its confederation, which expanded the legal protection of intellectual property to a group of states. The subsequent developments of IPR protection are the negotiation of the Paris Convention in 1883 and the Berne Convention in 1886. The former established related terms and rules covering industrial property rights while the latter covered copyrights. However, these two conventions are limited not only on the small number of participating countries, but also on the small range of rights, coverage, extent and enforcement. In 1984, the United States stated that the lack of protections of patents, copyrights and trademarks would cause unfair trade protection to some extent. A great improvement of IPR protection was promoted in 1990s for there were more countries involved in the strengthening of IPR protection and many regional trade and investment agreements were established to include IPR protection in their provisions. For example, the North American Free Trade Agreement (NAFTA) was set up in 1994 to explore a trilateral trade area in North America.

To expand the IPR protection into a multilateral and international level, the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) was established in the Uruguay Round of the General Agreement on Tariffs and
Trade (GATT) in World Trade Organization (WTO) in 1994. It was the first multinational agreement which set up the minimum standards of IPR protection. The requirements and regulations of TRIPS included copyright rights, geographical indications, industrial designs, integrated circuit layout-designs, patents, monopolies for the developers of new plant varieties, trademarks, tradenames and undisclosed or confidential information. A prominent creation of TRIPS was to elaborate the obligations and procedures for the enforcement, remedy and dispute resolution of IPR protection (Maskus, 2000).

The positive economic effect of IPR protection has been emphasized in many aspects. First, stronger IPR regime could facilitate the R&D inputs and innovation progress in the multinational firms (Chen and Putttinanun, 2005; Helpman, 1993). Second, the technology transfer cost will be reduced for tighter IPR protection will lower the imitation rate and create more secure environment against imitation. Consequently, the technology transfer will be stimulated (Javorcik, 2004; Branstetter, Fisman and Foley, 2006). Third, international trade and FDI are also positively correlated with IPR protection (Smith, 1999; Awokuse and Yin, 2010b; Lee and Mansfield, 1996). In addition, stronger IPR protection will have a dynamic effect through lower production cost, higher productivity and increasing product variety (Falvey, Foster and Greenaway, 2006). Furthermore, economic growth and global competitiveness will be enhanced by stronger IPR protection and the welfare will be improved (Branstetter, Fisman, Foley and Saggi,
2007; Branstetter and Saggi, 2009). As indicated by Maskus (2000), the importance of IPR protection will vary greatly by sectors. Generally, the strengthening of IPR protection will have a greater effect on technology-intensive sectors such as pharmaceuticals, biotechnology and electronical products.

Although the importance of IPR protection has been discussed in many previous studies, the concerns and debates about its negative influence still exist, particularly in the developing countries. As a way of technology transfer, the strengthening of IPR protection will block developing countries’ technology diffusion and innovation generation through restricting their imitation of the advanced technology from the developed countries. Furthermore, stronger IPR protection may lead to higher prices of protected inventions like pharmaceuticals, which will cause a welfare loss in the developing countries.

2.3 The Connection between FDI and IPR

Although the potential connection between FDI and IPR has been indicated by Markusen (2004) that multinationals tend to be firms whose value of intangible assets is larger than their market value, the specific relationship between FDI and IPR is ambiguous according to previous studies (Lee and Mansfield, 1996; Glass and Saggi, 2002).

When a market expansion effect dominates, stronger IPR protection in a host country will diminish the imitation rate and protect multinational enterprises’
reputation and benefits, leading to more attractiveness for foreign investors.

In contrast, a market power effect will lead FDI to decrease with the improvement of IPR protection. There are three main reasons. First, stronger IPR will raise imitation cost and cause resource scarcity to diminish FDI. Second, multinational firms may transfer preference from FDI to licensing because of stronger IPR. Third, with an improvement of IPR protection, stronger market power of the multinational enterprises will be motivated and the market competition will decrease. As a result, multinational firms may intend to gain maximum benefits by cutting their affiliate sales. Moreover, the effect of IPR on FDI may vary by industries and sectors. Especially, IPR protection will make a greater difference in technology-intensive industries or sectors (Mansfield, 1995; Javorcik, 2004). The detailed discussion of the connection between FDI and IPR will be supplied in section 3.

2.4 Incorporating the Knowledge-Capital Model

To better estimate the relationship between FDI and IPR, a recently developed model called knowledge-capital (KC) model is used in this study (Markusen, 1997, 2004; Markusen, Venables, Konan, and Zhang, 1996). Different from traditional horizontal or vertical models of FDI, the key creation of this model is to allow for a jointly evaluation of both horizontal and vertical FDI.

For horizontal and vertical FDI, there are different motivations.
Horizontal multinational firms will duplicate their production and services in multiple countries with the aim of seeking a larger consumption market and avoiding high tariff or transportation cost. Therefore, the similarity of market size will be a crucial incentive for horizontal FDI. In addition, horizontal FDI will dominate if there are similar relative factor endowments and relatively high trade costs. On the other hand, vertical firms tend to fragment the production process into several stages and locate their plant and headquarters in different countries. By locating their production plants in host countries, vertical multinational firms tend to take advantage of the local low-cost inputs like unskilled labor. Therefore, vertical FDI will dominate if the countries have significant difference in relative endowments, but are similar in market size to some extent.

According to the different motivations, the basic variables of knowledge-capital model are generated as market size, similarity in market size, similarity in relative factor endowments, trade cost and investment cost. Their related predictions are developed by previous studies as well. When horizontal FDI dominates, both the sum of gross domestic product (GDP) as a proxy for market size, and the trade cost in host country will have a positive effect, while the squared difference of GDP standing for country similarity, the trade cost in parent country and the investment cost in host country will act negatively. When vertical FDI dominates, stronger relative endowments dissimilarity represented by larger differences in skilled labor and physical capital, lower trade cost in host and parent
country, and lower investment cost in host country will induce more vertical FDI.

The incorporation of IPR into the knowledge-capital model is mainly motivated by the various performances of IPR based on the types of FDI. According to the basic theories of knowledge-capital model (Markusen, 1997, 2004; Markusen, Venables, Konan, and Zhang, 1996), horizontal firms are assumed to be skilled-labor-intensive and rely more on R&D inputs while vertical firms tend to be unskilled-labor-intensive. In addition, horizontal FDI will always contain services, such as management, marketing and finance, transferred from the headquarters to the plant in host country. Therefore, it is expected that horizontal firms are more sensitive to the strengthening of IPR protection.
Chapter 3

LITERATURE REVIEW

The striking development of FDI has led various studies to estimate the potential determinants of FDI. However, few of them examined the determinants through knowledge-capital model which nests both horizontal FDI and vertical FDI. The application of the knowledge-capital model allows for the analysis to determine if the impact of IPR will vary by FDI types. In this section, previous studies focusing on various theoretical model specifications of FDI determinants are reviewed respectively.

3.1 Studies Related to Horizontal FDI

A general-equilibrium model of horizontal multinationals was initially developed by Markusen (1984), which had been theoretically extended and empirically tested by later studies with the general prediction and pattern of horizontal model. The horizontal model predicts that horizontal multinational activities will be encouraged by higher similarity in market size and relative factor endowments, higher transportation cost and trade cost, and less investment barriers (Horstmann and Markusen, 1987a; Brainard, 1993b, 1997; Markusen and
One of the key determinants of horizontal FDI is the host-country market size. Both focusing on the direct investment from U.S. multinational firms to E.E.C. countries, Scaperlands and Mauer (1969) and Scaperlanda and Balough (1983) empirically tested the market-size hypothesis and drew a conclusion that large market size will induce more FDI by improving the efficiency of resource distribution, specialization of production, technology transfer and economies of scale. Using GDP as a measurement of market size, Wheeler and Mody (1992) analyzed U.S. manufacturing investment in a panel of 42 countries from 1982 to 1988. They reaffirmed the importance of market size as a significant and positive determinant of FDI and highlighted the influence of agglomeration effects. The same result was also found by Nunnenkamp (2002) exploring the determinants of FDI in 28 developing countries. Based on the survey data conducted by the European Round Table (ERT) for three separate periods of 1987-1992, 1993-1996 and 1997-1999, Nunnenkamp concluded that traditional market-related determinants like population, GDP per capita and GDP growth still play a crucial role in attracting foreign investment. Schneider and Frey (1985) developed four models - political model, economic model, amalgamated model and politico-economic model - to analyze the joint and simultaneous influences of both economic and political determinants of FDI in 80 less developed countries for 1976, 1979 and 1980 respectively. It was indicated that real per capita GNP as a
proxy for market size and economic development is a highly important incentive for FDI (Tsai, 1994; Loree and Guisinger, 1995; Chakrabarti, 2001).

As indicated by many earlier studies, there was certain substitutitional relationship between export and horizontal multinational activities as two options of servicing foreign market. Therefore, horizontal FDI will be encouraged when there was higher trade cost, higher transportation cost or longer distance. Based on disaggregated U.S. outward FDI to 39 countries, Yeaple (2003) incorporated the knowledge-capital model to test both the market-access motive (horizontal nature) and comparative advantage motive (vertical nature). The market-access motive of horizontal FDI was demonstrated and it was indicated that international trade would be supplanted by horizontal FDI to avoid the related impediments caused by higher trade cost and market size was still an important incentive for U.S. multinational activities. According to Brainard (1993a, 1997), multinationals could either gain concentration advantage by locating their plants in parent country and export their products to foreign market or make use of proximity advantage by horizontally expanded to foreign market and approach to local consumers. The proximity-concentration hypothesis was confirmed in these studies, that horizontal multinational expansion would increase with higher transportation cost and trade cost, and lower plant-level scale economies relative to corporate-level.

Although earlier studies had suggested the important role of transportation cost or distance, which were positively correlated with each other,
Brainard (1993b) indicated that their effects on FDI locations could vary sharply by FDI types through analyzing the bilateral U.S. inward and outward FDI for a cross-sectional data in 1989. In the existence of high transportation cost or long distance, horizontal FDI would be improved by substituting for exports to host countries while vertical FDI may diminish along with the decrease of exports. The consistent result was also provided by Awokuse and Yin (2010a) focusing on inward FDI to China which was characterized as a large developing economy with relatively high level of imitation. The positive effect of IPR protection on China’s FDI was demonstrated and it was indicated that longer distance would induce more horizontal FDI. Incorporating a Hausman-Taylor SUR model, Egger and Pfaffermayr (2004a) estimated the role of distance in exports and FDI stock from OECD countries, respectively. According to their results, whether distance would raise or diminish FDI relied not only on the types of FDI but also on the distance’s weight between fixed set-up cost and transportation cost.

3.2 Studies Related to Vertical FDI

Vertical multinational expansion was developed and explained by Helpman (1984) with the extension of Helpman (1985) and Helpman and Krugman (1985). These studies illustrated that relative factor proportion differences had a crucial influence on the appearance of multinational activities.

Destined for export to parent country, an important incentive of
vertical FDI is to take advantage of the low-cost unskilled labor in the local market. Since the 1960s, the availability of unskilled labor has been a key determinant for vertical FDI (UNCTAD, 1998). Cheng and Kwan (2000) estimated foreign direct investment in China, which was the largest FDI recipient among developing countries. The results from the dynamic panel data analysis implied that wage cost was negatively associated with FDI. Focusing on the bilateral FDI flows from Western countries to Central and Eastern European countries (CEEC), Bevan and Estrin (2004) stressed that the multinational activities in this region had been strongly incented by the efficiency seeking motive for lower unite labor cost could attract more FDI. The similar negative relationship between low labor cost and prominent FDI were also reported in other studies (Schneider and Frey, 1985; Shamsuddin, 1994).

In addition to the low-cost unskilled labor which could encourage the investors’ motives to make use of comparative advantage, skilled labor in host country has a significant influence on foreign investment as well. In the wake of globalization and the improvement of technology, multinational firms have transferred their focuses toward technology-intensive manufacturing and services since the 1980s. Therefore, there is a growing valuation of skill-intensive labor relative to low-cost unskilled labor (UNCTAD, 1998, 2004; Pfeffermann and Madarassy, 1992). The positive influence of skilled labor on the location decision of FDI had been empirically tested by Noorbakhsh, Paloni and Youssef (2001),
Miyamoto (2003), Lall (1998) and Carstensen and Toubal (2004). Along with the global competitiveness and technology progress, more and more skilled labor were required to master the modern facilities, advanced techniques and managerial skills. Hence, the availability of human capital could attract more technology-intensive and value-added foreign investment, stimulate the economic growth and innovation, and improve the industrial structure from basic manufacturing to high-tech industries.

While horizontal FDI may substitute for trade, vertical FDI and international trade tend to be complementary in two ways. On the one hand, vertical multinationals may export intermediates to host country to exploit the cheap production factors for processing and assembling (Blonigen, 2001). Brainard (1993a) noted that vertical multinational activity will generate more trade flows of intermediates. Hence, vertical FDI and trade were complementary in some extent and high trade cost would decrease both international investment and trade. On the other hand, vertical FDI could also serve the home market by re-exporting the products from the affiliates in host countries. Therefore, less trade barriers in both host and parent countries would decrease the cost of re-export and attract more vertical FDI (Edwards, 1992; Asiedu, 2002).

In addition, other factors like distance will also affect vertical FDI. Long distance between host and parent country would raise vertical multinationals’ transportation cost of exporting intermediates and re-exporting final products,
which may discourage vertical FDI (Bevan and Estrin, 2004).

3.3 Studies Relating FDI and IPR

Recently, more and more studies have paid attention to the importance of IPR protection in FDI strategy. However, the effect of IPR protection on FDI tends to be indeterminate according to the previous ambiguous results. On the one hand, stronger IPR protection will prevent the imitation of foreign assets and improve the multinationals’ control of and profits from the knowledge-based assets. The increasing control and market shares will lead to the ownership advantage of the multinational firms. Therefore, more FDI will be induced by the strengthening of IPR protection, which is referred to market expansion effect. On the other hand, stronger IPR protection may cause the monopoly power of the multinational firms leading them to achieve higher unit price by limiting their production volume. Hence, a market power effect will dominate when tighter IPR protection reduces FDI (Smith, 2001).

3.3.1 Evidence for Positive Relationship between FDI and IPR

With a market expansion effect, tighter IPR protection will attract more FDI by diminishing the imitation level in host country and increase foreign investors’ returns to their knowledge assets. Branstetter, Fisman, Foley and Saggi (2007) and Branstetter and Saggi (2009) exploited a North-South product
framework to study how FDI, Southern industrial development, Southern welfare and Northern innovation would interact with each other after IPR reform in the South. When treating FDI, Southern imitation and Northern innovation as three endogenous elements, stronger IPR protection will not only decrease the imitation rate and lead to the increase of FDI but also achieve the subsequent results of raising industrial development, real wages and innovative capacity. Awokuse and Yin (2010a) estimated the linkage between IPR and FDI in the case of China, which was representative considering China as the largest FDI host country among developing countries and the one undertaking a series of IPR reforms. Based on a panel data consisting of 38 parent countries from 1992 to 2005 and two alternative measurements of IPR, dynamic development of IPR and FDI in China had been considered in the analysis of the paper. According to the random effects estimation, stronger IPR would encourage more inward FDI to China and the effect of IPR protection on FDI would depend on the economic development of source country.

The stimulation effect of stronger IPR on FDI was highlighted by Lai (1998) as well, although they stated that IPR protection would act distinctively depending on the channel of technology transfer.

As indicated by previous studies, strengthening IPR protection could not only enhance the total volume of FDI but also transform the composition of FDI through increasing the technical components of FDI and attract more FDI into technology-intensive industries. Based on firm-level data from 100 U.S. firms, Lee
and Mansfield (1996) demonstrated that IPR protection and FDI were positively correlated and suggested that stronger IPR protection would induce more investments in technology-intensive industries like final products manufacturing and R&D facilities. Similar result was also found by Nunnenkamp and Spatz (2004) using R&D expenses, value added and exports as three indicators to measure the quality of FDI. As a result, higher level of IPR would improve not only the technology ingredients of FDI but also the value added and exports generated by FDI.

Focusing on FDI inflows to transition economies, Javorcik (2004) incorporated sectoral indicators and reaffirmed the point suggested by Mansfield (1995) that weak IPR protection would hinder FDI from engaging in technology-intensive sectors relative to other sectors. In addition, weak IPR protection would encourage investors to construct distribution facilities instead of local production. Similarly, Maskus (2000) emphasized the importance of characteristics and indicated that IPR protection would have a stronger effect on FDI in IPR sensitive industries, such as pharmaceuticals, biotechnology and industrial chemicals. These industries contained more R&D investments, technology components and innovation costs compared to low-tech manufacturing. The industry-specific distinctions of IPR’s influence could also be observed in the connection between IPR and international trade. Awokuse and Yin (2010b) focused on the effect of China’s IPR protection on its imports from both OECD and non-OECD countries
for 1991-2004. Both aggregated and product-disaggregated trade data were analyzed by Hausman-Taylor estimation and it was concluded that the improvement of IPR protection would enhance China’s imports through market expansion effect, especially for the knowledge-intensive products.

Nunnenkamp and Spatz (2004) also mentioned that the importance of IPR protection would not only rely on the industry-specific but also the country-specific characteristics. In terms of country-specific conditions, Zhuang and Zou (2010) analyzed an extended North (U.S.) – South (China) model by distinguishing the market structures in China into two types, which were oligopoly markets with vertical innovation and monopolistically competitive markets with horizontal innovation. According to their results, the strengthening of IPR protection would increase horizontal FDI but decrease vertical FDI in the former market, while increasing vertical FDI in the latter one.

### 3.3.2 Evidence for Negative Relationship between FDI and IPR

In addition to the market expansion effect, the strengthening of IPR protection may also have a market power effect to reduce FDI. According to previous studies, there are several explanations for the negative influence.

showed that the strengthening of IPR protection would result in rigorous technology access for imitation and raise imitation cost. Consequently, more resources would be driven into imitation for the possible imitation achievements and FDI would be eliminated because of resource scarcity in the South such as the shortage of labor supply or capital formation. Even though casting imitation as an exogenous element, Helpman (1993) also concluded that imitation cost would be promoted by stronger IPR and consequently weakened international flows of technology transfer through FDI, export and so on.

FDI would also decline if the multinational enterprises choose to serve the foreign market through licensing instead of direct investment. Based on a dynamic general-equilibrium product cycle model, Yang and Maskus (2001a, 2001b) indicated that tighter IPR protection could motivate the Northern firms to license more technology for two reasons. First, stronger IPR protection would decrease the cost of licensing by protecting the licensed knowledge-based assets from violation. As a result, there would be higher economic returns to licensing and innovation. Second, the increase of rent share of licensing following stronger IPR protection will stimulate licensing and innovation.

Although the positive effect of IPR protection on licensing had been indicated by Yang and Maskus (2001a, 2001b), whether the expansion of licensing would act as a complementary of FDI or a substitute of FDI still need further estimation. According to Yang and Maskus (2009) and Markusen (2001), as three
ways of international technology transfer, export, FDI and licensing may switch among each other. Based on the framework of fixed setup cost, imitation condition and IPR protection, there would be three switching situations. First, when setup cost was large and IPR protection was insufficient, licensing would be less preferred relative to export and FDI in that weak IPR protection could not protect the licensors’ economic returns to and control of the knowledge-based assets. In addition, large setup cost would raise the cost to directly invest abroad. Therefore, export from the North to the South would dominate in order to avoid the high setup cost and internalize the knowledge-based assets within the source firms to prevent the profit loss and reputation damage through imitation. Second, when IPR protection was still weak but setup cost turned to be low, FDI would replace export because FDI would transfer more comprehensive technology, own the lowest marginal cost and could internalize the knowledge-based assets of the multinational firms as well. Third, when setup cost was low and IPR protection was strengthened, the motive to avoid imitation risk by internalizing the knowledge assets within the source firm would diminish. As a result, there would be more licensing instead of FDI considering that stronger IPR would prevent the economic loss of licensing and the fixed setup cost of licensing was less relative to FDI (Horstmann and Markusen, 1987b; Smith, 2001).

In addition, Maskus and Penubarti (1995) and Smith (2001) indicated that strengthening IPR protection would stimulate multinational firms’ monopoly
power and diminish market competition, causing the firms to restrict their affiliate sales to achieve higher market price and profit maximization. The monopoly power could have a negative influence on innovation and technology transfer as well. With the monopoly power, the patent-holding firms would enhance their competitiveness by restricting and hindering the technology assimilation and innovation among other firms, leading to the reduction of global technology dissemination (Zhuang and Zou, 2010; Chaudhuri, Gordberg, and Jia, 2006; Maskus and McDanniel, 1999; Helpman, 1993).

3.4 The Knowledge-Capital Model

In this study, the recently developed knowledge-capital model (Markusen, Venables, Konan, and Zhang, 1996; Markusen 1997, 2004) nesting both horizontal and vertical FDI will be utilized. The following part will be divided into two aspects. One is the theoretical framework of the knowledge-capital model. The other is the literature review of the previous papers that have adopted the model.

3.4.1 Theoretical Framework of Knowledge-Capital Model

The fundamental structure for the knowledge-capital model involves two countries, two homogeneous products and two factor endowments. These two factors are unskilled labor and skilled labor, respectively. One of the product
sectors is unskilled-labor-intensive with constant returns under perfect competition. The other product sector intensively uses skilled labor with both firm-level and plant-level scale economies under imperfect competition. Particularly, the skilled-labor-intensive sector involves not only production activity but also headquarter activity (e.g. R&D, marketing), which determines the increasing returns to scale.

There are three basic assumptions for the knowledge-capital model.

First, the locations of knowledge-intensive assets, such as blueprints, manuals, formulas, marketing and finance, and production activity could be fragmented from each other. In addition, the cost to transfer the knowledge-intensive services to the production plants is relatively low. This assumption provides a main incentive for vertical investment. With fragmentation and low transferring cost, it is feasible and reasonable to divide the operation of single plant and headquarters across different countries.

Second, the knowledge-based services from headquarters are more skilled-labor-intensive relative to the final production. While headquarters are mainly encouraged by low-cost skilled labor, the location of production facilities considers both low-cost unskilled labor and large market size. As a result, vertical multinational firms will be motivated to achieve optimal resource distributions by locating headquarters in parent country where skilled-labor is abundant and locating final production in host country where there is cheap unskilled labor and moderately larger market size.
Finally, the knowledge-intensive services are assumed to be joint inputs which could be transferred to multiple production facilities. This assumption means that the services provided by headquarters could be used simultaneously by many different production plants. Therefore, horizontal FDI will be motivated to duplicate their production and services in multiple countries.

In terms of these assumptions, three types of multinational firms emerge. One is the national firms that maintain a single plant and headquarters in only one country. The other two are horizontal firms and vertical firms which will be mainly discussed in this thesis.

Horizontal multinational firms tend to replicate their production and services in multiple countries in order to serve the local market. Specifically, they will maintain a plant and headquarters in parent country while locating the other plants in multiple host countries. Horizontal FDI is mainly encouraged by market-seeking and market-access motives. Therefore, horizontal FDI will dominate if the differences of two countries in market size and relative factor endowments are small, host-country trade cost is relatively high and transportation cost is high.

By separating headquarters in skilled-labor-intensive country and production facilities in unskilled-labor-intensive country, vertical multinational firms could take advantage of the cheap labor force in host country and re-export final products back to the parent country. As a result, the crucial incentive for vertical FDI is the difference of relative factor endowments like the difference of
skilled labor. Moreover, similar country size, lower trade cost and transportation cost will reinforce vertical FDI as well.

In addition to the three underlying assumptions, several additional assumptions and ideas are incorporated to better extend the knowledge capital model.

At first, it is assumed that horizontal firms are more knowledge-intensive or skilled-labor-intensive than vertical firms. It is because that in order to support the operation of production plants, more skilled labor is needed for horizontal firms in both parent country and host country and there are more service flows transferring from headquarters to oversea plants within horizontal firms. Since technology-intensive investments are sensitive to IPR protection (Lee and Mansfield, 1996; Nunnenkamp and Spatz, 2004), it is expected that stronger IPR protection could have a greater effect on horizontal FDI. The higher intensity of skilled labor in horizontal firms was also confirmed by Markusen, Venables, Konan, and Zhang (1996), indicating that production use only unskilled labor, while headquarters use skilled labor and the fixed cost of plants use the integration of skilled labor and unskilled labor.

Second, it is assumed that increasing returns to scales exists in multiple plants and the setup cost of establishing an additional plant in foreign market is lower relative to the cost of establishing a domestic plant. Therefore, headquarter services could be supplied to multiple production facilities with low
marginal cost which will stimulate the horizontal expansion of multinational firms.

In addition, the emergence of vertical multinationals will be most remarkable when the parent country is small and skilled-labor-intensive and the host country is large and unskilled-labor-intensive. Therefore, there is more vertical FDI if the two countries have huge differences in market size and relative factor endowments.

3.4.2 Studies Using Knowledge-Capital Model

The basic theories of knowledge-capital model are well explained by Markusen, Venables, Konan, and Zhang (1996) and Markusen (1997). The authors reached the general conclusion that horizontal FDI would dominate if there was huge similarity in market size and relative factor endowments, and trade cost was moderately high. However, vertical FDI would dominate if there was a huge difference in relative factor endowments while the two countries were similar in market size to some extent. Particularly, by designing a ratio of multinationals’ affiliate sales to affiliate sales plus commodity trade volume, it was implied that horizontal FDI and trade were substitutable while vertical FDI and trade tended to be complementary.

The theoretical predictions and conclusions were empirically evaluated by Carr, Markusen and Maskus (2001). They used bilateral U.S. FDI data from 1986 to 1994, which was measured by affiliate sales of U.S. parent firms in foreign
market and affiliate sales of foreign parent firms in the U.S.. The basic knowledge-capital model was tested by OLS, WLS and Tobit estimations, with the additional marginal effect tests of trade cost, country similarity and relative factor endowments similarity. As a result, most of the basic variables in knowledge-capital model showed expected signs and strong statistical significance, indicating that the direct investment would be encouraged with larger sum of market size, greater similarity in market size, larger difference in skilled-labor endowments, higher host-country trade cost and lower investment cost.

Markusen and Maskus (2001a) theoretically reviewed the previous papers concerning the knowledge-capital model and empirically tested the basic results of the model. Particularly, the popular controversy that whether trade and FDI are complements or substitutes was estimated. As a result, trade and FDI tended to be complementary in intermediates but substitutable in final goods. Considering that horizontal multinational firms generally produce final goods in host country to serve local market and vertical multinational firms tend to assemble or process imported intermediates in host country to make use of the abundant unskilled labor, their result is consistent with the prediction that there is a substituional relationship between trade and horizontal FDI while trade and vertical FDI tend to be complementary.

With regard to the relative factor endowments, many studies only focused on the two standard factors, which are unskilled labor and skilled labor.
Incorporating a three-factor approach which contained unskilled labor, skilled labor and physical capital into the knowledge-capital model, Egger and Pfaffermayr (2004a, 2005) and Bergstrand and Egger (2007) emphasized the importance of physical capital and indicated that FDI would increase with a larger difference of physical capital endowments between two countries.

Based on the knowledge-capital model, Awokuse, Maskus and An (2011) expanded the existing aggregated analysis to disaggregated sectoral analysis with data from total manufacturing and five manufacturing sub-sectors. Total affiliate sales, local affiliate sales and affiliate exports were treated as three measurements of U.S. affiliates’ multinational activities. Considering the dynamic nature of investment, a dynamic panel data regression approach (GMM) was applied to analyze a panel data consisting of 39 FDI recipient countries from 1985 to 1999. The results indicated that the basic predictions of knowledge-capital model were affirmed and the predictions may vary by the type of industries or sectors.

According to the previous studies, the knowledge-capital model in levels was usually used, in that the affiliate sales of multinationals were treated as a proxy for FDI activities in these studies and the existence of zero volume of affiliate sales would hinder the direct usage of log form model specification. However, based on the huge data variations across countries and years, log form is usually suggested to fit for the models analyzing international trade and
multinational investment activities. Using U.S. outward stocks of FDI as a proxy of multinational activities, Egger and Pfaffermayr (2004b) use FDI stock as a proxy for FDI activities and presented a knowledge-capital model in log form. As a result, they reaffirmed the basic predictions of the model.

Based on a knowledge-capital model in logs as well, Egger and Pfaffermayr (2004a) conducted two separate regressions to estimate the effects of distance on U.S. bilateral exports and outward FDI stocks. It was indicated that trade and FDI could be either substitutable or complementary depending on the relative importance of distance between the fixed plant setup cost and trade cost. Long distance could raise not only the trade cost but also the setup and management cost of foreign investment. Therefore, if distance accounted more for trade cost, long distance would increase more trade cost relative to fixed setup cost. As a result, FDI would be encouraged to substitute exports to avoid the higher trade cost.

Blonigen, Davies and Head (2003) suggested that the analysis performed by Carr, Markusen and Maskus (2001) was inappropriate because of the misspecification of the related skilled-labor difference terms. According to their studies, whether the sign of the skilled-labor difference term was positive or negative would make a great difference on the signs and explanations of the related coefficients. Therefore, they switched the skilled-labor difference term and its interaction term with GDP difference into absolute specifications. Being totally
opposite to the original signs from the study by Carr, Markusen and Maskus (2001), the signs of skilled-labor difference and its interaction with GDP difference appeared to be negative and positive, respectively. It was indicated that similarity in skilled labor endowments would have a positive effect on FDI which rejected the basic prediction of knowledge-capital model and displayed a strong motive for horizontal MNEs. This result was consistent with the studies by Markusen and Maskus (2001b, 2002), Cravino, Lederman and Olarreaga (2008) and Brainard (1993b), implying that FDI will be primarily encouraged by the similarities in factor proportions and market size rather than the differences and horizontal FDI motivations had been the main incentives for international investment.
Chapter 4

ECONOMETRIC FRAMEWORK

4.1 Model Specification and Hypothesis

Carr, Markusen and Marskus (2001) developed a basic specification of the knowledge-capital model which included factors like market size, relative factor endowments similarity, investment cost and trade cost.

Following the model extension by Bergstrand and Egger (2007) and Awokuse, Maskus and An (2011), a third factor, physical capital, is introduced into the standard knowledge-capital model with only skilled and unskilled labor. To analyze the effect of IPR on FDI and how the effect varies by FDI types, IPR and its interactions with other variables are incorporated into the model as well. To fix the problem of large variations in FDI data and provide elasticity coefficients to better explain the related influences, the knowledge-capital model is estimated in logs. The model specification in this study is expressed as follows:
In Equation (1), \( i \) stands for the U.S. which is the parent country. The host country is represented by \( j \) and \( t \) refers to year. The dependent variable \( FDI_{it} \) is represented by the real volume of affiliate sales by U.S. affiliates in the host countries. As indicated by Davies, Ionascu and Kristjansdottir (2008), affiliate sales are preferred to FDI stocks and FDI flows because it captures the actual and current value of FDI activities. \( GDPS_{it} \) is the sum of gross domestic production in both parent country and host country. It is a proxy for market size which is an important incentive for both horizontal and vertical FDI. It is expected that the market size will have a positive effect on FDI.

\( GDPDSQ_{it} \) is the square of GDP difference between parent country and host country, which is used to measure market similarity. Horizontal FDI tends to grow between countries with greater similarities in market size or relative factor endowments. Therefore, \( GDPDSQ_{it} \) should have a negative effect on FDI, indicating that the smaller the squared GDP difference between two countries is, the more the FDI will be.
\( SKLD_{ij} \) is the difference of skilled-labor between parent country and host country, which is a main incentive for vertical FDI according to the theory of knowledge-capital model. When the skilled-labor difference is large, vertical FDI will be encouraged because the multinationals are more likely to fragment their production processes by locating their headquarters in a skilled-labor-abundant country while locating their plant in a skilled-labor-scarce country. In contrast, horizontal FDI will be enhanced when there is more skilled-labor similarity. Consequently, the difference in skilled-labor across countries is expected to have a positive effect on FDI.

However, this basic prediction of the knowledge-capital model was questioned by Blonigen, Davies and Head (2003), indicating that the effect depended on the actual sign of the skilled-labor difference and horizontal FDI was still accounting for the dominant bulk of global FDI. Following their study, an absolute specification of skilled-labor difference is used in this study. A negative coefficient is expected because more horizontal FDI will be stimulated when the difference in relative factor endowments is decreasing. But if the skilled-labor difference appears to be positive, it implies that vertical FDI motivation dominates.

\( GDPD_{ij}*SKLD_{ij} \) is the product of GDP difference and skilled-labor difference. Referring to the basic theory of the knowledge-capital model, the amount of FDI will be maximized when the parent country is small and skilled-labor-abundant and the host country is large and unskilled-labor-abundant. Thus, it
is predicted that this interaction term should be negatively related to FDI. However, absolute value of $GDPD_{ijt}^*SD_{ijt}$ is also applied in this study to correct for the variable misspecification indicated by Blonigen, Davies and Head (2003) that the signs of GDP difference and skilled-labor difference will influence the coefficient sign of this interaction term. The influence is expected to be positive suggesting that vertical FDI will be encouraged given the large differences in relative factor endowments and market size.

The expectations of $GDPDSQ_{ijt}$, $SKLD_{ijt}$ and $GDPD_{ijt}^*SKLD_{ijt}$ are consistent with the former statement that horizontal FDI will be encouraged by market size and relative factor endowment similarities, while vertical multinationals focus their investment in host countries that have a huge gap with parent countries in market size and factor endowments (Markusen, Venables, Konan and Zhang, 1996).

$PKD_{ijt}$ is the difference in physical capital per worker between parent and host countries. $GDPD_{ijt}^*PKD_{ijt}$ is the interaction term of GDP difference and physical capital difference. Both of these two variables are in absolute values and should have similar effects as $SKLD_{ijt}$ and $GDPD_{ijt}^*SKLD_{ijt}$. Therefore, the coefficients of $PKD_{ijt}$ and $GDPD_{ijt}^*PKD_{ijt}$ are expected to be negative and positive, respectively.

$IC_{ij}$ is the investment cost in the host country. Higher investment cost should raise the fixed cost of the multinationals and discourage their investment in
the host country.

$TC_{it}$ measures the trade cost of exporting from the host country to the parent country and its coefficient is expected to be negative. Vertical multinationals tend to locate their plants in host country for cheaper relative factor endowments and re-export the products back to parent country. Consequently, high trade cost in parent country should decrease vertical FDI which is export-oriented.

Differing from $TC_{it}$, $TC_{jt}$, the trade cost in host country, is usually predicted to have a positive effect because of the substitutional relationship between trade and horizontal FDI (Yeaple, 2003). When trade cost in the host country increases, particularly when it exceeds the fixed setup cost of multinational firms, incentives for direct investments will be promoted in order to avoid the high tariff and consequently the amount of exports to host countries will diminish.

$TC_{jt} * SKLDSQ_{jt}$ is the product of trade cost in host country and the squared skilled-labor difference. This variable implies that the effect of host-country trade cost will rely on the types of FDI and high trade cost in host country may motivate horizontal FDI but decrease vertical FDI. Given high trade cost, small skilled-labor difference will stimulate horizontal FDI to substitute for international trade. On the other hand, vertical FDI will be diminished by higher host-country trade cost in that high host-country trade cost will impede multinationals’ intermediates export to host country and increase their production cost. Thus, the sign of the variable should be negative. However, this is not a
strong theoretical prediction. The term $TC_p^*PKDSQ_{ij}$ interacts host-country trade cost with the squared physical capital difference and its influence is expected to be negative.

$IPR_p$ is the protection of intellectual property rights in host country. The empirical results of how IPR protection influences FDI are ambiguous. As previously noted, it could either enhance FDI because of market expansion effect or discourage FDI if market power effect is prevalent.

Besides the single $IPR_p$ variable, its interaction terms with $SKLDSQ_{ij}$ and $PKDSQ_{ij}$ are included, which are designed to capture whether IPR’s influence will vary by FDI types. According to the factor-intensity assumptions of knowledge-capital model, horizontal FDI involves more skilled-labor-intensive or knowledge-capital-intensive ingredients than vertical FDI. Horizontal multinational firms often duplicate production in host country and gain similar services from the headquarters in parent country, such as management, marketing, finance and R&D. Therefore, horizontal FDI will be influenced more than vertical FDI given a stronger protection of IPR in the host country. However, whether the influence is positive or negative will depend on the coefficient of $IPR_p$. It is generally predicted that small factor endowments difference will motivate horizontal FDI while large difference will encourage vertical FDI. Therefore, when there is a market expansion effect (the sign of $IPR_p$ is positive), the coefficients of the two interaction terms are expected to be negative. For given a tight IPR protection, the
positive market expansion effect will be stronger on horizontal FDI relative to vertical FDI. On the other hand, when there is a market power effect (the sign of $IPR_j$ is negative), the signs of the two interaction terms are expected to be positive for the negative market power effect will also be stronger on horizontal FDI given a tight IPR protection.

$DIST_{ij}$ is the distance between parent country and host country. The effect of distance depends on the type of FDI (Brainard, 1993b). As a component of transportation cost and trade cost, longer distance will raise these costs and FDI will be encouraged to take place of export. This positive relationship between distance and FDI indicates the existence of horizontal FDI. However, long distance could also augment the cost to export intermediates to host country and the cost of shipping final products back to the parent country. Therefore, a negative sign of distance suggests vertical FDI considering its nature of re-export. In addition to the types of FDI, the mixed results could also be attributed to the relative importance of distance in fixed set-up cost and transportation cost (Egger and Pfaffermayr, 2004a). Longer distance will discourage FDI if distance has more effect on fixed set-up cost (e.g. investment cost, management cost) while increasing FDI if distance affects transportation more. In most of the existing studies, distance appears to have a negative effect.

The definition of each variable is summarized in Table 4.1 while Table 4.2 presents the variable specifications and hypothesis.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$FDI_{ijt}$</td>
<td>Affiliate sales of U.S. affiliates in host country</td>
</tr>
<tr>
<td>$GDPS_{ijt}$</td>
<td>Sum of GDP in both parent and host countries</td>
</tr>
<tr>
<td>$GDPDSQ_{ijt}$</td>
<td>Square of GDP difference between parent and host countries</td>
</tr>
<tr>
<td>$SKLD_{ijt}$</td>
<td>Absolute difference of skilled labor between parent and host countries</td>
</tr>
<tr>
<td>$GDPD_{ijt} * SKLD_{ijt}$</td>
<td>Interaction term of GDP difference and skilled-labor difference in absolute value</td>
</tr>
<tr>
<td>$PKD_{ijt}$</td>
<td>Absolute Difference of physical capital per worker between parent and host countries</td>
</tr>
<tr>
<td>$GDPD_{ijt} * PKD_{ijt}$</td>
<td>Interaction term of GDP difference and physical capital difference in absolute value</td>
</tr>
<tr>
<td>$IC_{jt}$</td>
<td>Investment cost in host country</td>
</tr>
<tr>
<td>$TC_{it}$</td>
<td>Trade cost in parent country</td>
</tr>
<tr>
<td>$TC_{jt}$</td>
<td>Trade cost in host country</td>
</tr>
<tr>
<td>$TC_{jt} * SKLDSQ_{ijt}$</td>
<td>Interaction term of host-country trade cost and squared skilled-labor difference</td>
</tr>
<tr>
<td>$TC_{jt} * PKDSQ_{ijt}$</td>
<td>Interaction term of host-country trade cost and squared physical capital difference</td>
</tr>
<tr>
<td>$IPR_{jt}$</td>
<td>IPR protection in host country</td>
</tr>
<tr>
<td>$IPR_{jt} * SKLDSQ_{ijt}$</td>
<td>Interaction term of IPR protection and squared skilled-labor difference</td>
</tr>
<tr>
<td>$IPR_{jt} * PKDSQ_{ijt}$</td>
<td>Interaction term of IPR protection and squared physical capital difference</td>
</tr>
<tr>
<td>$DIST_{ijt}$</td>
<td>Distance</td>
</tr>
</tbody>
</table>
Table 4.2 Variable Specification and Hypothesis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Specification</th>
<th>Hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>( FDI_{ijt} )</td>
<td>( \ln(FDI_{ijt}) )</td>
<td>+</td>
</tr>
<tr>
<td>( GDPS_{ijt} )</td>
<td>( \ln(GDP_{it} + GDP_{jt}) )</td>
<td>-</td>
</tr>
<tr>
<td>( GDPDQS_{ijt} )</td>
<td>( (\ln GDP_{it} - \ln GDP_{jt})^2 )</td>
<td>-</td>
</tr>
<tr>
<td>( SKLD_{ijt} )</td>
<td>( /\ln SKLD_{it} - \ln SKLD_{jt} / )</td>
<td>-</td>
</tr>
<tr>
<td>( GDPD_{ijt} )*( SKLD_{ijt} )</td>
<td>( /\ln GDP_{it} - \ln GDP_{jt} / )*( /\ln SKLD_{it} - \ln SKLD_{jt} / )</td>
<td>+</td>
</tr>
<tr>
<td>( PKD_{ijt} )</td>
<td>( /\ln PKD_{it} - \ln PKD_{jt} / )</td>
<td>-</td>
</tr>
<tr>
<td>( GDPD_{ijt} )*( PKD_{ijt} )</td>
<td>( /\ln GDP_{it} - \ln GDP_{jt} / )*( /\ln PKD_{it} - \ln PKD_{jt} / )</td>
<td>+</td>
</tr>
<tr>
<td>( IC_{jt} )</td>
<td>( IC_{jt} )</td>
<td>-</td>
</tr>
<tr>
<td>( TC_{it} )</td>
<td>( TC_{it} )</td>
<td>-</td>
</tr>
<tr>
<td>( TC_{jt} )</td>
<td>( TC_{jt} )</td>
<td>+</td>
</tr>
<tr>
<td>( TC_{jt} )*( SKLDQS_{ijt} )</td>
<td>( TC_{jt} *(\ln SKLD_{it} - \ln SKLD_{jt})^2 )</td>
<td>-</td>
</tr>
<tr>
<td>( TC_{jt} )*( PKDSQ_{ijt} )</td>
<td>( TC_{jt} *(\ln PKD_{it} - \ln PKD_{jt})^2 )</td>
<td>-</td>
</tr>
<tr>
<td>( IPR_{jt} )</td>
<td>( IPR_{jt} )</td>
<td>+/-</td>
</tr>
<tr>
<td>( IPR_{jt} )*( SKLDQS_{ijt} )</td>
<td>( IPR_{jt} *(\ln SKLD_{it} - \ln SKLD_{jt})^2 )</td>
<td>-/+</td>
</tr>
<tr>
<td>( IPR_{jt} )*( PKDSQ_{ijt} )</td>
<td>( IPR_{jt} *(\ln PKD_{it} - \ln PKD_{jt})^2 )</td>
<td>-/+</td>
</tr>
<tr>
<td>( DIST_{ijt} )</td>
<td>( DIST_{ijt} )</td>
<td>+/-</td>
</tr>
</tbody>
</table>

4.2 Methodology

4.2.1 Fixed Effects and Random Effects Estimation

According to the existing studies estimating the knowledge-capital model, the pooled ordinary least squares (OLS) and the weighted least squares (WLS) are employed mostly for the data analysis (Carr, Markusen and Maskus, 2001; Markusen and Maskus, 2002). Given a data set with at most 50 countries ranging from 2000 to 2008, a panel data approach is applied instead of OLS or WLS in that the former owns an advantage of addressing problems like unobserved heterogeneity, ignorance of time variation and imprecise estimation. A
general panel data regression model assumes the existence of unobserved individual heterogeneity and it is written as

$$y_{it} = \alpha + \beta'X_{it} + u_{it} \quad t = 1, ..., T \quad (2)$$

where $\alpha$ is the intercept, $X_{it}$ is a vector of explanatory variables, and the error term $u_{it}$ contains the unobserved heterogeneity, which is presumed to be constant over time but varies across cross-sectional units. Different assumptions about the error term $u_{it}$ will generate different forms of the panel regression model. The two commonly specified variants are the fixed effects model and random effects model.

The basic framework of fixed effects model is presented as follows:

$$y_{it} = \alpha + \beta'X_{it} + a_i + u_{it} \quad t = 1, ..., T \quad (3)$$

where $\alpha$ is the intercept, $a_i$ is the unobserved heterogeneity and $u_{it}$ is the error term. The key assumption making fixed effects model distinct from random effects model is that the time-invariant unobserved heterogeneity term $a_i$ is correlated with the explanatory variables. Based on fixed effects transformation, the unobserved heterogeneity term is eliminated by subtracting the group means from equation (3) and the related coefficients are estimated via OLS after the time-demeaning transformation:

$$y_{it} - \overline{y_i} = \beta (X_{it} - \overline{X_i}) + u_{it} - \overline{u_i} \quad t = 1, ..., T \quad (4)$$

The main problems rising from fixed effects estimation are country-specific heteroskedasticity, serial correlation over time and contemporaneous cross-sectional correlation (Wooldridge, 2000). Heteroskedasticity could be
inspected via Modified Wald test with the null hypothesis of no groupwise heteroskedasticity. With regard to serial correlation, the Wooldridge test proposed by Wooldridge (2002) is applied to check whether there is autocorrelation within the residuals. The null hypothesis is that there is no serial correlation. Furthermore, to achieve unbiased results, Pasaran CD (cross-sectional dependence) test of contemporaneous correlation is used to test whether the residuals are correlated across country units with the null hypothesis that no cross-sectional dependence exists. If there are problems of heteroskedasticity, serial correlation and contemporaneous correlation, the robust standard error could be used to control for these problems.

The other form of the panel data regression model is the random effects model, which is analyzed by generalized least squares (GLS) when the variance structure is known and feasible generalized least squares (FGLS) when the variance is unknown. The random effects model allows for time-invariant explanatory variables:

\[ y_{it} = \alpha + \beta' X_{it} + v_{it} \quad t = 1, ..., T \]  \hspace{1cm} (5)

\[ v_{it} = a_i + u_{it} \]  \hspace{1cm} (6)

where \( \alpha \) is the intercept, \( v_{it} \) is defined as composite error term, and \( a_i \) stands for the term of unobserved heterogeneity which follows the random effects assumption that unobserved heterogeneity term is uncorrelated with the explanatory variables. Under this assumption, the composite error term is serially correlated across time:
Because pooled OLS standard errors usually ignore this positive serial correlation, they will be inefficient. In addition, pooled OLS estimation assumes to have no unobserved individual heterogeneity which makes it less efficient when estimating panel data. Breusch-Pagan (1980) developed a Breusch-Pagan Lagrangian Multiplier test to examine the relevance of random effects to be incorporated in a panel model. Therefore, the rejection of the null hypothesis that random effects are not proper will imply the appropriateness to use a random effects model instead of a pooled OLS model.

While fixed effects model allows arbitrary correlation between unobserved heterogeneity term and explanatory variables, random effects model assumes there is no connection between these two. Therefore, fixed effects model is widely treated as a more reasonable and convincing way to analyze panel data. However, it may not be the most efficient model. To compare these two models and estimate whether the more efficient random effects model also supplies consistent results, a Hausman test proposed by Hausman (1978) is applied in this study. Based on the null hypothesis that there is no systematic difference in the coefficients from fixed effects and random effects estimations, a failure to reject the null hypothesis indicates that the random effects model is appropriate and preferred over fixed effects model.
4.2.2 Hausman-Taylor Instrumental Variable Estimation

Although fixed effects and random effects models have considered the cross-sectional and time variations to a great extent, they still suffer from several estimation problems.

One issue is that time-invariant explanatory variables, such as geographic distance, are not allowed in the fixed effects model. Because of the fixed effects transformation, explanatory variables which are constant over time will be eliminated to generate a time-demeaned equation of (4).

Another problem is the potential exogeneity of some regressors which will lead to a biased and inconsistent estimation. Fixed effects model involves endogeneity of all the explanatory variables by assuming the correlation between these variables and the unobserved heterogeneity while random effects model assumes the independence of all the explanatory variables on the unobserved heterogeneity. Therefore, a Durbin-Wu-Hausman (DWH) test is used to detect the endogeneity of the explanatory variable and the potential endogeneity should be solved by an instrumental variable method.

In this study, a Hausman-Taylor Instrumental Variable method proposed by Hausman and Taylor (1981) is utilized to address the above problems, which requires the transformation of the variables within the model as instruments. The Hausman-Taylor estimation requires a benchmark model that consists of both time-variant explanatory variables (X) and time-invariant explanatory variables (Z).
Each of the two explanatory variable vectors could be divided into two partitions:

\[ y_{it} = X_{1it}' \beta_1 + X_{2it}' \beta_2 + Z_{1i}' \alpha_3 + Z_{2i}' \alpha_4 + a + u_{it} \] (8)

\[ \text{Cov}(a_i, X_{1i}') = 0, \text{Cov}(a_i, X_{2i}') \neq 0 \] (9)

\[ \text{Cov}(a_i, Z_{1i}') = 0, \text{Cov}(a_i, Z_{2i}') \neq 0 \] (10)

Equation (9) and (10) indicates that \( X_{1i}' \) and \( Z_{1i}' \), as the first partition of \( X \) and \( Z \) respectively, are exogenous while \( X_{2i}' \) and \( Z_{2i}' \), as the second partition of \( X \) and \( Z \) respectively, are endogenous in that they are correlated with the unobserved heterogeneity. For the exogenous variables, the estimators will be unbiased therefore they will be treated as their own instruments. For the time-variant endogenous variable \( X_{2i}' \), its own time-demeaned data will be used as an instrument. In addition, the average value of the time-variant exogenous variable will be an instrument for the time-invariant variable \( Z_{2i}' \). The instrumental variable vector is presented as follows:

\[ IV = \begin{bmatrix} X_{1i}', (X_{2i}' - \bar{X}_{2i}), Z_{1i}', \bar{X}_{1i} \end{bmatrix} \] (11)

### 4.2.3 Specific Tests

To ensure that the estimated models are appropriate, various model specification tests were explored. Table 4.3 presents two tests for the selections among OLS estimation, fixed effects estimation and random effects estimation. Breusch and Pagan Lagrangian Multiplier test is employed to choose between random effects model and OLS estimation. The null hypothesis is rejected in all the
industry total and industry sub-sectors. Therefore, it is proper to use the random effects model in all cases. In addition, Hausman test is applied to test the appropriateness of random effects model. A significant p-value in Hausman test indicates a rejection of the null hypothesis that random effects model is appropriate. Thus, the fixed effects estimation is used in machinery sector, electrical equipment, appliances, and component sector and transportation equipment sector while the random effects estimation is used in total manufacturing and other sectors.

Table 4.3 Tests for Model Specification

<table>
<thead>
<tr>
<th></th>
<th>Breusch and Pagan Lagrangian Multiplier testa</th>
<th>Hausman Testb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Manufacturing</td>
<td>1458.09*** (0.0000)</td>
<td>8.40 (0.8677)</td>
</tr>
<tr>
<td>Food Processing</td>
<td>1151.73*** (0.0000)</td>
<td>12.95 (0.5304)</td>
</tr>
<tr>
<td>Chemicals</td>
<td>1459.45*** (0.0000)</td>
<td>9.77 (0.7788)</td>
</tr>
<tr>
<td>Primary and Fabricated Metals</td>
<td>796.66*** (0.0000)</td>
<td>8.79 (0.8440)</td>
</tr>
<tr>
<td>Machinery</td>
<td>536.71*** (0.0000)</td>
<td>25.67** (0.0285)</td>
</tr>
<tr>
<td>Computers and Electronic Products</td>
<td>923.25*** (0.0000)</td>
<td>13.27 (0.5051)</td>
</tr>
<tr>
<td>Electrical Equipment, Appliances, and Component</td>
<td>566.05*** (0.0000)</td>
<td>38.72*** (0.0004)</td>
</tr>
<tr>
<td>Transportation Equipment</td>
<td>739.77*** (0.0000)</td>
<td>68.14*** (0.0000)</td>
</tr>
</tbody>
</table>

a Chi-square values reported, H0: random effects estimation is not appropriate
b Chi-square values reported, H0: both fixed effects and random effects estimation are appropriate
p-value in parenthesis
*denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level
When dealing with panel data by fixed effects and random effects estimations, three main potential issues need to be tested (Table 4.4). For group-wise heteroskedasticity and serial correlation, Modified Wald test and Wooldridge test are used respectively. According to the results, heteroskedasticity and first-order autocorrelation are detected to exist in all cases due to the existence of a significant p-value. Pesaran’s test is conducted for cross-sectional correlation with a significant p-value indicating that there is cross-sectional dependence. Except machinery sector and computers and electronic products sector, all other industry and sub-sectors have the issue of cross-sectional correlation based on the results of Pesaran’s test. Therefore, robust standard error is adopted in the fixed effects and random effects estimations for all eight cases.
Table 4.4 Tests for Heteroskedasticity, Serial Correlation and Cross-Sectional Correlation

<table>
<thead>
<tr>
<th>Industry</th>
<th>Modified Wald Test&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Wooldridge Test&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Pesaran's Test&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Manufacturing</td>
<td>11520.75***</td>
<td>419.424***</td>
<td>2.227**</td>
</tr>
<tr>
<td></td>
<td>(0.0000)</td>
<td>(0.0000)</td>
<td>(0.0259)</td>
</tr>
<tr>
<td>Food Processing</td>
<td>3450.83***</td>
<td>133.615***</td>
<td>1.872*</td>
</tr>
<tr>
<td></td>
<td>(0.0000)</td>
<td>(0.0000)</td>
<td>(0.0612)</td>
</tr>
<tr>
<td>Chemicals</td>
<td>2898.44***</td>
<td>48.792***</td>
<td>4.083***</td>
</tr>
<tr>
<td></td>
<td>(0.0000)</td>
<td>(0.0000)</td>
<td>(0.0000)</td>
</tr>
<tr>
<td>Primary and Fabricated Metals</td>
<td>33649.94***</td>
<td>451.352***</td>
<td>3.154***</td>
</tr>
<tr>
<td></td>
<td>(0.0000)</td>
<td>(0.0000)</td>
<td>(0.0016)</td>
</tr>
<tr>
<td>Machinery</td>
<td>2677.83***</td>
<td>129.007***</td>
<td>-0.684</td>
</tr>
<tr>
<td></td>
<td>(0.0000)</td>
<td>(0.0000)</td>
<td>(0.4335)</td>
</tr>
<tr>
<td>Computers and Electronic Products</td>
<td>14978.47***</td>
<td>396.336***</td>
<td>2.399</td>
</tr>
<tr>
<td></td>
<td>(0.0000)</td>
<td>(0.0000)</td>
<td>(0.4937)</td>
</tr>
<tr>
<td>Electrical Equipment, Appliances, and Component</td>
<td>14978.47***</td>
<td>396.336***</td>
<td>2.399**</td>
</tr>
<tr>
<td></td>
<td>(0.0000)</td>
<td>(0.0000)</td>
<td>(0.0165)</td>
</tr>
<tr>
<td>Transportation Equipment</td>
<td>10839.25***</td>
<td>557.164***</td>
<td>3.879***</td>
</tr>
<tr>
<td></td>
<td>(0.0000)</td>
<td>(0.0000)</td>
<td>(0.0001)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Chi-square values reported, H<sub>0</sub>: constant variance (no heteroskedasticity)

<sup>b</sup>F-statistics reported, H<sub>0</sub>: no first-order autocorrelation

<sup>c</sup> CD statistics reported, H<sub>0</sub>: no cross-sectional correlation

p-value in parenthesis

*denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level

4.3 Data Source

This analysis is based on the panel data from 2000 to 2008. The number of countries contained in the analysis varies by different industries and sectors. To better estimate the effect of FDI determinants, affiliate sales of foreign affiliates is used as a proxy for FDI. In the aggregated analysis of total manufacturing, 50 countries are included with both developed and developing countries. Disaggregated sectoral analysis, which covers 7 sectors in the
manufacturing industry, focuses on whether the influence of each factor on FDI will vary by sectors. After deleting the countries with missing data, sectoral samples are determined with 44 countries in food processing, 49 countries in chemicals, 39 countries in primary and fabricated metals, 44 countries in machinery, 35 countries in computers and electronic products, 39 countries in electrical equipment, appliances, and component, and 36 countries in transportation equipment. The country sample of total manufacturing is listed in Table 4.5. The country samples of each product sector are presented in Tables A1-A7.

<table>
<thead>
<tr>
<th>Table 4.5 Country List of Total Manufacturing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country List</td>
</tr>
<tr>
<td>Argentina Ecuador Israel Russia</td>
</tr>
<tr>
<td>Austria Egypt Japan South Korea</td>
</tr>
<tr>
<td>Australia Finland Luxembourg South Africa</td>
</tr>
<tr>
<td>Belgium France Malaysia Spain</td>
</tr>
<tr>
<td>Brazil Germany Mexico Sweden</td>
</tr>
<tr>
<td>Canada Greece Netherlands Switzerland</td>
</tr>
<tr>
<td>Chile Honduras New Zealand Thailand</td>
</tr>
<tr>
<td>China Hong Kong Norway Turkey</td>
</tr>
<tr>
<td>Colombia Hungary Panama United Kingdom</td>
</tr>
<tr>
<td>Costa Rica India Peru United Arab Emirates</td>
</tr>
<tr>
<td>Czech Republic Indonesia Philippines Venezuela</td>
</tr>
<tr>
<td>Denmark Ireland Poland</td>
</tr>
<tr>
<td>Dominican Republic Italy Portugal</td>
</tr>
</tbody>
</table>

The dependent variable is affiliate sales of majority-owned nonbank
foreign affiliates of nonbank U.S. parent firms\(^1\) in host countries. The data for this variable come from the Bureau of Economic Analysis (BEA) in millions of dollars and only the available sales data after 1999 are used because of the changes of sectoral definition and composition in 2000. The United States is the only parent country. The values of affiliate sales are transformed into real 2000 U.S. dollars using GDP deflator from the World Development Indicator (WDI) of World Bank.

The data for real GDP are obtained from the WDI of the World Bank, and it is measured in billions of constant 2000 U.S. dollars.

According to previous studies (Carr, Markusen and Maskus, 2001; Markusen and Maskus, 2002), skilled-labor abundance is represented by the sum of occupational categories 0/1 (professional, technical, and kindred workers) and 2 (administrative workers) in employment in each country, divided by total employment. In addition, school enrollment is also used as a measure of skilled labor (Noorbakhsh, Paloni and Youssef, 2001; Carstensen and Toubal, 2004; Egger and Pfaffermayr, 2004b). In this study, secondary school enrollment is selected as a proxy for skilled-labor abundance. This variable is defined as the ratio of total secondary enrollment to the population of the age group that officially corresponds to the level of secondary education. The data are reported by the WDI of the World Bank. Relative to primary education, secondary education is assumed to

\(^{1}\) A “majority-owned nonbank affiliate” (MOFA) is a foreign affiliate in which the combined direct and indirect ownership interest of all U.S. parents exceeds 50 percent.
provide more skill-oriented instruction and focuses more on permanent learning and human capital improvement. Therefore, the higher the level of enrollment in secondary education is, the higher the skill level of the labor force is.

Besides skilled labor and unskilled labor, a third factor—physical capital—is incorporated in this study. Physical capital per worker is measured by the investment-labor ratio which is a proxy for the unobservable capital-labor ratio. Investment is represented by gross fixed capital formation in thousands of constant 2000 U.S. dollars, which consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Labor is measured as the total labor force in the host country. All of these data are from the WDI of the World Bank.

An index from the Economic Freedom of the World (EFW) is used as the measurement of investment cost. The survey data for the EFW report are gathered from different sources, such as Global Competitiveness Report, International Country Risk Guide, World Bank and International Monetary Fund (IMF). The index is constructed based on three aspects, which are credit market regulations (ownership of banks, foreign bank competition, private sector credit, interest rate controls/negative real interest rates), labor market regulations (hiring regulations and minimum wage, hiring and firing regulations, centralized collective bargaining, hours regulations, mandated cost of worker dismissal, conscription) and business regulations (price controls, administrative requirements, bureaucracy.
costs, starting a business, extra payments/bribes, licensing restrictions, cost of tax compliance). The initial index ranges from 0 to 10 with a higher score suggesting better investment environment or lower investment cost. To correspond to the negative effect of investment cost, the initial index is subtracted by 10 to obtain a new investment index, implying that the higher the score is, the higher the investment cost is.

Trade cost is captured by the index of freedom to trade internationally from the Economic Freedom of the World. The index, ranging from 0 to 10, consists of taxes on international trade, regulatory trade barriers, size of trade sector relative to expected, black-market exchange rates and international capital market controls. This index is also transformed, through being subtracted by 10, to comply with the principle that higher score suggests higher trade cost.

With regard to distance, the great circle distance from each host country’s capital city to Washington DC in the United States is used. The great circle distance refers to the shortest distance between any two points on the surface of a sphere. The distance is measured in kilometers and comes from Haveman’s international trade website.

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2 The structure of investment cost index has some differences by years in the Economic Freedom of the World. The components of the index listed in this paper are based on Economic Freedom of the World Report, 2008.

3 The structure of trade cost index has some differences by years in the Economic Freedom of the World. The components of the index listed in this paper are based on Economic Freedom of the World.
An index of legal structure and security of property rights from the Economic Freedom of the World is employed in this study to estimate the protection of IPR. From 2000 to 2004, the index is made up of five categories: (1) judicial independence, (2) impartial courts, (3) protection of intellectual property, (4) military interference in rule of law and the political process, (5) integrity of the legal system. Starting from 2005, two more categories were covered: (6) legal enforcement of contracts, (7) regulatory restrictions on the sale of real property. Comparing to the traditional GP index measuring IPR protection (Ginarte and Park, 1997), this index is collected annually and has a wider coverage of the whole legal protection system including the enforcement of contracts. Under this index, a country or region with higher score will have stronger IPR protection.

Two more issues need to be addressed. First, some missing data for certain years exist in affiliate sales and skilled-labor abundance. For the countries that have missing data for less than five years, the missing parts are substituted using moving averages of adjacent data values. Second, most of the existing studies which used log form to adjust the model specification when estimating the determinants of FDI, employ FDI flows or FDI stock as proxies of FDI. The data for FDI flows or FDI stock are usually nonzero. However, there are zero values for affiliate sales which will impede the usage of log form. Therefore, a value of 0.01 is used to take place of zero value when processing the data of affiliate sales, which will make the log form feasible. The descriptive statistics of variables in total
manufacturing are provided in Table 4.6. The descriptive statistics of variables in seven product sectors are presented in the appendix (Table A8-A14).

**Table 4.6 Descriptive Statistics of Total Manufacturing**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>( FDI_{ijt} )</td>
<td>26924.8310</td>
<td>42784.8820</td>
<td>147.0000</td>
<td>212748.7805</td>
</tr>
<tr>
<td>( GDP_{ijt} )</td>
<td>11087.1672</td>
<td>1056.6705</td>
<td>9771.9100</td>
<td>16684.3000</td>
</tr>
<tr>
<td>( GDP_{ijt} + GDP_{ijt} )</td>
<td>104535506.2567</td>
<td>18847379.0332</td>
<td>25982994.3321</td>
<td>132746990.2845</td>
</tr>
<tr>
<td>( SKL_{ijt} )</td>
<td>16.0132</td>
<td>13.3397</td>
<td>0.2019</td>
<td>68.8726</td>
</tr>
<tr>
<td>( GDP_{ijt} * SKL_{ijt} )</td>
<td>162418.0487</td>
<td>134315.2791</td>
<td>1918.7750</td>
<td>667937.1236</td>
</tr>
<tr>
<td>( PKD_{ijt} )</td>
<td>7.8870</td>
<td>4.4924</td>
<td>0.0178</td>
<td>17.1995</td>
</tr>
<tr>
<td>( GDP_{ijt} * PKD_{ijt} )</td>
<td>81176.5748</td>
<td>48082.1547</td>
<td>195.3772</td>
<td>197878.7072</td>
</tr>
<tr>
<td>( IC_{ijt} )</td>
<td>3.5907</td>
<td>0.9998</td>
<td>1.2000</td>
<td>6.0000</td>
</tr>
<tr>
<td>( TC_{ijt} )</td>
<td>2.3000</td>
<td>0.1688</td>
<td>2.0000</td>
<td>2.5000</td>
</tr>
<tr>
<td>( TC_{ijt} )</td>
<td>2.5665</td>
<td>0.8815</td>
<td>0.2000</td>
<td>6.4800</td>
</tr>
<tr>
<td>( TC_{ijt} * SKLD_{ijt} )</td>
<td>1098.1008</td>
<td>1776.3873</td>
<td>0.1263</td>
<td>10909.9062</td>
</tr>
<tr>
<td>( TC_{ijt} * PKD_{ijt} )</td>
<td>238.1470</td>
<td>219.1625</td>
<td>0.0001</td>
<td>845.2051</td>
</tr>
<tr>
<td>( IPR_{ijt} )</td>
<td>6.5644</td>
<td>1.8553</td>
<td>1.4000</td>
<td>9.6000</td>
</tr>
<tr>
<td>( IPR_{ijt} * SKLD_{ijt} )</td>
<td>2963.1657</td>
<td>5888.2316</td>
<td>0.1793</td>
<td>45062.6558</td>
</tr>
<tr>
<td>( IPR_{ijt} * PKD_{ijt} )</td>
<td>450.0653</td>
<td>369.6225</td>
<td>0.0027</td>
<td>2470.1158</td>
</tr>
<tr>
<td>( DIST_{ijt} )</td>
<td>7903.5771</td>
<td>3724.9104</td>
<td>733.8900</td>
<td>16370.8000</td>
</tr>
</tbody>
</table>

Note: Affiliates sales (FDI) are in millions of dollars. Gross domestic production (GDP) is in billions of dollars. Skilled labor related terms (SKL and SKLD) are in percentage. Physical capital per worker related terms (PKD and PKDS) are in thousands of dollars. Investment cost (IC), trade cost (TC) and IPR protection (IPR) are indices. Distance (DIST) is in kilometers.
CHAPTER 5
EMPIRICAL RESULTS

In this section, the results of the basic regressions and certain specification tests will be discussed. According to the selection of aggregated industry and disaggregated sub-sectors, there will be eight cases: 1) total manufacturing, 2) food processing, 3) chemicals, 4) primary and fabricated metals, 5) machinery, 6) computers and electronic products, 7) electrical equipment, appliances, and component, 8) transportation equipment. In each case, there will be two regression specifications. First of all, the model will be analyzed via fixed effects or random effects estimations incorporating robust standard error. The second regression is analyzed by Hausman-Taylor estimation to further fix the problem of endogeneity. In this chapter, the results of Hausman-Taylor estimation are presented and discussed (Table 5.1-5.2). As a robustness check, the results of fixed effects and random effects estimations are attached in the appendix (Table A15-A16).

5.1 Aggregated Total Manufacturing

The empirical results of the basic regressions are presented in Table
5.1-5.2. In the aggregated level, total manufacturing is analyzed. In Table 5.1, column (1) includes the regression for aggregated manufacturing industry and most variables appear to be statistically significant with the expected signs of the basic KC model predictions. $GDPS_{it}$ and $GDPDSQ_{it}$, as the variables for market size and market similarity, are both statistically significant at 1% level based on the Hausman-Taylor estimation. The positive coefficient of $GDPS_{it}$ confirms the crucial role of market size in attracting FDI. The negative coefficient of $GDPDSQ_{it}$ suggests that greater similarity in market size will induce more affiliate sales, which is consistent with the horizontal FDI motivations. Skilled-labor difference ($SKLD_{it}$) is insignificant while both physical capital difference ($PKD_{it}$) and its interaction with GDP difference ($GDPD_{it}$*$PKD_{it}$) are statistically significant, supporting the necessity and facilitation of incorporating the physical capital variables. Similar results from Blonigen, Davies and Head (2003) are obtained concerning the variables $PKD_{it}$ and $GDPD_{it}$*$PKD_{it}$. Smaller dissimilarity in physical capital endowments will encourage more affiliate sales, indicating that the affiliate sales in total manufacturing are mainly captured by the horizontal FDI motivation.

The following is a set of variables related to investment and trade cost. Higher investment cost in host country ($IC_{it}$) will decrease affiliate sales. Trade cost in parent country ($TC_{it}$) has an expected negative influence on affiliate sales though it is statistically insignificant. The substitutional relationship between horizontal FDI and international trade is confirmed by the positive influence of
host-country trade cost ($TC_p$). Thus, more affiliate sales will be encouraged by the increase of host-country trade cost. Both of the host-country trade cost interaction terms ($TC_p^*SKLD^Q_{ij}, \; TC_p^*PKDS^Q_{ij}$) are statistically significant but only $TC_p^*PKDS^Q_{ij}$ exhibit an expected negative sign which suggests that host-country trade cost will have a positive effect on horizontal FDI while decreasing vertical FDI.

The major interest in this study is the influence of IPR ($IPR_p$) and its related interaction terms ($IPR_p^*SKLD^Q_{ij}, \; IPR_p^*PKDS^Q_{ij}$) on the affiliate sales of foreign affiliates. According to the empirical results from column (1), stronger IPR protection will increase affiliate sales, which is consistent with the market expansion effect (Branstetter, et al., 2007; Branstetter and Saggi, 2009). In addition, the interaction term between IPR and squared physical capital difference ($TC_p^*PKDS^Q_{ij}$) is negative and statistically significant at 10% level. Therefore, the prediction is confirmed that tighter IPR protection will have a stronger acceleration effect on horizontal FDI. The relationship between FDI and distance is negative which is consistent with several previous studies (Carr, Markusen and Maskus, 2001; Blonigen, Davies and Head, 2003).

5.2 Disaggregated Sub-Sectors in Manufacturing

Seven different product sectors are selected to conduct the disaggregated analysis. Column (2) in Table 5.1 exhibits the regression results for
food processing sector which is quite similar to the ones from total manufacturing. With statistically significant values and expected signs, $GDPS_{i,t}$ and $GDPSQ_{i,t}$ continue to confirm the fact that affiliate sales will be promoted when both of the host and parent countries have larger and more similar market sizes. All the factor-endowments-relative variables are statistically significant except the skilled labor difference ($SKLD_{i,t}$). The negative effect of $PKD_{i,t}$ implies that greater similarity in physical capital will induce more affiliate sales, which is accordant with the horizontal FDI motivation indicated by the negative coefficient of $GDPDSQ_{i,t}$ as well. Therefore, the multinational activity in the food processing sector is mainly dominated by horizontal FDI incentives. High parent-country trade cost ($TC_{i,t}$) will discourage affiliate sales and horizontal FDI and trade are substitutable with each other based on the positive effect of host-country trade cost ($TC_{i,t}$). With regard to $TC_{i,t} * SKLD_{i,t}$, the influence of host-country trade cost is affirmed to vary by the types of FDI. All the IPR related variables are statistically significant at 5% level with the expected signs in the food processing sector. Tighter IPR protection will enhance affiliate sales, particularly with a stronger influence on horizontal FDI relative to vertical FDI. In general, horizontal FDI accounts for a bulk of multinational activities in food processing sector and most of the multinational firms in food processing sector will tend to seek and server large market.

For chemicals sector (column (3) in Table 5.1), most of the variables follow the basic predictions of KC model closely. Both $GDPDSQ_{i,t}$ and $PKD_{i,t}$ have
a negative influence on affiliate sales, suggesting a lot of FDI is horizontal in nature in chemicals sector. However, large difference in skilled labor tends to increase affiliate sales which is consistent with the vertical FDI motivation of fragmenting the production stages and locating the production plants in the unskilled-labor-intensive country. Therefore, both horizontal and vertical FDI motivations serve as important impellents in chemicals sector. Differing from food processing sector, IPR protection displays a negative effect but it is statistically insignificant.

In the primary and fabricated metals sector (column (4) in Table 5.1), few variables show statistical significance. Although both $GDP_{DSQ_{it}}$ and $PKD_{it}$ are statistically insignificant, the positive coefficient of $SKL_{it}$ demonstrates the leading role of vertical FDI in this sector. Considering the production nature of the primary and fabricated metals sector which requires fragmenting the production process and processing and assembling the intermediates in various unskilled-labor-intensive countries, it is reasonable for the multinational firms to fragment their production stages by locating fabricating process in the host country with abundant and cheap unskilled labor. Concerning IPR protection ($IPR_{jt}$) and its interactions with relative factor endowments ($IPR_{jt}^{*SKLDSQ_{it}}, IPR_{jt}^{*PKDSQ_{it}}$), IPR protection will have a market expansion effect on affiliate sales and tighter IPR protection tends to increase more horizontal FDI relative to vertical FDI. Comparing the magnitudes of the coefficients of $IPR_{jt}$ in food processing sector and primary and fabricated metals sector, the latter appears to have more influence.
on affiliate sales considering that the investment activities in primary and fabricated metals sector involves more skill- and capital-intensive components (Lee and Mansfield, 1996; Nunnenkamp and Spatz, 2004).
### Table 5.1 Results of Hausman- Taylor Estimation (1)

<table>
<thead>
<tr>
<th></th>
<th>Total Manufacturing</th>
<th>Food Processing</th>
<th>Chemicals</th>
<th>Primary and Fabricated Metals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FDI(_{ij})</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GDPS(_{ij})</strong></td>
<td>2.5282 ***</td>
<td>2.6529 ***</td>
<td>2.8939 ***</td>
<td>2.7396</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.162)</td>
</tr>
<tr>
<td><strong>GDPDSQ(_{ij})</strong></td>
<td>-0.1539 ***</td>
<td>-0.1366 ***</td>
<td>-0.1731 ***</td>
<td>0.1786</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.182)</td>
</tr>
<tr>
<td><strong>SKLD(_{ij})</strong></td>
<td>1.1409</td>
<td>0.2451</td>
<td>2.7132 ***</td>
<td>8.6801 **</td>
</tr>
<tr>
<td></td>
<td>(0.239)</td>
<td>(0.838)</td>
<td>(0.003)</td>
<td>(0.015)</td>
</tr>
<tr>
<td><strong>GDPD(_{ij})</strong> <em>SKLD(_{ij})</em>*</td>
<td>-0.3395 *</td>
<td>0.4614 *</td>
<td>-0.6620 ***</td>
<td>-0.3456</td>
</tr>
<tr>
<td></td>
<td>(0.080)</td>
<td>(0.054)</td>
<td>(0.000)</td>
<td>(0.641)</td>
</tr>
<tr>
<td><strong>PKD(_{ij})</strong></td>
<td>-0.7501 **</td>
<td>-0.9770 **</td>
<td>-0.9566 ***</td>
<td>-1.9170</td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.023)</td>
<td>(0.002)</td>
<td>(0.236)</td>
</tr>
<tr>
<td><strong>GDPD(_{ij})</strong> <em>PKD(_{ij})</em>*</td>
<td>0.2672 ***</td>
<td>0.2410 ***</td>
<td>0.3159 ***</td>
<td>0.3045</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.007)</td>
<td>(0.000)</td>
<td>(0.411)</td>
</tr>
<tr>
<td><strong>IC(_{it})</strong></td>
<td>-0.1128 ***</td>
<td>0.0947 **</td>
<td>-0.1116 ***</td>
<td>-0.0408</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.026)</td>
<td>(0.000)</td>
<td>(0.740)</td>
</tr>
<tr>
<td><strong>TC(_{it})</strong></td>
<td>-0.0788</td>
<td>-0.3390 *</td>
<td>-0.1365</td>
<td>0.0218</td>
</tr>
<tr>
<td></td>
<td>(0.593)</td>
<td>(0.081)</td>
<td>(0.325)</td>
<td>(0.969)</td>
</tr>
<tr>
<td><strong>TC(_{it})</strong></td>
<td>0.0988 **</td>
<td>0.1499 ***</td>
<td>0.1379 ***</td>
<td>-0.2064</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.005)</td>
<td>(0.000)</td>
<td>(0.202)</td>
</tr>
<tr>
<td><strong>TC(_{it})</strong> <em>SKLDSQ(_{ij})</em>*</td>
<td>0.4338 *</td>
<td>-0.6628 **</td>
<td>0.5314 **</td>
<td>0.6478</td>
</tr>
<tr>
<td></td>
<td>(0.055)</td>
<td>(0.020)</td>
<td>(0.012)</td>
<td>(0.510)</td>
</tr>
<tr>
<td><strong>TC(_{it})</strong> <em>PKDSQ(_{ij})</em>*</td>
<td>-0.0283 ***</td>
<td>-0.0064</td>
<td>-0.0334 ***</td>
<td>0.0590</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.578)</td>
<td>(0.000)</td>
<td>(0.167)</td>
</tr>
<tr>
<td><strong>IPR(_{jt})</strong></td>
<td>0.0878 ***</td>
<td>0.1120 **</td>
<td>-0.0105</td>
<td>0.6357 ***</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.012)</td>
<td>(0.738)</td>
<td>(0.000)</td>
</tr>
<tr>
<td><strong>IPR(_{jt})</strong> <em>SKLDSQ(_{ij})</em>*</td>
<td>-0.1014</td>
<td>-0.3036 **</td>
<td>-0.0626</td>
<td>-1.9729 ***</td>
</tr>
<tr>
<td></td>
<td>(0.351)</td>
<td>(0.026)</td>
<td>(0.537)</td>
<td>(0.000)</td>
</tr>
<tr>
<td><strong>IPR(_{jt})</strong> <em>PKDSQ(_{ij})</em>*</td>
<td>-0.0097 *</td>
<td>-0.0174 **</td>
<td>-0.0044</td>
<td>-0.0571 **</td>
</tr>
<tr>
<td></td>
<td>(0.093)</td>
<td>(0.018)</td>
<td>(0.418)</td>
<td>(0.021)</td>
</tr>
<tr>
<td><strong>DIST(_{ij})</strong></td>
<td>-0.5122 *</td>
<td>-0.5042</td>
<td>-0.5570 *</td>
<td>-0.0292</td>
</tr>
<tr>
<td></td>
<td>(0.071)</td>
<td>(0.268)</td>
<td>(0.061)</td>
<td>(0.990)</td>
</tr>
<tr>
<td></td>
<td>(0.149)</td>
<td>(0.103)</td>
<td>(0.025)</td>
<td>(0.330)</td>
</tr>
<tr>
<td>Observations</td>
<td>450</td>
<td>396</td>
<td>441</td>
<td>351</td>
</tr>
</tbody>
</table>

p-value in parenthesis

*denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level
All the statistically significant variables in the Hausman-Taylor estimation of machinery sector (column (5) in Table 5.2) show the expected signs expect $IPR_{jt} \times PKDSQ_{ij}$. The fact that $GDPDSQ_{ij}$ and $SKLD_{ij}$ both display a negative effect implies that affiliate sales in machinery sector will increase with smaller dissimilarity in market size and skilled labor. Thus, the FDI in this sector is also dominated by horizontal FDI motivations. $IPR_{jt}$ has a negative coefficient different from the above sectors and correspondently, the sign of $IPR_{jt} \times SKLDSQ_{ij}$ turns to be positive. One of the possible explanations is that it is relatively more popular and easier to imitate the products in machinery sectors. As a result, the resource wasting effect will lead to the decrease of FDI following tighter IPR protection and more horizontal FDI will be diminished.

According to the results for the computers and electronic products sector (column (6) Table 5.2), the sum of the market size in both countries $GDP_{ij}$ will encourage the affiliate sales. $GDPDSQ_{ij}$ shows a negative sign but it is statistically insignificant. With regard to $PKD_{ij}$ and $TC_{jt}$, larger physical capital difference plays a positive role in affiliate sales and high host-country trade cost decreases FDI, both indicating a vertical FDI incentive to fragment production processes into various stages across countries. Thus, analogous to primary and fabricated metals sector, the multinational activities in this sector support strong vertical FDI motivations which are accordance with its production nature of fragmentation and assembling as well. High host-country investment cost ($IC_{jt}$) and
parent-country trade cost \((TC_{it})\) will decrease affiliate sales. In terms of \(IPR_{jt}SKLDSQ_{ijt}\), the stronger effect of IPR protection on horizontal FDI relative to vertical FDI is confirmed in this sector as well.

With regard to electrical equipment, appliances, and component sector (column (7) in Table 5.2), a bulk of the FDI in this sector is dominated by horizontal motivations because of the negative coefficient of \(PKDSQ_{ijt}\) which implies that smaller difference in physical capital will motivate more affiliate sales. The coefficient of \(IPR_{jt}\) turns to be negative indicating a market power effect.

In Table 5.2, column (8) exhibits the results for transportation equipment sector. The coefficient of \(PKDSQ_{ijt}\) tends to be negative so that horizontal FDI motivations are displayed. IPR protection \((IPR_{jt})\) indicates a market expansion effect and it is also indicated that tighter IPR protection will have more influence on horizontal FDI relative to vertical FDI associated with the negative sign of \(IPR_{jt}PKDSQ_{ijt}\).
### Table 5.2 Results of Hausman- Taylor Estimation (2)

<table>
<thead>
<tr>
<th></th>
<th>Machinery</th>
<th>Computers and Electronic Products</th>
<th>Electrical Equipment, Appliances, and Component</th>
<th>Transportation Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_{Dj}^{ij}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$GDPS_{it}^{ij}$</td>
<td>2.2225</td>
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* p-value in parenthesis
** denotes significance at the 10% level, * at the 5% level, and *** at the 1% level
Particularly, the effect of IPR protection is much stronger in primary and fabricated metals sector, machinery sector, electrical equipment, appliances, and component sector and transportation equipment sector according to their relatively larger magnitude of $IPR_p$ coefficients. Therefore, these results confirm the previous findings that IPR protection will play a more important role in technology- and capital-intensive sectors. The fact that the type of FDI varies across different sectors affirms the statement of Yeaple (2003) that the type of FDI depends on how the country and industry choose between market-access motive (horizontal nature) and comparative advantage motive (vertical nature). For the dominant types of FDI in each sector, consistent results are obtained in machinery sector, computer and electronic products sector and transportation equipment sector when comparing to the study of Awokuse, Maskus and An (2011). However, because of the changes of sector definitions, the comparison may be inappropriate.

In this thesis, the country sample is a mixture of both developed and developing countries. In order to explore whether the effects will vary by the level of economic development, simulations of affiliate sales in different groups of economies are conducted for each industry and sector and the related results are presented in Table A17. The results from the simulation analysis indicate that there is notable variation in the level of affiliate sales across developed and developing countries. Thus, the level of economic development matters to the type and amount of FDI into a country.
CHAPTER 6

CONCLUSIONS AND POLICY IMPLICATIONS

This study examines how different factors, particularly IPR protection, will affect FDI based on a set of panel data consisting of 50 countries over a time period from 2000 to 2008. A recently developed knowledge-capital model and both aggregated and disaggregated FDI data are used to implement the analysis.

Several issues are discussed and addressed in this study. First of all, the recently developed knowledge-capital model, which allows for the simultaneous existence of horizontal and vertical FDI motivations, is used to estimate whether the effects of FDI determinants will vary by the type of FDI. According to the empirical results, most of the basic predictions of the knowledge-capital model are confirmed such that horizontal FDI will dominate if there is larger market size, greater similarities in market size and relative factor endowments and higher host-country trade cost, while vertical FDI will dominate if there is larger difference in relative factor endowments and lower investment cost.

In addition, it is found that each sector is dominated by different types of FDI and the effects of the basic factors in knowledge-capital model will vary by
the type of FDI and the specific sector. Multinational firms are dominated by horizontal FDI motivation to seek larger markets in certain industry and sectors such as the total manufacturing, food processing sector, machinery sector, electrical equipment, appliances, and component sector and transportation equipment sector. In chemicals sector, both horizontal and vertical FDI motivations explain for the multinational activities. Therefore, production of chemicals will not only tend to fragment the production process to take advantage of the cheap endowments like unskilled labor, but also be attracted to serve larger markets. Strong vertical FDI motivation is exhibited in other sectors suggesting that fragmentation of production stages and global cooperation of assembling and processing are still dominant in several sectors. These sectors include primary and fabricated metals sector and computers and electronic products sector. Overall, the mixed empirical results suggest that horizontal FDI motivation accounts for a bulk of global multinational activities although vertical FDI motivation still plays an important role in certain areas.

Second, the results show a strong linkage between FDI and IPR protection. Based on the results, IPR protection has significant effect on FDI in all cases except in two sectors (chemicals sector and computers and electronic products sector), indicating that IPR protection matters for attracting FDI. By incorporating the aggregated manufacturing industry and seven disaggregated product sectors, however, whether the effect is positive or negative tends to
depend on the sectors. Specifically, stronger IPR protection will encourage FDI with a market expansion effect in total manufacturing, food processing sector, primary and fabricated metals sector and transportation equipment sector. In contrast, stronger IPR protection has a negative effect on FDI indicating a market power effect in some other sectors (machinery sector and electrical equipment, appliances, and component sector).

Third, although many existing papers have investigated the relationship between FDI and IPR protection, none of them estimated whether the influence of IPR protection will vary by the type of FDI. In this study, two interaction terms between IPR protection and relative factor endowments, are used to address this issue. According to the results, most of the industry or sub-sectors show statistically significant estimates with the expected signs for at least one of the IPR interaction terms. Overall, tighter IPR protection will have a stronger effect on horizontal FDI relative to vertical FDI.

Furthermore, based on the relative larger magnitude of IPR protection coefficient in certain technology-intensive sectors, it is indicated that tighter IPR protection will have a stronger influence on technology- or capital-intensive product sectors.

The results of the thesis could shed some light on the governmental policies of IPR protection. In general, the influence of IPR protection should be emphasized in all of the countries. For developing countries, especially for those
intending to expand their technology transfer, stronger IPR protection could attract more technology-intensive FDI and enhance the technology transfer. Taking China as an example, during the 1980s and 1990s, China has focused on its abundant resource of unskilled labor and made use of the comparative advantage to attract more multinational firms to locate their processing and assembling plants in China. However, stronger IPR protection should be implemented to address the negative effect of imitation problem in China.

The research of this thesis is limited in several ways. First of all, the IPR index used in this thesis is limited in scope. Therefore, measurement of IPR protection which is more accurate and comprehensive will improve the efficiency of the empirical results. In further studies, more advanced econometric methodology could be considered. For example, Awokuse, Maskus and An (2011) used the GMM panel data regression method to better explore the dynamic nature of FDI. In addition, the affiliate sales of U.S. firms in foreign countries are used to better capture the actual and current value of FDI activities in this thesis. However, the data of affiliate sales does not cover a large country sample and the existence of zero values for affiliate sales may cause problems when using models in log form. Hence, the usage of other measurements of FDI like FDI stock may be considered to improve the country representativeness and model specification.
APPENDIX A

TABLES

Table A1 Country List of Food Processing

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### Table A6 Country List of Electrical Equipment, Appliances, and Component

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### Table A7 Country List of Transportation Equipment

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Note: Affiliates sales (FDI) are in millions of dollars. Gross domestic production (GDP) is in billions of dollars. Skilled labor related terms (SKLD and SKLDSQ) are in percentage. Physical capital per worker related terms (PKD and PKDSQ) are in thousands of dollars. Investment cost (IC), trade cost (TC) and IPR protection (IPR) are indices. Distance (DIST) is in kilometers.
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Note: Affiliates sales ($FDI$) are in millions of dollars. Gross domestic production ($GDP$) is in billions of dollars. Skilled labor related terms ($SKLD$ and $SKLDSQ$) are in percentage. Physical capital per worker related terms ($PKD$ and $PKDSQ$) are in thousands of dollars. Investment cost ($IC$), trade cost ($TC$) and IPR protection ($IPR$) are indices. Distance ($DIST$) is in kilometers.
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<td>16.1679</td>
<td>13.7679</td>
<td>0.3417</td>
<td>68.8726</td>
</tr>
<tr>
<td>$GDPD_{ijt} \times SKLD_{ijt}$</td>
<td>162729.5992</td>
<td>138253.4451</td>
<td>3237.1773</td>
<td>667937.1236</td>
</tr>
<tr>
<td>$PKD_{ijt}$</td>
<td>7.6896</td>
<td>4.6274</td>
<td>0.0178</td>
<td>17.1995</td>
</tr>
<tr>
<td>$GDPD_{ijt} \times PKD_{ijt}$</td>
<td>78677.8490</td>
<td>49408.0270</td>
<td>195.3772</td>
<td>197878.7072</td>
</tr>
<tr>
<td>$IC_{jt}$</td>
<td>3.4969</td>
<td>1.0115</td>
<td>2.0000</td>
<td>5.9000</td>
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<tr>
<td>$TC_{jt}$</td>
<td>2.3000</td>
<td>0.1688</td>
<td>2.0000</td>
<td>2.5000</td>
</tr>
<tr>
<td>$TC_{jt} \times SKLDSQ_{ijt}$</td>
<td>2.5325</td>
<td>0.9286</td>
<td>0.2000</td>
<td>6.4800</td>
</tr>
<tr>
<td>$TC_{jt} \times PKDSQ_{ijt}$</td>
<td>1118.1275</td>
<td>1912.5127</td>
<td>0.2452</td>
<td>10909.9062</td>
</tr>
<tr>
<td>$IPR_{jt}$</td>
<td>230.6453</td>
<td>219.5587</td>
<td>0.0001</td>
<td>845.2051</td>
</tr>
<tr>
<td>$IPR_{jt} \times SKLDSQ_{ijt}$</td>
<td>6.7197</td>
<td>1.8169</td>
<td>1.4000</td>
<td>12.6000</td>
</tr>
<tr>
<td>$IPR_{jt} \times PKDSQ_{ijt}$</td>
<td>3259.3427</td>
<td>6514.1799</td>
<td>1.0157</td>
<td>45062.6558</td>
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<tr>
<td>$DIST_{ijt}$</td>
<td>456.1604</td>
<td>394.5792</td>
<td>0.0027</td>
<td>2470.1158</td>
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<tr>
<td></td>
<td>7956.5723</td>
<td>3682.9686</td>
<td>733.8900</td>
<td>15958.0000</td>
</tr>
</tbody>
</table>

Note: Affiliates sales (FDI) are in millions of dollars. Gross domestic production (GDP) is in billions of dollars. Skilled labor related terms (SKLD and SKLDSQ) are in percentage. Physical capital per worker related terms (PKD and PKDSQ) are in thousands of dollars. Investment cost (IC), trade cost (TC) and IPR protection (IPR) are indices. Distance (DIST) is in kilometers.
### Table A14 Descriptive Statistics of Transportation Equipment

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>$FDI_{ijt}$</td>
<td>8223.4421</td>
<td>15216.1741</td>
<td>0.0000</td>
<td>76337.0000</td>
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<tr>
<td>$GDPS_{ijt}$</td>
<td>11224.7259</td>
<td>1142.2097</td>
<td>9776.4200</td>
<td>16684.3000</td>
</tr>
<tr>
<td>$GDPDSQ_{ijt}$</td>
<td>101914193.6669</td>
<td>19867137.3808</td>
<td>25982994.3321</td>
<td>132543508.2657</td>
</tr>
<tr>
<td>$SKLD_{ijt}$</td>
<td>15.9972</td>
<td>14.1812</td>
<td>0.2934</td>
<td>68.8726</td>
</tr>
<tr>
<td>$GDPD_{ijt} \times SKLD_{ijt}$</td>
<td>160441.2451</td>
<td>142066.8916</td>
<td>2759.2591</td>
<td>667937.1236</td>
</tr>
<tr>
<td>$PKD_{ijt}$</td>
<td>7.1009</td>
<td>4.3753</td>
<td>0.0178</td>
<td>13.9737</td>
</tr>
<tr>
<td>$GDPD_{ijt} \times PKD_{ijt}$</td>
<td>72047.6959</td>
<td>46140.4878</td>
<td>195.3772</td>
<td>154013.6249</td>
</tr>
<tr>
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<td>3.5199</td>
<td>1.0032</td>
<td>1.2000</td>
<td>5.9000</td>
</tr>
<tr>
<td>$TC_{it}$</td>
<td>2.3000</td>
<td>0.1688</td>
<td>2.0000</td>
<td>2.5000</td>
</tr>
<tr>
<td>$TC_{jt}$</td>
<td>2.4857</td>
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<td>0.2000</td>
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<tr>
<td>$TC_{jt} \times SKLDSQ_{ijt}$</td>
<td>1110.6425</td>
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<td>10909.9062</td>
</tr>
<tr>
<td>$TC_{jt} \times PKDSQ_{ijt}$</td>
<td>199.6983</td>
<td>204.3481</td>
<td>0.0001</td>
<td>845.2051</td>
</tr>
<tr>
<td>$IPR_{jt}$</td>
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<td>1.7448</td>
<td>1.4000</td>
<td>9.6000</td>
</tr>
<tr>
<td>$IPR_{jt} \times SKLDSQ_{ijt}$</td>
<td>3314.4572</td>
<td>6734.2913</td>
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<td>45062.6558</td>
</tr>
<tr>
<td>$IPR_{jt} \times PKDSQ_{ijt}$</td>
<td>392.2420</td>
<td>340.3101</td>
<td>0.0027</td>
<td>1285.8990</td>
</tr>
<tr>
<td>$DIST_{jt}$</td>
<td>8353.6135</td>
<td>3817.0878</td>
<td>733.8900</td>
<td>16370.8000</td>
</tr>
</tbody>
</table>

Note: Affiliates sales (FDI) are in millions of dollars. Gross domestic production (GDP) is in billions of dollars. Skilled labor related terms (SKLD and SKLDSQ) are in percentage. Physical capital per worker related terms (PKD and PKDSQ) are in thousands of dollars. Investment cost (IC), trade cost (TC) and IPR protection (IPR) are indices. Distance (DIST) is in kilometers.
Table A15 Results of Fixed Effects and Random Effects Estimations (1)

<table>
<thead>
<tr>
<th></th>
<th>Total Manufacturing</th>
<th>Food Processing</th>
<th>Chemicals</th>
<th>Primary and Fabricated Metals</th>
</tr>
</thead>
<tbody>
<tr>
<td>$FDI_{ij}$</td>
<td>RE (1)</td>
<td>RE (2)</td>
<td>RE (3)</td>
<td>RE (4)</td>
</tr>
<tr>
<td>$GDPS_{ij}$</td>
<td>2.5688 ***</td>
<td>2.5319 ***</td>
<td>2.9249 ***</td>
<td>1.9978</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.001)</td>
<td>(0.000)</td>
<td>(0.290)</td>
</tr>
<tr>
<td>$GDPD_{ij}$</td>
<td>-0.1476 ***</td>
<td>-0.1452 ***</td>
<td>-0.1651 ***</td>
<td>-0.1283 ***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>$SKLD_{ij}$</td>
<td>1.2155</td>
<td>0.1277</td>
<td>2.7772</td>
<td>7.6124</td>
</tr>
<tr>
<td></td>
<td>(0.554)</td>
<td>(0.950)</td>
<td>(0.108)</td>
<td>(0.341)</td>
</tr>
<tr>
<td>$GDPD_{ij}^{*}SKLD_{ij}$</td>
<td>-0.3436</td>
<td>0.4969</td>
<td>-0.6640 **</td>
<td>-0.1209</td>
</tr>
<tr>
<td></td>
<td>(0.344)</td>
<td>(0.136)</td>
<td>(0.012)</td>
<td>(0.899)</td>
</tr>
<tr>
<td>$PKD_{ij}$</td>
<td>-0.6673 *</td>
<td>-0.5834</td>
<td>-0.9089 **</td>
<td>-0.2702</td>
</tr>
<tr>
<td></td>
<td>(0.079)</td>
<td>(0.332)</td>
<td>(0.022)</td>
<td>(0.832)</td>
</tr>
<tr>
<td>$GDPD_{ij}^{*}PKD_{ij}$</td>
<td>0.2469 **</td>
<td>0.1861</td>
<td>0.2995 ***</td>
<td>0.1595</td>
</tr>
<tr>
<td></td>
<td>(0.024)</td>
<td>(0.233)</td>
<td>(0.003)</td>
<td>(0.433)</td>
</tr>
<tr>
<td>$IC_{ij}$</td>
<td>-0.1131 **</td>
<td>0.0904</td>
<td>-0.1128 **</td>
<td>-0.0490</td>
</tr>
<tr>
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<td>(0.027)</td>
<td>(0.207)</td>
<td>(0.024)</td>
<td>(0.841)</td>
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<tr>
<td>$TC_{ij}$</td>
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<td>-0.3096</td>
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<td>-0.0806</td>
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<tr>
<td></td>
<td>(0.638)</td>
<td>(0.109)</td>
<td>(0.291)</td>
<td>(0.916)</td>
</tr>
<tr>
<td>$TC_{ij}^{*}SKLD_{ij}$</td>
<td>0.0926</td>
<td>0.1699 *</td>
<td>-0.1289</td>
<td>-0.0974</td>
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<tr>
<td></td>
<td>(0.206)</td>
<td>(0.064)</td>
<td>(0.165)</td>
<td>(0.619)</td>
</tr>
<tr>
<td>$TC_{ij}^{*}PKDSQ_{ij}$</td>
<td>0.4303</td>
<td>-0.6237</td>
<td>0.5056 *</td>
<td>1.3991</td>
</tr>
<tr>
<td></td>
<td>(0.197)</td>
<td>(0.314)</td>
<td>(0.056)</td>
<td>(0.150)</td>
</tr>
<tr>
<td>$DC_{ij}^{*}PKDSQ_{ij}$</td>
<td>-0.0277 **</td>
<td>-0.0109</td>
<td>-0.0322 **</td>
<td>0.0147</td>
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<tr>
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<td>(0.041)</td>
<td>(0.675)</td>
<td>(0.020)</td>
<td>(0.730)</td>
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<tr>
<td>$IPR_{ij}$</td>
<td>0.0902 *</td>
<td>0.1101 *</td>
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<tr>
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<td>(0.058)</td>
<td>(0.096)</td>
<td>(0.815)</td>
<td>(0.160)</td>
</tr>
<tr>
<td>$IPR_{ij}^{*}SKLD_{ij}$</td>
<td>-0.1114</td>
<td>-0.3046</td>
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<td>-2.0661 **</td>
</tr>
<tr>
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<td>(0.609)</td>
<td>(0.247)</td>
<td>(0.747)</td>
<td>(0.042)</td>
</tr>
<tr>
<td>$IPR_{ij}^{*}PKDSQ_{ij}$</td>
<td>-0.0097</td>
<td>-0.0168</td>
<td>0.0043</td>
<td>-0.0422</td>
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<tr>
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<td>(0.139)</td>
<td>(0.125)</td>
<td>(0.563)</td>
<td>(0.240)</td>
</tr>
<tr>
<td>$DIST_{ij}$</td>
<td>-0.5140 **</td>
<td>-0.6588 **</td>
<td>-0.5443 ***</td>
<td>-0.7690 **</td>
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<tr>
<td></td>
<td>(0.015)</td>
<td>(0.019)</td>
<td>(0.001)</td>
<td>(0.023)</td>
</tr>
<tr>
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<td>(0.119)</td>
<td>(0.180)</td>
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<td>(0.636)</td>
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<tr>
<td>Observations</td>
<td>450</td>
<td>396</td>
<td>441</td>
<td>351</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.7000</td>
<td>0.5798</td>
<td>0.7094</td>
<td>0.4288</td>
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</tbody>
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p-value in parenthesis
*denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level
Table A16 Results of Fixed Effects and Random Effects Estimations (2)

<table>
<thead>
<tr>
<th></th>
<th>Machinery</th>
<th>Computers and Electronic Products</th>
<th>Electrical Equipment, Appliances, and Component</th>
<th>Transportation Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>$FDI_{ijt}$</td>
<td>FE (5)</td>
<td>RE (6)</td>
<td>FE (7)</td>
<td>FE (8)</td>
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<tr>
<td>$GDPS_{ijt}$</td>
<td>1.3054</td>
<td>3.9137 ***</td>
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<td>(0.684)</td>
<td>(0.000)</td>
<td>(0.626)</td>
<td>(0.391)</td>
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<tr>
<td>$GDPDSQ_{ijt}$</td>
<td>-1.0815 **</td>
<td>-0.1042 **</td>
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<td>0.9331</td>
</tr>
<tr>
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<td>$SKLD_{ijt}$</td>
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<td>4.2108</td>
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</tr>
<tr>
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<td>(0.264)</td>
<td>(0.333)</td>
<td>(0.496)</td>
<td>(0.250)</td>
</tr>
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<td>4.7622</td>
<td>-0.0131</td>
<td>-0.7673</td>
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</tr>
<tr>
<td></td>
<td>(0.292)</td>
<td>(0.990)</td>
<td>(0.676)</td>
<td>(0.091)</td>
</tr>
<tr>
<td>$PKD_{ijt}$</td>
<td>0.4029</td>
<td>1.3284</td>
<td>-8.3375 **</td>
<td>-8.5073 ***</td>
</tr>
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<td>(0.424)</td>
<td>(0.164)</td>
<td>(0.050)</td>
<td>(0.000)</td>
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<tr>
<td>$GDPD_{ijt} \times PKD_{ijt}$</td>
<td>-0.3236</td>
<td>-0.1800</td>
<td>1.6860</td>
<td>1.6567 ***</td>
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<td>(0.803)</td>
<td>(0.482)</td>
<td>(0.171)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>$IC_{jt}$</td>
<td>-0.4810 ***</td>
<td>-0.1667</td>
<td>-0.2595</td>
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<td>(0.138)</td>
<td>(0.499)</td>
<td>(0.980)</td>
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<tr>
<td>$TC_{jt}$</td>
<td>-0.0637</td>
<td>-0.6120 *</td>
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</tr>
<tr>
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<td>(0.951)</td>
<td>(0.091)</td>
<td>(0.295)</td>
<td>(0.482)</td>
</tr>
<tr>
<td>$TC_{jt}$</td>
<td>0.3475</td>
<td>-0.4470 **</td>
<td>0.2147</td>
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<tr>
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<td>(0.981)</td>
</tr>
<tr>
<td>$TC_{jt} \times SKLDSQ_{ijt}$</td>
<td>-0.6691</td>
<td>1.9452 **</td>
<td>-2.1558</td>
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<tr>
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<td>(0.288)</td>
<td>(0.541)</td>
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<td>-0.0551</td>
<td>-0.0144</td>
<td>0.0065</td>
</tr>
<tr>
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<td>(0.907)</td>
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<tr>
<td>$IPR_{jt}$</td>
<td>-0.5083 **</td>
<td>0.0966</td>
<td>-0.4447 *</td>
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<tr>
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<td>(0.050)</td>
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<td>(0.075)</td>
<td>(0.211)</td>
</tr>
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<td>$IPR_{jt} \times SKLDSQ_{ijt}$</td>
<td>0.6774</td>
<td>-1.3025 ***</td>
<td>0.1398</td>
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<td>(0.003)</td>
<td>(0.881)</td>
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<td>0.0459</td>
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<td>-0.0020</td>
<td>-0.1010 **</td>
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<td>(0.045)</td>
</tr>
<tr>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.726)</td>
<td>(0.012)</td>
<td>(0.673)</td>
<td>(0.393)</td>
</tr>
<tr>
<td>Observations</td>
<td>396</td>
<td>315</td>
<td>351</td>
<td>324</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.3651</td>
<td>0.3131</td>
<td>0.3171</td>
<td>0.2758</td>
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</tbody>
</table>

p-value in parenthesis
*denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level
### Table A17 Simulated Affiliate Sales (Millions of Dollars)

<table>
<thead>
<tr>
<th>Category</th>
<th>All countries</th>
<th>Developed Countries</th>
<th>Developing Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Manufacturing</td>
<td>8763.0440</td>
<td>15359.9309</td>
<td>4289.9199</td>
</tr>
<tr>
<td>Food Processing</td>
<td>688.5542</td>
<td>1523.9556</td>
<td>311.1088</td>
</tr>
<tr>
<td>Chemicals</td>
<td>1629.0858</td>
<td>2753.4442</td>
<td>855.0939</td>
</tr>
<tr>
<td>Primary and Fabricated Metals</td>
<td>210.2311</td>
<td>547.1376</td>
<td>38.0920</td>
</tr>
<tr>
<td>Machinery</td>
<td>239.2279</td>
<td>120.5530</td>
<td>710.9225</td>
</tr>
<tr>
<td>Computers and Electronic Products</td>
<td>45.3976</td>
<td>909.4576</td>
<td>0.0253</td>
</tr>
<tr>
<td>Electrical Equipment, Appliances, and Component</td>
<td>100.7806</td>
<td>69.7125</td>
<td>162.3295</td>
</tr>
<tr>
<td>Transportation Equipment</td>
<td>831.5537</td>
<td>4548.7863</td>
<td>47.4160</td>
</tr>
</tbody>
</table>
REFERENCES


Brainard, S. L., 1993a. A Simple Theory of Multinational Corporations and Trade with A Trade-off between Proximity and Concentration. NBER (Cambridge,


UNCTAD.


