ESSAYS IN INTERNATIONAL ECONOMICS AND DEVELOPMENT

by

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of the Requirement for the Degree
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Graduate Supervisory Committee:

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This dissertation consists of three essays that broadly deal with the international economics and development.

The first chapter provides empirical evidence of the prevalence and importance of intangible capital transfer within multinational corporations (MNCs). Using a unique data set of Korean multinational foreign affiliates, I find that most of the foreign affiliates have managers transferred from their parent, while almost half are isolated from the parent in terms of physical trade. Furthermore, the transferred managers are positively associated with labor productivity, while physical trade from the parent is less so. I consider two possibilities for this productivity effect: (1) the managers transferred from the parent are simply more efficient than native managers; and (2) they provide knowledge that increases the productivity of all inputs. I find that the latter is consistent with the data. My findings provide evidence that transferring managers from the parent is a main source of benefit from foreign direct investment (FDI) to foreign affiliates because the managers transfer firm-specific knowledge.

The second chapter analyzes importance role of service or other sectors for economic growth of manufacturing. Productivity in agriculture or services has long been understood as playing an important role in the growth of manufacturing. In this paper we provide an endogenous growth model in which manufacturing growth is stimulated by the non-manufacturing sector that provides goods used for both research and final consumption. The model permits to evaluation of two policy options for stimulating manufacturing growth: (1) a country imports more non-manufacturing goods from a foreign country with a higher productivity; or (2) the country increases productivity of domestic non-manufacturing. We find that both policies increase welfare of the economy, but depending on the policy the manufacturing sector responses differently. Specifically, employment and value added in manufacturing rise with policy
(1), but contract with policy (2). Therefore, specialization through importing non-manufacturing goods explains how some Asian economies experience fast growth in the manufacturing sector without progress in the other sectors.

The third chapter tests for the importance of composition effects in affecting levels and changes of education wage premiums. In this paper I revisit composition effects in the context of Korea. Korea’s large and rapid expansion of education makes it an ideal place to look for composition effects. A large, policy-induced increase in attainment in the 1980s offers additional scope for identifying composition effects. I find strong evidence that the policy-induced expansion of education lowered education wage premiums for the affected cohorts, but only weak evidence that the trend expansion of education lowered education wage premiums.
To Youngeun whose love, support and devotion made all my achievements possible
and to our lovely girls, Cheryl and Isabella who are the most precious gift.
ACKNOWLEDGEMENTS

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I would like to thank my parents and other family members. They always support and encourage me with the best wishes. I also owe a huge debt to James Kerber and Cheryl Kerber. They never hesitate to help and support me as parents in the states.

Finally, the second chapter of this dissertation is coauthored with Zhizhuang (Andy) Ge and the third chapter is coauthored with Todd Schoellman and Hakki Lee. I am grateful to have such dedicated and talented colleagues.
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Chapter 1

INTANGIBLE CAPITAL TRANSFER WITHIN MULTINATIONALS

1.1 Introduction

Productivity differences are the main source of income differences across countries. Foreign direct investment (FDI) is one of the main channels for international linkages and knowledge transfers to improve productivity. A large literature provides empirical evidence that FDI increases the recipient’s productivity. However, the previous literature does not provide empirical evidence of what benefit transfers to the recipient and how this transfer increases the recipient’s productivity. In this paper, I provide empirical evidence of the benefit from FDI by examining foreign affiliates of multinational corporations (MNCs).

The goal of this paper is to evaluate whether managers sent from a parent to its foreign affiliates transfer intangible capital and, if so, whether the benefits from doing so are substantial. I document three findings using data on Korean MNCs. First, managers from the parent at foreign affiliates are common relative to production workers from the parent or to physical trade within the MNC. Second, the managers substantially raise the foreign affiliate’s productivity. Third, the managers’ presence is inconsistent with the simple view that they are simply more efficient than native managers as an input, but is consistent with the view that they transfer firm-specific knowledge that increases the productivity of all inputs.

The previous literature emphasizes the importance of knowledge transfers through

\footnote{Hall and Jones (1999), Caselli and Coleman (2001) and Comin and Hobijn (2004).}

FDI. Theoretical work, including Markusen (1984), Garicano and Rossi-Hansberg (2006) and McGrattan and Prescott (2009), argues that an MNC can transfer its firm-specific knowledge – such as proprietary technology and superior marketing or management techniques – to its foreign affiliates to overcome difficulties in a foreign country. ³ At the aggregate level, quantitative studies, including Burstein and Monge-Naranjo (2009), McGrattan and Prescott (2009), Ramondo (2012) and Ramondo and Rodríguez-Clare (2013), emphasize that such knowledge transfers through MNCs are an important source of welfare gains to the host country. However, there is little empirical work to provide evidence about how an MNC transfers its specific knowledge to its affiliates. The contribution of this paper is to bridge that gap by providing empirical evidence on intangible capital transfers within MNCs.

This paper exploits a unique data set, the “Benchmark Survey of Korean Multinational Affiliates Abroad”, which comprises data collected by the Korean Export Import Bank (EXIM). The novel feature of the data is that they track the assignment of employees and of physical trade in foreign affiliates of Korean multinationals. These data allow me to observe employee transfers and physical trade within MNCs. ⁴ From details regarding employees and transactions, I document three new facts:

1. Intangible capital – especially via manager transfer – is more common. That

³This literature refers to firm-specific knowledge by different terms, such as knowledge capital (Markusen (1984)), managerial ability (Garicano and Rossi-Hansberg (2006)) and technology capital (McGrattan and Prescott (2009)). It is unique knowledge that a firm possesses and is different from other inputs because it can be used in multiple locations at the same time, but does not hurt the returns of existing operations.

⁴The two channels, physical trade and employee transfers, as avenues to transfer knowledge have been proposed and investigated theoretically and empirically. Theoretically, literature motivated by vertical FDI, including Helpman (1984), and literature about economic development, including Romer (1990), Grossman and Helpman (1991) and Aghion and Howitt (1992), emphasize the trade of intermediate goods to transfer knowledge. Empirically, Keller (2002), Madsen (2007) Nishioka and Ripoll (2012) and Keller and Yeaple (2013), among others, provide evidence that intermediate goods augmented with knowledge are an important channel to transfer knowledge from developed countries to developing countries. However, Fosfuri, Motta, and Ronde (2001) and Glass and Saggi (2002), among others, emphasize the importance of employee moves to transfer knowledge across firms. Empirically, Balsvik (2011), using Norwegian manufacturing, shows that employees from MNCs increase productivity of non-MNCs.
is, more affiliates have managers from the parent than production workers or physical trade.

2. Managers from the parent are positively associated with an affiliate’s labor productivity.

3. The percentage of native managers increases as the affiliates become larger.

The data indicate that manager flows, but neither production worker flows nor physical trade, are a key link between parents and their affiliates. In 2010, foreign affiliates had employees from the parent in ten percent of their management positions but in only one percent in their production positions. Furthermore, 81 percent of the foreign affiliates had at least one manager from the parent, whereas only 30 percent had any production workers from the parent. In addition, most of the foreign affiliates are isolated from the parent in terms of physical trade, which indicates that firm-specific knowledge is not transferred in the form of physical technologies. A large fraction, 44 percent, of foreign affiliates made precisely zero purchases from the parent. Even if I include indirect imports from the parent through other affiliates within the same MNCs, 35 percent of the affiliates still had no purchases.

In addition, I find that managers from the parent are positively associated with labor productivity. The estimation results show that a ten-percent increase in the share of managers from the parent over total managers is positively associated with a four-percent increase in value-added per employee of a foreign affiliate. However, intra-firm or family trades have smaller or insignificant effects on labor productivity. The correlation between the share of intra-firm or family trade over total transactions and value-added per employee is less than one percent, or statistically insignificant.

Even though most foreign affiliates of MNCs have managers from the parent and though they are positively associated with the affiliate’s productivity, only a few
managers are transferred from the parent, and the number of the managers is not dependent on the affiliate’s size. Most of the foreign affiliates have fewer than ten managers from the parent, while the number of native managers seems to increase as the affiliates become larger. Thus, the share of managers from the parent over total managers tends to decrease as the affiliates become larger. In the context of a standard model of firm productivity, this result implies that managers from the parent are not more efficient than managers from the host country, but that managers from the parent transfer knowledge that can improve the affiliate’s productivity. Furthermore, my result also shows that managers from the parent can provide information or knowledge held by the MNC but not knowledge specific to the host country. Thus, these findings provide evidence that parents transfer firm-specific knowledge to their affiliates through managers.

My findings support a view of the importance of transferring intangible capital within MNCs or multi-plant firms that share the same ownership, as in Atalay, Hortacsu, and Syverson (2012) and Ramondo, Rappoport, and Ruhl (2012). Atalay, Hortacsu, and Syverson (2012) show that even if a U.S. firm owns its affiliate within its production chain, it is hard to see physical transactions. As an alternative explanation, they suggest that vertical ownership promotes efficient intra-firm transfers of intangible inputs. Using U.S. multinationals, Ramondo, Rappoport, and Ruhl (2012) also show that U.S. MNCs are isolated from the parents in terms of physical trade, and that input-output links between the affiliates and the parent are not associated with intra-firm flows of physical goods. They suggest that the comparative advantage of MNCs may come from transferring intangible assets, not from physical trades.

Neither Atalay, Hortacsu, and Syverson (2012) nor Ramondo, Rappoport, and Ruhl (2012), however, provides explicit evidence of an intangible capital transfer. In this paper, I show new evidence of intangible capital transfer through manager transfers.
and examine the characteristics of the managers.

The remainder of the paper is organized as follows. Section 1.2 describes the Korean MNCs foreign affiliates data and documents some interesting facts using it. Section 1.3 provides a simple model for choosing a manager from either the parent or the host country. Section 1.4 presents an empirical analysis of foreign affiliates in MNCs using Korean MNCs data related to patterns of managers and discusses the results from the estimations. Section 1.5 concludes.

1.2 Data

1.2.1 Multinational Corporations Data

The firm-level data set is from the “Benchmark Survey of Korean Multinational Affiliates Abroad” collected by the state-owned EXIM and conducted yearly since 1999. In 2010, for example, 35,950 Korean foreign affiliates operating abroad reported to the EXIM. Among them, the EXIM attempted to survey 7,332 affiliates that had total accumulated investments of more than $1 million and are required by law to submit their annual business report. My original sample from the EXIM has details of 3,893 affiliates that responded to the 2010 survey. \(^5\) It covers 11 percent of the total number of Korean affiliates abroad but 65 percent of the total accumulated investments of Korean MNCs in that year. The data are, therefore, a non-random sample that overrepresents relatively large foreign affiliates in terms of total accumulated investments.

The key feature of these data is information about employees and trade of foreign affiliates abroad from 2005 to 2010, including 3,583 parents investing in 5,970 foreign

\(^5\)Under some circumstances, such a close inspection, the EXIM may excuse an affiliate from submitting its annual business report. The EXIM also dropped some observations due to reliability.
Some affiliates reported either total sales or purchases of zero for a certain year, and I exclude these for that year from my analysis. The exclusion does not change my main results: The final sample has 2,349 parents investing in 3,908 affiliates. On average, in 2010, a parent had 1.9 affiliates, and the median parent had one affiliate. A parent had, at most, 55 affiliates throughout the world. Additionally, the data set provides information regarding the country and industry in which each affiliate operates.

The foreign affiliates in these data operate actively in both developing and developed countries. Table 1.1 shows the top 20 countries hosting Korean MNCs in terms of number of affiliates in 2010. In the sample, China hosted the most Korean affiliates, 1,033, with total sales of $124,485 million and 465,936 employees. The U.S. hosted the second-most Korean MNCs with 244 affiliates, total sales of $69,912 million and 30,553 employees. In terms of the number of employees only 223,323 Vietnam hosted the second-most Korean MNCs with 193 affiliates and $5,597 million in sales. As Table 1.1 shows, these affiliates operate in various countries that are quite different by market size or endowments.

Across industries, Korean MNCs operate their foreign affiliates mainly in manufacturing. Table 1.2 shows that 69 percent of Korean foreign affiliates were in manufacturing in 2010. They hired more than 90 percent of the total employees and accounted for more than 55 percent of the total sales of the Korean foreign affiliates. The wholesale and retail trade industry hosted the second-most Korean affiliates abroad in terms of number of affiliates. They hired relatively fewer employees, but

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6 Not all affiliates reported for the entire six years. As I noted before, 3,893 affiliates responded in 2010.

7 Industries are classified by a two-digit Korean Standard Industrial Classification (KSIC) and is broken down into 65 industries.

8 I define as a developing country one in which PPP GDP per capita from Penn World Table 7.1 was lower than that of Korea, $25,029 in 2010, and as a developed country if not. Even if I consider the breakpoint as $20,000, the result is not different.
Table 1.1: Foreign Affiliates of Korean MNCs in 2010, by Country

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of Affiliates</th>
<th>Sales ($millions)</th>
<th>Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>1,033</td>
<td>124,485</td>
<td>465,936</td>
</tr>
<tr>
<td>US</td>
<td>244</td>
<td>66,912</td>
<td>30,553</td>
</tr>
<tr>
<td>Vietnam</td>
<td>193</td>
<td>5,597</td>
<td>223,323</td>
</tr>
<tr>
<td>Indonesia</td>
<td>89</td>
<td>11,270</td>
<td>114,601</td>
</tr>
<tr>
<td>Japan</td>
<td>77</td>
<td>15,073</td>
<td>3,701</td>
</tr>
<tr>
<td>Panama</td>
<td>54</td>
<td>1,412</td>
<td>1,600</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>49</td>
<td>16,752</td>
<td>18,719</td>
</tr>
<tr>
<td>India</td>
<td>47</td>
<td>9,756</td>
<td>30,686</td>
</tr>
<tr>
<td>Thailand</td>
<td>42</td>
<td>6,041</td>
<td>16,810</td>
</tr>
<tr>
<td>Slovakia</td>
<td>31</td>
<td>10,992</td>
<td>12,629</td>
</tr>
<tr>
<td>Germany</td>
<td>31</td>
<td>23,632</td>
<td>2,113</td>
</tr>
<tr>
<td>Malaysia</td>
<td>24</td>
<td>5,935</td>
<td>2,771</td>
</tr>
<tr>
<td>Singapore</td>
<td>22</td>
<td>35,823</td>
<td>1,561</td>
</tr>
<tr>
<td>Taiwan</td>
<td>22</td>
<td>17,855</td>
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<tr>
<td>Poland</td>
<td>21</td>
<td>6,545</td>
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<tr>
<td>Russia</td>
<td>20</td>
<td>8,292</td>
<td>7,448</td>
</tr>
<tr>
<td>Philippine</td>
<td>19</td>
<td>2,594</td>
<td>16,150</td>
</tr>
<tr>
<td>Mexico</td>
<td>19</td>
<td>3,854</td>
<td>9,185</td>
</tr>
<tr>
<td>Turkey</td>
<td>17</td>
<td>2,378</td>
<td>4,496</td>
</tr>
<tr>
<td>Canada</td>
<td>17</td>
<td>5,928</td>
<td>1,143</td>
</tr>
</tbody>
</table>

Notes: The table shows the top 20 countries in 2010 with the most Korean foreign affiliates in the sample.

they sold, on average, more than manufacturing. Although other sectors are not as prevalent as manufacturing or wholesale and retail trade, Korean MNCs invest in a variety of industries.

The distinctive feature of this data set is that it provides details of foreign affiliates’ employee information. It records the number of employees of affiliates categorized
### Table 1.2: Foreign Affiliates of Korean MNCs in 2010, by Industry

<table>
<thead>
<tr>
<th>Industry</th>
<th>Number of Affiliates</th>
<th>Sales ($millions)</th>
<th>Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>1,597</td>
<td>244,429</td>
<td>1,008,455</td>
</tr>
<tr>
<td>Wholesale and Retail Trade</td>
<td>325</td>
<td>166,747</td>
<td>52,863</td>
</tr>
<tr>
<td>Real Estate and Renting</td>
<td>99</td>
<td>1,594</td>
<td>3,923</td>
</tr>
<tr>
<td>Transportation</td>
<td>59</td>
<td>10,183</td>
<td>11,459</td>
</tr>
<tr>
<td>Publishing and Communications</td>
<td>50</td>
<td>925</td>
<td>4,587</td>
</tr>
<tr>
<td>Professional, Scientific and Technical Activities</td>
<td>35</td>
<td>3,452</td>
<td>2,203</td>
</tr>
<tr>
<td>Construction</td>
<td>33</td>
<td>1,122</td>
<td>6,089</td>
</tr>
<tr>
<td>Mining</td>
<td>31</td>
<td>13,775</td>
<td>12,886</td>
</tr>
<tr>
<td>Arts, Sports and Recreation Related Services</td>
<td>28</td>
<td>119</td>
<td>2,157</td>
</tr>
<tr>
<td>Hotels and Restaurants</td>
<td>19</td>
<td>384</td>
<td>3,417</td>
</tr>
<tr>
<td>Agriculture, Forestry And Fishery</td>
<td>16</td>
<td>53</td>
<td>972</td>
</tr>
<tr>
<td>Business Facilities Management and Support Services</td>
<td>6</td>
<td>849</td>
<td>498</td>
</tr>
<tr>
<td>Other Service</td>
<td>5</td>
<td>19</td>
<td>277</td>
</tr>
<tr>
<td>Education Service</td>
<td>4</td>
<td>4</td>
<td>84</td>
</tr>
<tr>
<td>Electricity, Sewerage and Waste Management</td>
<td>3</td>
<td>46</td>
<td>21</td>
</tr>
<tr>
<td>Human Health and Social Work</td>
<td>3</td>
<td>3</td>
<td>60</td>
</tr>
<tr>
<td>Materials Recovery and Remediation</td>
<td>1</td>
<td>3</td>
<td>40</td>
</tr>
</tbody>
</table>

Notes: The table sorts industries in terms of number of Korean foreign affiliates operating in 2010 in the sample. The industry classification follows KSIC.

by whether the employees are natives or Koreans and which one of four positions they hold in the affiliate: Executive, Manager, Sales or Production. Henceforth, I classify employees in Executive and Manager positions as managers and in Sales and Production positions as production workers, following Caliendo, Monte, and Rossi-Hansberg (2012). Furthermore, I assume that all Korean employees are sent from the parent in Korea. In view of the fact that the Korean government allowed people to hold only one citizenship before 2011, being Korean means that the individual is a permanent Korean resident; and because it is rare that an MNC transfers a worker from a third-party firm to an affiliate, my assumption is reasonable. From this assumption, I can distinguish two types of managers by origin.
Another advantage of this data set is that I have relatively detailed information on sales and purchases in the affiliates. I have the value, in dollars, of affiliates’ exports and imports with other partners around the world. A partner is identified by two criteria: whether it is within the same MNC; and whether it is in the same country, either Korea or another country. From this information, I define sales and purchases directly with the parent as intra-firm exports and imports, respectively, and with the parent and partners within the same MNC as intra-family exports and imports.

In what follows, I analyze the composition of employees and the pattern of trade for the foreign affiliates. In particular, I document which interaction — transferring employees or physical trade — is more prevalent between a parent and its foreign affiliates.

1.2.2 Employee Transfers vs. Physical Trade

This section compares the relative prevalence of physical trade and employee transfers to establish stylized facts. Interactions through either physical trade or employee transfers can be observed within MNCs to determine if firm-specific knowledge is transferred through one or both of these methods. I show that manager transfers are common, and far more common than either production worker transfers or physical trade within MNCs. This provides insight into why a firm decides on FDI instead of outsourcing and becomes organized into families.

A broad overview of the aggregate data could lead into the mistaken conclusion that physical trade flows, and not employee flows, link MNCs to foreign affiliates. At the aggregate level, intra-firm or family trades are a prominent portion of total sales and total purchases, whereas employees from the parent represent a very small

---

9In the data, the parent is the only partner who is within the same MNC in Korea.
portion of total employees in foreign affiliates abroad. These affiliates hire employees mainly from the host country instead of transferring them from the parent. In 2010, Korean MNCs affiliates in the sample hired 1,109,991 total employees, but only two percent, 26,029, were Korean. In contrast, they bought 36 percent and 59 percent of total purchases and sold 16 percent and 34 percent of the total sales through intra-firm and family trade, respectively. If one considers only the aggregate statistics, it would seem that that MNCs depend more on physical trade, especially imports, than on employee transfers.

Table 1.3: Composition of Purchases and Sales in Korean Affiliates in 2010

<table>
<thead>
<tr>
<th></th>
<th>Intra-firm</th>
<th>Intra-family</th>
<th>Domestic others</th>
<th>Foreign others</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(including parent)</td>
<td>(including Korea)</td>
<td></td>
</tr>
<tr>
<td>Purchases</td>
<td>35.5%</td>
<td>59.2%</td>
<td>29.5%</td>
<td>11.2%</td>
</tr>
<tr>
<td>Sales</td>
<td>15.9%</td>
<td>33.7%</td>
<td>51.9%</td>
<td>14.5%</td>
</tr>
</tbody>
</table>

Note: Domestic others means third-party firms in the same host country. Foreign others means third-party firms in the other countries including Korea.

There is, however, a different pattern to the composition of employees across different positions. Even though the share of employees from the parent is very small, the share of employees in management positions is relatively higher than that in production positions. In 2010, the share of Korean managers was ten percent, while the share of Korean production workers was one percent.

On the extensive margin, furthermore, most foreign affiliates had at least one Korean manager. In 2010, among 2,314 affiliates, 81 percent of Korean foreign affiliates had at least one Korean manager, while only 30 percent had Korean production workers. With the exception of 14 affiliates, 407 Korean affiliates had both a Korean production worker
Table 1.4: Composition of Employees in Korean Affiliates in 2010

<table>
<thead>
<tr>
<th>Position</th>
<th>Korean %</th>
<th>Native %</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive</td>
<td>26.6%</td>
<td>73.4%</td>
<td>103,26</td>
</tr>
<tr>
<td>Manager</td>
<td>8.7%</td>
<td>91.3%</td>
<td>123,547</td>
</tr>
<tr>
<td>Sales</td>
<td>3.9%</td>
<td>96.1%</td>
<td>70,646</td>
</tr>
<tr>
<td>Production</td>
<td>1.1%</td>
<td>98.9%</td>
<td>905,472</td>
</tr>
<tr>
<td>Total</td>
<td>2.3%</td>
<td>97.7%</td>
<td>1,109,991</td>
</tr>
</tbody>
</table>

Notes: The second and third columns show the share of Korean or native employees for each position in Korean foreign affiliates in 2010.

labor with managerial skills is higher, 72 percent of Korean affiliates still had some Korean managers. The difference in patterns between Korean managers and production workers at foreign affiliates is striking in Figure 1.1 and Figure 1.2. Figure 1.2 shows that most foreign affiliates’ share of Korean production workers is less than ten percent. Figure 1.1 shows, however, that the share of Korean managers varies across the affiliates.

Regarding physical trade, however, almost half of the affiliates had zero purchases from the parent. In Table 1.5, 44 percent of the affiliates had no purchases through intra-firm imports in 2010, and this pattern is the same across developing and developed countries. Because 32 percent of the parents had more than a single affiliate abroad, I consider the possibility of physical trade from the parent to an affiliate through the other affiliates within the MNC. This is captured, in part, by intra-family trade. Even after considering this kind of physical trade not only from the parent directly, but also from the related affiliates indirectly, 35 percent of the total and a Korean manager. So there are only a few affiliates that have only Korean production workers without Korean managers.
Table 1.5: Fraction of Korean Affiliates in 2010

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Developing</th>
<th>Developed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imports from parent (&gt; 0)</td>
<td>56.1%</td>
<td>56.3%</td>
<td>55.8%</td>
</tr>
<tr>
<td>Exports to parent (&gt; 0)</td>
<td>38.1%</td>
<td>41.8%</td>
<td>26.6%</td>
</tr>
<tr>
<td>Imports from family (&gt; 0)</td>
<td>65.5%</td>
<td>65.1%</td>
<td>66.7%</td>
</tr>
<tr>
<td>Exports to family (&gt; 0)</td>
<td>54.5%</td>
<td>57.5%</td>
<td>44.7%</td>
</tr>
<tr>
<td>Korean manager (&gt; 0)</td>
<td>81.4%</td>
<td>84.4%</td>
<td>71.9%</td>
</tr>
<tr>
<td>Korean production worker (&gt; 0)</td>
<td>29.9%</td>
<td>30.8%</td>
<td>27.2%</td>
</tr>
</tbody>
</table>

# of Affiliates 2314 1749 552

Notes: In rows one through four, the table shows the share of Korean foreign affiliates that had trades with either the parent or the family. Family includes the parent and other affiliates who share the same parent. The fifth and sixth rows show the share of Korean foreign affiliates that have a positive number of Koreans in the each position. Developed and developing countries are classified by whether their PPP GDP per capita is higher than that of Korea.

affiliates still had zero intra-family trade in 2010.

When they do occur, intra-firm and intra-family imports are most likely to occur in only large affiliates. Figures 1.3 and 1.4 show the distribution of the fraction of the foreign affiliates with respect to the share of intra-firm imports in 2010, by country and by industry, respectively. The distribution is similar to that of Korean production workers in Figure 1.2 but not that of Korean managers in Figure 1.1. More than half of the foreign affiliates bought less than ten percent of their purchases from their parent. Table 1.6 shows that the median affiliate bought only five percent of its purchases through intra-firm imports, while affiliates, on average, bought 27 percent of their purchases through intra-firm imports. Combined with the fact that the affiliates bought more than one third of their purchases from the parent on the aggregate level, the positive skewness implies that most intra-firm imports come from
Figure 1.1: Distribution of Affiliates by The Share of Korean Managers

![Chart showing distribution of affiliates by the share of Korean managers.]

Notes: The fraction of Korean foreign affiliates depending on the share of Korean managers over total managers in 2010. I define developing and developed countries based on Korea’s PPP GDP per capita.

Figure 1.2: Distribution of Affiliates by The Share of Korean Production Workers

![Chart showing distribution of affiliates by the share of Korean production workers.]

Note: The fraction of Korean foreign affiliates depending on the share of Korean production workers over total production workers in 2010. I define developing and developed countries based on Korea’s PPP GDP per capita.
some large affiliates. Although intra-family imports were a little more common than intra-firm imports, the pattern is basically the same. These stylized facts are observable across both the countries and industries.

Table 1.6: Share of Internal Shipments and Workers in 2010

<table>
<thead>
<tr>
<th>Share of</th>
<th>Average</th>
<th>25&lt;sup&gt;th&lt;/sup&gt;</th>
<th>50&lt;sup&gt;th&lt;/sup&gt;</th>
<th>75&lt;sup&gt;th&lt;/sup&gt;</th>
<th>90&lt;sup&gt;th&lt;/sup&gt;</th>
<th>95&lt;sup&gt;th&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imports from parent</td>
<td>27.4%</td>
<td>0.0%</td>
<td>5.0%</td>
<td>51.7%</td>
<td>92.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Exports to parent</td>
<td>19.1%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>16.0%</td>
<td>94.5%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Imports from family</td>
<td>40.6%</td>
<td>0.0%</td>
<td>28.0%</td>
<td>85.0%</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Exports to family</td>
<td>34.1%</td>
<td>0.0%</td>
<td>2.0%</td>
<td>88.0%</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Korean manager</td>
<td>27.8%</td>
<td>6.3%</td>
<td>15.4%</td>
<td>33.3%</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Korean production worker</td>
<td>4.1%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>1.2%</td>
<td>7.5%</td>
<td>21.9%</td>
</tr>
</tbody>
</table>

In summary, the aggregate data mask substantial firm-level differences. Employee flows seem insignificant because managers from the parent make up such a small share of total employment. Aggregated trade flows mask the fact that a majority of affiliates have no trade at all with the parent. This fact suggests that aggregate-level data can lead to improper conclusions about the importance of physical trade between the foreign affiliates and the parent within the MNCs. As my data showed, only a few large foreign affiliates actually heavily depend on intra-firm and intra-family trade, while most foreign affiliates do not. As in Ramondo, Rappoport, and Ruhl (2012) and Baldwin and Okubo (2012), this pattern is also observable in U.S. and Japanese MNCs. Aggregate data, therefore, can possibly overestimate the importance of physical trade within MNCs. Furthermore, my sample is already likely to have large foreign affiliates, so in that sense, the entire population of foreign affiliates in MNCs

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11See Figure A.1 and Figure A.2 in Appendix A.1.
Figure 1.3: Distribution of Affiliates by The Share of Intra-Firm Imports, by Country

Note: The fraction of Korean foreign affiliates depending on the share of purchases from the parent in 2010. I define developing and developed countries based on Korea’s PPP GDP per capita.

would be more isolated from the parent or other family affiliates in terms of physical trade.

I discussed two mechanisms behind the interactions between a parent and its foreign affiliates: physical trade and transfer of employees. Overall, the data suggest that manager transfers are more common than intra-firm or intra-family imports on the extensive margin. Then, I explore what motivates manager transfers from the parent to the foreign affiliates and how manager transfers are the main mechanism to have comparative advantages for foreign affiliates in practice. To examine these issues, I provide a simple model of a foreign affiliate’s decision to fill management positions from the parent or the host country.
In this section, I introduce a partial equilibrium model describing the choice of managers for a foreign affiliate. The previous section documented two key facts about MNCs’ intangible capital transfers and physical trades. First, an MNC transfers its managers, but not its production workers, to its foreign affiliates. Second, in terms of physical trade, foreign affiliates are isolated from the parent. This suggests the importance of managers from the parent but does not prove that they are at the foreign affiliates to transfer firm-specific knowledge. A natural alternative is that they are just better managers than managers from the host country. Therefore, I develop a model that embeds both hypotheses, and I study its predictions. The model yields predictions that distinguish between the two hypotheses. The model also guides what moments I look at in the data for empirical analysis in the next
The model describes a decision regarding a foreign affiliate’s production. The foreign affiliate uses two kinds of labor services for production, managers $M$ and production workers $L$. The affiliate can hire managers from either the parent $M^k$ or the host country $M^n$. Based on the facts from the previous section, the affiliate hires production workers only from the host country. Using these labor services, the affiliate produces its output $Y$ according to the following production function:

$$Y = \left( F(M^k) \right)^\beta \left( (\alpha M^k + M^n)^\gamma L^{1-\gamma} \right)^{1-\beta}$$  

(1.1)

In equation 1.1, $F(\cdot)$ is second-order differentiable, $F'(\cdot)$ is non-negative and $F''(\cdot)$ is non-positive. And there is an $\bar{M}_k$ satisfying $F'(\bar{M}_k) = 0$ and $F'(M^k) \to \infty$ as $M^k \to 0$. I assume that $0 \leq \beta < 1$ and $0 < \gamma < 1$. The parameter $\alpha$ is non-negative and denotes the productivity of the managers from the parent relative to that of the managers from the host country.

The production function has two features depending on two key parameters, $\beta$ and $\alpha$. First, it allows for the possibility of managers from the parent being augmented with knowledge. If $\beta$ is positive, these managers from the parent work for the affiliate as an input but also increase the productivity of each input used. $^{12}$ If $\beta$ equals zero, the managers from the parent work only as an input for management. Second, the parameter $\alpha$ is the productivity of managers from the parent relative to that of managers from the host country. If $\alpha$ is bigger than one, this means that managers from the parent are more productive than managers from the host country. $^{13}$

From the production function, I can derive a prediction about how managers

$^{12}$This is a similar setup to the model in McGrattan and Prescott (2009), Ramondo and Rodríguez-Clare (2009) and Ramondo (2012).

$^{13}$See Burstein and Monge-Naranjo (2009).
from the parent affect productivity of the foreign affiliate. Since the affiliate uses only labor services as inputs for production, I consider the labor productivity of the foreign affiliate. From the production function, I can derive equation 1.2:

\[
\log\left(\frac{Y}{E}\right) = \beta\log\left(\frac{F(M^k)}{M}\right) + \gamma(1 - \beta)\log\left((\alpha - 1)\frac{M^k}{M} + 1\right) + \\
+(1 - \gamma)(1 - \beta)\log\left(1 - \frac{M}{E}\right) + (\gamma + \beta - \gamma\beta)\log\left(\frac{M}{E}\right)
\] (1.2)

In equation 1.2, \(M\) is the total number of managers, \(M^k + M^n\), and \(E\) is the total number of employees, \(M + L\), so LHS of the equation is the logarithm of labor productivity of the affiliate. The equation demonstrates that when the share of managers from the parent over total managers changes, a change of labor productivity depends on the parameters, \(\alpha\) and \(\beta\). Table 1.7 shows the effect of the share of managers from the parent on labor productivity. When \(\beta\) is equal to zero, the first term in equation 1.2 becomes zero and only \(\alpha\) determines the effect. If \(\alpha\) is bigger than one, which means that managers from the parent are more productive than managers from the host country, the share of managers from the parent is positively associated with labor productivity. If \(\alpha\) is smaller than one, the share of managers from the parent is negatively associated with labor productivity.

If \(\beta\) is positive, managers from the parent work as an input and increase productivity, just as technology does. So, if managers from the parent are a better input than managers from the host country, in which \(\alpha > 1\), it is trivial that the share of managers from the parent is positively associated with labor productivity because it is positively associated with both the first and second terms in equation 1.2. If \(\alpha\) is smaller than one, the relation between the share of managers from the parent and labor productivity is ambiguous because it is positively associated with the first term.

\[14\text{The proof of Proposition 1 in Appendix A.2 provides details of how the equation is derived.}\]
Table 1.7: Effect of Managers from the Parent on Labor Productivity

<table>
<thead>
<tr>
<th></th>
<th>α &gt; 1</th>
<th>α &lt; 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>β = 0</td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>β &gt; 0</td>
<td>Positive</td>
<td>Ambiguous</td>
</tr>
</tbody>
</table>

Note: The table shows predictions of \( \frac{\partial \log(Y/E)}{\partial \log(M^k/M)} \) given \( \frac{M}{E} \) from the equation 1.2.

but negatively with the second term in equation 1.2.

**Proposition 1.** If \( \beta > 0 \) and \( \alpha < 1 \), there exists a feasible choice of a foreign affiliate that satisfies that \( \frac{\partial \log(Y/E)}{\partial \log(M^k/M)} \) is positive.

**Proof.** See Appendix A.2.

Proposition 1 demonstrates that even if managers from the parent are less productive than managers from the host country, there is still a possibility that managers from the parent increase the foreign affiliate’s labor productivity. The reason is that they can transfer knowledge that increases all other inputs’ productivity.

From the impact of managers from the parent on labor productivity, I note that both hypotheses – providing better input, in which \( \beta = 0 \) and \( \alpha > 0 \), and transferring knowledge from the parent, in which \( \beta > 0 \) – support a positive relation between the share of managers from the parent and labor productivity.

With the production function and an exogenous shock \( z \), a foreign affiliate maximizes profit so that \( M^k, M^n \) and \( L \) are the solution to

\[
\max_{M^k, M^n, L} zY - w^k M^k - w^n M^n - w^L L
\]  

(1.3)

s.t

\[
M^k \geq 0, \ M^n \geq 0 \text{ and } L \geq 0,
\]  

(1.4)
where price of the output is numeraire and $w^j_{k,n,L}$ are the wage paid per unit of $M^k$, $M^n$ and $L$, respectively. $z$ is an exogenous shock that affects the affiliate output and follows

$$z = e^{\eta_a + \eta_{mt} + \eta_{ct} + \eta_c + \eta_i + \eta_t}$$  (1.5)

$\eta_a$ is the fixed characteristic of the affiliate affecting its labor productivity. For example, different affiliates can have different FDIs or initial investments, and each affiliate faces a different market for its product. So, these kinds of affiliate-specific characteristics can affect its output. $\eta_{mt}$ is an exogenous shock coming from the MNC. Tintelnot (2012) shows that, with a fixed cost for a foreign affiliate entering a market, the affiliate as an export platform can be influenced by other affiliates within the same MNC. $\eta_{ct}$ is an exogenous shock that captures the country-time fixed-effect. For example, in a horizontal FDI mode, Markusen (1984) points out that, to avoid trade costs that are motivated by serving the market in the host country, the foreign affiliate output would be affected by domestic demand. $\eta_c$ is a country fixed-effect that captures different TFP across countries. $\eta_i$ captures different characteristics across industries, such as R&D or capital intensity. And $\eta_t$ captures the time fixed-effect. My sample includes the great recession in 2009, so the time fixed-effect captures the global shock for each time period.

The prediction about the pattern of foreign affiliates’ choice between managers from the parent and managers from the host country is derived from the foreign affiliate’s maximization problem. With the Cobb-Douglas combination of managers and production workers, a higher exogenous shock induces an affiliate to hire more managers and more production workers to produce more output. Depending on parameters $\beta$ and $\alpha$ and the wages for each labor service, the affiliate will choose managers from either the parent or the host country. Table 1.8 shows how the share of the
managers from the parent over total managers changes as the affiliate becomes larger with a larger $z$. If $\beta$ is equal to zero, the affiliate chooses either all managers from the parent or all managers from the host country, depending on the marginal return per unit cost because they are perfectly substitutable.\footnote{Even if I consider the case in which managers from the parent and the host country have a constant elasticity of substitution, the share of the managers from the parent is still constant, but not zero or one, as the affiliate becomes larger.} It is trivial, in other words, that the affiliate hires only managers from the parent if $\alpha w^m_n > 1$ and $\beta$ is positive, which means that the marginal return per unit cost of managers from the parent from working only as an input for management is always larger than the marginal return per unit cost of native managers. The reason is that the whole marginal return from managers from the parent is larger than that derived from only working as an input because of the additional benefit of transferring knowledge.

I focus on the most interesting part—the case in which $\beta$ is positive and $\alpha w^m_n < 1$. In this case, managers from the parent transfer knowledge, but their marginal return per unit cost as an input for management positions only is lower than that of managers from the host country. In this case, the prediction of the share of managers from the parent over the affiliate’s size is ambiguous.

Table 1.8: The Share of Korean Managers over Affiliates’ Sizes

<table>
<thead>
<tr>
<th>$\alpha w^m_n$</th>
<th>$\beta$</th>
<th>Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>$&gt; 1$</td>
<td>$= 0$</td>
<td>Constant (equal to 1)</td>
</tr>
<tr>
<td>$&lt; 1$</td>
<td>$&gt; 0$</td>
<td>Ambiguous</td>
</tr>
</tbody>
</table>

Note: The table shows predictions of $\frac{\partial (M_k(z)/M(z))}{\partial Y(z)}$ from the affiliates’ maximization problem.

Proposition 2. If $\beta > 0$ and $\alpha w^m_n < 1$, considering $z'$ and $z$ such that $z' > z$, there exist optimal choices from the affiliates’ maximization problems that satisfy that
\[ Y_{\text{amcit}}(z') > Y_{\text{amcit}}(z) \text{ and } \frac{M_k}{M_k + M^n}(z') < \frac{M_k}{M_k + M^n}(z). \]

**Proof.** See Appendix A.2. \qed

**Corollary 1.** If \( \beta > 0 \) and \( \alpha \frac{w^n}{w^k} < 1 \), all optimal choices from the affiliates’ maximization problems across \( z \) satisfy that \( M^k(z) \) is positive and bounded from above by \( \bar{M}^k \).

**Proof.** See proof of Proposition 2 in Appendix A.2; it is trivial that the marginal product per unit cost of \( M^k(z) \) is lower than the marginal product per unit cost of \( M^n(z) \) for all \( M^k(z) \geq \bar{M}^k \). \qed

Proposition 2 shows that even if managers from the parent are less efficient inputs than managers from the host country, there is a reason why the affiliates still utilize them. Interestingly, the affiliates limit the number of managers from the parent because the benefit from these additional managers transferring knowledge becomes smaller and smaller. The affiliates receive knowledge transfers at a certain level, and additional managers from the parent would not increase productivity as much as before because \( F(\cdot) \) is concave. Then, the affiliates fill management positions with managers from the host country because they are more efficient than managers from the parent. In this case, as Corollary 1 says, the number of managers from the parent in management positions is constant over the affiliates’ size. \(^{16}\)

In this section, I used the simple model to provide different predictions depending on the characteristics of managers from the parent. In the next section, I use the data to examine which predictions from the model are consistent with foreign affiliates abroad.

\(^{16}\)In the case in which managers from the parent and the host country have a constant elasticity of substitution, \( M^k \) is bounded from above only with \( \beta > 0 \) and \( \alpha \frac{w^n}{w^k} < 1 \).
1.4 Empirical Analysis

In this section, I examine the characteristics of managers from the parent, using the data on foreign affiliates of Korean MNCs with guidelines from the simple model in the previous section. From the assumption in Section 1.2, which is that all Koreans in foreign affiliates originally come from the parent in Korea, I can distinguish between managers from the parent and from the host country. Thus, I examine which of the model’s predictions are consistent with Korean foreign affiliates’ data. The model in the previous section shows that two key parameters are crucial for the decision between managers from the parent and from the host country. The first one is $\beta$, which determines whether managers from the parent transfer their knowledge to the foreign affiliate. The second one is $\alpha$, which determines whether managers from the parent are a better input than managers from the host country. Depending on these two parameters, the model’s predictions about the pattern of managers from the parent and their effect on the foreign affiliate vary.

1.4.1 Effect of Managers on Productivity

First, I examine the effect of Korean managers on foreign affiliates’ productivity. In the previous section, Table 1.7 shows the effect of managers from the parent on labor productivity. Each column shows the sign of $\frac{\partial \log(Y/E)}{\partial \log(M^k/M)}$ as given $\frac{M}{E}$. To examine which prediction is consistent with the data, I estimate the following equation.

$$V_{amcit} = \beta_0 + \beta_1 \cdot S_{1amcit} + \beta_2 \cdot S_{2amcit} +$$
$$+ \beta_4 \cdot \eta_a + \beta_5 \cdot \eta_{mt} + \beta_6 \cdot \eta_{ct} + \beta_7 \cdot \eta_c + \beta_8 \cdot \eta_i + \beta_9 \cdot \eta_t + \epsilon_{amcit} \quad (1.6)$$

In equation 1.6, the dependent variable ($V_{amcit}$) is labor productivity for affiliate $a$ within MNC $m$ in country $c$, industry $i$ and time $t$. I measure labor productivity...
as valued-added divided by the total number of employees. \(^{17}\) \(S_{1 \text{amcit}}\) is the share of Korean managers over total managers and \(S_{2 \text{amct}}\) is total managers over total employees. \(^{18}\) I also control for exogenous shocks that affect the affiliate’s productivity. I control for affiliate fixed-effect \((\eta_a)\), country and time fixed-effect \((\eta_{ct})\), country fixed-effect \((\eta_c)\), industry fixed-effect \((\eta_i)\) and time fixed-effect \((\eta_t)\) using dummy variables. I also control for multinational and time fixed-effect \((\eta_{mt})\) using the sum of total sales of affiliates that share the same parent, which captures the size of MNCs.

My estimation results from equation 1.6 using Korean foreign affiliates’ data show that the share of Korean managers is positively associated with labor productivity. Table 1.9 shows the estimation results. Column (1) in Table 1.9, shows that a ten-percent increase in the share of Korean managers is positively associated with a four-percent increase in labor productivity. In the previous section, I showed that almost half of the Korean foreign affiliates are isolated from the parent in terms of physical trade. However, I can test how intra-firm trade affects affiliates’ labor productivity. In column (2) of Table 1.9, I consider affiliates that have intra-firm imports and examine how the share of intra-firm imports over total purchases affects their productivity. The result shows that a ten-percent increase in the share of intra-firm imports over total purchases is positively associated with only a 0.8-percent increase in labor productivity. So, not only are employee transfers in management positions more common than physical imports from the parent, but the effect on labor productivity is also more than four times larger than that of intra-firm imports.

One question that I can ask is whether physical import goods might be used

---

\(^{17}\)The value added is calculated by total sales minus total purchases. In my data set, total purchases include any costs to buy inputs from outside of the affiliate.

\(^{18}\)Beside the predictions from the model, I include the variable \(S_{2 \text{amct}}\) for empirical purposes. I want to double check whether my measure of labor productivity is valid. The previous literature documents that management skills are positively associated with a firm’s productivity; see Bloom and Reenen (2007). If I’ve measured labor productivity well, therefore, the sign of the coefficient for \(S_{2 \text{amcit}}\) can be expected to be significantly positive.
Table 1.9: Effect on Labor Productivity

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>log($\frac{\text{Korean managers}}{\text{Total managers}}$)</td>
<td>0.406***</td>
<td>0.383***</td>
<td>0.372***</td>
<td>0.344***</td>
<td>0.325***</td>
<td>0.547***</td>
</tr>
<tr>
<td></td>
<td>[0.033]</td>
<td>[0.045]</td>
<td>[0.064]</td>
<td>[0.052]</td>
<td>[0.050]</td>
<td>[0.097]</td>
</tr>
<tr>
<td>log($\frac{\text{Total managers}}{\text{Total employees}}$)</td>
<td>0.519***</td>
<td>0.485***</td>
<td>0.438***</td>
<td>0.449***</td>
<td>0.418***</td>
<td>0.676***</td>
</tr>
<tr>
<td></td>
<td>[0.037]</td>
<td>[0.050]</td>
<td>[0.073]</td>
<td>[0.061]</td>
<td>[0.060]</td>
<td>[0.082]</td>
</tr>
<tr>
<td>log($\frac{\text{Intra-firm import}}{\text{Total purchase}}$)</td>
<td>0.081***</td>
<td>0.040</td>
<td>0.057**</td>
<td>0.057**</td>
<td>0.194***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.023]</td>
<td>[0.031]</td>
<td>[0.024]</td>
<td>[0.024]</td>
<td>[0.067]</td>
<td></td>
</tr>
<tr>
<td>L.log($\frac{\text{Korean managers}}{\text{Total managers}}$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.038</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>[0.046]</td>
<td></td>
</tr>
<tr>
<td>L.log($\frac{\text{Total managers}}{\text{Total employees}}$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.023</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>[0.053]</td>
<td></td>
</tr>
<tr>
<td>L.log($\frac{\text{Intra-firm import}}{\text{Total purchase}}$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.039</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>[0.026]</td>
<td></td>
</tr>
</tbody>
</table>

| Observations                                      | 8,370 | 5,168 | 2,939 | 3,994 | 3,964 | 1,204 |
| R-squared                                         | 0.227 | 0.239 | 0.197 | 0.222 | 0.214 | 0.341 |
| Number of Affiliates                              | 3,164 | 2,047 | 1,247 | 1,603 | 1,603 | 446   |

Robust standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Notes: I control for affiliate fixed-effect, country and time fixed-effect, country fixed-effect, industry fixed-effect and time fixed-effect using dummy variables. I also control for multinational and time fixed-effect using the sum of total sales of affiliates in the same MNC. Of 10,416 affiliates, I drop 1,244 because their labor productivity is negative. For the first column, I consider affiliates that have at least one Korean in a management position. For the second column, I consider only affiliates that have positive intra-firm imports. For the third column, I control for the one-year lagged variable for each explanatory variable. For the fourth column, I consider only affiliates in the manufacturing sector. For the fifth and sixth columns, I consider affiliates in developing and developed countries, respectively. For the results regarding the whole sample using a different specification, see Table A.3 in Appendix A.1.

for production with a time lag. Because the value-added of some observations was negative and so was their labor productivity, I dropped 1,244 affiliates. It might be possible, therefore, for an affiliate to buy intermediate goods from the parent to use
in a future year. Therefore, considering this case, I use a time lag for each variable and report the results in column (3). However, my result shows that the coefficient of the share of Korean managers does not change much, but that of the share of intra-firm imports becomes statistically insignificant. Since it might not be easy to define physical trade in the non-manufacturing sector, I consider only samples in the manufacturing sector. However, column (4) shows that the result is consistent with that of column (2). Finally, I separate the sample into developing and developed countries, but the results are consistent with those in the other columns. Interestingly, column (6) shows that developed countries, which probably have better management inputs, have a higher effect from Korean managers on labor productivity. 19

Even though I consider only the effect of intra-firm imports on labor productivity, the effects of other intra-firm or family trades on labor productivity are also either relatively small or statistically insignificant. Table 1.10 shows the effects of various intra-firm and family trades on labor productivity. Despite the prevalence of intra-family imports over intra-firm imports, the coefficient of intra-family imports is less than half of that of intra-firm imports and is statistically insignificant. However, the other intra-firm and family exports and trades are negatively associated with labor productivity. One possible explanation could be transfer-pricing within MNCs, but it is clear that intra-firm or family exports do not make the affiliate more productive.

The estimation result shows that the share of Korean managers is positively associated with labor productivity. In particular, the coefficient is more than four times larger than that of intra-firm imports. However, either knowledge transfer, \( \beta > 0 \), or

---

19 I consider only the intensive margin of Koreans in management positions and intra-firm imports because the logarithm of zero values for variables is dropped based on the model’s prediction. However, only 555 and 888 affiliates among 3,908 affiliates experienced extensive margin changes for Koreans in management positions and intra-firm imports, respectively. I also report a different specification to estimate using the whole sample in Appendix A.3 to do a robustness check, but my results are not different.
Table 1.10: Effect of Physical Trades within MNCs on Labor Productivity

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \log(\frac{\text{Korean managers}}{\text{Total managers}}) )</td>
<td>0.383***</td>
<td>0.379***</td>
<td>0.389***</td>
<td>0.390***</td>
<td>0.391***</td>
<td>0.392***</td>
</tr>
<tr>
<td></td>
<td>[0.045]</td>
<td>[0.056]</td>
<td>[0.041]</td>
<td>[0.042]</td>
<td>[0.045]</td>
<td>[0.038]</td>
</tr>
<tr>
<td>( \log(\frac{\text{Total managers}}{\text{Total employees}}) )</td>
<td>0.484***</td>
<td>0.467***</td>
<td>0.474***</td>
<td>0.504***</td>
<td>0.482***</td>
<td>0.488***</td>
</tr>
<tr>
<td></td>
<td>[0.050]</td>
<td>[0.065]</td>
<td>[0.046]</td>
<td>[0.046]</td>
<td>[0.051]</td>
<td>[0.042]</td>
</tr>
<tr>
<td>( \log(\frac{\text{Intra-firm import}}{\text{Total purchase}}) )</td>
<td>0.082***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.023]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \log(\frac{\text{Intra-firm export}}{\text{Total sale}}) )</td>
<td></td>
<td>-0.043**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.020]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \log(\frac{\text{Intra-firm export+import}}{\text{Total sale+purchase}}) )</td>
<td></td>
<td>-0.034</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.029]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \log(\frac{\text{Intra-family import}}{\text{Total purchase}}) )</td>
<td></td>
<td>0.036</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.023]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \log(\frac{\text{Intra-family export}}{\text{Total sale}}) )</td>
<td></td>
<td>-0.022</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.017]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \log(\frac{\text{Intra-family export+import}}{\text{Total sale+purchase}}) )</td>
<td></td>
<td>-0.062**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.027]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Observations: 5,168  3,709  5,912  5,904  4,994  6,661  
R-squared: 0.242  0.216  0.224  0.237  0.218  0.219  
Number of Affiliates: 2,047  1,552  2,389  2,363  2,077  2,589  

Robust standard errors in brackets  
*** p<0.01, ** p<0.05, * p<0.1  

Notes: I control for affiliate fixed-effect, country and time fixed-effect, country fixed-effect, industry fixed-effect and time fixed-effect using dummy variables. I also control for multinational and time fixed-effect using the sum of total sales of affiliates in the same MNC. I consider only the effects of intra-firm and intra-family trades on the intensive margin. So, observations for each column are different depending on the number of Korean foreign affiliates that were involved in intra-firm and family trades.

better input for management positions, \( \beta = 0 \) and \( \alpha > 1 \), through managers from the parent can support the result. So, to examine the characteristics of managers from the parent, I determine how their share changes as affiliates become larger.
1.4.2 Determinants of Managers from the Parent

From Corollary 1 in the previous section, the number of managers from the parent for a foreign affiliate would be limited under certain conditions. Figure 1.5 shows the cumulative distribution of Korean foreign affiliates with respect to the number of managers. The cumulative distribution tells us that 90 percent of the affiliates had ten or fewer Korean managers, while they had a relatively monotonic increase in the numbers of native managers in 2010 as their size became larger. \footnote{On average, a Korean affiliate had five Korean and 52 native managers.} Interestingly, even though most Korean affiliates had Korean managers, they had only a few of them, confirming the prediction from Corollary 1.

Figure 1.5: Cumulative Distribution of Affiliates with respect to the Number of Managers

Note: This is the cumulative distribution of the fraction of foreign affiliates with respect to the number of Korean and native managers in 2010. On average, Korean foreign affiliates had five Korean and 52 native managers in 2010.

Therefore, I expect that the number of Korean managers does not depend on the relative size of the affiliate, while that of native managers does. The share of Koreans
managers is expected to decrease in relation to the affiliate’s size. To test this, I estimate the following equation.

\[ KS_{amcit} = \beta_0 + \beta_1 \cdot Size_{amcit} + \beta_2 \cdot Horizontal_{amcit} + \]
\[ + \beta_3 \cdot \eta_{mt} + \beta_4 \cdot \eta_{ct} + \beta_5 \cdot \eta_c + \beta_6 \cdot \eta_i + + \beta_7 \cdot \eta_t + \epsilon_{amcit} \]  

In equation 2.12, the dependent variable \( KS_{amcit} \) is the share of Koreans in management positions. For explanatory variables, I first measure the size of the affiliates, \( Size_{amcit} \), by either their total sales or their total number of employees. \( Horizontal_{amcit} \) is the share of sales to third-party firms in the host country, which measures how much an affiliate serves for the domestic market as the horizontal FDI mode motivates.

I include variables to control for the parent-time (\( \eta_{mt} \)), country-time (\( \eta_{ct} \)), country (\( \eta_c \)), industry (\( \eta_i \)) fixed-effects. To control for the parent-time effect, I use total sales of the MNCs. \(^{21}\) For variables to control for country-time effects, I consider GDP, GDP per capita and investment share of GDP per capita from the Penn World Table 7.1 from Heston, Summers, and Aten (2012). To control for country effects, I also determine the distance to Korea from CEPII, as documented in Mayer and Zignago (2011). To consider the education level in the host country, I determine the average attained years of schooling from Barro and Lee (2012). Finally, besides the distance, to determine an accurate cost to send a Korean manager from Korea to the host country, I use the Rules of Overseas Service Allowance of the Ministry of Foreign Affairs and Trade in Korea. \(^{22}\) To control for the industry effect, I use the share of

---

\(^{21}\)I cannot identify the parent but can only recognize whether affiliates share the same parent. So, total sales of the parent in Korea is the sum of total sales of the Korean affiliates in my sample that share the same parent only.

\(^{22}\)Actually, many Korean MNCs refer to the rules to decide expatriate compensation. One advantage from using these is that I can get the cost of sending Korean managers for most countries. These rules are constructed based on UN Living Costs and Employment Conditions Abroad.
R&D expenditures over total sales from The Survey of Research and Development in Korea, and I also include time-dummy variables to control for the time fixed-effects.

My dependent variable is the share, so it is censored below zero and above one. Considering that, I use the Tobit model to estimate coefficients. Because not many observations turn out to be censored, I also use OLS for a robustness check. 23 Table 1.11 reports the estimation result.

In Table 1.11, the first and second columns show the result that is estimated by the Tobit model using a different measure of the size of the affiliates. The third and fourth columns show the same result that is estimated by the OLS model for the robustness check. In all columns, the dependent variable is the share of Korean managers. As Table 1.11 shows, all columns’ results are very similar and robust. The result implies some interesting consequences of sending Koreans to hold management positions with the affiliates.

First, the result shows that the share of Koreans in management positions is negatively associated with the size of the affiliate. If an affiliate has a positive exogenous shock, $z$ increases, and the firm’s optimal decision is to increase its output as well as to use more inputs. Thus the negative coefficient means that to use more managers, the affiliate keeps hiring managers from the host country rather than having managers from the parent. This result is consistent with the model’s prediction in the case when $\beta > 0$ and $\alpha_{w_k} < 1$, which means that managers from the parent are a less efficient input for management positions than are managers from the host country, but they transfer knowledge and increase productivity of each input, so the affiliate has an incentive to hire a few of them. 24

There are two possible explanations why Korean managers from the parent are

---

23 Among 10,170 observations, 868 are censored below zero and 1,115 are censored above one.
24 As Figure 1.5 shows, 90 percent of Korean foreign affiliates had fewer than ten Korean managers in 2010.
Table 1.11: Determinant of the Share of Koreans in Management Positions

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Tobit</th>
<th>OLS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\log(\text{Total sale})$</td>
<td>-0.011***</td>
<td>-0.013***</td>
</tr>
<tr>
<td></td>
<td>[0.003]</td>
<td>[0.002]</td>
</tr>
<tr>
<td>$\log(\text{Total employee})$</td>
<td>-0.046***</td>
<td>-0.043***</td>
</tr>
<tr>
<td></td>
<td>[0.003]</td>
<td>[0.002]</td>
</tr>
<tr>
<td>$\frac{\text{Sale to the domestic}}{\text{Total sale}}$</td>
<td>-0.050***</td>
<td>-0.073***</td>
</tr>
<tr>
<td></td>
<td>[0.008]</td>
<td>[0.008]</td>
</tr>
<tr>
<td>$\log(\text{Total sale of the MNC})$</td>
<td>-0.017***</td>
<td>-0.014***</td>
</tr>
<tr>
<td></td>
<td>[0.002]</td>
<td>[0.001]</td>
</tr>
<tr>
<td>$\log(\text{Distance})$</td>
<td>0.033***</td>
<td>0.027***</td>
</tr>
<tr>
<td></td>
<td>[0.009]</td>
<td>[0.009]</td>
</tr>
<tr>
<td>$\log(\text{R&amp;D intensity})$</td>
<td>-0.020***</td>
<td>-0.008**</td>
</tr>
<tr>
<td></td>
<td>[0.004]</td>
<td>[0.004]</td>
</tr>
<tr>
<td>$\log(\text{GDP per capita})$</td>
<td>0.030**</td>
<td>-0.016</td>
</tr>
<tr>
<td></td>
<td>[0.012]</td>
<td>[0.012]</td>
</tr>
<tr>
<td>$\log(\text{GDP})$</td>
<td>-0.006*</td>
<td>-0.004</td>
</tr>
<tr>
<td></td>
<td>[0.003]</td>
<td>[0.003]</td>
</tr>
<tr>
<td>$\log(\text{Schooling})$</td>
<td>0.029</td>
<td>0.054</td>
</tr>
<tr>
<td></td>
<td>[0.040]</td>
<td>[0.039]</td>
</tr>
<tr>
<td>$\log(\text{Cost of dispatchment})$</td>
<td>-0.034</td>
<td>-0.066**</td>
</tr>
<tr>
<td></td>
<td>[0.031]</td>
<td>[0.030]</td>
</tr>
<tr>
<td>$\log(\text{Capital Intensity})$</td>
<td>0.037*</td>
<td>0.019</td>
</tr>
<tr>
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<td>[0.022]</td>
<td>[0.022]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Observations</th>
<th>10,347</th>
<th>10,347</th>
<th>10,347</th>
<th>10,347</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Pseudo) R-squared</td>
<td>0.05</td>
<td>0.07</td>
<td>0.07</td>
<td>0.11</td>
</tr>
</tbody>
</table>

Standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Notes: I control for year-fixed effect. The dependent variable is the share of Korean managers. The first two columns show the results from Tobit, and the other two columns show those from OLS. Among 11,254 foreign affiliates, 838 foreign affiliates have no managers. I drop 907 affiliates lacking income or schooling data.
a less efficient input than managers from the host country. The first explanation is that \( \alpha \) is smaller than one, which means that Korean managers are less productive than native managers without regarding the cost. In fact, most production workers are natives of the host country in the data. In 2010, at the aggregate level, only one percent of production workers were Koreans and, on the extensive margin, more than 70 percent of Korean foreign affiliates had zero Korean production workers and all native production workers. Therefore, even in a developing country, where the supply of labor with managerial skills is lower, Korean managers could be less productive than native managers in managing native production workers. The second explanation is that the cost of sending Korean managers is much higher than that of hiring native managers, \( w^k > w^n \). According to Mercer’s 2008 survey, expatriates at the management level in Singapore were paid, on average, 2.6 times more because of accommodations, mobility premium, education or other factors.

Another interesting finding from the results in Table 1.11 is that \( \text{Horizontal}_{\text{amcit}} \), which measures how much the firm serves its domestic market, is negatively associated with the share of Korean managers over total managers. If an affiliate is to target the domestic market, understanding the circumstances of the domestic situation is very important to maximizing its profit. Using U.S. MNCs, empirically, Oldenski (2012) shows that products requiring direct communication with domestic consumers are likely to be produced in the destination market through FDI instead of by arms-length export. My result shows that even after FDI decisions, an affiliate still adjusts its hiring of managers to fulfill the communication requirement. In line with Oldenski’s result, I can claim that Korean managers from the parent have relatively more firm-specific knowledge, which the MNC already holds, but native managers from the domestic market have relatively more host-country-specific knowledge.

The results can also show that a parent that has more multinational activities,
measured as total sales of the all affiliates, is likely to have a relatively smaller share of Korean managers. However, as an affiliate operates in a country that is farther away from Korea, the affiliate holds a relatively higher share of Koreans in management positions. These two results can be interpreted in the following way. As an MNC becomes larger, it can transfer its own knowledge through managers more easily because it has the know-how to operate the other affiliates. Also, as the distance from the parent increases, it becomes harder to transfer its own knowledge through managers, and it needs to send relatively more Korean managers to transfer its own knowledge. I also note that an affiliate in an R&D-intense industry has fewer Korean managers. This result is consistent with Keller and Yeaple (2013), who show that if inputs that an affiliate uses most are highly dependent on non-codified knowledge – that is, knowledge-intensive – the affiliate depends highly on physical trade and is sensitive to trade costs. However, my result implies that although employees from the parent may have specialized knowledge in areas such as marketing or operating know-how, they do not in R&D because affiliates in an R&D-intensive industry have fewer Korean managers.

1.4.3 Time Variation of Number of Managers

In the previous section, I used a simple static model that did not consider how the choice of managers changes over time. In this chapter, I examine how the number of managers from the parent and from the host country changes over time. This has an important implication. If the number of managers from either the parent or the host country changes over time, I need to consider a dynamic property in the model.

---

25 This interpretation can be in line with Ramondo and Rodríguez-Clare (2009), Irarrazabal, Moxnes, and Opremolla (2013) and Tintelnot (2012). They calibrate the transportability of intangible assets and productivity within an MNC as a function of the distance between the parent and the affiliates.
relating to the choice of managers. Furthermore, if the number of managers from the
parent decreases, which means that managers from the parent are needed less over
time, it implies that there is spillover of firm-specific knowledge from managers from
the parent to managers from the host country. To check this, I estimate the following
equation.

\[
M_{amcit}^{j(k,n)} = \beta_0 + \beta_1 \cdot Time_t + \beta_2 \cdot Size_{amcit} + \\
+ \beta_3 \cdot \eta_a + \beta_4 \cdot \eta_{mt} + \beta_5 \cdot \eta_{ct} + \beta_6 \cdot \eta_i + \beta_7 \cdot \eta_t + \beta_8 \cdot \eta + \epsilon_{amcit}
\] (1.8)

I assign \(Time_t\) as one to six from 2005 to 2010, so it is different from the time
fixed-effect controlled for by a dummy variable for each year. I also control for affiliate
size effect by controlling for the affiliates’ total sales or total employees. To see the
time effects within the affiliates, I control for affiliate fixed-effect. I also control
unobservable effects of the affiliate, MNC, country, industry and time using affiliate,
MNC-time, country-time, country, industry and time fixed-effects, as I did in Section
1.4.2. Table 1.12 shows the estimation results.

The estimation results tell us that the number of Korean managers does not change
over time. Columns (1) and (2) show that the coefficients of the \(Time\) variable for the
number of Korean managers are negative but statistically insignificant, and columns
(3) and (4) show that the coefficients of the \(Time\) variable for the number of native
managers are positive and statistically significant. However, I do not know when FDI
for an affiliate occurred and when the affiliate started its business or became a part
of the MNC. These results confirm, therefore, that the number of Korean managers
is stable at least in the short term six years, and knowledge diffusion from Korean
managers to native managers may happen very slowly or not at all.

In Table 1.12, I also reconfirm the result that the share of Korean managers
Table 1.12: Change in the Number of Managers over Time

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Dependent Variable: # of Managers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Korean (1)</td>
</tr>
<tr>
<td></td>
<td>Native (2)</td>
</tr>
<tr>
<td></td>
<td>Native (3)</td>
</tr>
<tr>
<td></td>
<td>Native (4)</td>
</tr>
<tr>
<td>Time</td>
<td>-0.043</td>
</tr>
<tr>
<td></td>
<td>-0.060</td>
</tr>
<tr>
<td></td>
<td>0.380***</td>
</tr>
<tr>
<td></td>
<td>0.343***</td>
</tr>
<tr>
<td></td>
<td>[0.069]</td>
</tr>
<tr>
<td></td>
<td>[0.068]</td>
</tr>
<tr>
<td></td>
<td>[0.013]</td>
</tr>
<tr>
<td></td>
<td>[0.009]</td>
</tr>
<tr>
<td>\text{log(Total Sale)}</td>
<td>0.133***</td>
</tr>
<tr>
<td></td>
<td>0.256***</td>
</tr>
<tr>
<td></td>
<td>[0.015]</td>
</tr>
<tr>
<td></td>
<td>[0.029]</td>
</tr>
<tr>
<td>\text{log(Total Employee)}</td>
<td>0.275***</td>
</tr>
<tr>
<td></td>
<td>0.546***</td>
</tr>
<tr>
<td></td>
<td>[0.008]</td>
</tr>
<tr>
<td></td>
<td>[0.014]</td>
</tr>
<tr>
<td>Observations</td>
<td>11,254</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.070</td>
</tr>
<tr>
<td></td>
<td>0.345</td>
</tr>
<tr>
<td></td>
<td>0.068</td>
</tr>
<tr>
<td></td>
<td>0.358</td>
</tr>
<tr>
<td>Number of Affiliates</td>
<td>3,880</td>
</tr>
<tr>
<td></td>
<td>3,880</td>
</tr>
<tr>
<td></td>
<td>3,880</td>
</tr>
<tr>
<td></td>
<td>3,880</td>
</tr>
</tbody>
</table>

Robust standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Notes: I control for affiliate fixed-effect, country and time fixed-effect, country fixed-effect industry fixed-effect and time fixed-effect using dummy variables. I also control for multinational and time fixed-effect using the sum of total sales of affiliates in the same MNC. I assign Time as one to six from 2005 to 2010, so it is different from the time fixed-effect controlled for by a dummy variable for each year. The dependent variable for the first two columns is the number of Korean managers and for the other two columns is the number of native managers.
decreases as the affiliate becomes larger. By comparing the coefficient of total sales or total employees in Columns (1) and (3) or Columns (2) and (4), the number of native managers increases more than two times that of Korean managers.

1.5 Conclusion

Using Korean MNCs’ foreign affiliates data from the EXIM, this paper answers, empirically, the questions: What are the comparative advantages of being in an MNC and, along the same lines, what is the benefit of receiving FDI? I show the relative importance of an MNC transfer of managers from the parent to the foreign affiliates via physical trade or production worker transfers within the MNC. Moreover, by examining characteristics of managers from the parent in various dimensions, I provide new evidence of transferring firm-specific knowledge within an MNC through transferring managers, as well as a guide for future research on the gains of FDI and multinationals.

From a theoretical perspective, my result suggests that manager transfers can result in a huge gain in welfare from FDI. The previous literature often presumes that knowledge is transferred from a developed country to a less developed country. However, an MNC can transfer firm-specific knowledge to its foreign affiliates. Because this knowledge is not held by a country, including developed countries, but held by the MNC, it is possible that it can be beneficial to both developing and developed countries. Thus, while it is clear that knowledge is transferred from developed to developing countries, the reverse is also true. In the previous section, my estimation results show that the effect of Korean managers on labor productivity in developed countries is larger than that in developing countries. Furthermore, my empirical result shows that an MNC becomes better at transferring its firm-specific knowledge to the affiliates at a lower cost as its size increases. The knowledge, therefore, can be
replicable in multiple locations with lower costs.

From a policy perspective, my result emphasizes the importance of an environment in which expatriates can successfully put down roots in a host country. Most government policies focus on tax benefits or financial subsides to attract FDI. My result demonstrates, however, that it is hard to transfer firm-specific knowledge, which is a main gain from FDI, without manager transfers from the parent. Mervosh and McClenahen (1997) estimate that the direct cost of a failed foreign assignment in a U.S. multinational ranges from $250,000 to $500,000 and that half of all expatriates fail to complete their assignment for various reasons, such as family or culture. So, to achieve a gain from FDI or multinational affiliates, it is necessary to carry out a policy to help expatriates settle in and work well with the foreign affiliate.
Chapter 2

SPECIALIZATION AND UNBALANCED SECTOR GROWTH

2.1 Introduction

A large literature in economic development has discussed the important role that productivity in agriculture or services has for the growth of manufacturing and the economy as whole. However, empirical evidence from some Asian economies such as Japan, Korea or China is inconsistent with this literature. These countries achieved unprecedented growth in the manufacturing sector without a significant improvement of productivity in other sectors. This raises a question: is high productivity in the other sectors necessary to achieving rapid manufacturing growth?

To answer this question, I provide an endogenous growth model with two sectors. In one sector, manufacturing, heterogeneous firms grow endogenously by innovation investment. The other sector, non-manufacturing, provides a non-manufacturing good, which is a source of final good used for either the innovation investment or final consumption. With the model, I consider two policy choices that exogenously expand the output of the non-manufacturing good. The first exogenous change involves increasing the productivity of the firm in the domestic non-manufacturing sector, the structural transformation emphasized in the previous literature. The second change

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1 The literature highlights that increases of productivity in the agriculture sector are an essential condition to reallocate labor from the agriculture sector to the manufacturing sector and to initiate manufacturing sector growth on structural transformation. See Kuznets and Murphy (1966), Matuyama (1992), Kögel and Prskawetz (2001) and Gollin, Parente, and Rogerson (2002). Moreover, recent literatures also focus on productivity of the service sector, especially financial or business supports. See Francois (1990), Neusser and Kugler (1998), Francois and Hoekman (2010) and Kehoe and Ruhl (2012)

consists of expanding imports of the non-manufacturing good from a foreign country which has higher productivity in the non-manufacturing sector. I then study how these two exogenous changes affect innovation decision of firms and economic growth in the manufacturing sector.

The model predicts that both exogenous policies increase welfare of the economy due to the falling price of non-manufacturing good, but predicts contrary outcomes in the manufacturing sector. When the economy imports more non-manufacturing goods from foreign countries, firms in the manufacturing sector have an increased incentive to conduct innovation because of the lower price of non-manufacturing goods. As their pace of productivity increases, labor moves from non-manufacturing to manufacturing. On the other hand, when the policy entails increasing the productivity of the domestic firm in the non-manufacturing sector, the productivity of the firms in the manufacturing sector increases relatively slowly and can even decrease depending on parameters in the model. In this last case, labor can even shift from the manufacturing sector to the non-manufacturing sector.

This consequence has an intuitive explanation. Both policy changes reduce the price of the non-manufacturing good and give the firms in the manufacturing sector more incentive for innovation. However, if the economy increases the productivity of the firm in the non-manufacturing sector, this firm will hire more labor. Thus, this change increases the demand for labor – and labor cost – throughout the economy. The higher costs lower the profitability of firms in the manufacturing sector and cause them to conduct less innovation. On the other hand, importing more non-manufacturing goods benefits firms in the manufacturing sector through a lower price for the non-manufacturing good but has no impact on labor costs. Thus, firms in the manufacturing sector conduct more innovation and grow rapidly, causing the economy to become specialized in the manufacturing sector.
Table 2.1: Growth Rate of Labor Productivity from 1977-1988

<table>
<thead>
<tr>
<th>Sector</th>
<th>Korea</th>
<th>EU15</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL INDUSTRIES</td>
<td>6.6%</td>
<td>2.4%</td>
<td>1.1%</td>
</tr>
<tr>
<td>AGRICULTURE, HUNTING, FORESTRY AND FISHING</td>
<td>6.7%</td>
<td>6.0%</td>
<td>2.9%</td>
</tr>
<tr>
<td>MINING AND QUARRYING</td>
<td>-0.3%</td>
<td>4.6%</td>
<td>2.0%</td>
</tr>
<tr>
<td>MANUFACTURING</td>
<td>8.9%</td>
<td>3.2%</td>
<td>2.7%</td>
</tr>
<tr>
<td>ELECTRICITY, GAS AND WATER SUPPLY</td>
<td>11.8%</td>
<td>3.3%</td>
<td>-0.2%</td>
</tr>
<tr>
<td>CONSTRUCTION</td>
<td>4.1%</td>
<td>1.7%</td>
<td>-1.5%</td>
</tr>
<tr>
<td>WHOLESALE AND RETAIL TRADE</td>
<td>1.6%</td>
<td>1.9%</td>
<td>2.2%</td>
</tr>
<tr>
<td>HOTELS AND RESTAURANTS</td>
<td>5.4%</td>
<td>-0.9%</td>
<td>0.0%</td>
</tr>
<tr>
<td>TRANSPORT AND STORAGE AND COMMUNICATION</td>
<td>5.4%</td>
<td>3.3%</td>
<td>2.0%</td>
</tr>
<tr>
<td>FINANCE, INSURANCE, REAL ESTATE AND BUSINESS SERVICES</td>
<td>1.9%</td>
<td>0.3%</td>
<td>-1.0%</td>
</tr>
<tr>
<td>COMMUNITY SOCIAL AND PERSONAL SERVICES</td>
<td>-0.3%</td>
<td>0.5%</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

Note: I calculate growth rate of labor productivity using gross value-added per hour from EU KLEMS.

The motivation for this research is the experience of Asian economies such as Japan, Korea or China. Each experienced unprecedented rapid economic growth with lagging growth in non-manufacturing sectors. For instance, consider the pattern of Korean economic growth. From 1977 to 1988, Korean total labor productivity increased by 6.6% yearly, while total labor productivity in the manufacturing sector increased by 8.9% yearly and that in other sectors stagnated. 3 Even compared to the respective sectoral growth rates of the EU and US during the same time period, the manufacturing sector in Korea grew faster but the other sectors did not. The growth miracle in Japan, which experienced rapid growth before Korea, also had the similar pattern. Ito and Weinstein (1996) show that the primary source of Japan’s rapid growth was the high rate of productivity growth in the manufacturing sector and the shift of resources to the manufacturing sector is observable during the rapid growth period.

3I choose this period because the share of Korean labor in the manufacturing sector increased until 1988. Extending the time period to 1970 does not affect the conclusion. Except for Electricity, gas and water supply. However, this sector has only small share of the total economy.
Consistent with my modeling framework, I also observe a significant increase in imports of non-manufacturing goods during the same period in Korea. From 1977 to 1988, imports of agriculture and raw materials increased by 16.8% yearly and those of services increased by 18.5% yearly. 4 Apparently, the economy imported more goods from those sectors, the non-manufacturing sector, where domestic production grew slowly. These facts suggest that “unbalanced growth” occurred due to specialization according to comparative advantage, but not “balanced growth” where all sectors of the economy improved simultaneously. 5 It is also different from the pattern experienced by the developed countries during their structural transformation.

I also use the model to conduct several numerical experiments. I obtain three findings with implications for development of a country. First, I show that allowing the import of more non-manufacturing goods from abroad makes firms in the manufacturing sectors grow more rapidly than increasing the productivity of the non-manufacturing sector quantitatively. Second, I show that the growth of the manufacturing sector is slower with higher productivity in the non-manufacturing sector when the economy allows imports more non-manufacturing goods. Lastly, I find that a larger economy has a greater welfare increase from a policy that focuses on increasing the domestic productivity of the non-manufacturing sector and developing both sectors in tandem.

Our research is related to previous works in economic growth and development. Specifically, it is in line with the development literature that attempts to explain how a country initiates manufacturing sector growth and the role of other sectors in that process. Matsuyama (1992), Kögel and Prskawetz (2001) and Gollin, Parente, Matsuyama (1992), Kögel and Prskawetz (2001) and Gollin, Parente,

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4World Development Indicator

5I use terminology balanced and unbalanced growth from Rauch (1997). In an economy which has two sectors, Rauch (1997) named ”balanced growth” if both sectors have the same growth rates and ”unbalanced growth” if not.
and Rogerson (2002) emphasize the importance of the productivity of the agriculture sector letting labor or other resource be transferred to the manufacturing sector. Moreover, other literature such as Francois (1990), Neusser and Kugler (1998), Francois and Hoekman (2010) and Kehoe and Ruhl (2012) emphasize the importance of productivity in the service sector, such as providing financial or business services, as intermediates for manufacturing. While the previous works consider the productivity of non-manufacturing sector as the only determinant of producing non-manufacturing goods, I consider the additional alternative of providing non-manufacturing goods that are imported with better technology.

Our work is also related to a broad range of the endogenous growth literature that incorporates endogenous R&D decision driving economy growth as in Romer (1990), Aghion and Howitt (1992) and Grossman and Helpman (1993). The success of innovation is stochastic as in Griliches (1979) and Ericson and Pakes (1995). I incorporate endogenous innovation decisions of firms in the manufacturing sector similar to Klette and Kortum (2004), Lentz and Mortensen (2008) and Atkeson and Burstein (2010). Finally, the model is closely related to that of Atkeson and Burstein (2010) which has firm-level innovation decisions. While they consider symmetric countries to focus on gains from trade, I focus on growth of a developing country by considering an asymmetric case with a small open economy. In my model, since it has two industries, specialization is a key mechanism to evaluate the effects of two policy changes.

A recent work by Gersbach, Schneider, and Schneller (2013) evaluates the effect of similar policies. They argue that if an economy imports leading technology from foreign countries instead of public research investment, then the economy has a lower level of domestic innovation. This seems to be opposite to my main results. However, in their work, openness to foreign technology discourages optimal domestic innovation
because foreign technology substitutes domestic technology. In my model, however, there are two sectors and openness to foreign technology means that an economy imports more non-manufacturing good. This foreign non-manufacturing good as a part of research goods complements innovations in the manufacturing sector. This difference results in the opposite consequence.

The remainder of the paper is organized as follows. Section 2.2 provides the two sector growth model where firms in the manufacturing sector grow endogenously and the non-manufacturing sector provides parts of research goods for firms in the manufacturing sector to innovate. In section 2.3, I demonstrate how the two policies result in different consequences, especially in the manufacturing sector. In section 2.4, I conduct some experiments using the model and provide some implications for the development path of different countries. Section 2.5 is the conclusion.

2.2 Model

2.2.1 Environment

I consider a small open economy being surrounded by one continent. The economy has two sectors called manufacturing and non-manufacturing respectively. I assume that goods in manufacturing are perfectly tradable but goods in non-manufacturing are partly tradable. In the manufacturing sector, there are heterogeneous firms in terms of productivity and they can grow endogenously by investing in R&D while there is a homogeneous firm with a productivity in the non-manufacturing sector.

---

6While I focus on endogenous growth in manufacturing related to productivity in the non-manufacturing sector in a developing country, Gersbach, Schneider, and Schneller (2013) understand domestic optimal innovation with an option to adopt foreign technology in a developed country.

7I am particularly interested in the growth miracle in East Asian countries. Sachs and Warner (1995) emphasizes that if a country is not endowed with natural resources like some East Asian economies, then it does not have comparative advantage. In the economy, export firms in the manufacturing lead an economic growth.
There is a measure L of infinitely lived homogeneous household in the economy who only values his consumption and is endowed with one unit of labor.

### 2.2.2 Manufacturing sector

There are a continuum number of varieties between 0 and N·K in the manufacturing sector, indexed by i. In each variety i, there is only one firm, either a domestic firm, or a foreign firm. A firm is the only monopolist for its own variety, but engages in monopolistic competition with firms producing other varieties.

There are two possible state for a firm’s productivity for each variety, indexed by \( z_L \) and \( z_H \). The firm with productivity index \( z \), has labor productivity \( \exp(z \frac{1}{\sigma-1}) \).

The firm uses labor \( l \) as its only input. The firm’s output is the following production technology,

\[ x_i = (e^{z_i})^{\frac{1}{\sigma-1}}l_i \]  

(2.1)

Each output from firms in the manufacturing sector is aggregated by combining with other varieties in the same sector. I call the good which is aggregated by all varieties from the manufacturing sector as manufacturing good. There is no trade cost for the manufacturing good and it can be used both domestically and internationally. Therefore, the aggregation function for the manufacturing good is following.

\[ M = \left( \int_{0}^{N} x_i^{\frac{1}{\sigma-1}} di + \int_{N}^{NK} x_i^{\frac{1}{\sigma-1}} di \right)^{\frac{\sigma}{\sigma-1}} \]  

(2.2)

The small open economy produces variety from \((0, N]\) domestically while foreign firms produces varieties from \((N, NK]\). 

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8In this framework, \( K \to \infty \) imply that the economy is a small open economy
Innovation of the Firm

A Firm in the manufacturing sector can grow endogenously by conducting research and development investment for their future productivity. The final goods $Y$ is used as the input for such investment. If a firm spends $c(q)$ for the innovation where $c(\cdot)$ is second-order differential and it satisfies that $c'(\cdot) > 0$ and $c''(\cdot) > 0$, regardless whatever his productivity is today, his productivity $z'$ tomorrow would be

$$z' = \begin{cases} 
  z_H & \text{with probability } q \\
  z_L & \text{with probability } 1 - q
\end{cases} \quad (2.3)$$

Manufacturing firm’s problem

The objective of the firm is maximizing its value determined by the sum of current and future values. From the assumption of small open economy, each individual firm takes total market size for the manufacturing sector denoted by $M$ and the world price for manufacturing good, $P_M$ as given. Since I do not have entry and exit in the model, the mass of domestic firms is fixed as $N$. 

$$V(z) = \max_{p,l} p \cdot \exp(z) \frac{1}{\tau + 1} l - \omega l - c(q) + \beta[qV(z_H) + (1-q)V(z_L)] \quad (2.4)$$

s.t.

$$D(p, p_M, M) = \exp(z) \frac{1}{\tau + 1} l \quad (2.5)$$

where $D(\cdot)$ is demand for the firm from the final manufacturing sector that I will define later. $p \cdot \exp(z) \frac{1}{\tau + 1} l - \omega l$ is the profit determine the firm’s current value, $c(q)$

---

9The main goal of the paper is not to analyze a change of the number of firms but growth in size of incumbent firms. If I allow the free entry condition to determine the number of firms endogenously, I can have different size of the manufacturing sector instead of those of individual firms’ growth patterns.
is the amount of R&D investment the firm conducts, and \( qV(z_H) + (1 - q)V(z_L) \) will be the expected firm value in the future, which is discounted at rate \( \beta \).

### 2.2.3 Non-manufacturing sector

The non-manufacturing sector is operated by perfectly competitive producers and perfectly competitive aggregators. A representative firm in the non-manufacturing sector uses labor with constant return to scale production technology to produce non-manufacturing output.

The production function of the firm in the non-manufacturing is:

\[
S_D = \theta L_S
\]  

(2.6)

Where \( S_D \) is the total non-manufacturing good provided by the domestic firm, while \( L_S \) is the total labor engaged in the non-manufacturing good production. I normalize the productivity of the firm as one in the continent, and let \( \theta \) be the productivity of the domestic firm in the non-manufacturing sector, where \( \theta < 1 \).

Since the non-manufacturing sector is partially tradable, some of the foreign non-manufacturing goods are also available in the domestic market. However, the imported non-manufacturing goods and domestic non-manufacturing goods are not perfect substitutes. The elasticity of substitution between the two types of non-manufacturing goods is \( \rho \).

There is the final non-manufacturing goods producers by aggregating non-manufacturing good from both domestic and foreign. And both domestic and foreign non-manufacturing goods are aggregated into final non-manufacturing good via the following function,

\[
S = (\lambda^\frac{1}{\rho} S_F^\frac{\rho}{\rho-1} + (1 - \lambda)^\frac{1}{\rho} S_D^\frac{\rho-1}{\rho-1})^\frac{\rho}{\rho-1}
\]  

(2.7)

\( S_F \) is the imported non-manufacturing goods, and \( S_D \) is domestically provided.
Here $\theta$ and $\lambda$ are the parameters which relate to productivity of the non-manufacturing sector. I am interested in two exogenous changes in these parameters. If $\theta$ increases and productivity of the domestic non-manufacturing sector becomes more productive, the economy provides more non-manufacturing goods from the domestic and $S_F$ becomes higher in the equilibrium. In the other hand, if $\lambda$ increases which I consider a case where the non-manufacturing market becomes more accessible to foreign firms. Then, $S_F$ becomes lower in the equilibrium.

\subsection*{2.2.4 Final Good Sector}

The final good producers are perfect competitive producers who use manufacturing goods bundle ($M_c$) and non-manufacturing goods bundles ($S$) and aggregate it in to the final output. They take the price of manufacturing goods bundle $P_M$, and the price of non-manufacturing goods bundle $P_S$ as given.

The production function of final good production is take as follows:

$$Y = M_c^\alpha S^{1-\alpha} \quad (2.8)$$

The final output is used in consumption and making R&D investments.

\subsection*{2.2.5 Households}

A stand-in consumer is endowed with $L$ unit of labor each period. He derives utility from the final good consumption, and chooses consumption allocations \(\{c_t\}, t = 0, 1, \ldots\), to maximize lifetime utility.

$$\max \sum \beta^t \log C_t \quad (2.9)$$

subject to the budget constraints

$$\sum p' t(C_t) \leq \sum p'(\omega_t L + E(d_t)), t = 0, 1, \ldots \quad (2.10)$$

47
Here, \( p^t \) is the Arrow-Debru price, \( P_t \) is the price of final good, \( \omega_t \) is the wage rate, and 
\[
E(d_t) = \int_0^N p_i \exp(z_i)^{\frac{1}{\sigma}} l_i - \omega l_i - c(q_i) d\mu(i)
\]
is the expected dividend from firms in the manufacturing sector.

The consumer does not value leisure in my model, so he devotes all his labor endowment into the production. On the other hand, the consumer does not accumulate any capital, so he consumes the exactly same amount of consumption goods for each period following the permanent income hypothesis.

2.2.6 Equilibrium

A stationary recursive equilibrium is a list of aggregate state variables, the distribution of firms’ productivity \( \{\mu(z)\} \), and individual state variables, \( (z_i) \), for each firm in the manufacturing sector,

a list of prices:
\[
P(\mu(z)), \omega(\mu(z)), p_i(z, \mu(z))
\]
and a list of decision functions:

a) \( V(z, \mu(z)), d(z, \mu(z)), l(z, \mu(z)), x(z, \mu(z)), q(z, \mu(z)) \) for a manufacturing firm
b) \( S^S_D(\mu(z)), L_S(\mu(z)) \) for a non-manufacturing firm
c) \( S^S(\mu(z)), S_F(\mu(z)), S^D_B(\mu(z)) \) for a non-manufacturing aggregator
d) \( Y(\mu(z)), M_c(\mu(z)), S^D(\mu(z)) \), for a final aggregator
e) \( c(\mu(z)) \)
and an updating rule for the state variables:
\[
z' = \begin{cases} 
z_H & \text{with probability } q \\
z_L & \text{with probability } 1 - q 
\end{cases}
\]
\[
\mu(z) = H(\mu(z))
\]
such that
1) The consumer takes the wage as given, the future dividend, and the other prices. He maximizes his life time utility by having his consumption equal to his life-time income.

2) Firms in the manufacturing sector take the demand function and the wage as given, choose \( d(z, \mu(z)) \), \( l(z, \mu(z)) \) and innovation intensity \( q(z, \mu(z)) \) that maximize the value of this firm \( V(z, \mu(z)) \)

3) The firm in the non-manufacturing sector takes prices as given and produces \( S_D^S(\mu(z)) \), domestic non-manufacturing goods, to maximize its profit using \( L_S(\mu(z)) \).

4) The non-manufacturing aggregator takes prices as given and it produces final non-manufacturing goods, \( S_S^S(\mu(z)) \), using \( S_F(\mu(z)) \) and \( S_D^D(\mu(z)) \) as inputs.

5) The final aggregator takes prices as given and it produces final output, \( Y(\mu(z)) \) using \( S^D(\mu(z)) \) as inputs.

6) How to aggregate each good is consistent to the updating rule of \( \mu(z) \)

7) All market clearings and the trade balance conditions hold.

2.2.7 Equilibrium Results

2.2.8 Non-Manufacturing sector:

Since the non-manufacturing sector is perfectly competitive, the price of the non-manufacturing good will be equal to the firm’s marginal unit cost:

\[
P_N = \frac{W}{\theta}
\] (2.11)

The non-manufacturing aggregator combines both domestic and foreign non-manufacturing goods into final non-manufacturing goods under a CES technology. In the equilibrium, its unit cost of producing non-manufacturing goods will be:

\[
P_S = (\lambda P_T^{1-\rho} + (1 - \lambda) P_N^{1-\rho})^{\frac{1}{1-\rho}}
\] (2.12)
which equals to the equilibrium price for the non-manufacturing goods.

Then the demand for domestic non-manufacturing inputs should satisfy:

\[ P_N S_N = (1 - \lambda) \left( \frac{P_N}{P_S} \right)^{-(\rho - 1)} P_S S \]  
(2.13)

which equals the total amount of the wage paid to the workers in the domestic non-manufacturing sectors, \( \omega L_N \).

On the other hand, the total amount of non-manufacturing goods from a foreign country is

\[ P_T^* S_T = \lambda \left( \frac{P_T^*}{P_S} \right)^{-(\rho - 1)} P_S S \]  
(2.14)

### 2.2.9 Manufacturing sector

A firm with productivity \( z \) in the manufacturing sector maximizes its profit under the monopolistic competition, given the world market size for manufacturing goods, \( M \).

In the equilibrium, the demand for labor in manufacturing firms with productivity index \( z \) will be:

\[ l(z) = \left( \frac{\sigma}{\sigma - 1} \right)^{-\sigma} \left( \frac{\omega}{P_M} \right)^{-\sigma} M \exp(z_H) \]  
(2.15)

And its profit will be:

\[ \pi(z) = \frac{P^\sigma M \omega^{1-\sigma}}{\sigma^\sigma (\sigma - 1)^{1-\sigma}} \exp(z) \]  
(2.16)

The innovation cost function is \( c(q) = P \omega^q \). Let \( \pi = \frac{P^\sigma M}{\sigma^\sigma (\sigma - 1)^{1-\sigma}} \) for simplicity in writing. In the equilibrium, the value function of a manufacturing industry firm is:

\[ V(z_L) = \pi \omega^{1-\sigma} (C_1 + C_2 (\ln \pi(\omega) - \ln(P))) \]  
(2.17)
\[ V(z_H) = V(z_L) + \pi(z_H) - \pi(z_L) \quad (2.18) \]

The optimal innovation cost \( c(q) = \beta(1 - \delta)[\pi(A_H) - \pi(A_L)] \) and the optimal \( q \) is
\[ q = \ln(\pi\beta(1 - \delta)[\exp(z_H) - \exp(z_L)]/h) + (1 - \sigma)\ln \omega - \ln P \quad (2.19) \]

### 2.2.10 Final Aggregation sector

Since the production function is Cobb-Douglas and the final good sector is perfectly competitive, the two first order condition gives the equilibrium demand for manufacturing goods and non-manufacturing goods:
\[ \frac{P_M M_c}{P_S S^D} = \frac{\alpha}{1 - \alpha} \quad (2.20) \]

And correspondingly, the equilibrium price of the final goods will be
\[ P = \frac{P_M^\alpha P_S^{1-\alpha}}{\alpha^\alpha(1-\alpha)^{(1-\alpha)}} \quad (2.21) \]

### 2.2.11 Market Clearing

The labor demand for the manufacturing sector and the non manufacturing sector are
\[ L_M = N(\frac{\sigma}{\sigma - 1})^{-\sigma}(\frac{\omega}{P_M})^{-\sigma}M(\mu \exp(z_H) + (1 - \mu) \exp(z_L)) \quad (2.22) \]
\[ L_N = (1 - \alpha)(\frac{\lambda}{1 - \lambda}P_T^{\rho-1}(\frac{\omega}{\theta})^{\rho-1} + 1)^{-1}(L + \frac{N}{\omega}(\mu d(z_H) + (1 - \mu)d(z_L))) \quad (2.23) \]

\( L_M + L_N \) equals to the labor supply, \( L_S = L \).

The final good market is cleared for each period:
\[ PC = \omega L + N(\mu \pi_H + (1 - \mu)\pi_L - \beta(1 - \delta)[\pi_H - \pi_L]) \quad (2.24) \]

\[ \frac{10}{1} \text{Where } C_1 = \frac{\exp(z_H) + (1 - \delta)[\exp(z_H) - \exp(z_L)](\ln(\beta(1 - \delta)[\exp(z_H) - \exp(z_L)]/h) - 1)}{(1 - \beta(1 - \delta))} \quad \text{and } C_2 = \frac{\beta(1 - \delta)[\exp(z_H) - \exp(z_L)]}{(1 - \beta(1 - \delta))} \]
From the trade balance condition,

\[ P(Y - C) = \lambda \left( \frac{P^*_T}{P_S} \right)^{(\rho - 1)} P_S S \]  \hspace{1cm} (2.25)

**Proposition 3.** There exists a unique stationary recursive equilibrium in the model.

*Proof.* See Appendix. \qed

### 2.3 Comparative Statics for Parameter \( \theta \) and \( \lambda \)

The model equilibrium is characterized by the equilibrium wage and prices. Since the unique equilibrium exists in the model, I conduct comparative analysis by altering parameters \( \theta \) and \( \lambda \) and see how the equilibrium responds.

As I discussed before, a higher \( \lambda \) means the economy is allowed to import more non-manufacturing goods from a foreign country. Otherwise, higher \( \theta \) means the economy has higher productivity in the non-manufacturing sector. Both changes are favorable to a firm’s innovation in the manufacturing sector because the changes provide cheaper non-manufacturing goods and finally they reduce costs of innovation.

Since the equilibrium \((\omega^*, P^*)\) is characterized by the market clearing for the final goods and labor. The equilibrium condition gives,

\[ P = \left( \frac{P_M}{\alpha} \right)^{\alpha} \left( \frac{P_S}{1 - \alpha} \right)^{1 - \alpha} \]  \hspace{1cm} (2.26)

\[ P_S = \left( 1 - \lambda \left( \frac{\omega}{\theta} \right)^{1 - \rho} + \lambda P^*_T \right)^{\frac{1}{1 - \rho}} \]  \hspace{1cm} (2.27)

I rewrite the market clearing condition for the final goods as

\[ P^* = P^*(\omega, \theta, \lambda) \]  \hspace{1cm} (2.28)

and substitute it into the market clearing condition for labor. Then the equilibrium \( \omega^* \) satisfies

\[ L_M(\omega^*, P^*(\omega^*, \theta, \lambda), \theta, \lambda) + L_N(\omega^*, P^*(\omega^*, \theta, \lambda), \theta, \lambda) - L_S = 0 \]  \hspace{1cm} (2.29)
Let $\nu(\omega, \theta, \lambda)$ be the wedge between the demand and supply of the labor:

$$
\nu(\omega, \theta, \lambda) = L_M(\omega, P^*(\omega, \theta, \lambda), \theta, \lambda) + L_N(\omega, P^*(\omega, \theta, \lambda), \theta, \lambda) - L_S
$$

(2.30)

I take first order derivatives of the wedge equation with respect to $\omega$, $\theta$ and $\lambda$ Because \( \frac{\partial L_M}{\partial P}, \frac{\partial L_N}{\partial P}, \frac{\partial L_N}{\partial \lambda}, \frac{\partial P}{\partial \lambda}, \frac{\partial L_N}{\partial \theta} \) are negative and \( \frac{\partial P}{\partial \omega}, \frac{\partial L_M}{\partial \omega} \) are positive in the equilibrium.

$$
\frac{\partial \nu}{\partial \omega} = \frac{\partial L_M}{\partial P} \frac{\partial P}{\partial \omega} + \frac{\partial L_N}{\partial P} \frac{\partial P}{\partial \omega} + \frac{\partial L_N}{\partial \omega} + \frac{\partial L_M}{\partial \omega}
$$

(2.31)

$$
\frac{\partial \nu}{\partial \lambda} = \frac{\partial P}{\partial \lambda} \left( \frac{\partial L_M}{\partial P} + \frac{\partial L_N}{\partial P} \right) + \frac{\partial L_N}{\partial \lambda}
$$

(2.32)

$$
\frac{\partial \nu}{\partial \theta} = \frac{\partial P}{\partial \theta} \left( \frac{\partial L_M}{\partial P} + \frac{\partial L_N}{\partial P} \right) + \frac{\partial L_N}{\partial \theta}
$$

(2.33)

The indirect effect comes from changes in prices. Because an economy can either import more non-manufacturing goods from a foreign country or produce non-manufacturing goods with a higher productivity, it can use cheaper non-manufacturing goods which reduce the final goods and innovation costs. So firms in the manufacturing sector grows and attract labor.

The direct effect of the two possible parameter changes moves the equilibrium in opposite directions. When the economy can import more non-manufacturing goods from a foreign country, domestic non manufacturing goods are replaced by the foreign non manufacturing goods. Then the labor demand of the non-manufacturing sector decreases and there is surplus of the labor from the non-manufacturing sector. On the other hand, when the economy increases productivity of the non manufacturing sector, the labor demand of the non-manufacturing sector increases and there is shortage of labor.

From the three equations above, the implicit function theorem tells us that

$$
\frac{\partial \omega^*}{\partial \lambda} = -\frac{\partial \nu}{\partial \lambda}, \text{ sign unknown}
$$

(2.34)
\[ \frac{\partial \omega^*}{\partial \theta} = -\frac{\partial \nu}{\partial \omega} > 0 \] (2.35)

I do the same thing for \( P^* \) as rewriting the market clearing condition for the final good. I plug the market clearing condition rewritten into \( \omega(P, \theta, \lambda) \) and substitute it into the market clearing condition for labor. Then I can show

\[ \frac{\partial P^*}{\partial \lambda} = -\frac{\partial \psi}{\partial \lambda} \frac{\partial \psi}{\partial P} < 0 \] (2.36)

\[ \frac{\partial P^*}{\partial \theta} = -\frac{\partial \psi}{\partial \omega} \frac{\partial \omega}{\partial P} : \text{sign unknown} \] (2.37)

Similarly to the case of wage, I argue that when an economy imports more non-manufacturing goods, an increase in \( \lambda \), both the direct effect and the indirect effect move in the same way to bring down the price. But the effect of an increase of \( \theta \) is ambiguous.

**Lemma 1.** If \( \rho \to \infty \), there is a pair of \( (\theta, \lambda) \) satisfying \( \frac{\partial \omega^*}{\partial \lambda} = 0 \) and \( \frac{\partial P^*}{\partial \theta} = 0 \).

**Proof.** See Appendix.

**Proposition 4.** If \( \rho \to \infty \) and a pair of \( (\theta, \lambda) \) satisfies \( \frac{\partial \omega^*}{\partial \lambda} = 0 \) and \( \frac{\partial P^*}{\partial \theta} = 0 \), increases in \( \theta \) and \( \lambda \) both increase the welfare of the economy, but the effect on productivity and labor in the manufacturing sector is opposite.

**Proof.** See Appendix.

2.4 Quantitative Analysis

2.4.1 Extended Model for Simulation

In this section, I extend the baseline model to an infinite number of possible productivity for firms in the manufacturing sector in order to conduct quantitative
Table 2.2: Parameters of the Model for the Simulations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_M$</td>
<td>The final good price level</td>
<td>0.85</td>
</tr>
<tr>
<td>$P_T$</td>
<td>Price level of continent non-manufacturing goods</td>
<td>1</td>
</tr>
<tr>
<td>$M$</td>
<td>The world market size for manufacturing intermediate goods</td>
<td>10</td>
</tr>
<tr>
<td>$N$</td>
<td>Measure of domestic manufacturing firms</td>
<td>10</td>
</tr>
<tr>
<td>$K$</td>
<td>Measure of total manufacturing firm</td>
<td>unnecessary 12</td>
</tr>
<tr>
<td>$L$</td>
<td>Total domestic labor force</td>
<td>100000</td>
</tr>
<tr>
<td>$\beta$</td>
<td>Discount rate</td>
<td>0.96</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Exogenous quit rate</td>
<td>0.005</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Manufacturing share</td>
<td>0.3</td>
</tr>
<tr>
<td>$\rho$</td>
<td>Elasticity of substitution between service goods</td>
<td>10</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>Elasticity of substitution between manufacturing goods</td>
<td>5</td>
</tr>
<tr>
<td>$\Delta$</td>
<td>Step Length for innovation</td>
<td>0.1</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Productivity of the firm in the domestic non-manufacturing sector</td>
<td></td>
</tr>
<tr>
<td>$\lambda$</td>
<td>Parameter to determine the weight for foreign non-manufacturing goods</td>
<td>13</td>
</tr>
</tbody>
</table>

Analysis. Following Atkeson and Burstein (2010), a firm in the manufacturing sector invests $C(q, z) = P h e^\theta e^z$ units of final output to do the innovation. Then it will get the following innovation outcomes:

$$z' = \begin{cases} 
    z + \Delta & \text{with probability } q \\
    z - \Delta & \text{with probability } 1 - q 
\end{cases}$$

(2.38)

$\exp(\Delta)$ is the productivity difference between the two adjacent productivity indexes. Now $\mu(z)$ is the distribution of infinite possible productivity indexes so I can define the a equilibrium as what I have done in the Section 2.2.

For conducting some simulation results, I parameterize the model. I provide each value of the parameters which I use in Table 2. 11

11My goal is not to give an accurate quantitative analysis for policies but to give implications about different policies. So I do not calibrate the parameters precisely.
2.4.2 Simulation Analysis

Using the extended model, I will conduct some counterfactual analysis. I especially focus on two exogenous changes of \( \lambda \) and \( \theta \). Both changes provide lower prices of non-manufacturing goods but, as I studied before, the impact on the manufacturing sectors is different. First, I show how \( \lambda \) and \( \theta \) affects innovation decisions of firms in the manufacturing sectors which provided theoretical results with the simple model before. This analysis will tell us the growth pattern from different policies. Second, I show the effect of a change of \( \lambda \) given different level of \( \theta \). This result will tell us how much specialization will benefit on economics depending on different levels of development in the non-manufacturing sector. Finally, I show that how the size of an economy matters for the effects of two exogenous changes.

**Experiment 1. Effects of two policies on the distribution of the manufacturing sector**

In Experiment 1, I show Proposition 2 quantitatively with heterogeneity in firms’ productivity but with multiple productivity levels using the extended model. For the experiment, I start from a specific \((\theta, \lambda)\) pair as \((0.1, 0.1)\). I do not construct an explicit cost function for the two policies. To consider changes of the two policies comparably, first I change \( \theta \) to 0.3 and calculate the change of household’s welfare. From the change of household’s welfare, I find the change of \( \lambda \) which guarantees the same change of the household’s welfare, \( \lambda = 0.247 \). So I compare each change of the two policies which increase \( \theta \) from 0.1 to 0.3 and \( \lambda \) from 0.1 to 0.247. I provide the probability density function for productivity of the firms after two policies in Figure 1.

The Figure 1 says that the increase in \( \lambda \) has a favorable change for a firms’ innovation in the manufacturing sector rather than an increase in \( \theta \). In the experiment,
the increase in $\lambda$ has a higher fraction of firms with an increase in productivity and a lower fraction of firms with lower productivity ex-post. On the other hand, the increase in $\theta$ even makes firms ex-post have lower productivity than before the policy change. I calculate the change of average productivity of the firms in the manufacturing sector using $\sum^N_{i=0} z_i \mu(z) dz$. Although both changes were designed to give the same change in the welfare, the change of the $\lambda$ increases the firms’ average productivity by 4 percent while that of the $\theta$ decreases the productivity by 34 percent. About labor movement, two changes give opposite result. The change of the $\lambda$ make the firms in the manufacturing hire more labor by 0.9 percent while that of the $\theta$ make the firm hire only less than half of labor.

The quantitative result is consistent with Proposition 2 in Section 2.2 which is the analytic result with two possible productivity levels. As I explained in the model, this is related to specialization. Because of a lower price of non-manufacturing goods, both parameter changes give a higher incentive to conduct innovation. However,
an increase in $\lambda$ makes firms in the manufacturing sector suffer from a relatively small increase in the labor cost because there is no change of productivity of the firm in the non-manufacturing sector. The firms in the manufacturing sector have higher profits and conduct more innovation compared to an increase in $\theta$. Then, the economy becomes specialized in the manufacturing sector without improvement of the non-manufacturing sector.

**Experiment 2. Effects of $\lambda$ increase on the manufacturing sector in different $\theta$s**

For Experiment 2, I start from two different pairs $(\theta, \lambda)$ as $(0.3, 0.1)$ and $(0.5, 0.1)$, then I increase $\lambda$ to 0.3. As I show firm’s productivity distribution in Figure 2, the increase in $\lambda$ is likely to drive a more rapid growth in the manufacturing sector with a lower $\theta$. It happens because a higher productivity of the non-manufacturing sector make the equilibrium price of the labor service higher then decreases profits of firms in the manufacturing sector as well as incentive of innovation of them. Openness in the non-manufacturing sector, therefore, is less desirable when a country already has a high non-manufacturing productivity. Reversely, a country which has low productivity in non-manufacturing finds it necessary to import more goods for growth in the manufacturing sector.

Quantitatively, the change of the $\lambda$ from 0.1 to 0.3 will give 17 percent increases the average productivity of the firms in the manufacturing sector with $\theta = 0.3$ while the same change increases the productivity only by 1.4 percent with $\theta = 0.5$. And also, the first change makes the firms in the manufacturing sector hire much more labor than the second one, by 40 percent and 11 percent respectively.

The result implies that when a country has very low productivity across all industries, the manufacturing sector takes comparative advantage through opening the non-manufacturing sector, the county experiences rapid growth and specializes in
the manufacturing sector as in the case of the growth miracle economies in Asia. However, a country that has relatively higher productivity in the non-manufacturing sector or when a country’s income increases due to higher productivity in the non-manufacturing sector then the comparative advantage disappears. This can explain why a developing country can have firms which grow extremely rapidly in the manufacturing sector compared to those in a developed country.

**Experiment 3.** *Effect of $\theta$ and $\lambda$ on the welfare for the household by different numbers of labor.*

In Experiment 3, I show different impacts on the policy depending on different sizes of countries. I start from a specific $(\theta, \lambda)$ pair as (0.1, 0.1). I increase $\theta$ to 0.3 and then try finding each level of $\lambda$ to give the same change in the welfare of the household by different number of labor. This implies that I implicitly find out $\lambda$ which provides the same benefit as the change of the increase $\theta$ by 0.3 by different sizes of economy.
As I show in Figure 3, if I have more labor, I need a higher $\lambda$ to get the same welfare gain from the change of the same $\theta$. Similarly, a larger country, which has more labor, will have a smaller welfare gain from the same change of $\lambda$ which allows IT to import more non-manufacturing goods than a smaller country.

The result provides an implication that a larger country will get a rapid growth in the manufacturing sector through specialization in the sector. However, in terms of welfare gain, the gain from the openness for the non-manufacturing sector relative to increasing its own productivity in the non-manufacturing sector is smaller because of its size. This tells us that a balanced growth through increasing productivity of the non-manufacturing sector as well would be a necessary policy if the country is larger.

Eichengreen, Park, and Shin (2012) analyze historical growth experiences of countries and they argue that a country experiences a slowdown of economic growth when per capita GDP of the country reaches $13,000 named 'Middle income trap’. To avoid 'Middle income trap’ they emphasize an increase in productivity in the non-
manufacturing sector. From historical analysis of other countries, They also argue that China will be in the trap when its income level reaches to $13,000. However, my model suggests that it is necessary to increase productivity of the non-manufacturing sector even if it has a lower income level than other countries in terms of welfare because China is much bigger than other countries.

2.5 Conclusion

In this paper, I provide a model with two sectors where the manufacturing sector grows endogenously and the non-manufacturing sector provide goods used for both research and final consumption stimulating innovation of firms in the manufacturing sector. Using the model, I examine the effects of two exogenous changes that expand the output of goods in the non-manufacturing sector. The first policy is to increase domestic productivity in the non-manufacturing sector by itself and the other is to import more non-manufacturing goods from a foreign country that has higher productivity. Even though both changes increase the welfare of the economy, both theoretically and quantitatively, I show that effects on the manufacturing sector are different. Our model predicts that the latter change makes firms in the manufacturing sector grow faster and attracts more labor to the manufacturing sector than the former. Based on my result, I argue that the specialization through importing non-manufacturing goods contributes to Asian economic growth but not increasing productivity in the non-manufacturing sector emphasized in previous literature on structural transformation.

I also conduct some experiments using the model and provide interesting insight for economic development. Our experiments suggest that the growth of manufacturing is slower with higher productivity in the non-manufacturing sector when the economy allows imports more non-manufacturing goods. This implies that in terms of
growth of manufacturing a developing country has more incentive to be specialized in manufacturing through importing more non-manufacturing goods than a developed country does because it has a lower productivity in the non-manufacturing sector. Furthermore, a larger economy has a larger welfare gain from increasing the domestic productivity of non-manufacturing sector and developing both sector in a balanced way. This result has an important implication for growth of the Chinese economy. The similar pattern of economic growth to that of Japan or Korea could guarantee the fast growth of Chinese manufacturing. In terms of welfare, however, China might have a lower welfare improving relative to that of Japan and Korea’s growth experiences because China is much larger than the other countries.

\[14\] Bosworth and Collins (2008) show, using the growth accounting, that productivity of the industry sector including manufacturing, utility and construction has increased by 6.1% while those of agriculture and service sectors increased by 1.7% and 0.9% respectively from 1993 to 2004.
Chapter 3

POLICY-INDUCED VARIATION IN COLLEGE LABOR SUPPLY AND THE SKILL PREMIUM

3.1 Introduction

Two well-documented educational trends have affected most advanced economies. First, there is a broad increase in educational attainment (Restuccia and Vandenbergroucke, 2013). Second, there has been a general increase in the educational wage premium, whether measured as the coefficient on return to schooling or the college-high school wage premium (Machin and Van Reenen, 1998; Bekman, Bound, and Machin, 1998; Katz and David, 1999). An important and still open question in the literature is whether these two patterns are linked. An expansion of education means changes in who acquires different levels of schooling. For example, one hypothesis would be that the expansion has led progressively less able students to attend and graduate from college over time. This raises two questions: is this hypothesis true? And if so, can it help us understand the patterns of wage premiums?

A small literature has sought to answer this question, with an almost exclusive focus on the United States. Here, I revisit these questions in the context of Korea. Korea is a useful laboratory for revisiting these questions for three reasons. First, as I have already noted, the basic patterns are shared by most advanced economies; Korea is no exception. The relevant data are shown in Figure 3.1. Figure 3.1a shows the educational attainment by cohort, with attainment measured in four complete and mutually exclusive categories: those with less than a high school degree; high

---

1Details on the construction of this and subsequent data are delayed to Section 3.2.
school graduates; those with more than a high school degree but less than a four-year college degree; and four-year college graduates. The expansion has been large and rapid: while most of the 1930 birth cohort did not complete high school, nearly all Koreans of recent birth cohorts do. Indeed, high school graduates are now a shrinking share of the population, due to the increase in college attendance. Figure 3.1b shows the college wage premium from 1980 onward. The wage premium fluctuated until 1995 but has risen 15–20 log points since that time.

Figure 3.1: Changes in Korean Education

(a) Expansion of Education

(b) College Wage Premium

These patterns are qualitatively consistent with the United States. However, a second advantage of focusing on Korea is that the changes happened much more rapidly and were quantitatively larger. This fact is particularly apparent for the rise in educational attainment. The college completion rate in Korea is roughly 40 percent today, as compared to 30 percent for the United States; it took thirty years for the college completion rate to rise from 10 to 30 percent of the population in the United States, but just ten years in Korea. These rapid changes are useful for my empirical approach, which I discuss below. The third and final reason I find Korea to be a useful
laboratory is that college dropout rates in Korea are comparatively low, roughly two percent as opposed to twenty percent in the U.S. throughout this time period. This fact is useful because the college wage premium is typically calculated as the wage of college graduates relative to high school graduates. In this calculation it is unclear whether or how to take into account those who start at a four-year college but do not acquire a degree. This group is particularly concerning when one is considering issues of ability and composition effects, since college dropouts are unlikely to be randomly selected of the group that starts college. The small share of such persons in Korea suggests that I can abstract from them without missing too much.

Our empirical strategy is twofold. First, I replicate two empirical strategies previously used in the literature to quantify ability and composition effects in the United States. As I show below, strong assumptions are needed to identify these effects. Each paper utilizes slightly different identifying assumptions. Our goal here is to replicate these papers in a consistent and unified way. A common feature of the empirical strategies is that they rely on comparing wage patterns for nearby birth cohorts with different educational attainments. Under some assumptions, they link differential wage patterns to the differential educational attainment. Korea offers a clear advantage for such empirical approaches because of the larger differences in educational attainment for nearby cohorts, which I exploit.

The second component of my empirical strategy relies on changes in educational attainment induced by policy. The Korean government limited university enrollment throughout my period of interest. By the late 1970s the limit was sufficiently binding that it encouraged the growth of a large tutoring industry that help high school students score better on the college entrance exam. The change in government after the assassination of President Park in 1979 brought large policy changes throughout the economy. Of particular interest to us is a large and sudden increase in university
enrollments in 1981 and 1982. Our regression discontinuity analysis below suggests that this policy increased the post-policy university attainment by about 3 percentage points, as compared to pre-policy trends. I exploit this exogenous increase in enrollment within the framework of the existing empirical strategies for alternative, exogenous variation in the quantity of schooling.

Our analysis yields two main results. The first concerns the importance of composition effects in accounting for the cross-sectional return to schooling. In line with Kaymak (2009), I find that composition effects account for nearly one-half of the observed return to schooling, indicating that the true private return to schooling is slightly more than half of the observed Mincer return. The magnitude of this effect is consistent regardless of whether I use all educational variation or only exogenous educational variation to estimate the effect. The second result concerns the importance of composition effects in the time series. Consistent with Juhn, Kim, and Vella (2005), I find evidence that increasing college attainment lowers the college wage premium for a cohort, suggesting that higher college attainment is obtained by lowering the relative ability of college graduates. However, the results here depend somewhat on whether I use all the variation or only policy-induced variation in educational attainment. The former suggests a small and relatively weak effect, while the latter suggests a much stronger effect. Our preferred interpretation of this finding is that long-run trend changes in educational attainment may come in part from better sorting by ability or changes in educational preparation, in line with Hendricks and Schoellman (2014), while sudden short-run changes in educational attainment cannot and hence cause stronger decreases in ability and wages.

In addition to the papers listed above, I am also closely related to a number of other studies that investigate similar issues, primarily within the United States. Laitner (2000) formulates a model that generates qualitative predictions in line with
what I study here, but does not attempt to quantify these forces. Recently Bowlus and Robinson (2012) use the flat spot method of Heckman, Lochner, and Taber (1998) to try to identify changes in skill prices versus skill quantities in explaining changes in wages for four educational groups in the U.S.; changes in innate ability can be thought of as one source of changes in skill quantities. Carneiro and Lee (2011) use a different empirical strategy that relies on controlling for all possible sources of skill price variation to help identify skill quantities as a residual; again, ability is one component of the quantity of skill. Carneiro and Lee (2011) use a local instrumental variable approach to predict the wage implications of expanding college enrollment. Unfortunately it is difficult to provide a consensus result from these papers because the literature has yet to reach one. Some papers find modest composition effects (Juhn, Kim, and Vella, 2005; Carneiro and Lee, 2011), but others find sizable ones (Kaymak, 2009; Bowlus and Robinson, 2012). Our hope is to provide further evidence to this debate by exploiting the advantages of the Korean experience outlined above.

The rest of the paper proceeds as follows. Section 3.2 reviews the Korean data and the relevant details about Korean educational policy. Section 3.3 conducts the analysis. Section 4 concludes.

3.2 Education and Education Policy in Korea

In this section I outline briefly the relevant details of the Korean educational experience. Our focus is on two main aspects. First, I highlight the post-World War II trends, which include a large expansion of education and a recent increase in the college wage premium. Second, I highlight the role of exogenous policy changes in the 1980s in affecting the educational expansion.

I measure educational attainment using the Korean population censuses conducted in 1966 and then every five years from 1970 to 2010. Throughout this period the
census has contained a question on the highest educational attainment of respondents. I code respondents into four broad categories that are comparable over time: those with less than a high school degree; high school graduates; those with more than a high school degree but less than a four-year college degree; and those with at least a four-year college degree. I measure attainment for the 1929–1977 cohorts using the census taken when they were aged 33–37. Using this five year window with censuses taken every five years gives us exactly one observation of attainment per cohort. The results are plotted in Figure 3.1a. Korea has experienced a larger and more rapid rise in education than the United States. I show in the appendix that similar patterns hold for men and women separately.

Examination of Figure 1 shows that a substantial fraction of Koreans have more than a high school degree but less than a four-year college degree. A similarly large group is present in U.S. data (Hendricks and Schoellman, 2014). However, this group contains two subgroups: those who obtain a two-year degree and those who start college but obtain no degree. Further, the relative proportion of the subgroups varies greatly between the U.S. and Korea. This is shown in Figure 3.2. Roughly two-thirds of the “some college” group in the U.S. consists of those who obtain no degree, whereas in Korea almost all students with less than a four-year degree obtain a two-year degree.  

A final advantage of using Korean data is that variation in educational policy provides exogenous variation in educational attainment. The most important change for my purposes came in the summer of 1980. High school education was available to all students and paid for by the federal government since 1968. However, the federal

---

2This is also a minor advantage as compared to the United States. There the main data sources are the Current Population Survey and the Population Census. They asked only about years of schooling and not attainment until 1992 and 1990, which generally forces researchers to assume that, say, workers with 12 years of schooling are high school graduates and so on.

government strictly controlled university admissions. Students took two examinations to determine who would be admitted (Lee, 1992). As the fraction of students who graduated high school rose, the restriction on enrollment became more binding. By 1980, nearly half of all high school students were enrolled in after-school private tutoring to help improve their college enrollment test scores.

Education policy changed discretely after the 1979 assassination of President Park. General Cheon assumed control of the country in 1980 and was recognized as President in 1981. He instituted a host of reforms throughout the economy. The educational reform had two key components. First, he banned private tutoring. Second, he greatly expanded educational enrollments through several mechanisms: by opening new universities; by expanding the departments per university; and by expanding the students per department. The aggregate effect was large: total new enrollments were nearly 50 percent larger in 1981 as compared to 1980, and enrollment in four-year degrees were 60 percent larger. This large, exogenous increase is critical to my empirical approach.
In order to utilize the effect of this policy in my empirical work, I need to define which cohorts were affected by it. It is clear that all cohorts who were age 19 or younger in 1981 (born 1962 or later) was affected by the policy. Those who were slightly older may have also benefited from a second chance to enter university. This is less clear in the case of Korea, because many who were marginally denied admission to four-year colleges would have been accepted to and attended two-year colleges instead. Roughly two-thirds of applications to college in the early 1980s were from high school seniors taking the college entrance for the first time; the remainder were from repeat test-takers. Nonetheless, I think of those born 1962–1964 as having potentially been marginally affected by the policy. Those born before 1962 were likely not affected. Hence, I intend to exploit the large rise in college attendance and completion between cohorts born before this time and those born just after the policy came into effect.

Figure 3.3 isolates the fraction of each birth cohort that obtains at least a four-year college degree. The vertical line marks the 1962 cohort, which was the first to be fully affected by the policy. By comparing the attainment of cohorts on either side I can see that the policy did indeed increase attainment. To make this statement more precise I estimate the effect of the policy using a regression discontinuity approach. I consider the following specification:

$$S_{ic} = \alpha + \tau D_i + \beta g(c) + \varepsilon_i$$  \hspace{1cm} (3.1)

where the dependent variable, $S$, is an indicator variable that takes on value 1 if individual $i$ from cohort $c$ obtained a four-year degree. I predict this value under the assumption that there is a smooth trend relationship between attainment and cohort captured by $g(c)$. $D$ is an indicator which takes the value of 1 if $c \geq 1962$.

---

4 Data from the Korea Statistical Yearbook, 1985.
and 0 otherwise. I am interested in \( \tau \), the estimated jump effect of the policy on educational attainment.

Figure 3.3: Fraction College Graduates by Birth Cohort

Note: Figure shows college graduation rates by birth cohort, taken from the Korean census. The vertical line indicates the birth cohort that was marginally exposed to the educational reform; younger cohorts to the right were fully exposed, while older cohorts to the left were not exposed at all.

Table 3.1 gives the estimated results when I assume that the underlying trends in cohort \( g(c) \) are captured by quadratic polynomials. I estimate a discontinuous effect of the policy on college attainment of 3.2 percentage points (column 1), or 2.1 percentage points if I focus only on the fraction of students who graduate at least high school (column 3). One slight complication is that I am using educational attainment data for people drawn from different ages. I find that controlling of this possible confounding effect using a quartic polynomial in age makes no difference for my results (columns 2 and 4). Thus, policy induced a large change in college attainment in Korea. To put the figure into context, note that total college attainment for the 1980 cohort was around 25 percent, and that the policy induced an additional
(above trend) increase of 3.2 percentage points, or roughly 12 percent of total 1980 attainment. This effect is large and gives us hope to provide alternative identification of composition effects.

Table 3.1: Estimated Increase in College Attainment Induced by Policy Change

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>dependent variable:</td>
<td>Total Fraction</td>
<td>Fraction of High School Graduates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birth Cohort Polynomial</td>
<td>Quadratic</td>
<td>Quadratic</td>
<td>Quadratic</td>
<td>Quadratic</td>
</tr>
<tr>
<td>Age Polynomial Controls</td>
<td>No</td>
<td>Quartic</td>
<td>No</td>
<td>Quartic</td>
</tr>
<tr>
<td>Initial Sample Size</td>
<td>253896</td>
<td>253896</td>
<td>160204</td>
<td>160204</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>0.032***</th>
<th>0.033***</th>
<th>0.021***</th>
<th>0.022***</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[0.009]</td>
<td>[0.008]</td>
<td>[0.007]</td>
<td>[0.007]</td>
</tr>
</tbody>
</table>

Note: The dependent variables are whether the individual graduates a college. Each coefficient is from a separate regression. Each regression includes controls for a birth cohort quadratic polynomial and an indicator whether or not a cohort entered a college after the educational reform. The bracketed values indicate corresponding standard errors.

Finally, I turn my attention to the evolution of the college wage premium in Korea. The Korean census does not collect data on wages. Instead, I use the Korean Survey Report on Wage Structure’s annual data from 1980–2011. The survey collects data about the characteristics of workers and their compensation from firms with ten or more regular workers. The important data for my purposes are each worker’s final education degree, their age and gender, and their labor market earnings. The survey

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5Since 1998, the sampling criteria has been extended to firms with 5 or more regular workers. I use the information on firms with 10 or more workers only to maintain comparability of the data over time.
is large, containing roughly half a million workers each year.  

In order to measure the skill premium I construct a sample along the lines of Katz and Murphy (1992). I include only full-time, full-year workers aged 18–65 who worked at least 35 hours per week at the time of the survey. I define hourly wages using monthly income and hours worked per month. I use the CPI to deflate all wages to 2010 dollars. Individuals whose real wages are less than $4.11 per hour (the 2010 minimum wage) are excluded from the sample.

I estimate the college wage premium by regressing log-hourly wages on dummies for educational attainment, controlling for age, gender, and potential experience interacted with gender, where potential experience is defined as age minus years of schooling minus 6. The college wage premium is the estimated coefficient for having graduated with a four-year college degree minus the estimated coefficient for having only a high school diploma. Figure 3.1b shows the results. The college wage premium fluctuated between 0.3 and 0.4 between 1980 and 1995; from 1995 to 2010 it rose from about 0.3 to 0.45, with some modest signs of falling recently. In the next section I explore whether the changes in the college wage premium can be linked to the changes in educational attainment.

3.3 Empirical Analysis

I now turn to the empirical analysis. Our goal here is to consider several approaches proposed in the literature. As I will see, these approaches generally rely on comparing nearby birth cohorts with different education levels. Our goal is to exploit two features of the Korean data. First, the rise in education was much sharper. Since identification rests on comparing across cohorts, this is an advantage. Second, I have exogenous, policy-induced variation in the supply of education.

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6Further information on this survey can be found at http://laborstat.molab.go.kr
It is useful to provide a unified treatment of the problem. To do so, I focus on the following wage equation:

$$\log(w_{itc}) = \beta_t + \beta_c + \beta_{t-c} + (\gamma_t + \gamma_c + \gamma_{t-c})S_i + a_i + \varepsilon_i,$$  \hspace{1cm} (3.2)

where $w$ denotes the hourly wage, $S$ denotes schooling, $a$ denotes ability, and $\varepsilon$ is the error term. At some points I focus on the college-high school wage premium, in which case $S_i \in \{0, 1\}$ will denote high school and college graduates, respectively; at other I focus on the Mincerian return to schooling, in which case $S \in [0, S]$ will be a continuous variable. Throughout, I use subscript $i$ for individuals, $t$ for time, and $c$ for birth cohort. It follows that $t - c$ is age. I use $\beta_t$ as a shorthand for a full set of year dummies, and similarly for the remaining $\beta$s and $\gamma$s. Note that I allow both the level of wages and the return to schooling to depend in an arbitrary way on age, year, and cohort. It is well-known that at this level of generality these effects are not well-identified because of a linear dependence among the three; I return to this point further below.

Our goal is to understand the role that ability plays in the patterns of average wage by school group, given by:

$$E[\log(w_{itc})|S] = \beta_t + \beta_c + \beta_{t-c} + (\gamma_t + \gamma_c + \gamma_{t-c})S + E[a_i|S].$$  \hspace{1cm} (3.3)

I want to understand the importance of composition effects for wages, by which I mean differences in $E[a_i|S]$ across cohorts and time. I will explore both discretized and continuous schooling models, in which case the relevant expressions are

$$E[\log(w_{itc})|1] - E[\log(w_{itc})|0] = \gamma_t + \gamma_c + \gamma_{t-c} + E[a_i|1] - E[a_i|0]$$  \hspace{1cm} (3.4)

and

$$\frac{\partial E[\log(w_{itc})|S]}{\partial S} = \gamma_t + \gamma_c + \gamma_{t-c} + \frac{\partial E[a_i|S]}{\partial S}$$  \hspace{1cm} (3.5)
Composition effects affect wages unless $E[a_i|1] - E[a_i|0] = 0$ or $\frac{\partial E[a_i|S]}{\partial S} = 0$. However, quantifying composition effects is generally challenging, which likely explains the diversity of approaches and results in the literature. There are two main obstacles. First, ability is not observed directly. Some datasets include proxies for ability (such as standardized test scores), but it is necessary to account for the noise inherent in test scores (Taubman and Wales, 1972; Bishop, 1989; Hendricks and Schoellman, 2014). The Korean data, and most other large datasets worldwide such as censuses, lack such proxies. A second challenge is that both of these wage equations suffer from a classic collinearity between age, time, and cohort effects. This collinearity is worsened by the inclusion of ability conditional on schooling. Since schooling is usually fixed by cohort in the empirical analysis, this implies that mean ability conditional on schooling is itself another cohort effect.

In some cases it is possible to rule out the importance of age, time, or cohort effects, but that does not appear to be the case here. It is well-known that the college wage premium varies by age. Time effects are naturally suggested by the typical framework that models the wages of college and high-school educated workers as a function of the quantity of workers with the two types of skill and the prevailing level of skill-biased technical change in the economy (Katz and Murphy, 1992; Goldin and Katz, 2008). I have already discussed that cohort effects capture (at least) the role for differences in ability conditional on schooling.

Thus I conclude that empirical progress depends on confronting these two challenges. I now discuss and implement the approaches suggested in the literature. Throughout, I emphasize how composition effects can be identified and separated from time or age effects.
Our first approach follows Kaymak (2009). Kaymak works with the continuous school model in equation (3.2) and a linear return to schooling. He uses a cohort-based instrumental variable approach to estimate the return to schooling. Intuitively, a valid instrument allows one to measure the true return to schooling $\gamma_t + \gamma_c + \gamma_{t-c}$, whereas OLS estimates are biased and yield $\gamma_t + \gamma_c + \gamma_{t-c} + \frac{\partial E[a_i|S]}{\partial S}$. Simple subtraction yields an estimate for the cross-sectional role of ability bias $\frac{\partial E[a_i|S]}{\partial S}$. Note that this approach also sidesteps the age-time-cohort problem by not attempting to disentangle them at all.

Kaymak proposes using cohort dummies as instruments. Cohort dummies are clearly exogenous to an individual and highly correlated with school attainment (even more so in Korea). It is less clear whether they satisfy the exclusion restriction. That restriction requires that cohort only affects wages through its affect on average educational attainment. It precludes effects that might arise through, say, labor market conditions upon first arrival to the labor market, which would likely be common to a cohort. Kaymak (2009) proposes and implements a number of controls to help capture such effects. Here I explore an alternative approach, which is to use my educational policy change as an alternative instrument that affected schooling and satisfies the exclusion restriction.

I start by following Kaymak (2009) closely. I estimate the effect of years of schooling on real wage using the data from the Korean Survey Report on Wage Structure.

I implement my regression as:

$$\log(w_{itc}) = \beta_t + \gamma S_i + \beta X_i + \varepsilon_i,$$

where $X$ includes control variables: a quartic trend in cohort (to capture slow-moving,

\footnote{The detailed description of the sample is provided in Appendix C.1.}
cohort-specific trends such as changes in mean ability (Flynn, 1984, 2007)); a quartic function of age (to capture returns to experience); and dummies for survey year. I estimate this equation three ways: by OLS, and then using two different instruments.

Table 3.2: Return to Education

<table>
<thead>
<tr>
<th>Dependent Variable: log(Real Wage per Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>(1)</td>
</tr>
<tr>
<td>$100 \times$ Years of Education</td>
</tr>
<tr>
<td>[0.006]</td>
</tr>
<tr>
<td>Instruments</td>
</tr>
<tr>
<td>Observations</td>
</tr>
<tr>
<td>R-squared</td>
</tr>
</tbody>
</table>

Standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Note: I include a quartic age trend, a quartic year of birth trend and dummies for survey year. The instrument in column (2) is a full set of birth cohort dummies; in column (3) it is a dummy for cohorts born in the three-year window 1962–1964 who were most suddenly affected by the educational reform.

Table 3.2 displays the estimation results. The estimates in columns (1) and (2) are quite comparable to Kaymak (2009) and indicate that a little more than half of the return to education (4.34/7.01) is true return to schooling, while the other half is due to composition effects. In column (3) I explore my alternative instrument. Our instrument variable is dummy for the cohorts who were born between 1962–1964. I find out that a little more than one over third of the return to education (2.85/7.01) is true return to schooling and composition effects are a little larger than the result in column (2).
I then follow Kaymak (2009) by estimating the same equation separately for each decade. Our goal here is to assess whether the patterns of the skill premium observed in Figure 3.1b are accounted for by composition effects or by changes in skill prices. The results are given in Table 3.3. The least squares estimates are in line with the changes in the college wage premium plotted in Figure 3.3, showing first a decline in the 1990s and then a pronounced rise to higher levels in the 2000s. In column (2) I again show the result of instrumenting for attainment using cohort as in Kaymak. I find evidence that the return to schooling is increasing over time. Taking the difference between columns (1) and (2) suggests a nonlinear pattern: ability bias was the largest in the 1980s, declined in the 1990s, and rose again in the 2000s. In column (3) I again explore the role of using my alternative instrument that controls 1962–1964 born cohorts. As I already show for the whole period, true return to schooling is smaller than when I use the instrument in Kaymak. When I use my instrument variable, true return to schooling is statistically zero in 1980s and 2000s.

### 3.3.2 A Distributional Approach

Our second approach follows Juhn, Kim, and Vella (2005). These authors work with the discretized school model in equation (3.4) and discrete schooling groups. Their approach is based on an assumption about how cohort effects will enter the wage equation. The intuition is conveyed by Figure 3.4, which draws closely on a similar figure in their paper. To simplify, suppose that ability is (log-) normally distributed and that selection by ability into educational attainment is perfect. In this case there is an ability cutoff for each cohort $\lambda^*$ such that all higher-ability individuals complete college and work as college graduates, while all lower-ability individuals do not attend college and work as high school graduates. An expansion of college attainment means a shift left in the cutoff, so that the individuals that
Table 3.3: Patterns of the Return to Education: 1980–2010

<table>
<thead>
<tr>
<th>Year</th>
<th>LS (1)</th>
<th>IV (2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981-1990</td>
<td>7.2***</td>
<td>3.8***</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>[0.008]</td>
<td>[0.419]</td>
<td>[1.495]</td>
</tr>
<tr>
<td>1991-2000</td>
<td>5.8***</td>
<td>4.1***</td>
<td>2.9***</td>
</tr>
<tr>
<td></td>
<td>[0.009]</td>
<td>[0.261]</td>
<td>[0.497]</td>
</tr>
<tr>
<td>2001-2010</td>
<td>8.7***</td>
<td>1.9***</td>
<td>-0.7</td>
</tr>
<tr>
<td></td>
<td>[0.014]</td>
<td>[0.269]</td>
<td>[0.611]</td>
</tr>
</tbody>
</table>

Standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Notes: I control for a quadratic age trend, a quadratic trend in year of birth, survey year, cohort size by education and survey year.

are shaded light gray now graduate college instead of only completing high school. Under this simple and clear model of selection effects, mean relative ability by cohort $E(a_{i,t-v}|s = 1) - E(a_{i,t-v}|s = 0)$ can be proxied for by using the fraction of the population that attains college for each cohort.

This approach obviously embeds strong assumptions about how ability effects work. Hendricks and Schoellman (2014) find that there are two important complications to this view of selection effects. First, the sorting of students ability into attainment is not perfect, as the figure suggests. Second, there are not only two mutually exclusive school categories as that figure suggests. Hendricks and Schoellman (2014) find that both of these factors play an important role in the U.S. Their results
suggest, for example, that the expansion of education had essentially no effect on the mean ability of college graduates, although it did cause a decline in the mean ability of high school graduates. These findings suggest it may be worthwhile to explore alternative assumptions.

I do so by once again exploiting my exogenous educational policy change. These approaches exploit the idea that while long-term changes in educational attainment may be complicated by simultaneous trends in sorting and the attainment of some college, large short-run changes are unlikely to be. Hence, instead of asking whether the growth in college attainment over the long run has caused changes in the college wage premium, I ask whether the large growth in college attainment induced by the policy reform cause changes in the affected cohorts’ college wage premium.

I start by following Juhn, Kim, and Vella (2005) closely. They suggest the equiv-
alent of differencing equation (3.4) over time,

\[
\frac{\Delta E[\log(w_{ite})|s = 1]}{E[\log(w_{ite})|s = 0]} = \Delta \gamma_c + \Delta \gamma_{t-c} + \Delta [E(a_i|1) - E(a_i|0)].
\]

which has the effect of netting out time effects. They assume that cohort effects and changes in mean ability are accounted for by changes in average educational attainment, \(\Delta \gamma_c + \Delta [E(a_i|1) - E(a_i|0)] = \omega \Delta [E(s_{ite})]\). I use a regression of education on age and cohort dummies to predict for each cohort the average attainment at age 35, which I use as \(E[s_{ite}]\).

Before giving the regression results it is useful to look at the raw relationship between the college wage premium and the fraction of the population with a college degree. The two are plotted together in Figure 3.5. Each panel of this figure corresponds to one five-year differenced comparison; for example, the top left panel shows the difference in wages and attainment when comparing similarly aged workers between 1980 and 1985. The blue line in each figure shows the five-year change in the college wage premium, while the red line shows the five-year change in the fraction of the population who graduates college. The correlation between the two is generally weak, much weaker than what Juhn, Kim, and Vella (2005) find in the United States. However I also shade in each figure in gray the cohorts that were marginally affected by the educational reform. I can see in each figure that the reform consistently induced an unusually large increase in attainment and that the college wage premium consistently declined.

To check these visual results I estimate the above equation using weighted least squares. Table 3.4 reports the estimation results. In column (1) I follow Juhn, Kim, and Vella (2005) and estimate the change in the college wage premium as a function of the change in the share of the cohort in college. I find a negative result consistent with their work, but the estimate is imprecise. In columns (2)–(5) I explore the value
Figure 3.5: Log Change in Relative Wage and College Share
of incorporating my educational reform. In these regressions I continue to include
the share of the cohort that graduates college, but I also include a dummy variable
that takes the value of 1 for cohorts that were marginally affected by the educational
reform. The difference between columns (2)–(5) lies only in the which cohorts I define
as having been affected. In column (2) I use a strict definition, the 1962–1964 cohorts.
In column (3) I expand the affected cohorts to the 1962–1966 cohorts; in column (4)
I expand it to the 1962–1971 cohorts; and last in column (5) I expand it to the

The results of regressions (2)–(5) agree closely. In each case the effect of cohort
college share is of the wrong sign and is statistically insignificant. This indicates that
for cohorts not affected by the educational reform, there is no strong relationship
between the fraction graduating college and college wage premiums. As explained
above this could be the case if offsetting forces (such as changes in the structure
of education, education quality, or the sorting of students) offset the increase in
attainment. Indeed, it could be the case that such forces are themselves responsible
in part for causing the increase one educational attainment. The regressions also
agree closely on the effect of the educational reform. Marginally affected cohorts
have statistically and economically lower college wage premiums, on the order of 18–
23 log points, as compared to the unaffected cohorts (those born earlier or much later).

As I expand the scope of the number of cohorts affected, I find that the estimated
effect declines. The intuition is that the rapid expansion in education that took place
at this time was exogenous and happened too quickly to be offset by other factors.
In this case, the policy had the expected effect consistent with the findings of Juhn,
Kim, and Vella (2005).
Table 3.4: Effects of Cohort-Specific College Share on Wages of College Graduate

Men

| Dependent Variable: $\Delta \frac{E[\log(w_{itc})|s=1]}{E[\log(w_{itc})|s=0]}$ | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Cohort College Share | -0.081 | -0.009 | 0.065 | -0.011 | -0.050 |
| | [0.130] | [0.134] | [0.136] | [0.134] | [0.135] |
| Cohort Size | -0.249** | -0.243** | -0.275*** | -0.282*** | -0.269** |
| | [0.103] | [0.103] | [0.101] | [0.104] | [0.106] |
| Education Reform | -0.188** | -0.233*** | -0.129* | -0.057 |
| | [0.095] | [0.077] | [0.066] | [0.069] |
| Constant | -0.166 | -0.192 | -0.211 | 0.214 | 0.419*** |
| | [0.154] | [0.153] | [0.152] | [0.152] | [0.153] |

Observations 230 230 230 230 230
R-squared 0.321 0.335 0.353 0.335 0.324

Standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

I use wage information for the dependent variable from Report on Wage Structure Survey. In each column I use predicted college share of each cohort at age 35 as specified in equation (1) in Juhn, Kim, and Vella (2005). The regression also includes controls for cohort size, seven year dummy variables, and two age dummy variables for young and middle age workers. Education Reform is a dummy that indicates cohorts affected by the educational reform as explained in the text. Each column describe the cohorts who were born within 3 years in (2), 5 years in (3), 10 years in (4) and 15 years in (5) after the education reform passed.
3.4 Conclusion

In this paper I study the importance of composition effects for education wage premiums in Korea. Korea offers an interesting case because it has experienced a rise in educational attainment and education wage premiums, like most other advanced economies. However, the rise in education was much larger and more rapid than that in most other advanced economies. Further, some of the increase was policy-induced.

I used a simple empirical framework to introduce the main challenges confronted in the literature. I then implemented several procedures suggested in the literature to overcome these challenges. I also showed how to modify the existing approaches to exploit my policy-related variation in educational attainment.

Our findings are robust across the approaches and specifications. I find only modest evidence for composition effects in the long run. By this I mean that more educated workers are of higher average ability, but there is little change in the strength of this relationship over time. However, I find strong evidence for a decrease in education wage premiums for the cohorts most affected by the policy-induced expansion of education. This suggests to us that composition effects do operate, but that they can be masked by offsetting forces when studied over longer horizons. While Hendricks and Schoellman (2014) suggest some possible forces that operated in the U.S., it is not clear that these forces generalize to Korea or other advanced economies. This is an open question for future work.
REFERENCES


Neusser, Klaus and Maurice Kugler. 1998. “Manufacturing growth and financial
80 (4):638–646.

Content of Intermediate Inputs.” European Economic Review.

Oldencki, Lindsay. 2012. “Export versus Fdi and the Communication of Complex


Vertical Foreign Direct Investment: Revisiting Evidence from US Multinationals.”

Ramondo, Natalia and Andrés Rodríguez-Clare. 2009. “Trade, Multinational Pro-

Journal of Political Economy 121 (2).


Restuccia, Diego and Guillaume Vandenbroucke. 2013. “Explaining Educational At-
tainment across Countries and over Time.” Mimeo, University of Toronto.

Economy 98 (5 pt 2).

Sachs, Jeffrey D and Andrew M Warner. 1995. “Natural resource abundance and

Taubman, Paul and Terence Wales. 1972. Mental Ability and Higher Educational


Yasar, Mahmut and Catherine J Morrison Paul. 2007. “International Linkages and
Productivity at the Plant Level: Foreign Direct Investment, Exports, Imports and
Figure A.1: Distribution of Affiliates by The Share of Intra-Family Imports

Note: The fraction of Korean foreign affiliates depending on the share of purchases from the parent and other family affiliates in 2010. I define developing and developed countries based on Korea’s PPP GDP per capita.
Figure A.2: Distribution of Affiliates by The Share of Intra-Family Imports

Note: The fraction of Korean foreign affiliates depending on the share of purchases from the parent and other family affiliates in 2010. I define manufacturing and others following KSIC.
A.2 Derivations

**Proposition 1.** If \( \beta > 0 \) and \( \alpha < 1 \), there exists a feasible choice of a foreign affiliate which satisfies that \( \frac{\partial \log \left( \frac{Y}{E} \right)}{\partial \log \left( \frac{M^k}{M} \right)} \) is positive.

**Proof.** Start from the production function.

\[
Y = \left( F(M^k) \right)^\beta \left( (\alpha M^k + M^n)^{\gamma \left( L^1 - \gamma \right)} \right)^{1-\beta}
\]

Dividing by \( E \)

\[
\frac{Y}{E} = \left( F(M^k) \right)^\beta \left( (\alpha M^k + M^n)^{\gamma \left( L^1 - \gamma \right)} \right)^{1-\beta} \frac{1}{E}
\]

\[
= \left( F(M^k) \right)^\beta \left( (\alpha M^k + M^n)^{\gamma \left( \frac{L}{E} \right)^{1-\gamma}} \right)^{1-\beta} \left( \frac{1}{E} \right)^{(\gamma + \beta - \gamma \beta)}
\]

\[
= \left( \frac{F(M^k)}{M} \right)^\beta \left( \left( \alpha \frac{M^k}{M} + \frac{M^n}{M} \right)^{\gamma \left( \frac{L}{E} \right)^{1-\gamma}} \right)^{1-\beta} \left( \frac{M}{E} \right)^{(\gamma + \beta - \gamma \beta)}
\]

by definition of \( M \) and \( E \)

\[
= \left( \frac{F(M^k)}{M} \right)^\beta \left( ((\alpha - 1) \frac{M^k}{M} + 1)^{\gamma \left( \frac{L}{E} \right)^{1-\gamma}} \right)^{1-\beta} \left( \frac{M}{E} \right)^{(\gamma + \beta - \gamma \beta)}
\]

Taking \( \log \),

\[
\log \left( \frac{Y}{E} \right) = \beta \log \left( \frac{F(M^k)}{M} \right) + \gamma(1 - \beta) \log \left( (\alpha - 1) \frac{M^k}{M} + 1 \right) +
\]

\[
+(1 - \gamma)(1 - \beta) \log \left( \frac{1}{M} \right) + (\gamma + \beta - \gamma \beta) \log \left( \frac{M}{E} \right)
\]

Given \( M \) and \( E \), differentiating by \( \log \left( \frac{M^k}{M} \right) \)

\[
\frac{\partial \log \left( \frac{Y}{E} \right)}{\partial \log \left( \frac{M^k}{M} \right)} = \beta M^k \frac{F'(M^k)}{F(M^k)} + \gamma(1 - \beta) M^k \frac{\alpha - 1}{(\alpha - 1)M^k + M}
\]

Now, suppose that for all feasible sets, the following is satisfied

\[
\frac{\partial \log \left( \frac{Y}{E} \right)}{\partial \log \left( \frac{M^k}{M} \right)} \leq 0
\]
Then,

\[-\beta \frac{F'(M^k)}{F(M^k)} \geq \gamma (1 - \beta) \frac{\alpha - 1}{(\alpha - 1)M^k + M}\]

Given a bounded exogenous shock ($z$), RHS of the above equation is a negative bounded number. However, since $F'(M^k) \to \infty$ as $M^k \to 0$, LHS converges to negative infinity. So it is in contradiction. \qed
Proposition 2. If $\beta > 0$ and $\alpha \frac{w^n}{w^k} < 1$, consider $z'$ and $z$ such that $z' > z$, there exist optimal choices from the affiliates’ maximization problems that satisfy that $Y_{amcit}(z') > Y_{amcit}(z)$ and $\frac{M_k}{M_k+M^n}(z') < \frac{M_k}{M_k+M^n}(z)$.

Proof. For simplicity, I only consider $z'$ and $z$ that guarantee non-negative solutions. When $z' > z$, then $Y_{amcit}(z') > Y_{amcit}(z)$ is trivial.

From the FOC,

- $(M^k) : \beta z F(M^k) (\alpha M^k + M^n) \gamma (1-\beta) L^{(1-\gamma)(1-\beta)} + \ldots + z F(M^k) \gamma (1-\beta)(\alpha M^k + M^n) \gamma (1-\beta) - 1 L^{(1-\gamma)(1-\beta)} \alpha = w^k$

- $(M^n) : z F(M^k) \gamma (1-\beta)(\alpha M^k + M^n) \gamma (1-\beta) - 1 L^{(1-\gamma)(1-\beta)} = w^n$

- $(L) : z F(M^k) (\alpha M^k + M^n) \gamma (1-\beta) (1-\gamma)(1-\beta) - 1 L^{(1-\gamma)(1-\beta)} = w^L$

From the FOC for $M^n$ and $L$, I can have $\frac{L}{(\alpha M^k + M^n)} = \frac{(1-\gamma) w^n}{\gamma w^k}$. Therefore, given wages $w^n$ and $w^L$, $\frac{\partial (\alpha M^k + M^n)}{\partial Y}$ are positive. From the FOC for $M^k$ and $M^n$, I can find the optimal choice between $M^k$ and $M^n$ by comparing the marginal return per unit cost. Suppose that $\frac{M^k}{M^k+M^n}(z') \geq \frac{M_k}{M_k+M^n}(z)$ for all optimal choices. Because the affiliates chooses only one between $M^k(z)$ and $M^n(z)$ exclusively and $M^k(z)$ increases, the marginal product of unit cost of $M^k(z)$ is always larger than that of $M^n(z)$.

$$\frac{\beta}{\gamma(1-\beta)} \frac{F'(M^k)}{F(M^k)} (\alpha M^k + M^n) + \alpha \geq \frac{w^k}{w^n} \quad (A.1)$$

As $M^k \to \bar{M}^k$, however, $F'(M^k) \to 0$ and $LHS \to \alpha$. Then $\alpha \frac{w^n}{w^k} \geq 1$. So it is in contradiction. \qed
A.3 Robustness

In Section 1.4.1, I provided evidence of a positive association between the share of Korean managers and labor productivity in Korean foreign affiliates. I used the equation based on the model’s prediction for the results. Because of logarithm relations between the share of Korean managers and labor productivity, I needed to drop some observations from my sample. About ten percent of the observations have negative value-added, which makes them have negative labor productivity, and about 19 percent of observations have no Korean managers, which makes them have zero share of Korean managers. In this section, to consider all observations, I use a different specification regarding the following linear relation between labor productivity and the share of Korean managers instead of logarithm.

Table 13 shows that the results from the estimation using the whole sample are consistent with the results of Table 9. Column (1) shows that a one-point increase in the share of Koreans in management positions is positively associated with about a 0.7-point increase in labor productivity. Interestingly, in this specification, the effect of intra-firm imports is statistically insignificant in column (2). So I confirm that my result is not sensitive because of the drop due to the logarithm.

![Table A.1: Effect on Labor Productivity](image)

Notes: This table shows the estimation results of equation 1.6 using a different specification to use all 10,416 affiliates. See note in Table 9. From 11,254 affiliates, 838 foreign affiliate have zero employees in management positions.
Lemma 1. Total labor demand is decreasing in $\omega$ and decreasing in $P$ in the general equilibrium.

*Proof.* Step 1: $L_M$ is decreasing in $\omega$ and decreasing in $P$.

In the equilibrium, the distribution of firm productivities $\mu$ is endogenously decided by firm’s optimal investment decisions where

$$
\mu = \ln(\pi \beta (1-\delta)[\exp(z_H) - \exp(z_L)]/h) + (1-\sigma) \ln \omega - \ln P
$$

So

$$
\frac{\partial \mu}{\partial \omega} = \frac{1-\sigma}{\omega} < 0
$$

and

$$
\frac{\partial \mu}{\partial P} = -\frac{1}{P} < 0
$$

given the expression of labor engaged in the manufacturing sector in the equation 2.22, and apply the chain rule:

$$
\frac{\partial L_M(\mu, \omega, P)}{\partial \omega} = \frac{\partial L_M(\mu, \omega, P)}{\partial \mu} \frac{\partial \mu}{\partial \omega} + \frac{\partial L_M(\mu, \omega, P)}{\partial \omega} < 0
$$

and

$$
\frac{\partial L_M(\mu, \omega, P)}{\partial P} = \frac{\partial L_M(\mu, \omega, P)}{\partial \mu} \frac{\partial \mu}{\partial P} < 0
$$

Step 2: $L_N$ is decreasing in $\omega$ and decreasing in $P$.

$$
L_N = (1-\alpha)\left(\frac{\lambda}{1-\lambda}P_T^{1-\rho}\left(\frac{\omega}{\theta}\right)^{\rho-1} + 1\right)^{-1}\left(L_t + \frac{N}{\omega}(\mu d(z_H) + (1-\mu)d(z_L))\right)
$$

Let

$$
A(\omega(\mu)) = (1-\alpha)\left(\frac{\lambda}{1-\lambda}P_T^{1-\rho}\left(\frac{\omega}{\theta}\right)^{\rho-1} + 1\right)^{-1}
$$

and

$$
B(\mu, \omega(\mu)) = L_t + \frac{N}{\omega}(\mu d(z_H) + (1-\mu)d(z_L))
$$

Then

$$
L_N = A(\omega(\mu)) * B(\mu, \omega(\mu))
$$
I can easily show that \( \frac{\partial A(\omega)}{\partial \omega} < 0 \)

From the definition of dividend,

\[
\mu d(z_H) + (1 - \mu)d(z_L) = (\mu \pi(z_H) + (1 - \mu)\pi(z_L)) - Phe^q_H
\]

By equation 2.16 and 2.19

\[
= \pi \omega^{1-\sigma}((\mu \exp(z_H)+(1-\mu)\exp(z_L))-\beta(1-\delta)[\exp(z_H)-\exp(z_L)])
\]

So,

\[
B(\mu, \omega) = L_t + N\pi \omega^{-\sigma}((\mu \exp(z_H)+(1-\mu)\exp(z_L))-\beta(1-\delta)[\exp(z_H)-\exp(z_L)])
\]

Since I know \( \frac{\partial \mu}{\partial \omega} = \frac{1-\sigma}{\omega} < 0 \) and \( \frac{\partial \mu}{\partial P} = -\frac{1}{P} < 0 \), and through the chain rule:

\[
\frac{\partial B(\mu, \omega)}{\partial \omega} = \frac{\partial B(\mu, \omega)}{\partial \mu} \frac{\partial \mu}{\partial \omega} + \frac{\partial B(\mu, \omega)}{\partial \omega} < 0
\]

and

\[
\frac{\partial B(\mu, \omega)}{\partial P} = \frac{\partial B(\mu, \omega)}{\partial \mu} \frac{\partial \mu}{\partial \omega} < 0
\]

So

\[
\frac{\partial L_N(\mu, \omega, P)}{\partial \omega} = \frac{\partial A(\omega)}{\partial \omega} + \frac{\partial B(\mu, \omega)}{\partial \omega} < 0
\]

and

\[
\frac{\partial L_N(\mu, \omega, P)}{\partial P} = \frac{\partial B(\mu, \omega)}{\partial \omega} < 0
\]

Since the total demand of labor equals the sum of demand from the manufacturing and non-manufacturing sector.

\[
L_M + L_N = L_D, \frac{\partial L_D(\omega,P)}{\partial \omega} < 0 \text{ and } \frac{\partial L_D(\omega,P)}{\partial P} < 0
\]
Proposition 3. There exists a unique stationary recursive equilibrium.

Proof. In the equilibrium, the wage and price level is pinned down by labor market and final market clearing conditions.

1. Labor market clearing condition: $L_D = L_S$

Since $L_S$ is a fixed number, $L_D$ is decreasing in $\omega$ and decreasing in $P$.
All the equilibrium $P$ satisfying the labor market clearing condition must monotonically decreasing with equilibrium wage level $\omega$.

2. Final good clearing condition under optimal choice of aggregating firms gives:

$$P = \left(\frac{P_M}{\alpha}\right)^\alpha \left(\frac{P_S}{1-\alpha}\right)^{1-\alpha}$$

$$P_S = \left((1-\lambda)\left(\frac{\omega}{\theta}\right)^{1-\rho} + \lambda P_T^{x-\rho}\right)^{\frac{1}{1-\rho}}$$

All the equilibrium $P$ satisfying the final good and intermediate good clearing condition must monotonically increasing in equilibrium wage level $\omega$.

So, the $(\omega, P)$ which satisfied both equilibrium condition must be unique.

And from this wage price level pair, the entire equilibrium under this price system is unique. \(\square\)
Lemma 2. If $\rho \to \infty$, there is a pair of $(\theta, \lambda)$ satisfying $\frac{\partial \omega^*}{\partial \lambda} = 0$ and $\frac{\partial P^*}{\partial \theta} = 0$

Proof. Let’s do the direct effect and indirect effect separately.

Direct Effect:

By the equation 2.23

$$\frac{\partial L_N}{\partial \lambda} = -(1-\alpha)(L_t + \frac{N}{\omega}(\mu d(z_H) + (1-\mu)d(z_L)))(P_T^{1-\rho}(\frac{\omega}{\theta})^{\rho-1})(\lambda P_T^{1-\rho}(\frac{\omega}{\theta})^{\rho-1} + 1 - \lambda)^{-2}$$

As $\lambda \to 0$, $\frac{\partial L_N}{\partial \lambda} \to -\infty$ while as $\lambda \to 1$, $\frac{\partial L_N}{\partial \lambda} \to 0$

Indirect Effect:

By the equation 2.21, 2.12, 2.22 and 2.23

$$\frac{\partial P}{\partial \lambda} (\frac{\partial L_M}{\partial P} + \frac{\partial L_N}{\partial P}) > 0 \text{ for all } \lambda$$

Since $\lim_{\rho \to \infty} \frac{\partial L_N}{\partial \lambda} \to -\infty$, there exist an $\bar{\rho}_\lambda$, for all $\rho > \bar{\rho}_\lambda$, such that $\lim_{\lambda \to 0} \frac{\partial L_N}{\partial \lambda} + \frac{\partial L_M}{\partial \lambda} + \frac{\partial L_N}{\partial \lambda} < 0$ and $\lim_{\lambda \to 1} \frac{\partial \omega^*}{\partial \lambda} > 0$

which implies that there is a correspondence of $\lambda(\theta)$, where the net effect of $\frac{\partial \omega}{\partial \lambda} |_{\lambda=\lambda(\theta)} = 0$

Similarly,

$$\frac{\partial L_N}{\partial \theta} = (\rho - 1)(1-\alpha)(\frac{\lambda}{1-\lambda} P_T^{1-\rho}(\frac{\omega}{\theta})^{\rho-1} + 1 - \lambda)^{-2}(L_t + \frac{N}{\omega}(\mu D(z_H) + \cdots)$$

$$\cdots + (1-\mu)D(z_L))((\frac{\lambda}{1-\lambda} P_T^{1-\rho}(\frac{\omega}{\theta})^{\rho-1} + 1)$$

As $\theta \to \frac{\omega}{P_T}$, $\frac{\partial L_N}{\partial \theta} \to \infty$ while as $\theta \to 0$, $\frac{\partial L_N}{\partial \theta} \to 0$

Therefore $\frac{\partial \omega}{\partial \theta} (\frac{\partial L_M}{\partial \omega} + \frac{\partial L_N}{\partial \omega}) < 0$ for all $\theta$

Since $\lim_{\rho \to \infty} \frac{\partial L_N}{\partial \theta} \to \infty$, there exist an $\bar{\rho}_\theta$, for all $\rho > \bar{\rho}_\theta$, such that $\lim_{\theta \to \frac{\omega}{P_T}} \frac{\partial L_N}{\partial \theta} + \frac{\partial L_M}{\partial \theta} + \frac{\partial L_N}{\partial \theta} > 0$ and $\lim_{\theta \to 0} \frac{\partial P^*}{\partial \theta} < 0$

This implies a correspondence of $\theta(\lambda)$, where the net effect of $\frac{\partial P}{\partial \theta} |_{\theta=\theta(\lambda)} = 0$

Let $\hat{\rho} = \max\{\bar{\rho}_\lambda, \bar{\rho}_\theta\}$, for all $\rho > \hat{\rho}$

The points on the intersection of this two correspondence would satisfies my requirement.
Proposition 4. If $\rho \to \infty$ and a pair of $(\theta, \lambda)$ satisfies $\frac{\partial \omega^*}{\partial \lambda} = 0$ and $\frac{\partial P^*}{\partial \omega} = 0$, increases in $\theta$ and $\lambda$ both increase the welfare of the economy, but the effect on productivity and labor in the manufacturing sector is opposite.

Proof. Given the above $\hat{\rho}$, for all $\rho > \hat{\rho}$, there exists some point satisfied the condition characterized by lemma 2.

Starting from the these $(\theta, \lambda)$, when $\theta$ increases by a small amount $d\theta$, $dP^* = \frac{\partial P^*}{\partial \theta} d\theta = 0$ and $d\omega^* = \frac{\partial \omega^*}{\partial \theta} d\theta > 0$.

When $\lambda$ increases by a small amount $d\lambda$, $d\omega^* = \frac{\partial \omega^*}{\partial \lambda} d\lambda = 0$ and $dP^* = \frac{\partial P^*}{\partial \lambda} d\lambda < 0$

Since the equilibrium $\mu$ is a function of $(\omega, P)$ and $\frac{\partial \mu}{\partial \omega} = \frac{1-\sigma}{\omega} < 0$ and $\frac{\partial \mu}{\partial P} = -\frac{1}{P} < 0$

$\mu$ is increasing as $\lambda$ increases, and decreasing as $\theta$ increases.

\qed
To estimate the effect of years of schooling on real wage following Kaymak (2009), I use the yearly data from Korean Survey Report on Wage Structure between 1980 to 2011. The sample is restricted to men between 25- and 60-years-old. Then the sample include cohorts, who were born in the same year, born between 1920-1985.

Wages are measured by hour earnings that are calculated by dividing monthly wage and salary earnings by monthly worked hours. Using CPI in 2010, I convert the wages to real wages. The Korean Survey Report on Wage Structure provides 5 groups of education attainments; Elementary, Middle and High schools, some college and four-years university. I assign 6, 9, 12, 14 and 16 years to each group for years of schooling respectively. I drop workers with less than half of the minimum wages in 2010, $4.11 and I also drop workers who worked less than 35 hours per week.

To estimate relation between college wages premium and college share following Juhn, Kim, and Vella (2005), I use the data from both Korean Survey Report on Wage Structure and Korea Population Census. For information about the real wages, I use wage profile from the Korean Survey Report on Wage Structure from 1980 to 2010 every 5-year. Wages are measured by hour earnings that are calculated by dividing monthly wage and salary earnings by monthly worked hours. Using CPI in 2010, I convert the wages to real wages. I drop workers with less than half of the minimum wages in 2010, $4.11. and I also drop workers who worked less than 35 hours per week. I get the numbers of college and non-college graduates from the data from Korean population census. I also restrict the sample to men between 27 and 65 years old and women between 23 and 65 years to consider people who under a schooling. To get the numbers of college graduates and non-college graduates for each cohort, I predict college share of each cohort at age 35 as a specified equation provided by Juhn, Kim, and Vella (2005) using Korean population census data. I predicted every 5 years using the data from Korean population census 1966 and from 1970 to 2010.
C.2 Figures

Figure C.1: Educational Attainment by Birth Cohort (Men)

Note: Educational attainment measured in four mutually exclusive and exhaustive categories. Attainment measured using 33-37 year-olds in the 1966 or 1970-2010 Korean population censuses, which provides a unique observation for each birth cohort.
Figure C.2: Educational Attainment by Birth Cohort (Women)

Note: Educational attainment measured in four mutually exclusive and exhaustive categories. Attainment measured using 33-37 year-olds in the 1966 or 1970-2010 Korean population censuses, which provides a unique observation for each birth cohort.
BIOGRAPHICAL SKETCH

Jaehan Cho is from Changwon, Republic of Korea. He entered Korea University in Seoul in 2000. After one year, he served for the Republic of Korea Air Force for two and half years. He earned a bachelor’s degree, cum laude, in Economics from Korea University in 2007. After graduation, he joined the master program at Korea University and earned a master’s degree in Economics. In 2009, he entered the W.P. Carey School of Business at Arizona State University to pursue a doctorate in Economics. During that period, he served as an instructor for several economic classes at ASU and as a research analyst at the Federal Reserve Bank of Minneapolis. He was honored to receive the Barchilon Award in 2014. Starting in the Fall of 2013, Jaehan will serve as an Associate Research Fellow of the Korea Institute of Industrial Economics and Trade.