INDUSTRIAL DEVELOPMENT AND REGIONAL INEQUALITY: THEORY AND THE KOREAN ECONOMY

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INDUSTRIAL DEVELOPMENT AND REGIONAL INEQUALITY: THEORY AND THE KOREAN ECONOMY

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This dissertation examines industrial development from regional perspectives. It is composed of three parts: spatial adaptation of the Murphy, Shleifer, and Vishny (MSV) Model, application of the model to North Korea's Kaesong Industrial Complex, and an analysis of regional inequality of South Korea.

Chapter 1 uses a combination of methods from economic development and economic geography. Departing from the MSV Model that views the poverty trap and industrialization as two Nash equilibria, this paper suggests the possibility of *partial* industrialization as equilibrium. In the beginning of an agglomeration, participating firms in a certain area may observe external economies with a decreasing fixed cost and rising productivity. However, once the number of firms exceeds a certain threshold of agglomeration capacity, the region will experience various congestion problems that may block further development and it will get stuck in a state of *partial* industrialization. Nevertheles, by *Critical Minimum Effort*, an economy may get out of this partial industrialization and reach the status of full industrialization as long as it overcomes congestion problems, as has been true for Mexico City, and Upper Silesia in Poland, and Seoul in Korea.

Chapter 2 again uses the MSV Model to suggest a possibility for development in the Kaesong area of North Korea. More specifically, this paper deals with the effect of the Kaesong Industrial Complex, where South Korean technology and North Korean labor are combined. Using the MSV Model, this paper predicts that if there is a sustained effort to maintain the momentum of the Kaesong Industrial Complex, then

this will have large spillover effects in the entire region, resulting in a big push which breaks the poverty trap and leads to full industrialization.

These two chapters focus on the developments of certain regions in themselves. However, development of various regions can be viewed in comparative terms, in which case regional *inequality* becomes an important issue. Against this backdrop, Chapter 3 analyzes the pattern of inter-regional inequality by comparing the per capita GDPs of 15 South Korean provinces. Using Theil's T Index, this research analyzes increasing or decreasing trend of regional inequality in South Korea, and then, *decomposes* the country into two different categories (Honam and non-Honam, Gangwon and non-Gangwon, urban and rural) and looks into the inequalities between the groups. Also, in investigating possible factors that may affect regional inequality, this research finds that trade openness, physical capital, and human capital are the three main factors involved and that a certain coordinated investment is needed to minimize regional inequality of the country, without compromising on development.

BIOGRAPHICAL SKETCH

Jinhwan Oh was born on February 23, 1977 in the town of Eumseong, Chungcheong Province, Korea. He lived there until he became 11 and moved to the city of Cheongju where he met Soohee Song, his future wife as a sixth-grade classmate in Unho Elementary School. Due to his father's business, he moved again to Seoul the next year. He graduated from Daewon Foreign Language High School and from Yonsei University in the year 2002 with Bachelor's Degrees in English Literature and Sociology. Attracted by development economics, he moved to the United States and was awarded a Master's in Development Studies at Brown University in 2004. Filled with enthusiasm for further studies, he moved to Cornell University in 2005. After spending four years at Cornell as a researcher, a teaching assistant for seven undergraduate economics courses, and an adjunct lecturer at the State University of New York at Cortland, he obtained a Ph.D. in Regional Science in August 2009. His first position as a Ph.D is at International University of Japan in Niigata, Japan, as an assistant professor. He will never forget whom he has met in the journey of this Ph.D. period and what he has learned at Cornell.

To My Parents

지금의 저를 있게 해 주신 부모님께 이 논문을 드립니다.

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In addition to my advisors mentioned above, I also had the fortune of having informal advice and help from Professors Jennifer Wissink and Tapan Mitra. By

TAing Introductory Microeconomics and Intermediate Microeconomics, I learned from Professor Wissink how to become a good teacher. She was very knowledgeable, was available outside classroom for students, and genuinely cared about them, all of which became a good model in my teaching. Professor Mitra has kindly offered me teaching assistantships since 2006. Without this financial help, I could not have continued my doctoral studies.

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In 1988, I had the good luck of meeting a smart, dashing, and attractive friend, Soohee Song, who has been my wife since 2005. As both Ph.D. students, Soohee and I have been study partners; we always went to libraries together and gave comments to each other's research. Outside our studies, we are the best friends sharing all the activities; oftentimes, we visited local state parks, enjoyed wine tasting in the Finger Lake wineries, went skiing at the Greek Peak, and enjoyed hiking. She is also a caring wife who fully supports her husband's research. With her, my life at Ithaca was truly pleasant, and without her, I could not have been able to finish my Ph.D. studies in four years. I would like to give my warm and special thanks to Soohee.

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CHAPTER 1

POVERTY TRAP, INDUSTRIALIZATION, AND THE ECONOMICS OF "GETTING STUCK": SPATIAL ADAPTATION OF THE MURPHY, SHLEIFER, AND VISHNY MODEL

Abstract

Based on spatial dimension to agglomeration, this paper investigates economic concentration and congestion. Departing from the original Murphy, Shleifer, and Vishny model, where the two equilibria of the poverty trap and full industrialization are discussed, this paper suggests the possibility of partial industrialization. Unlike the original model in which fixed cost F and productivity α are assumed to be constant, the author argues that both F and α are non-monotonic functions of n (number of entering monopolist firms), and that an economy stays in a partial industrialization state when congestion effects and external diseconomies are dominant. However, situations are dynamic in that either Critical Minimum Effort or Critical Minimum Retreat could occur in the status of partial industrialization so that an economy might return to full industrialization or fall into the poverty trap.

1. Introduction

The poverty trap has been a subject of great interest and investigation in development economics. Rosenstein-Rodan (RR) (1945) and Nurkse (1953) were pioneers in this area. They postulated that, in poor nations, a whole group of firms producing a variety of goods could become more prosperous by entering new markets together, yet each individual firm might make a loss by entering into production by

itself. As a consequence, in the absence of some kind of coordinated action, the economy remains mired in poverty. These economists argued that it is the aforementioned kind of trap that explains the persistence of poverty in less developed economies. Formalization of this idea into a model of multiple equilibria occurred much later: see Basu (1984), Murphy et al. (1989), and Paternostro (1997).

In particular, Murphy, Shleifer, and Vishny (MSV) (1989) formalized a model that explained the concepts of *poverty trap* and *industrialization* as multiple equilibria, as well as *big push* as a policy initiative that enabled a nation to break out of the poverty trap and industrialize. The model's multiplicity is frequently suspected in the real world. Many underdeveloped countries are in a stagnant poverty trap, which is a state of equilibrium. Furthermore, using Nurkse's (1953) term, the trap becomes a "vicious circle" in which a less developed economy may go back to the trap after a small deviation from the equilibrium. On the other hand, industrialization is another side of equilibrium; most of the current industrialized nations were also industrialized half a century ago, and they have maintained the highest income levels in the world. This trend of two-state-equilibria is well captured in the MSV model.

Nevertheless, a weakness of this model is that it does not fully explain the *incompleteness* of big push. Accordingly, once the economy reaches a point of *Critical Minimization Effort*, the economy moves seamlessly all the way to the higher level equilibrium of full industrialization. In reality, though, not all countries have directly moved toward full industrialization away from the poverty trap; perhaps Japan is the only example that actually fits into the model. In many cases, escaping from the poverty trap does not necessarily guarantee full industrialization. South Korea and Taiwan, for example, successfully escaped from the poverty trap, but their economies have tended to stall half way there with a per capita GDP of around $20,000. There is no clear way to judge whether a country is fully developed or not. Considering that

GDP per capita of G7 countries are all over $30,000, however, it is difficult to say that South Korea and Taiwan have realized their full potential. Latin America's cases are more obvious. Their economies seem to show stagnation between the poverty trap and industrialization; they are completely different from the poverty trap in Sub-Saharan countries, but also different from fully industrialized countries. All of these examples suggest the possibility of other equilibria with *partial* industrialization, or the phenomenon of *getting stuck*.

This paper investigates partial industrialization within the broad parameters of the MSV model. The basic structure will be maintained, but a modified version of the model will be offered. It is a second version modification in the sense that the modification of the first version was made by Murphy et al. to derive multiple equilibria by changing wage structures. This version is also derived from the multiplicity of equilibrium, but from a *spatial* perspective, which is based on agglomeration economies. Paternostro (1997) initiated this modification, assuming that the fixed cost of monopolist firms (F) is a monotonically decreasing function of the number of monopolists entering sectors (n). In the framework of agglomeration economies, he argued that the fixed cost incurred by a firm can be reduced as more and more firms participate in the production of goods. He achieved the same result as Murphy et al. (multiplicity of Nash equilibria in an economy), but with a simpler functional form.

This paper extends and generalizes Paternostro's argument with further emphasis on issues of regional economics and economic geography. More specifically, this paper assumes that not only F (fixed cost) but also α (labor productivity) is a function of n. Moreover, unlike Paternostro's study, this paper argues that these functions are *not* monotonically decreasing in n.

One of the most important findings of this generalization is that it provides a

theoretical framework for explaining the possibility of *partial industrialization* and its dynamics. Unlike the modification made by Murphy et al. or Paternostro, this paper presents the idea that an economy may stay in the middle of partial industrialization instead of jumping into full development. However, situations are dynamic in that either *Critical Minimum Effort* or *Critical Minimum Retreat* could occur in the status of partial industrialization so that an economy might reach full industrialization or fall into the poverty trap.

This paper is organized as follows. Section 2 gives a brief description of the original MSV model from the general equilibrium perspective. Section 3 presents the so-called first modification of the model, developed by Murphy et al. It is discussed with a supporting example: an application of the results to North Korean industrial development. Section 4 explains the second modification, which revisits the multiplicity of equilibria in terms of *spatial* dimension. This section also discusses partial industrialization and its dynamics, along with confirming examples. Section 5 concludes the paper.

2. Description of the Model

The ideas of Nurkse and Rosenstein-Rodan were formalized in the MSV model, which demonstrates that an economy will be trapped in poverty when no sector has an incentive to industrialize, but every sector will be industrialized if they all earn positive profits (Basu 2000, p. 23). From the general equilibrium approach, this paper *reinterprets* the original model, assuming the same wage structure between monopolists and fringes.

2.1. Background

The MSV model starts with the following assumptions.

(A.1.) There are *k* sectors in a closed and less developed economy, and each sector produces a distinct commodity.

(A.2.) There is a representative consumer (or, many consumers with identical preferences) with a utility function $u(x) = x_1x_2x_3\ldots x_k$ and income *y*.

(A.3.) *L* units of labor are supplied by the consumer, and l_j is the number of laborers employed in sector *j* for all $j=1,2,\ldots k$, where $l_1+l_2+\ldots+l_k=L$

(A.4.) Each sector has one fringe firm and one (potential) monopolist firm. The number of sectors having a monopolist firm is *n*.

(A.5.) Monopolist firms are defined as industrialized in that for a given input of labor, they produce more output than the fringe firms do. However, the quality of goods are the same regardless of whether they are from the monopolist or the fringe firms.

(A.6.) Both monopolist and fringe firms have the same wage *w* across sectors. In a later analysis, *w* will be normalized to 1.

(A.7.) Production functions of both types of firms are linear: in sector *j*, $x_j=f(l_j)= l_j$ (45 degree line and no sunk cost) for the fringe firm, and $x_j=g(l_j)=\alpha(l_j-F)$($\alpha>1$ and *F* is a sunk cost) for the monopolist firm, where the function *f* depends on the technology of the fringe firm and *g* depends on the technology of the monopolist.

(A.8.) While fringe firms freely enter and exit the economy in a competitive environment with zero economic profit, monopolist firms enter the market only when they gain positive economic profits.

2.2. Equilibrium

Based on these assumptions, equilibrium can be derived as follows:

1) Consumers' Utility Maximization Problem (UMP)

$$\max x_1 x_2 x_3 \ldots x_k \qquad \text{(P)}$$

$$\text{s.t. } p_1 x_1 + \ldots + p_k x_k \leq y$$

By solving for (P), we get $x_j^*_{demand} = \frac{y}{k p_j}$ for $j=1,\ldots,k$

2) Producers' Profit Maximization Problem (PMP)

$\pi^{fringe} = \max (p_j x_j - w l_j) = p_j x_j^*_{supply} - w\, l_j^*_{demand}$ where $x_j = l_j$ for $j=1,\ldots,k$

$\pi^{monopolist} = \max (p_j x_j - w l_j) = p_j x_j^*_{supply} - w\, l_j^*_{demand}$ where $x_j = \alpha(l_j - F)$

3) A competitive equilibrium in this economy is $(p_j; x_j, l_j)$ for $j=1,\ldots,k$ such that

i) $x_j^*_{demand}$ solves UMP

ii) $x_j^*_{supply}$ solves PMP

iii) There are equilibrium prices p_j^* and w^*(or λ^*) in which commodity markets and labor markets clear.[1]

2.3. Fringe Firms and Monopolists

In a perfectly competitive market, fringe firms maximize their profit. The profit

[1] There is no description of how the labor market clears, but we have two markets and find explicitly that the goods market clears ($\{x_j^*\}_{demand} = \{x_j^*\}_{supply}$). Therefore, the Walras Law says that the labor market also clears.

function is: $\pi = p_j x_j - w l_j = (p_j - w) l_j$ for $j=1,\ldots,k$. If $p_j > w$, when l_j increases, profit increases as well. Therefore, demand for labor keeps increasing, and the market does not clear. If $p_j < w$, the optimal demand for labor is 0, so there is no incentive to produce. The only significant case is when $p_j = w$ where the profit equals zero.[2]

Monopolist firms are more complicated to analyze. Consider the demand side first. If $p_j > w$, then, since the quality of goods from the monopolist or the fringe firms are assumed to be the same (A.5.), nobody will buy a good x_j from a monopolist. As a result, the demand function that a monopolist faces is $x_j = 0$. If $p_j < w$, people will only buy goods made by monopolist firms, and the demand curve[3] that they face is the same as the demand curve of the (representative) consumer in this country, which is $x_j = y/kp_j$. On the producer's side, however, because $x_j = \alpha(l_j - F)$, $l_j = x/\alpha + F$, making cost function $c(x) = wx/\alpha + wF$. Therefore, the profit maximization problem becomes:

$$\underset{x_j}{Max}\left(p_j x_j - \frac{w x_j}{\alpha} - wF\right) \qquad \text{(Q)}$$

Based on demand function, if $p_j > w$, $x_j = 0$, making a profit at $\pi_j = -wF$. If $p_j \le w$, $x_j = \frac{y}{kp_j}$, or $p_j = \frac{y}{kx_j} \le w \rightarrow x_j \ge \frac{y}{kw}$, (Q) is converted into:

$$\underset{xj \ge \frac{y}{kw}}{Max}\left(-\frac{w x_j}{\alpha} + \frac{y}{k} - wF\right) \qquad \text{(Q')}$$

Therefore, $x_j^* = \frac{y}{kw}$ and $\pi_j = \frac{y}{k}\left(1 - \frac{1}{\alpha}\right) - wF$. Let $a = 1 - \frac{1}{\alpha}$. Then, the aggregate

[2] In a competitive environment, technology is assumed to be linear, which is homogeneous of degree 1. Therefore, it is natural to say that profit is zero.

[3] A geometrical explanation is foregone in this paper. A graph of this demand curve, along with a Marginal Revenue curve is provided by Basu (2000, p. 26). In this book, he processed his ideas by directly finding a profit maximizing point where MR=MC. This paper uses an indirect approach, starting from cost minimization, but reaching the same results.

profits of all monopolist firms entering each market are:

$$\pi = n^* \pi_j = n(\frac{ay}{k} - wF) \qquad (1)$$

The aggregate income of this economy, denoted by y, is $y = \pi + wL$. Putting this result into (1), with *w* normalized to 1, we get $\pi = \frac{n(aL - kF)}{k - na}$. Therefore, the firm's profit in sector j is,

$$\pi_j = \frac{aL - kF}{k - na} \quad \text{for all } j=1,2,\ldots k \qquad (2)$$

The total number of sectors in this economy is *k*, so it is always the case that $k \geq n$. In addition, $a<1$ because $\alpha > 1$. So, in this case, the denominator is always positive; the sign of the profit of monopolist firms depends on *aL-kF*.

2.4. Modification for Multiple Equilibria

Note that result (2) cannot have multiple equilibria. If $aL-kF>0$, the profit is positive, and all monopolist firms will enter the market. If $aL-kF<0$, no sector will be industrialized. Hence barring a non-generic special case where $aL-kF=0$, there cannot be multiple equilibria. Understanding this, Murphy, Shleifer, and Vishny modified their model by changing (A.6.) into the following one.

> (A.6-1.) Work loads are heavier in monopolist firms, resulting in a higher wage than that of fringe firms. More specifically, fringe firms have the same wage *w* across sectors, while monopolist firms have wage λ across sectors, which is higher than *w.*

With (A. 6-1.), we solve the profit maximization problem using the same procedure that was discussed in 2.3. Now, let us normalize *w* and λ to *1* and *1+v*, respectively. Then, the individual firm's profit becomes $\pi_j = \frac{y}{k}(1-\frac{1+v}{\alpha}) - (1+v)F$. Let $1-\frac{1+v}{\alpha} = b$, then $\pi_j = \frac{by}{k} - (1+v)F$ where *b* is assumed to be positive. According to (A.4.), the number of firms entering the economy is *n*, so the total profit of this economy is

$$\pi = n[\frac{by}{k} - (1+v)F] \qquad (3)$$

According to (A.2.), *y* represents the income of a consumer in this economy where *y* is the sum of the firms' profit and the workers' wage income. More specifically,

y = profit of fringe firms (0) + profit of monopolist firms (from (3))
+ wage income of workers hired in fringe firms
+ wage income of workers hired in monopolist firms (4)

First, consider the number of workers in *fringe* firms and their wage income. The equilibrium output x_j* is $\frac{y}{kw}$ (where $p_j = w$), and when wage is normalized to 1, it is $\frac{y}{k}$, which is the same as l_j*. Because monopolist firms enter *n* sectors, fringe firms occupy *k-n* sectors. Therefore, the total number of people working for the fringe firms and their wage income (when *w* is 1) is *(k-n)*$\frac{y}{k}$. The rest of them work for the monopolist firms. From (A.3.), the total number of workers in this economy is L. Therefore, *L- (k-n)*$\frac{y}{k}$ equals the number of laborers working in the monopolist firms.

Because each worker's wage is *1+v*, his or her wage income is *(1+v)* [*L- (k-n)*$\frac{y}{k}$].

Plugging all of these into (4),

$$y = n[\frac{by}{k} - (1+v)F] + (k\text{-}n)\frac{y}{k} + (1+v)\,[L - (k\text{-}n)\frac{y}{k}]$$

$$\therefore y = \frac{(1+v)(L-nF)k}{(1+v)k - n(v+b)} \qquad (5)$$

Plugging (5) into (3), and dividing it by *n*, the profit of the firm in sector j is,

$$\pi_j = \frac{(1+v)[b(L-nF) - F(1+v)k + Fn(v+b)}{v(k-n) + k - bn} \text{ for all } j=1,2,\ldots k \qquad (6)$$

Because *k>n* and *b<1*,the denominator is positive. Therefore, whether or not profit is positive or negative depends on the sign of *b(L-nF)-F(1+v)k+Fn(v+b)*. Following Basu's notation (2000), let $\chi(n) = b(L - nF) - F(1+v)k + Fn(v+b)$ (p. 29). Then there exist *b,L, F, v,* and *k* such that $\chi(1)<0$ and $\chi(k)>0$, confirming the multiplicity of equilibria. A graphic explanation of this result is as follows:

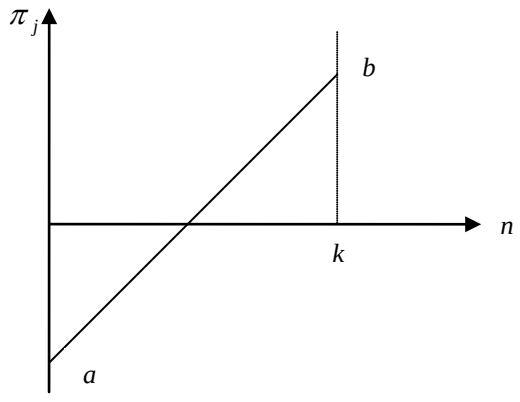


Figure 1.1. Multiple Equilibria

The two points at *a* and *b* can be viewed as Nash Equilibria. When other monopolists do not enter, the monopolist who enters the market alone gains a negative profit. This is true for every monopolistic firm in the country. Therefore, when no one enters the market, the Nash Equilibrium is *not entering*. However, when others enter, the monopolist can have a positive profit, so it has an incentive to enter the market, thus, another Nash equilibrium is made when everybody enters the market. Being stuck in the former equilibrium is a *poverty trap*; a small deviation from the equilibrium will cause the economy to go back to where it was. The latter equilibrium is synonymous with *industrialization*, and moving toward the latter from the former is possible by a *big push*, in which once monopolist firms enter more than a certain threshold of sectors, other sectors will be industrialized on their own, and the economy will jump into full industrialization. This idea is related with the so-called *Critical Minimum Effort*[4] in the sense that there is a minimum number of *n* such that once an economy has *n* industrialized sectors, the rest will industrialize on their own (Paternostro).

3. Spatial Adaptation of the Model

Although result (6) nicely captures multiple equilibria of an economy, it may be too complicated to understand readily. By using simpler methods, this section modifies the MSV model to derive multiple equilibria. More specifically, the MSV model will be revisited from a spatial perspective, which has often been ignored in conventional mainstream neo-classical economics.

One reason for this negligence was that spatial economics, also known as economic geography, was often regarded as “intractable,” using the expression of Fujita et al.

[4] More explanation on the Critical Minimum Effort will be provided.

(2000). For example, agglomeration, and increasing returns to scale are very important to explain spatial concentration in economic activities. However, conventional cost minimization or profit maximization problems do not have general solutions to the increasing returns to scale. Therefore, as noted in Krugman (1997), spatial issues remain a "blind spot" in the economic profession.

Only since the late 1970s have economists been paying increasing attention to this field. Dixit and Stiglitz (1977) developed a model of monopolistic competition, which contributed significantly to analyzing agglomeration and increasing returns to scale in a tractable manner. Shukla and Stark (1985) investigated socially optimal levels of migration in agglomeration economies, and Helpman and Krugman (1985) studied differentiated product markets and increasing returns to scale in international trade. Krugman (1991) named these recent theoretical and empirical developments the "new economic geography."

The next sections combine development economics and economic geography. As Krugman (1998) argued, geography should play a role in development economics. Given that, this paper will revisit the MSV model from the perspectives of regional economics or economic geography.[5] Paternostro's version has some relation to agglomeration, but I will generalize his ideas by assuming not only that *both F* and α are functions of *n*, but that these functions will *not* be monotonic functions of *n* as agglomeration proceeds.

3.1. Concentration and Congestion: Measurement

Economies tend to get agglomerate. By forming a cluster, firms can share not only

[5] There are many names that represent this field of economics: regional science, economic geography, regional economics, spatial economics, and economics of agglomeration, to name a few.

transportation costs for input/output shipment, but also knowledge or information that is essential for production. Using terminology from Fujita et al. (2000), all of these positive externalities are "centripetal forces" that will benefit the industry, and according to O'Sullivan (2003), the economy will enjoy lower costs and higher productivity. Thus, in the MSV model, *F* will be a decreasing function of *n,* and α will be an increasing function of *n*. In addition to supply-side externality, agglomeration economies will be realized in the form of "thick-market externalities," which will reduce asymmetric information for consumers and will give them better opportunities to compare the prices and quality of goods (Lall et al. (2004)).

Nevertheless, given that a physical space is limited, overconcentration can always be a problem, resulting in congestion and rent increases. The industry will experience external diseconomies where so-called "centrifugal forces" (Fujita et al. (2000)) will be dominant. Therefore, the MSV model will be modified such that *F* in the model will be an increasing function of *n* up to a certain threshold, and it will be a decreasing function of *n* thereafter; whereas α will be an increasing function of *n* initially, but eventually, it will not increase any more after it exceeds a certain point.

What, then, is the threshold that distinguishes concentration from over-concentration? How can the degree of concentration be measured? In Ellison and Glaeser's 1997 study, they developed indices[6] of geographic concentration using the so-called *Dartboard Approach*. They concluded that concentration does exist and the

[6] $\gamma = \dfrac{\sum_{i=1}^{M}(s_i - x_i)^2 - (1-\sum_{i=1}^{M} x_i^2)^2 H}{(1-\sum_{i=1}^{M} x_i^2)(1-H)}$ where s_i is the share of an industry's employment in each of M geographical areas, the share x_i is the total employment in each of those areas, and H is the Herfindahl index $H = \sum_{i=1}^{N} z_j^2$ of the industry plant size distribution. According to Ellison and Glaeser (1997), $\gamma < 0.02$ is regarded as not very localized, and $\gamma > 0.05$ is regarded as very concentrated.

extent of concentration varies *within* sectors.[7] On the other hand, Duranton and Overman (2002) proposed so-called *K-density*, and found, using UK industry data, that concentration takes place mostly on a small scale below 50 kilometers, and the degree of concentration is very skewed, and industries show broad sectoral patterns. Lall et al. (2004) suggested an alternate approach using industry employment in the district, and measured the localization economies *within* a sector. Data from the Indian manufacturing industry show negative coefficients for concentration economies from three industries, implying that benefits from external economies are offset by diseconomies of scale resulting from increasing wages and rents, as well as increasing transportation costs due to congestion.

3.2. *F(n)* and *α(n)*[8]

The literature on concentration measurement suggests that spatial agglomeration has a threshold from which it moves from sparse to overconcentration. Based on the MSV model, I argue in this section that there is a certain threshold of *n* separating concentration from overheated agglomeration. I further argue that *F* and *α* are the result of concentration and they tend to increase or decrease depending on whether or not the economy is overconcentrated, thus allowing for more externalities and also for non-monotonicities in the externalities.

First, F can be defined as:

[7] Using data from U.S. manufacturing industries, Ellison and Glaeser found that the tobacco, textile, and leather industries are relatively concentrated; and the paper, rubber and plastics, and fabricated metal products industries are loosely concentrated.

[8] In Appendix 1, a simple model is introduced to give a background explanation on this section. In this model, both *F(n)* and *α(n)* have step functions, but derives the same result.

$$F = \text{travel time } (T) + \text{money spent on traveling } (M) \quad (7)$$

T represents the time required to transport all the resources to a certain cluster; for example, a commute time for workers or the time required for input shipments. This does not contribute to improving the productivity, and it would be natural to assume that this is part of fixed costs. In order to quantify *T*, this paper uses the FHWA (or BPR) function.

$$T = t_0[1 + A(\frac{x}{C})^b] \quad (8)$$

t_0 = travel time without congestion (1hour)
C = practical capacity of a certain length of road (65miles if it is the speed limit) (typically 80% of absolute capacity U (U=2000/hour in a highway))
A = parameter (often A=0.15), b = parameter (often b=4)
x = the number of vehicles = the number of sectors = n[9]

Originated by the Federal Highway Administration (FHWA) and Bureau of Public Roads (BPR), this function is widely used[10] to measure the relationship between the number of vehicles and their travel time. The equation (8) reveals that once the number of vehicles exceeds the practical capacity of the road (1600 vehicles/hour if it is a highway), travel time increases exponentially.

In order to apply this function to industrial agglomeration, suppose that each incoming sector (*n*) requires one vehicle to transport people to their workplace or ship a variety of inputs to the sector. With this assumption, *x* can be simply converted into *n*. When the number of sectors exceeds a certain threshold, the road to the industrial cluster exceeds its capacity. Eventually, congestion problems arise and the travel time

[9] [The number of vehicles = the number of sectors] This assumes that one vechicle is required per each sector.

[10] In addition to this function, the Davidson Function and the Akcelik Function measure the same relationship. This paper chooses the FHWA (or BPA) Function because, unlike other ones, parameter values are easily accessible depending on the type of roads.

increases sharply.

M represents transportation costs. By sharing costs for input shipments, participating firms in a certain cluster may experience external economies of scale. This is one of the biggest benefits of being close to one another, and is a typical factor in explaining the concept of economic agglomeration (Krugman 1997, Fujita, Krugman, and Venables 2000).

The transport cost function discussed in this paper resembles the idea of the iceberg transport function, which is often heavily emphasized in regional economics or economic geography. As its name indicates, the iceberg transport cost is the good itself that melts away. Originated by Samuelson (1952), this idea significantly contributed to international trade by treating distance and transportation costs in exactly the same way as tariff costs (McCann 2005). According to Samuelson, the iceberg transportation cost is a step-wise discontinuous function, meaning that staying within an individual country does not change the cost, but going into another country causes a sudden increase in cost, which is basically the same as tariffs.

Krugman (1991) developed Samuelson's idea and introduced a continuous iceberg transport cost function, defined as:

$$V_d = V_o e^{-\tau D} \tag{9}$$

V_o: the value of the good at the origin location
τ: the iceberg decay parameter
D: the haulage distance
V_d: the quantity of good actually delivered at the delivery location d.

The equation (9) is the solution of the differential equation $\frac{dV}{dD}\Big/V = -\tau$, implying that the growth rate of the volume of an iceberg, which is a function of distance, is constant at $-\tau$. Departing from this functional form, but using the same idea, this

paper derives a relationship between the volume of the iceberg and its transport cost. The reason for focusing on the volume is that it is related to the agglomeration and economies of scale. Suppose that an iceberg can be interpreted as raw material (or input) shipped to an industrial cluster or interpreted as output products shipped to a market. Then, as an economy becomes agglomerated, the size of an iceberg will become larger.

On the other hand, the transport cost is measured by its melting rate. If the melting rate is a decreasing function of the volume of an iceberg, the transportation cost will decline as an economy becomes agglomerated, and the economy experiences the economies of scale.

In order to verify this, let us assume that V is now the function of time (t) instead of distance. Assume further that there is a cubic iceberg with length a, which is also the function of t. $a(t)$ has the original value a_0, but continuously decreasing at a constant rate k as the iceberg melts away. That is,

$$a(t) = a_0 - kt \tag{10}$$

Therefore, $V(t)=[a(t)]^3=(a_0-kt)^3$ and $\frac{dV}{dt}\Big/V = \frac{-3k(a_0-kt)^2}{(a_0-kt)^3} = \frac{-3k}{a_0-kt}$. Since $a_0 - kt = V^{\frac{1}{3}}$, it is derived that:

$$M = \frac{dV}{dt}\Big/V = -3kV^{\frac{-1}{3}} \tag{11}$$

The left hand side of (11) is the melting rate of an iceberg, which represents the transport cost. If absolute values are given to both sides, (11) shows a decreasing function (at a diminishing rate, which is a convex function).

Indeed, using the assumption presented in (10), it can be determined that as the size of

an iceberg becomes larger, its melting fraction relative to the whole declines. Applying this to regional economics, the horizontal axis can be interpreted as the amount of raw material or outputs proportional to the number of sectors (*n*), and the vertical axis, the transport cost (*M*). Then, as an economy is getting agglomerated and as many sectors in the economy share input or output shipments, the burden for the transportation cost that each sector needs to pay decreases. Eventually, the economy will achieve the economies of scale.

Summing up both *T* and *M*, represented at (9) and (11), the following figure reveals that *F* is a function of *n*. More specifically, it decreases in *n* up to a certain threshold and increases after the threshold is reached, describing the pattern of external diseconomies and external economies of scale, respectively.

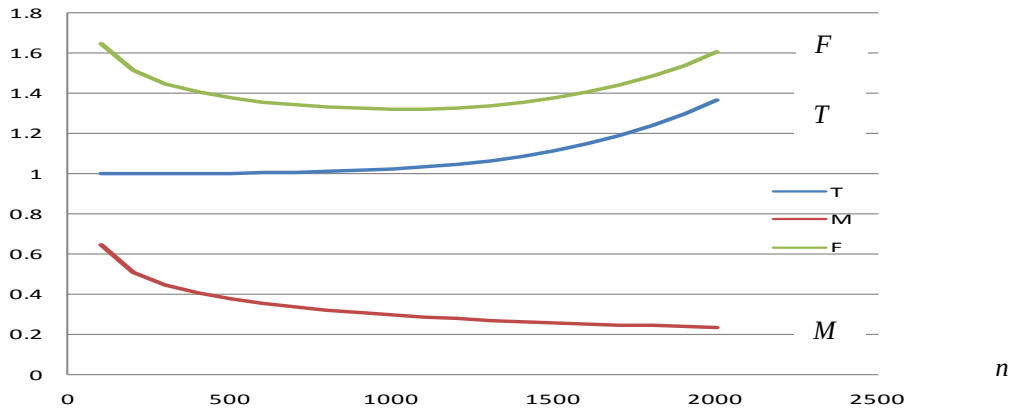


Figure 1.2. *F(n)* (*F = T+M*)

Note: The horizontal axis is the number of sectors (n). The graph for T is based on the parameter presented in the original function of (8) (t_0 = 1hour, C = 1600, A=0.15, b=4). The graph for M is based on the functional form of (11) and, for convenient reason, assumes that k is 1.

Next, define α as follows:

$$\alpha = \textit{knowledge spillover (K)} + \textit{leisure time (L)} \quad (12)$$

Along with the transport cost sharing, knowledge spillover is one of the factors that contributes to the external economies of scale and justifies the agglomeration trends. Bell and Albu (1999) argued that “knowledge systems” are core to the long run development of industrial clusters and that “intra-cluster” innovation and “extra-cluster” openness to flows of outside knowledge are crucial for developing countries. Sandee (1995) showed how collaboration in a rural industrial cluster in Indonesia fostered the diffusion of innovation and the improvement of technologies. Johansson and Nilsson (1997) demonstrated that clustering in export processing zones in Malaysia encouraged local firms to learn from foreign firms how to globally produce, sell, and distribute their products.

However, the amount of innovative knowledge is limited, and the external benefits of the knowledge may fade away. Jaffe et al (2000) used the patent citation as an indicator for the knowledge spillover, and showed that it tends to have diminishing returns to the number of claims. Audretsch and Keilbach (2008) also said that, with some exceptions, diminishing returns to R&D are the “rule”.

Taking these studies into account, this paper uses a natural log of n as the functional form of K. Additionally, if T in (8) refers to commute time, leisure time is adversely related to it, so it can be assumed that $L=-T$ for reasons of mathematical simplicity. Therefore, (12) can be explained as:

$$\alpha = \ln(K) - T \quad (13)$$

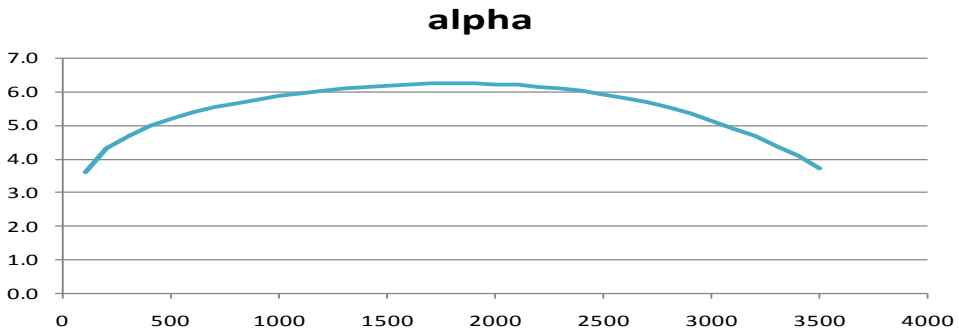


Figure 1.3. *α(n)*

3.3. Profit and the Phenomenon of *Getting Stuck*

Overall, using similar reasoning to that of previous sections but with greater generality allowed in this section by adding spatial issues to the MSV model, a modified version of (2) can be derived. That is:

$$\pi = \frac{a(n)L - kF(n)}{k - na(n)} \quad \text{where} \quad a(n) = 1 - \frac{1}{\alpha(n)} \tag{14}$$

Since $F(n) = t_0[1 + A(\frac{n}{C})^b] + \frac{B}{n}$ and $\alpha(n) = \ln(K) - \{t_0[1 + A(\frac{n}{C})^b] + \frac{B}{n}\}$, with their shapes displayed in Figure 1.2 and 1.3 respectively, the general version of the MSV model allows us to change Figure 1.1 into:

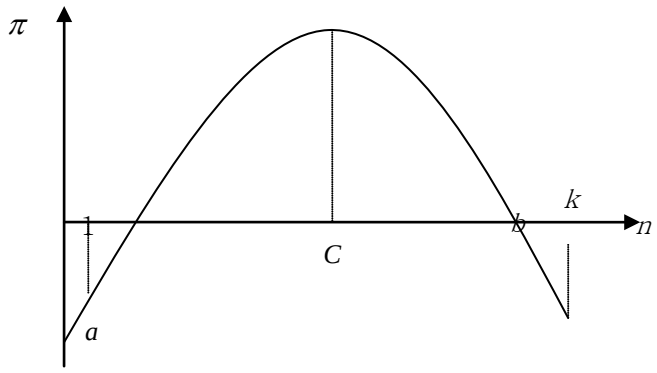


Figure 1.4. Modified Graph of Figure 1.1.

According to Figure 1.4, this economy still has two equilibria. Unlike the former analysis, however, the profit decreases after it reaches its maximum, after which the economy exhibits over-concentration and congestion. Two interesting results arise when it hits the *n*-axis. First, when there are *b+1* firms entering the market, they will have a negative profit, giving them an incentive to leave the market. When *b-1* firms enter the market, they will still enjoy a positive profit. Therefore, other firms will enter the market until there is no profit left. This story reveals that equilibrium is reached when the profit is zero. Even though we did not assume a competitive market, the economy ends up having a profit of zero.

More importantly, the results suggest the possibility of partial industrialization. Unlike the former results, not all of the monopolist firms enter the market at the equilibrium point *b*. This means that unlike the former case where industrialization gets off the ground when every firm participates in the market, this economy will get stuck in *partial* industrialization.

This *partial* industrialization occurs when external diseconomies, caused by congestion and over-concentration, outweigh external economies. When the agglomeration is made to accommodate a certain number of sectors in a cluster ($n \leq C$), then, as was argued by Murphy et al. and Paternostro, profit will be an increasing function of *n*. However, if agglomeration exceeds a threshold point *h*, the economy exhibits an over-heating problem. In this case, as *n* increases, *F* will increase and α will decrease[11]; accordingly, profit will decline. Equilibrium of partial industrialization occurs when profit reaches 0 before *n* reaches *k*.

[11] It is totally plausible that the economy can experience another case (e.g., both an *F* and α increase). However, an interesting case arises when *F* increases and α decreases from which partial industrialization can be easily derived.

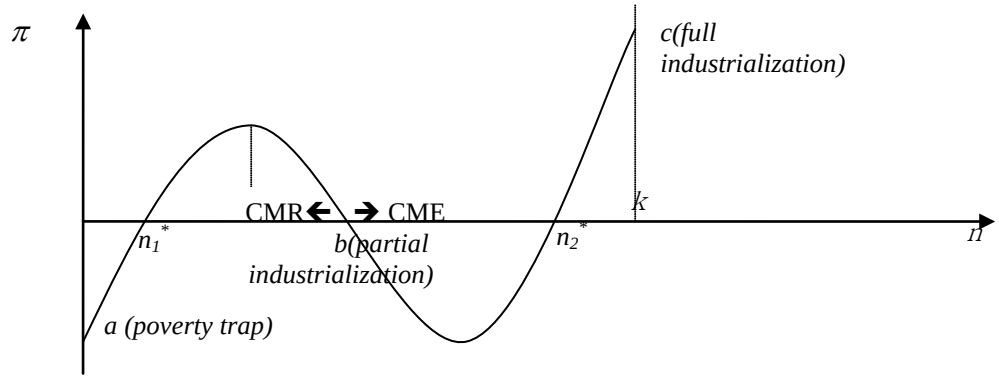


Figure 1.5. Poverty, Partial Industrialization, and Full Industrialization

It is also possible that an economy shows both partial and full industrialization *sequentially*. As displayed in Figure 1.5, even if an economy falls into a zero-profit partial equilibrium, it might recover if the external diseconomies of congestion disappear. For example, this upturn can occur by building more railways (See Appendix 1 for a model set-up), which can be generalized into an expanding spatially connective infrastructure[12]. Then, the threshold that distinguishes agglomeration from overconcentration shifts to the right. At the same time, external economies will again dominate, resulting in a decrease in F and an increase in α as n increases. In this case, profit will start to increase again to reach full industrialization. As a result, the economy observes three multiple and *stable* equilibria *a, b,* and *c* that exhibit the poverty trap, partial industrialization, and full industrialization, respectively.

[12] Chapter 7 of the *World Development Report (WDR)* (2009) of the World Bank has relevant contents. Titled as "Concentration Without Congestion", this chapter aims to identify and understand the interactions between geography, economic activities, and living standards, and to draw the implications of these interactions for public policy. In particular, this chapter introduces examples of some regions that solved congestion problems and made successful urbanization and industrialization after the provision and efficient management of spatially connective infrastructure in the transport sector.

3.4. Critical Minimum Effort and Critical Minimum Retreat

Figure 1.5 explains Critical Minimum Effort and Critical Minimum Retreat. Based on this Figure, this section explains Critical Minimum Effort (CME). According to Leibenstein (1957), underdeveloped countries need a certain level of investment in order to escape from their vicious circle of poverty. In that light, Critical Minimum Effort can be interpreted as the smallest number of *n*, denoted by n_2^*, such that once more than n_2^* sectors are industrialized in an economy, the other sectors will industrialize their own so that the economy escapes getting stuck in partial industrialization. Since partial industrialization is mainly due to over-concentration and congestion in an economy, if these problems are solved, the economy will attract investments from industrialized firms, and eventually reach and exceed n_2^*.

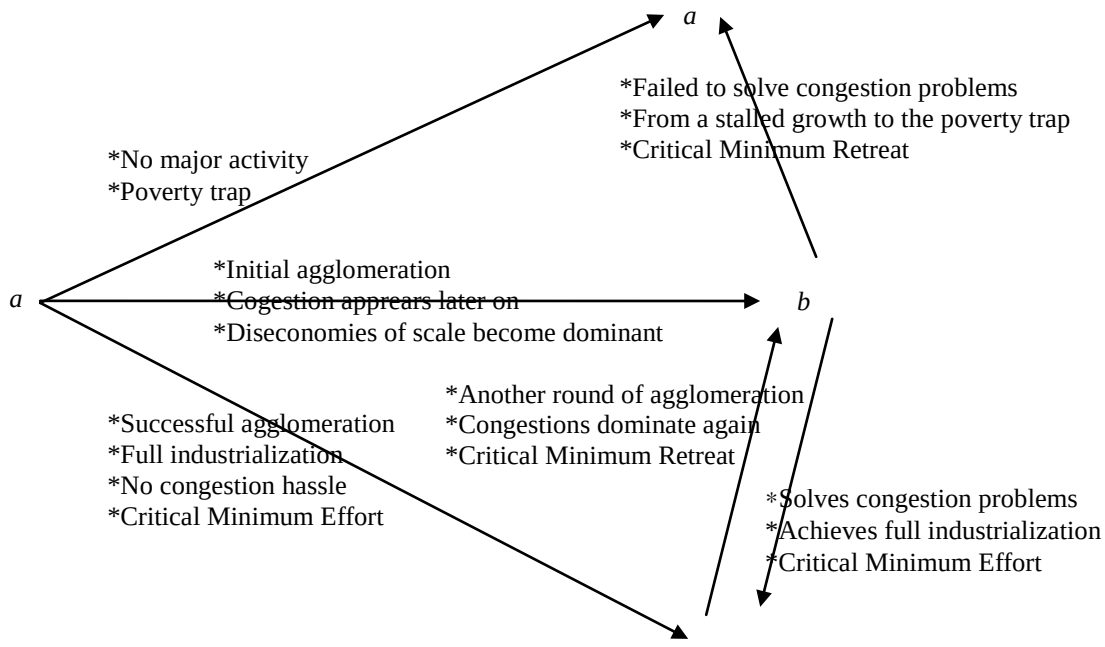


Figure 1.6. Summary (CME and CMR)

More importantly, Figure 1.6 also explains *Critical Minimum Retreat (CMR)* that will make the economy get out of partial industrialization and go in the opposite direction. In other words, there is the smallest number of n, denoted by n_1^*, such that once the number of remaining industrialized sectors is less than n_1^*, the rest of them will leave the economy to avoid a negative profit. When this happens, the economy will fall into the poverty trap with no industrialization. This scenario would occur if an economy is not able to solve its congestion problems and if external diseconomies of scale are too dominant in the economy for industrialized firms to maintain their businesses.

Figure 1.6 summarizes the discussion in Section 3.2 and 3.3. By introducing a new equilibrium point *b*, which is partial industrialization with the Critical Minimum Effort and the Critical Minimum Retreat, the situations are far more dynamic than having only the two equilibria *a* and *c*, as was argued in the original MSV model.

4. Examples

This section provides five examples of partial industrialization and CME/CMR: Mexico, Poland, the Philippines, and South Korea.

4.1. Mexico (b → CME)

As shown in Figure 1.7, Mexico suffered from an economic crisis in the 1980s. During the 1960s and 1970s, this country adopted an import-substituting industrialization policy, and most public investments in water, education, power, and transportation were mainly focused on Mexico City, fueled by government policies that offered a variety of direct and indirect subsidies to the region (Garza and

Schteingart 1978).

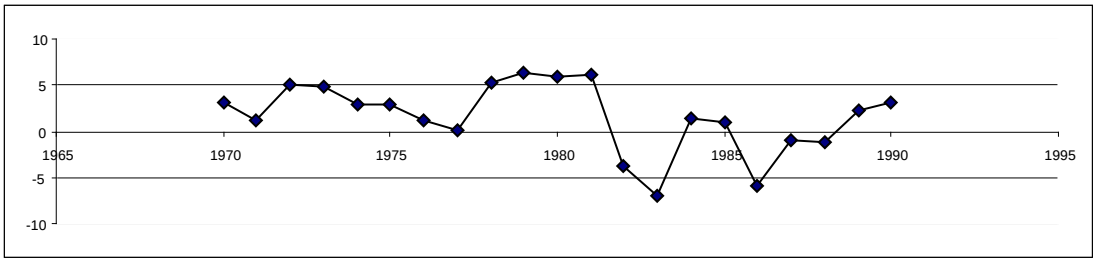


Figure 1.7. Mexico: Growth Rate of Real GDP per Capita (Constant Prices, 2000)
Source: Penn World Table

As a result, Mexico experienced a huge amount of spatial concentration, Table 1.1 reveals that a share of employment in the manufacturing industry in Mexico City soared to 42.1% in 1970 (Gordon et al. 1996).

Table 1.1. Number of Manufacturing Employment in Mexico

	1950	1970	1988
Mexico City (A)	156,697	672,446	745,387
National Total (B)	626,285	1,596,816	2,587,013
(A)/(B)*100	25.0	42.1	28.8

Sources: Derived from Garza et al., 1987, and Gordon et al., 1993

Accelerated by the country's industrial structure of import-substitution, the overconcentration contributed, in turn, to strengthening this structure. In the midst of this vicious circle, Mexico became vulnerable to an economic and debt crisis in the early 1980s.

In this direction, Kim (1990) pointed out that Mexico's economic hardships in the 1980s were due to overconcentration in a few "urban poles" such as Mexico City, Monterrey, and Guadalajara. According to his example, Mexico City alone had 44

percent of the total national industrial establishment with nearly 130,000 industrial facilities. Considering that the city suffered from severe congestion problems and that rural areas were deprived of opportunities for developing the non-agricultural sector, this geographical concentration widened urban-rural inequality, and became one of the main reasons that blocked the country from achieving full industrialization.

However, as Krugman (1998) argued, since the launch of export-oriented policies, together with the establishment of NAFTA, Mexico experienced a "dramatic decentralization" away from Mexico City in the early 1990s with the growth of a new export zone near ports and the U.S. border. Table 1.2 confirms this argument; a negative growth rate of employment in Mexico City has been recorded since 1980, but rings that surround its capital have been showing steady growth. This decentralization and spatial equality[13] may explain the "healthy growth" later on, in which the country's growth rate was 5.4 percent per year from 1996-2000 (Lustig (2001)).

In this light, it could be argued that Mexico has just departed from the point *b* due to the decentralization and export oriented policies, and the Critical Minimum Effort could be seen in this country to achieve a full industrialization.

Table 1.2. Average Annual Growth Rates (%) in Mexican Industrial Employment by 1960-1988

	1960-70	1970-80	1980-88	1980-85	1985-88
Mexico City Total	16.7	15.1	-11.6	-7.0	-4.8
Central City	5.4	2.5	-14.4	-8.4	-6.0
First Ring	26.6	16.0	-8.2	-5.0	-3.2
Second Ring	26.5	30.6	-17.2	-9.9	-7.5
Third Ring	3.6	27.7	10.8	4.1	4.0

Sources: Derived from Garza et al(1987)

[13] Basu (2006) stated that inequality within a country increases with globalization. The inequality he mentions deals with income level across people in the country. However, if we focus on regional perspectives, with globalization, a country is expected to be regionally equal due to decentralization (Krugman (1998)). Relationship between *income inequality* and *spatial unevenness* can be a further research topic.

Note: Mexico City Ring definitions:
***Central City** DF: Benito Juárez, Cuauhtémoc, Miguel Hidalgo, Venustiano Carranza.*
***First Ring:** DF: Azcapotzalco, Coyoacán, Cuajimalpa, Gustavo A. Madero, Iztacalco, Iztapalapa, Alvaro Obregón. State of Mexico: Naucalpán, Netzahualcóyotl*
***Second Ring:** DF: Magdalena Contreras, Tláhuac, Tlalpán, Xochimilco. State of Mexico: Atizapán de Zaragoza, Chimalhuacán, Coacalco, Cuautitlán Izcalli, Ecatepec, Huixquilucán, La Paz, Tlalnepantla de Baz, Tultitlán.*
***Third Ring:** DF: Milpa Alta. State of Mexico: Chalco, Chiautla, Chicoloapán, Chiconcuac, Cuautitlán, Ixtapaluca, Melchor Ocampo, Nicolás Romero, Tecamac, Tultepec.*

4.2. Poland (b → ?)

Gorzelak (1986) indicates that the economic crisis in Poland in 1979-1982, in which national income declined by 25%, was as severe as the Great Depression 50 years earlier (Figure 1.8), largely due to overconcentration of production in some areas.

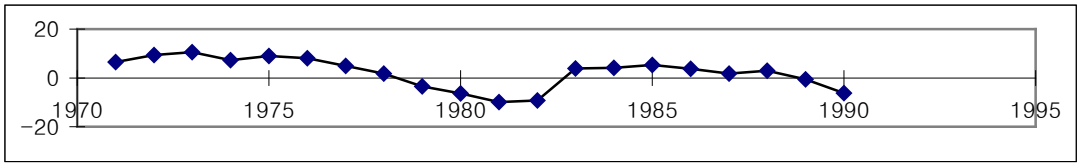


Figure 1.8. Poland: Growth Rate of Real GDP per Capita (Constant Prices, 2000)

Source: Penn World Table

He defined spatial concentration of productive activities as "a high spatial density of producing units in a given area," and argued that the economic breakdown in Poland resulted not from the consumption side but from the production side, particularly from an over-agglomerated industry structure. According to his research, the over-concentration problem is especially serious in the Upper Silesia region where, in 1982, 23.6% of the country's total industrial assets had been located on 2.1% of the nation's total area. This excessive industrial concentration resulted in overloading of the technical infrastructure system, including transportation, water and energy supplies,

sewage, and environment protection facilities, all of which led to a national decline in economic efficiency.

4.3. The Philippines (c → CMR → b → ?)

After World War II, the Philippines was a fast growing economy and one of the richest countries in Asia, following Japan. In the 1960s, it looked as if it would become one of the Asia's superpowers.

However, during the regime of Ferdinand Marcos, economic growth and productivity declined dramatically as the economy was destabilized by corruption. Additionally, a severe recession in 1984-85 saw the economy shrink by more than 10% (See Figure 1.9.)

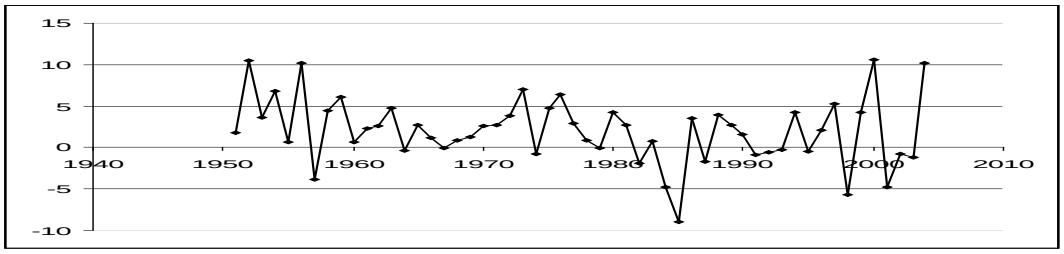


Figure 1.9. The Philippines: Growth Rate of Real GDP per Capita (Constant Prices, 2000)

Source: Penn World Table

From spatial perspectives, this economic downturn may have been due to congestion problems associated with over-concentration on a few urban areas. Markabenta (2002) revealed that industries in the Philippines were predominantly located in Manila region, which created a severe congestion problem. However, no effective decentralization policies or infrastructure provision had been active. Balisacan and Hill (2007) indicate the following three problems.

First, the country is under-investing in infrastructure. The immediate cause of this underinvestment is the chronic fiscal constraint since capital works are the first to be cut when the budget must be pruned. A tendency follows to rely on donor agencies, in the process resulting in an investment strategy that is short-term in orientation and is poorly integrated. Donor reliance also compounds the politically-driven bias to favor new projects over maintenance.

Second, the overall regulatory framework lacks cohesion, coordination between national agencies and between the various tiers of government, and a clear division of responsibilities. About 30 national agencies are involved in infrastructure decision-making, yet in some respects it appears that "nobody is in charge." Hence, toll roads are not necessarily consistent with national priorities, and half-built bridges are a frequent sight in the countryside, particularly in the aftermath of elections.

Third, national level decision-makers appear unable or unwilling to deliver the long-term policy predictability and guarantees that major private (and especially foreign) providers require. The politicization of large infrastructure investments appears to be unusually severe in the Philippines (Balisacan and Hill 2007).

Going back to the MSV model, the Philippines in the 1960s may have reached, or almost reached, the status of full industrialization. However, congestion problems and ineffective infrastructures associated with poor leadership resulted in a Ctitical Minimum Retreat (CMR), by which the country ended up falling into the position of partial industrialization (point b in Figure 1.5 or 1.6). This position is very important for the future of the Philippines to determine whether a Critical Minimum Effort (CME) might bring the country back to the old prosperous status, or another CMR may cause the country to fall into the poverty trap.

4.4. The Republic of Korea (South Korea) (a → b → CME)

For the past 50 years, Korea[14] has experienced a rapid economic growth of per capita GDP from $300 in 1960 to approximately $20,000 in 2007 (constant prices, Penn World Table). Along with this growth, Korea became dramatically industrialized, which facilitated urbanization. According to Table 1.3, the urbanization rate in South Korea has doubled from 40.7% in 1970 to 80.8% in 2005, higher than any of its neighbors.

Table 1.3. Urbanization Rates of East Asian Countries

	1970	1980	1990	1995	2000	2005
South Korea	40.7	56.7	73.8	78.2	79.6	80.8
North Korea	54.2	56.9	58.4	59.1	60.2	61.6
China	17.4	19.6	27.4	31.4	35.8	40.4
Japan	53.2	59.6	63.1	64.6	65.2	65.8

Source: Korea Statistical Information Service (KOSIS). National Statistical Office of the Republic of Korea

Urbanization: (Measured by Proportion of Urban Population)

Most investments were concentrated in the Seoul area in major industrial complexes. As shown in Table 1.4, Seoul's GDP is approximately 25% of the Korea's total GDP, and if expanded to the Seoul Metropolitan Area (SMA[15]), the share increases to almost 50%.

[14] For convenience, Korea refers to the Republic of Korea (South Korea). The Democratic People's Republic of Korea (North Korea) is excluded in this research.

[15] The SMA includes Seoul and its vicinities of Incheon City and Gyeonggi Province.

Table 1.4. GDP : The Whole Country, Seoul, and the SMA (Billion Korean Won)

	1985	1990	1995	2000	2005
Total	87,976	194,546	410,131	577,971	817,812
	(200,387)	(332,274)	(485,494)	(577,971)	(730,121)
Seoul	21,944	49,312	102,171	138,492	185,091
	(52,411)	(88,926)	(127,111)	(138,492)	(158,304)
SMA	38,092	91,311	195,805	276,516	386,990
	(91,715)	(158,958)	(238,114)	(276,516)	(350,218)

Source: Korea Statistical Information Service (KOSIS). National Statistical Office of the Republic of Korea
Note: 1 Million Won = $971 (May 30, 2008). The numbers not in parentheses are current prices, and those within parentheses are constant prices for 2000.

As industry became more concentrated, the population of Seoul skyrocketed from 2.4 million in 1960 to 10 million in 2005. As a result, the city faced severe congestion problems, especially from the late 1970s to the early 1990s. For example, the number of registered vehicles has increased sharply since the late 1970s, reaching 500,000 in 1987, 1 million in 1990, 2 million in 1995, and 2.5 million in 2000, most of which are private automobiles (1.8 million in 2000, 74% of the total). On the other hand, road construction in the city has slowed down since 1970 to somewhere around 7,000km[16] in 2000 (Seoul Development Institute 2008). As a result, the number of vehicles per one kilometer of roadways has exponentially increased. The growth rate was particularly high from the late 1970s to the early 1990s (Figure 1.10), and the average vehicle speed in downtown Seoul decreased from 25.0km/hour in 1984 to 16.4km/hour in 1990 (Seoul Metropolitan Police Agency)

[16] According to the Seoul Development Institute (SDI), the road length in Seoul is 7,888km in 2000.

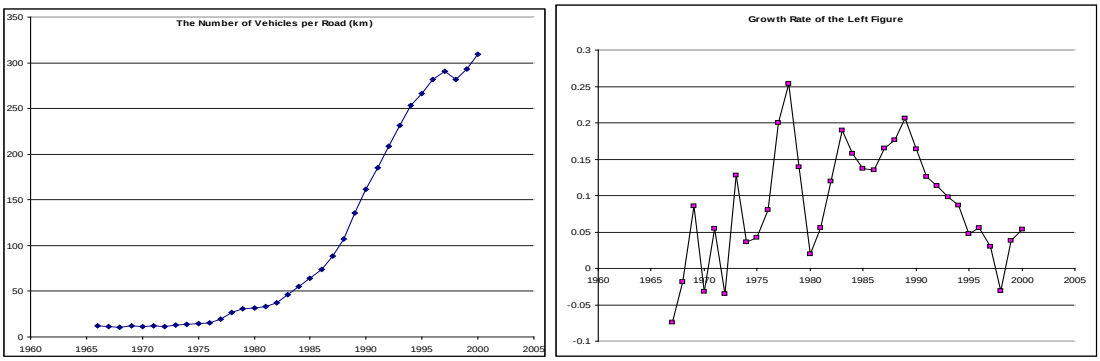


Figure 1.10. The Number of Vehicles and Growth Rate in Korea

Source: Seoul Statistics Yearbook, and Korea Statistical Information Services (KOSIS)

Another problem facing Korea up until the 1990s, especially in the SMA, was housing shortage, coupled with soaring land prices. The housing supply rate was stuck around 50% until 1990. This shortage was due to the population growth, coupled with many intervention policies, including urban growth boundaries (UGB)[17] and building-height restrictions[18] that prevented further supplies of land and housing. For this reason, land prices soared to 60% in the early 1980s (Figure 1.11).

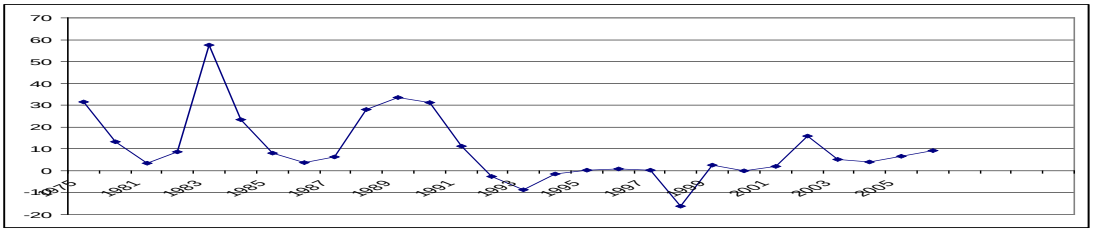


Figure 1.11. The Growth Rate of Land Prices in Korea

Source: Korea Land Corporation

[17] The UGB was introduced in Seoul in 1971 as the Greenbelt Policy to prevent the unlimited expansion of the city. This policy contributed to blocking the urban sprawl problem, but caused soaring housing prices.

[18] The building-height restriction policies in Korea are mainly for security reasons. The Blue House, the President's official residence, is in Gwanghwamun area, which is the core of downtown Seoul. Since the Korean War, there has been a strict policy that there should be no buildings in downtown Seoul that are higher than the Blue House.

All of these problems negatively affected the industrialization of the city, and as shown in Figure 1.12, the productivity of manufacturing sectors in Seoul and the Guro Industrial Complex (GIC), the biggest industrial complex within the Seoul Metropolitan Area, showed slow growth until 1988.

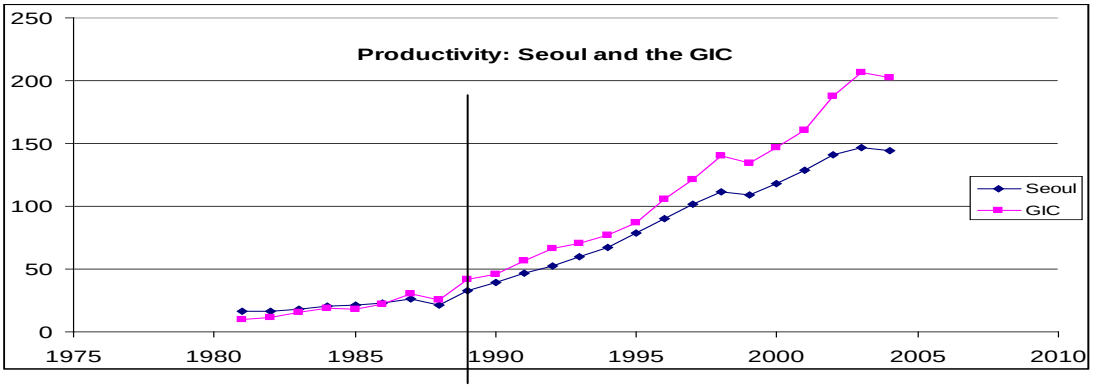


Figure 1.12. The Productivity of Manufacturing Firms in Seoul and the GIC

Note: Productivity ($) = Output ($) / Laborer
Source: Seoul Statistical Yearbook. Guro Statistical Yearbook

All of the above tables and figures, particularly Figure 1.12, indicate that Korea's growth was stalled in the 1980s. Using the terms in Figure 1.5 or 1.6, Korea was somewhere at point *b*. According to Figure 1.6, the CME is required to escape from the stalled situation which would help it to approach the point *c*. What the Korean government did was launching a number of decentralization plans. First, the so-called the New City Development Plan was launched in 1989 to decentralize the highly concentrated population outside Seoul by providing 200,000 new housing units. Based on this plan, five New Cities, *Bundang, Ilsan, Jungdong, Pyeongchon,* and *Sanbon,* which are all beyond the boundaries of Seoul and located in the surrounding Gyeonggi provinces, were newly constructed in 1989. This plan was quite successful because the

cities were not too far from Seoul (25~30 km), and were followed by the construction of social infrastructures, such as subways (lines 1, 2, 3, 4, and 7), highways, hospitals, and secondary schools. For example, Subway Line 3 was extended to connect Bundang, southeast of Seoul, (opened in 1994) and Ilsan, northwest of Seoul (opened in 1996). Line 4 was extended into Pyeongchon and Sanbon in 1994, and Line 7 was extended into Jungdong in 2000. Moreover, a beltway was opened in 1999 circling outside Seoul and connecting all of these new cities (See Appendix 2 for a map of Seoul, the surrounding area of new cities, and transportation networks)

On top of population decentralization, industry decentralization policies have also been developed in the 1990s. For example, companies in the Guro Industrial Complex (GIC) were relocated and decentralized into nearby areas. Opened in 1967, the GIC was the first industrial complex in Korea. It was the base camp of Korea's export-led development, focusing on labor intensive industries, such as textiles, in the 1960s and the 70s. It is even reported that the GIC alone accounted for 10% of Korea's total export in the 1970 (SERI). However, as Seoul became more and more expanded, the GIC area, which used to be a suburban area of Seoul, became rapidly urbanized. As usual, congestion problems arose and land prices soared, and the GIC lost its competitiveness in the 1980s; the number of workers dropped from 73,000 in 1987 to 25,000 in 1998, and the amount of export decreased from $4.2 billion in 1987 to $1.5 billion in 1989.

In order to solve congestion problems and recover competitiveness, most labor intensive industries in the area had to move to rural areas where they could find cheaper land and lower-wage workers. Moreover, as Korea's industrial comparative advantage turned gradually into a capital intensive one, the GIC itself became diversified and focused more on high-tech industry. As a result, the GIC changed its name into the Guro Digital Industrial Complex in 2000 and hosted many capital

intensive high-tech industries. Now, as shown in Table 1.5, the biggest business is IT industry, whereas the portion of textile industry is only 7%.

Table 1.5. Types of Business in the GDIC (January 2007) (Unit : Number of Companies, Percent)

IT	Animation	Electrics	Textile	Paper	Others	Total
4,364	18	43	427	246	1095	6193
70%	0.3%	0.7%	7%	4%	18%	100%

Source: Guro District Office

These decentralization policies worked well. The number of companies in the GIC has started increasing since the late 1990s (from 483 in 1998 to 6,711 in 2007), and the number of workers started increasing since then all the way up to 92,000 in 2007 (SERI). Not only the GIC area but also the entire Seoul had better circumstances. In 1995, Seoul recorded a negative population growth rate, the first time ever in its history, and the housing supply rate has increased sharply. Also, as shown in Figure 2.10 and 2.11, the growth rate of the number of vehicles and land prices have slowed down since the 1990s. As a result, another round of industrialization has been initiated in the GIC and in the entire Seoul, and their productivities, or per capita output, have turned into a rapid increasing path since the 1990s (Figure 1.12).

5. Conclusion

From spatial perspectives, this paper modifies the MSV model. The crucial part of this modification is the agglomeration capacity of a region. As long as external economies outweigh external diseconomies, economic profits will be an increasing function of *n*. On the other hand, when overheating or congestion problems become

significant, the profit will be a decreasing function of *n*, and the economy's growth might be stalled.

Unlike the original model where only one-way direction was made (how a region can be pulled out of a poverty trap and approaches industrialization), this modification allows us to analyze not only the two extremes, but also the possibility of *partial industrialization* as an intermediate stage. As summarized in Figure 1.6, by introducing this partial industrialization, along with the Critical Minimum Effort and Critical Minimum Retreat, this paper develops the original idea of the MSV model into a much richer level by incorporating various scenarios. The examples of the five countries are used to demonstrate these scenarios: Mexico and South Korea is in the stage of leaving the stage of stalled partial industrialization phenomenon for a fuller industrialization; in Poland, heavy economic congestion to a certain urban poles resulted in a stalled growth; The Philippines is in the Critical Minimum Retreat and the economy has degraded into partial industrialization. More work is needed on this topic regarding policy implications. Since the agglomeration capacity is a crucial threshold determining whether a region will achieve industrialization, policies that reduces economic congestion problems will work as critical minimum effort. Well established spatially connective policies, such as construction of spatial infrastructure (roads, bridges, etc), will reduce the cost of congestion and enhance the society's welfare. Decentralization policies, as were effectively performed in Mexico and South Korea, will also solve the problem of stalled growth and contribute to moving forward to fuller industrialization.

APPENDIX 1: MODEL

Consider labor, which is the only input in the MSV model. Assume the following:

- Workers are contracted to receive wages for 8 hours of work per day, and must have leisure for 16 hours to preserve productivity, which will decline as their leisure time shrinks.
- Workers can produce outputs only in the workplace.
- Commuting takes from one hour up to a certain point *h* and increases by S minutes thereafter. In addition, *half* of the workers' commuting time takes away from the number of work hours and the other *half*'s commuting time will take away from the number of leisure hours.
- Wages are the same across firms and across sectors.

In this framework, workers cannot work for the entire 8 hours due to commuting time, which is definitely a fixed cost. Fixed costs are normally composed of transportation costs and factor prices. In this model, there is no capital, so there is no rental rate, and wage is a fixed constant. Therefore, transportation costs, measured by commuting time, are the only fixed cost in this economy. More specifically, *F* can be defined as:

$$F = \text{time to commute}(C) + \text{money spent on commuting } (M)$$

Suppose there is only one railway going to work and there is one huge train that can accommodate *H* people from sector $1,2,\ldots h$ $(H=l_1+l_2+\ldots l_h)$. Suppose also that workers live in the same town, and it takes one hour from home to work using this train, which is the only option for commuting. Until *h* sectors are clustered, all of the

workers can take the train, and they have the same one-hour-commute, half of which will be assumed to take away from work hours, resulting in a fixed cost. However, when the number of clustered sectors exceeds *h*, there will be more than *H* people waiting for the train. Therefore, the economy is supposed to have an extra small train that can accommodate l_i people from each sector. This small train will depart *S* minutes later. Since there is only one railway in this scenario, many commuters will need to wait an additional *S* minutes. Therefore, as more and more sectors join this cluster, commuting time will increase like a step function, from which fixed costs will keep increasing as well. Regarding money, suppose that commuters need to pay $*m* per train, regardless of its size and number of passengers. Therefore, money spent will decrease until *n* reaches *h*, and will be a constant function thereafter.

Now, let's move onto productivity, α. This paper argues that α is also a function of *n*. More specifically,

$$\alpha = \textit{leisure time (L)} + \textit{knowledge spillover (K)}$$

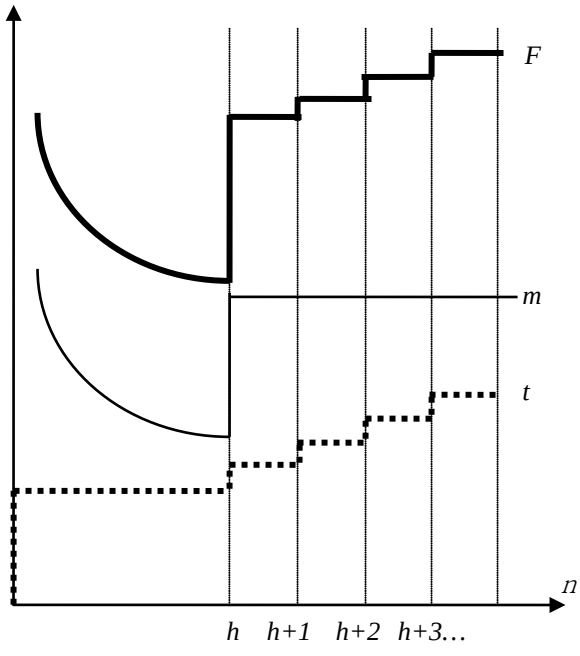
Suppose that worker productivity is proportional to leisure time, which is dependent on the number of commuting minutes. Then, until *h* sectors get agglomerated, commuting time is fixed at one hour, and therefore, leisure time will be the same. However, commuting time will increase by S minutes when firms of additional sectors join the cluster. According to an assumption used in this paper, *half* of this will reduce leisure time and eventually, productivity. Suppose also that knowledge spillover is increasing at a slower rate. This is quite intuitive given that when there are no communications across sectors; the first information-sharing will significantly benefit their productivity, but this effect will not be very significant because more and more firms with a similar level of technology become localized. Additionally, suppose that

this externality will stop when *n* reaches *h*. The formal algebraic and graphical summary is as follows:

$$W + L + C = 24(W : work, L : leisure, C : commute)$$
$$\Rightarrow (W + \frac{1}{2}C) + (L + \frac{1}{2}C) = 24$$
$$Assume W + \frac{1}{2}C = 8, L + \frac{1}{2}C = 16$$

$$F(n) = C(commute) + M(\ fare)$$
$$C = \begin{cases} 1(n < h) \\ 1 + S(h \le n < h + 1) \\ 1 + 2S(h + 1 \le n < h + 2)... \end{cases} \qquad M = \begin{cases} \frac{m}{n}(n < h) \\ \frac{m}{1}(n \ge h) \end{cases}$$

$$\alpha(n) = L(leisure) + K(knowledge)$$
$$L = 16 - \frac{1}{2}C = \begin{cases} 15.5(n < h) \\ 15.5 - \frac{S}{2}(h \le n < h + 1) \\ 15.5 - S(h + 1 \le n < h + 2)... \end{cases} \qquad K = \begin{cases} K(n), \frac{\partial K}{\partial n} > 0 \,\&\, \frac{\partial^2 K}{\partial n^2} < 0(n < h) \\ \overline{K}(n \ge h) \end{cases}$$



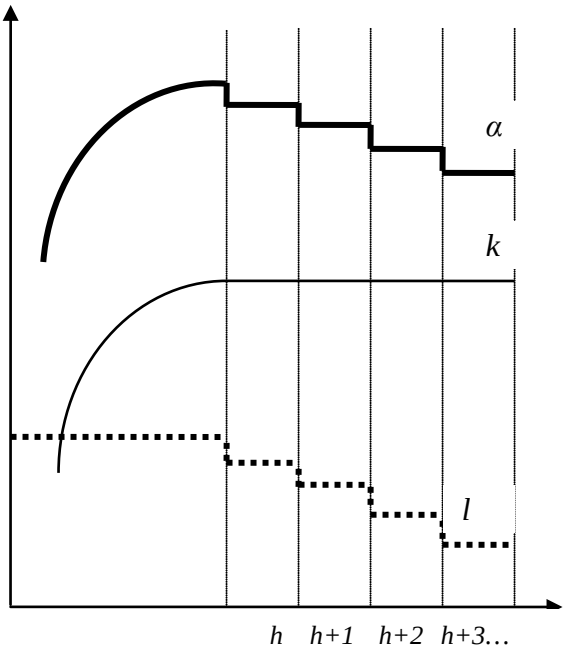


Figure. *F=F(n)*= time+money **Figure. *α = α (n)* = leisure + knowledge**

APPENDIX 2: SEOUL AND ITS SURROUNDING AREA

Figure: Seoul, Incheon, and surrounding Gyeonggi-do Province: a highway map

Figure: Seoul and the surrounding area of new cities: subway network

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CHAPTER 2

MULTIPLE EQUILIBRIA: IS BIG PUSH POSSIBLE? EVIDENCE FROM THE KAESONG INDUSTRIAL COMPLEX IN NORTH KOREA

Abstract

This paper tests whether a Big Push for moving from a lower level equilibrium (poverty trap) to a higher one (industrialization) could occur in North Korea. The Kaesong Industrial Complex (KIC), in which some South Korean firms have just started doing business with North Korean labor, will be the main focus of this paper. Using the Murphy, Shleifer, and Vishny Model, it will be argued that a successful launch of the KIC will bring about a spillover effect to the entire country, leading to industrialization and ending dependence on nuclear weapons as a bargaining chip.

1. Introduction

North Korea, once regarded as a successful communist state in the Far East, is one of the most devastated countries in the world, having severe food problems, a negative growth rate, and a decreasing budget. One of the biggest reasons that North Korea has fallen into a poverty trap is the collapse of the Soviet Union, its closest political ally and economic supporter, for the new Russia no longer backs North Korea. In order to get out of the trap, therefore, North Korea must find a partner to substitute for the former Soviet Union. A good candidate is South Korea, for the two Koreas share a common language, history, and culture. Moreover, since the historic summit meeting in 2000, there has been a variety of discussions on economic cooperation between

both Korean states. One of them is the Kaesong Industrial Complex (KIC),[19] in which some South Korean firms have just started doing business using North Korean labor. The KIC will be the main focus on this paper, and, in particular, this industrial complex will be a viable solution so North Korea can get out of the poverty trap and make a Big Push.

Getting out of the poverty trap and moving toward industrialization theoretically implies that North Korea's economy has multiple equilibria. Based on this implication, the researcher will use the Murphy, Shleifer, and Vishny model, which very effectively describes multiple equilibria in an economy.

It will be argued, both theoretically and empirically, that the MSV Model's prediction is such that the KIC is the key for reaching a higher equilibrium. Moreover, the successful launch of the KIC project will be a stepping stone for North Korea to open its door to the outer world, leading to industrialization and ending its dependence on nuclear weapons as a bargaining chip.

This paper is organized as follows. Section 2 gives a brief description of the original basis of the MSV model. After describing the current state of poverty in North Korea in Section 3, Section 4 uses the KIC and the MSV model to demonstrate the possibility of escaping from the trap. This section also provides two approaches for estimating productivity of the KIC (α in the MSV model) – an empirical approach by the Ordinary Least Squares (OLS) regression, and the relative approach by comparing the productivity of the KIC with other regions in the country. Section 5 discusses further spillover effects, and Section 6 concludes this paper.

[19] This complex is located in North Korea, just six miles north of the border. The Korean characters for Kaesong are 개성. Kaesong, Gaesong, Kaesung, Gaesung, Kaeseong, and Gaeseong all stand for the same city.

2. Description of the Model

See Section 2 in Chapter 2.

3. The Poverty Trap in North Korea

3.1. Current Situation

Before applying the MSV Model to North Korea's development, let us check the country's current situation. Table 2.1 obviously reveals that this country has fallen into a poverty trap. But for a few recent years, the economy has grown negatively, and the per capita income of 2004 was less than it was 13 years ago.

Table 2.1. North Korea's population, GNI, And GNI per capita

	1993	1995	1997	1999	2001	2003
Population (1,000)	21,123	21,543	21,810	22,082	22,253	22,522
GNI ($billon)	20.5	22.3	17.7	15.8	15.7	18.4
GNI/capita ($)	969	1,034	811	714	706	818

Source: Bank of Korea

In such a situation, the country's state budget keeps decreasing. In spite of this dilemma, the regime continues to spend approximately 30 percent of its total budget ($5.78 billion in 1997) on military expenses, which results in a smaller distribution of capital to its people (Ministry of Unification 2006).

The energy problem is also serious. As shown in Table 2.2, the decreasing production of coal and electrical power with the rapid curtailment of petroleum imports contributes greatly to the country's declining energy output.

Table 2.2. The energy supply situation in North Korea

	Coal Production (million tons)	Import of Crude Petroleum (million tons)	Electricity Production (billion KWh)
1990	33.15	2.52	27.7
1992	29.20	1.52	24.7
1994	25.40	0.91	23.1
1996	21.00	0.94	21.3
1998	18.60	0.37	17.0
2000	22.50	0.29	19.4
2002	21.90	0.44	19.0
2004	22.80	0.39	20.2

Source: Bank of Korea. Estimates on North Korea's economic indicators (in Korean)

Moreover, the steel, cement, and chemical industries, which play a central role in the North Korean economy, all suffer greatly from the low stocks of available energy. A South Korean who recently visited Pyongyang revealed in his essay that the most luxurious hotel in Pyongyang turned off most lights and stopped elevator operation (Oh 2001, pp. 2-3). Figure 2.1 reflects this situation; unlike the bright nights in South Korea, North Korea is almost completely dark.

Figure 2.1. Image of North Korea at Night

Source: Global Security

3.2. Falling into the Trap: Why?

One interesting fact is that the North Korean economy was not so bad until the 1980s. Like all of the postwar Communist states, North Korea undertook massive state investment in heavy industry and state infrastructure as soon after it was independent of Japan. Also, unlike the South, land reform in North Korea by the Kim Il Song regime was successful, and the country became rapidly stabilized under his control. As a result, North Korea was in a superior situation in contrast to South Korea in the 1950s and 60s; the conventional wisdom is that the North's per capita income exceeded the South's until the 1970s. Nonetheless, North Korea's economy started to degenerate in the 1980s and ultimately collapsed in the 90s. Figure 2.2 reflects this change**.**

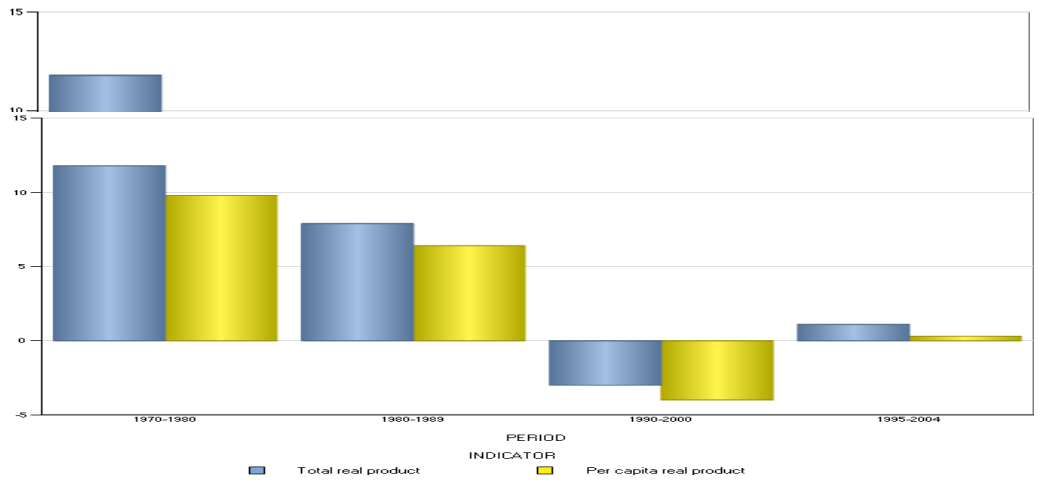

Figure 2.2. GDP growth rate of North Korea (percent)
Source: UNCTAD Handbook of Statistics On-line

One of the internal reasons for this crisis lies in a variety of problems typical of centrally planned economies (CPEs), exacerbated by the so-called *Juche* ideology, first proclaimed by Kim Il Sung in 1957 as the fundamental principle of North Korea's

state management that emphasized self-reliance. This ideology, though, resulted in an autarkic economy in North Korea, with an international trade share (exports and imports) of approximately 12 percent[20] of its total GDP, well below the 50 to 55 percent observed in South Korea (Noland 2000, p. 66). This autarkic situation is very vulnerable to internal shock in which the supply of necessities is blocked. For example, there was a big flood in July and August 1995. As a result of the worst catastrophe North Korea had ever had, 5.4 million people were displaced, 330,000 hectares of agricultural land were destroyed, and 1.9 million tons of grains were lost (Noland 2000, p. 175). The country's autarkic policies, coupled with its heavy-industry oriented policy causing fragile agriculture, turned the flood problem into a severe food problem.

Nevertheless, the CPE and the *Juche* ideology were fundamental philosophies even when the North Korean economy was relatively successful in the 1950s and 1960s. Therefore, these internal factors — CPE, Juche, and autarky — are not sufficient to explain the recent crisis. An examination of external factors provides a stronger explanation for Korea's current state.

A big external shock was the crash of North Korea's principle benefactor, the Soviet Union, and the subsequent breakup of the Eastern Bloc. The trade volume between North Korea and Russia dropped sharply in 1991; the decline in imports from Russia was equal to 40 percent of North Korea's total imports. Aid from the Soviet Union, which accounted for a large portion of the North Korean budget, came to a stop in 1986. Since then, strangely enough, North Korea had even supported the Soviet Union for a few years. The collapse of the former Soviet Union was a big shock to

[20] As will be discussed soon, this 12 percent figure is exclusively dependent upon trade with the Soviet Union and Eastern Bloc. Because of this bias, North Korea had a particularly disastrous shock when its partners' economies collapsed.

many third world countries. However, the shock was particularly disastrous to North Korea whose international trade pattern was extremely biased toward communist countries, particularly to the Soviet Union. After being cut off from international markets, North Korea interacted very little with capitalist countries like the United States. With this bias, the economic hardships of their partners transmitted directly into North Korea.

From an economic perspective, North Korea's stability until the 1980s and its collapse since then can be described as a movement from one equilibrium to another. Until the 1980s, North Korea's relatively stable economy was on a Production Possibility Frontier (PPF), a Walrasian equilibrium in which the first welfare theorem is satisfied. However, the collapse of the former Soviet Union, combined with no diversification trade patterns and severe natural disasters of flood and famine, resulted in the movement of the equilibrium toward the inside of the PPF where resources are not efficiently utilized.[21]

Using Nelson's terminology, requoted by Basu, this is a "low level equilibrium trap" (Basu, pp.17-18); it is stable in itself, meaning that any small deviation from this point does not change the equilibrium. It is by the so-called *Big Push* that the economy can go back to the pareto-efficient equilibrium point.

4. Escaping from the Trap: The MSV Model Revisited

4.1. The Kaesong Industrial Complex

Investigating how and why North Korea fell into a trap should generate ideas about

[21] Note that the PPF does not shift inward. These negative shocks are mostly external, and North Korea's resources including physical capital and human resources are not destroyed.

how it can get out of it. Falling into the trap was largely due to the collapse of the former Soviet Union that had once been the North's major trading partner and supporter. Therefore, finding another partner to substitute for the former Soviet Union is very important for North Korea; success toward these ends will be a stepping stone for the Big Push. In this regard, economic cooperation with South Korea in the Kaesong Industrial Complex (KIC) is suggested as a solution.

Opened in December, 2004, the KIC is a special administrative zone in North Korea being developed as a collaborative economic cooperation with South Korea. As shown in Figure 2.3, it is located only six miles north of the Korean Demilitarized Zone (DMZ) with direct road and rail access to South Korea and within an hour's drive from Seoul and Incheon International Airport.

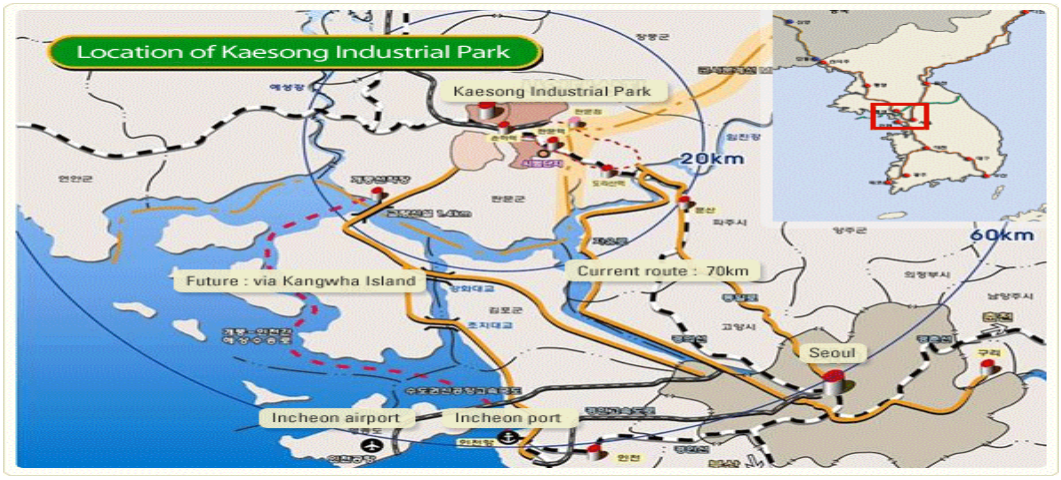

Figure 2.3: Location of the Kaesong Industrial Complex
Source: Hyundai Asan

The combination of South Korean technologies with North Korean cheap labor is definitely a pareto improvement for both countries. North Korea has high quality labor and human resources; the country has an eleven-year compulsory education system with a 98% literacy rate with 96% of the age cohort enrolling in the primary and

secondary educational system. This rate is far above the average of countries with similar incomes (GNI/capita: $914 (year 2004)). The recent famine might have deteriorated the “hardware” of the education environment, but in terms of “software,” its human resources are still highly available. Moreover, the fact that the two sides speak the same language and share the same culture and history makes the North Korean market even more attractive.

Before the KIC, South Korean firms used to invest mostly in China or in Southeast Asia because of the geographical proximity and relatively low wages, but since the KIC Project was launched, a large number of South Korean firms have shown great interest in making way for North Korea, which is significantly closer than China or South East Asia and has significantly lower wages than its neighbor to the south ($57.5 per month on average in the KIC, which is 1/30 of South Korea). This is obviously encouraging news for many South Korean firms, so when this plan was first publicly announced, 1806 firms from various sectors applied to enter the KIC. Due to competition for land, however, 54 of them were ultimately approved. Nonetheless, it was expected that approximately 300 South Korean firms with 100,000 North Korean workers would participate by 2007. The entire complex is scheduled for completion in 2012, covering 25 square miles with 1000 firms employing 350,000 people (Hyundai Asan).

4.2. Application of the MSV Model

The KIC is a very good source for applying the MSV Model to North Korea. It seems that the MSV Model is not a good tool to describe the multiple equilibria of the last Stalinist economy where there existed very few leading monopolist firms. However, the reclusive country now has a number of South Korean firms within its

territory. Assuming these South Korean firms are monopolists, the MSV Model will be very useful.

First, it is known that 1806 companies are interested in the KIC and have applied for the project. Therefore, it can be seen that *k* is the number of sectors by which these 1806 firms are sorted. The maximum capacity of the KIC area is 80 million square yards, and the predicted maximum number of firms within this area is 2000 (Hyundai Asan). This paper assumes that 1806 is very similar to the maximum capacity of 2000.[22] Furthermore, *n* is the number of sectors of South Korean firms that actually entered the KIC and *L* is the total number of workers in the *k* sectors.

Recall that the wage of the fringe firm is normalized to 1 and that of the monopolist firm to 1+*v*. Also recall that $b = 1 - \frac{1+v}{\alpha}$. It has been reported that wages in the KIC are two times higher than the average wages in North Korea (approximately \$50[23] in the KIC and \$25 on average) (Ministry of Unification). Thus, these prices can be normalized to 2 and 1, respectively, regarding *v* as 1. From here, $b = 1 - \frac{2}{\alpha} = \frac{\alpha - 2}{\alpha}$. Because α is greater than 1, *b* is smaller than 1. Also, *b* was assumed to be positive to guarantee a positive profit. Because $\frac{db}{d\alpha} > 0$ and $\frac{\partial^2 b}{\partial \alpha^2} < 0$, the function is slowly increasing. Therefore,α, which refers to the productivity of monopolist firms, must be the case in which

[22] Note that *k* is not the number of sectors that already exist in the area of Kaesong City. This paper assumes that it is only South Korean firms that play a role as monopolists. Preexisting North Korean firms in the neighborhood of the KIC are assumed to be fringe firms.

[23] Even though the official wage is \$50, firms give \$57.5 per worker to the North Korean authorities (Hyundai Asan). Then they take \$7.5 as their revenue and give basic necessities (food, clothing, etc.) worth \$50 to the workers.

$$\alpha > 2^{24} \quad (1)$$

The model says that $\chi(n) = b(L - nF) - F(1+v)k + Fn(v+b)$ determining the sign of the profit of monopolist firms. Now, v is known to be 1. Rewriting $\chi(n)$,

$$\chi(n) = bL - 2Fk + Fn \quad (2)$$

$\chi(n)>0$ if $n > \frac{2Fk - bL}{F} = 2k - \frac{bL}{F}$. Since $\frac{db}{d\alpha} > 0$, an increase in α results in an increase in b a decrease in $2k - \frac{bL}{F}$. Therefore, the larger the value of α is, the smaller the $2k - \frac{bL}{F}$ becomes, requiring fewer monopolist firms to enter the market to get a positive profit. From (1), $\alpha>2$. This range can be narrowed down by considering the multiplicity of equilibrium. To get multiple equilibria and to be consistent with the MSV Model, it must be the case that $\chi(1) = bL-2Fk+F <0$ and $\chi(k) = bL-Fk > 0$.

Because $b = \frac{\alpha - 2}{\alpha}$, rewriting and solving for α, we get

$$\frac{2L}{L - Fk} < \alpha < \frac{2L}{L + F - 2Fk} \quad (3)$$ [25]

Comparing (1) and (3), $\frac{2L}{L - Fk} - 2 > 0$ if

$$L > Fk \quad (4)$$

[24] This is consistent with $w>\alpha\lambda$, which is a profit maximization problem of a monopolist firm in the MSV model. By simply plugging in $w=1$ and $\lambda=2$, the exact same result is achieved.

[25] Because $k>1$, $(L+F-2Fk) - (L-Fk) = F-Fk < 0$. Indeed, the left-hand side is smaller than the right-hand side.

Under condition (4), (3) is left, finally, as a range of α. This result is achieved only knowing that v=1, not knowing other parameters including L, F, and k. Further research on these parameters will make it possible to get an estimated value of α.

4.3. Estimating α: An Empirical Approach

Initially, 15 firms from different sectors entered the KIC in the demonstration area (*shibom danji*), followed by the entrance of another 23 firms in the main area (*bon danji*). Table 2.3 introduces the firms that entered the KIC; the original 15 firms make up the first 15 rows, followed by the rest of the firms. Currently, all 15 original firms in the demonstration area and three firms in the main area are producing goods (Ministry of Unification).

Table 2.3. Companies in the KIC (October, 2006)

Name	Goods & Sector	F_j (Korean Won)		l_j (people)	x_j (Korean Won)
		F_j^1	F_j^2		
Samduk Trading	shoes	5,393,390	117,004	1,469	8,997,868
Shinwon	general clothing	3,068,230	117,004	563	8,528,785
S.J.Tech	semiconductor parts	4,559,701	117,004	195	4,264,392
Jaeyoung SoluTech	auto parts,digital components	3,042,644	117,004	193	5,330,490
Magic Micro	lamp assembly	2,022,388	58,560	55	3,198,294
Munchang	aircraft clothing	3,406,183	78,048	669	5,714,286
Yong-in Elec	transformer, coil	n.a.	117,004	149	4,264,392
Daehwa F&P	fuel pumps, polyurethane	1,973,348	58,560	181	5,415,778
Taesung Group	makeup goods(lipstick,	6,328,358	117,004	562	14,392,324

Table 2.3. (Continued)

Hosan Ace	air purifier, dust collector	n.a.	48,000	75	2,771,855
Sonoko Cusine	kitchen supplies	1,443,497	48,000	420	4,797,441
Romanson	watch	6,761,194	125,760	782	17,590,618
TS Precision	semiconductor mold die set	n.a.	78,048	54	2,985,075
JC Com	optical fiber cable	n.a.	85,344	98	4,584,222
Bucheon Ind	wire harness	4,708,955	117,004	499	7,995,736
M&S	ski gloves, snow board gloves	n.a.	n.a.	n.a.	5,010,661
Sunghwa Trading	socks	n.a.	n.a.	n.a.	6,609,808
Cotton Club	underwear (naeui)	n.a.	n.a.	223	2,771,856
Millions	bag, toy	n.a.	n.a.	n.a.	4,264,392
Rok Sec Garments	military uniform, sanitary clothes	n.a.	n.a.	n.a.	1,279,318
Artrang	leather goods, mobile charger	n.a.	n.a.	n.a.	6,396,588
Jason Group	DVD, PDP, phone	n.a.	n.a.	n.a.	6,396,588
Ivory	sports wear	n.a.	n.a.	n.a.	4,264,392
Sudo Corp	handkerchief, scarf	n.a.	n.a.	n.a.	3,731,343
Bedding Land	bedding supplies	n.a.	n.a.	n.a.	n.a.

Source: Hyundai Asan(www.hyundai-asan.com), Kaesong Industrial District Management Committee (www.kidmac.com), Ministry of Unification (www.unikorea.go.kr), Samduk Trading (www.shoemaker.co.kr), Shinwon (www.sw.co.kr), SJ Tech (www.sjseal.com), Jaeyoung Solutec (www.jysolutec.com) Magic Micro (www.magickr.com), Yong-in Electronics (www.samsungweb.co.kr/YE), Daewha Fuel &Pump (www.daewha21c.com), Taesung Group (www.makeuptaesung.com), Hosan Ace (www.hosanace.co.kr), Living Art (www.cusinware.com), Romanson (www.romanson.co.kr), TS Precision (www.tsprecision.co..kr), JC Com (www.jccomn.com), M&S (www.yokokorea.co.kr), Sunghwa (www.sunghwa.com), Cotton Club (www.cotton-club.co.kr), Artrang (www.artrang.co.kr), Jason Group (www.jasonkorea.com), Ivory (myivory.co.kr), Sudo Corp (www.sudocorp.co.kr), Bedding Land (www.beddingland.com),

F_j (fixed cost)= F_j^1 (cost of factory construction) + F_j^2 (rent of land for 50 years,

$48/m^2), measured by Korean won, converted into U.S. dollar ($1=938 won, as of 11/17/06), l_j : number of workers, x_j : output per month (Exact amount is not available for each firm's security reason. Therefore, each firm's predicted expenditures, for initial investment, submitted to Hyundai Asan, was used. A strong assumption is made here; rational firms' predicted initial expenditures will be the same as their two-year revenue. This assumption is based on the fact that some firms in the KIC exceeded break-even point after their first two years' business in the KIC.)

Note: Among 38 firms, there are some firms that are in the same sectors. In this case, to be consistent with the MSV Model, only one firm per sector with bigger size or having more information is introduced

Table 2.3 is not directly applicable to the situation and needs to be modified for the following reasons. First, F_j is measured by dollars and l_j is the number of people. To overcome this unit difference, this paper converts the *number of people* into *wage income*. Since their wage of $50 is normalized to 2, the modified result is achieved by simply multiplying l_j by 2. Second, while their wage of $50 is what they receive each month, F_j is the one-time payment and firms do not pay this for the following 50 years. Therefore, another multiplication of l_j by 600 (12 months*50 years) is required. Appendix has the modified version of l_j, which is 1,200 times bigger than the original one. Third, F_j is the actual amount of money, without normalization ($25 = 1). Therefore, to be consistent with this paper, F_j needs to be scaled down and Appendix reflects these changes; the F_j here is derived by dividing the original one by 25. Finally, x_j should also be measured in monetary terms. As explained above, x_j in Table 2.3 reveals the approximate annual revenue of each firm. Therefore, multiplication of 50 years and scaling down by 25 (normalization) will follow, which is actually twice the original amount. Based on this adjustment, α can be estimated by the equation $x_j = \alpha(l_j - F_j)$.

A simple regression analysis was conducted. The results are provided in Table 2.4, In order to stick to the original model, a constant term was ignored. The α, a slope of the regression line, is 11.360. Because L and k are not known, it is not clear whether

the estimated α is within the range of (9), in which these firms are expected to gain positive profits, and achieve the higher level of a Nash Equilibrium. However, the estimated α satisfies rough conditions of (7), at least, increasing the hope of the KIC's profitability.

Table 2.4. Statistical tests of the productivity of 25 firms in the KIC

Determinants (no constant)	Estimated Coefficient (α, Productivity)	t-statistic
l_j-F_j	11.36	(3.791)**
R^2	0.615	

***= significant at 99% confidence level*
Note: This result is based on data of Table 2.3, modified in Appendix. Following the original model, no constant was used. Independent variable is x_j

4.4. Estimating α: A Relative Approach

According the MSV model, whether an economy reaches a higher level equilibrium of industrialization or stays in a poverty trap depends on each monopolist firm's profits. If each firm produces a significantly large output per given labor, the chances for reaching industrialization are high. However, due to the limited data source, the results in Table 2.4 do not clearly confirm whether α, productivity in the KIC, is superior enough to create industrialization in the region.

In order to analyze α further, this section takes a relative approach. That is, productivity of the KIC will be divided by that of the entire country, assuming that all of the high-tech monopolist firms are agglomerated in the KIC and other areas have only fringe firms. Because the MSV model assumes that fringe firms have a 45-degree line production function, we can assume that productivity (measured by output per worker) for the whole of North Korea is 1, and the relative productivity of the KIC can

be derived accordingly.

As for the KIC, three-year time series data on the total output and labor are used, which are summarized in Table 2.5. Unlike Table 2.3, which are cross-sectional data for October 2006, Table 2.5 has monthly data from 2005 through 2008. As seen in this table, monthly output has increased more than five times from $336,000 in April 2005 to $1,906,000 in April 2008. In the same period of time, the number of North Korean workers in the KIC has increased more than 13 times to 27,341from 2006. Overall, as is shown in Figure 2.4, per capita output has increased from $167 all the way up to $1,063 in July 2007 and was reduced to $697 in April 2008. Because the MSV model's only input is labor, this per capita output can be interpreted in the model as productivity.

Table 2.5. Monthly statistics for the KIC (04/2005 – 04/2008)

Year	Month	Output ($1000)	Export ($1000)	Export/ Output (%)	Worker (people)	Output/ Worker ($)
2005	4	336	38	11.31	2006	167
	5	441	64	14.51	2335	189
	6	437	5	1.14	3607	121
	7	775	37	4.77	4036	192
	8	1193	135	11.32	4263	282
	9	2051	181	8.83	4712	435
	10	2844	141	4.96	5265	540
	11	2942	138	4.69	5641	522
	12	3382	127	3.76	6013	562
2006	1	3396	655	19.29	6050	561
	2	3792	661	17.43	6103	621
	3	5209	964	18.51	6541	796
	4	4350	1020	23.45	6874	633
	5	5143	1131	21.99	7534	683
	6	5508	1624	29.48	7871	700
	7	5515	2183	39.58	7984	691
	8	6811	2219	32.58	8561	796
	9	7621	2240	29.39	8879	858
	10	7555	2213	29.29	9465	798

Table 2.5. (Continued)

	11	8868	2421	27.30	10345	857
	12	9969	2494	25.02	11160	893
	1	11962	2717	22.71	11330	1056
	2	10355	2502	24.16	11778	879
	3	13281	3161	23.80	12492	1063
	4	12460	2996	24.04	13070	953
	5	14388	3510	24.39	15147	950
2007	6	15058	3307	21.96	15584	966
	7	14903	2818	18.91	16607	897
	8	15697	3261	20.77	17699	887
	9	17107	3128	18.28	17671	968
	10	20905	4234	20.25	19502	1072
	11	19265	4236	21.99	21053	915
	12	19398	3799	19.58	22804	850
	1	18873	3202	16.97	22778	829
	2	17677	4322	24.45	23529	751
2008	3	24220	5753	23.75	25930	934
	4	19060	2997	15.72	27341	697

Source: Output, Export, Worker: KIDMAC. Others: author's calculation

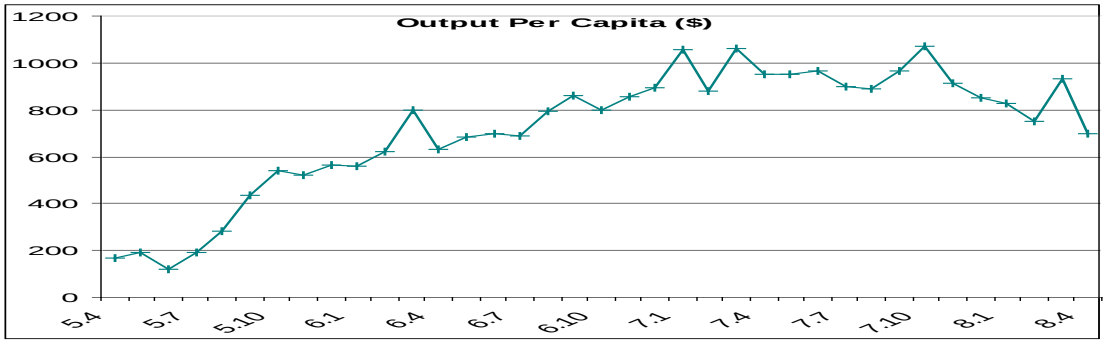

Figure 2.4. Per capita output in the KIC

In order to interpret whether this per capita output (or productivity) of the KIC is large enough for the region to reach industrialization, a similar analysis should be conducted using the dataset for the whole country to compare the result with that of the KIC. However, data accessibility of the hermit kingdom is very limited. In particular, data on the number of workers in manufacturing sectors and their ouput levels are unknown.

The only available data are the number of employees by sector, released only once by the North Korea Census Bureau (requoted by Choi), summarized in Table 2.6.

Table 2.6. Number of workers by sector in North Korea

Sector	1993 (thousand)			1995 (thousand)			1999 (thousand)		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
1	4118	1922	2197	4284	2001	2283	**4410**	2063	2347
2	3382	1718	1664	3454	1751	1703	3567	1806	1761
3	464	352	112	460	350	110	482	367	115
4	402	285	117	415	294	121	434	310	124
5	509	161	348	514	161	353	529	169	360
6	844	339	504	863	348	515	886	356	530
7	251	153	98	258	157	101	265	161	104
8	1035	631	403	966	612	354	954	614	340
Total	11005	5562	5443	11214	5674	5540	11527	5846	5681

Source: Choi
1: Manufacture, 2: Agriculture, 3: Construction, 4: Transport, 5: Commerce, 6: Health, 7: Administration, 8: Other

This paper uses the figure 4,410,000, the number of workers in the manufacturing sector because first, it reflects the most recent data, and second, the country went through a great famine and arduous march in the mid 1990s, so data for 1993 and 1995 may not reflect reality after the period of famine.

Fortunately, data on output are easily accessible; the Bank of Korea releases data annually on total and sectoral GDP of North Korea, available from 1990 to 2007. In order to be consistent with the data on the number of workers, this paper uses data for 1999, which is provided in Table 2.7.

Table 2.7. GDP of North Korea in 1999 (total and sectoral)

Agri-culture, Fishery	Mining	Manufacture		Elec-tricity, Gas	Cons truc-tion	Ser-vice	Gov't	Other	Total
		Light	Heavy						
5872	1365	1144	2272	849	1142	6046	4268	1788	18688

Source: The Bank of Korea
Unit: 1 billion South Korean Won (KRW) (approximately 1 million USD)

As shown in Table 2.3, almost all of the products made in the KIC are from light industry. So, if we want to stick to the comparison between light industrial goods in the KIC and in all of North Korea, 1,144 billion Won or 1,144 million USD can be used as the output of the whole country, opposed to the output in the KIC. Then, per capita output of North Korea is $259, which is $1,144 million divided by 4,410,000. On the other hand, if we focus on the fact that 4,410,000 people work in all manufacturing sectors, including both light and heavy industry, $1,144 million plus $2,272 million, which is $3,416 million, can be used as the total output for the country, so the per capita output of North Korea is $774, which is $3,416 million divided by 4,410,000. See Table 2.8 for a summary.

Table 2.8. Gross and per capita output of North Korea: Manufacturing sector

Output ($million)	Workers[26] (million people)	Output/Worker ($)
1144 (Light Industry)	4.41	259
3416 (Entire mfg)	4.41	774

Now, the final step is to derive relative productivity by dividing output per worker in the KIC (provided in Table 6) by $259 and $774, respectively. Figure 6 shows the results. When $259 is used as the productivity of fringe firms in North Korea, this value is interpreted as slope 1 in the MSV model. Then, α, the slope of high-tech firms

[26] It is true that the number of workers in light industry sectors should be less than the number of workers in the whole manufacturing sector. However, the number of workers in light industry only is not available. Under the assumption that light industry is mostly labor intensive, this paper uses the same number of the workers as is employed in the entire manufacturing sectors. Even though this is an obviously limited assumption, the reason for considering light industry is that most of goods made in the KIC are from light industry. By comparing the output of light industry in North Korea, I intended to derive a better result.

in the KIC, has exceeded 1 since September 2005, and been increasing. If $774 is used instead, the slope of high-tech firms in the KIC has been higher than 1 since August 2006. Even though they show a slightly decreasing pattern these days, the relative productivities of the area are mostly greater than 1. With a higher value of α (greater than 1), the prediction of the MSV Model is such that all of the entering firms will be more likely to gain positive profits, which enables achievement of the higher level of the Nash Equilibrium.

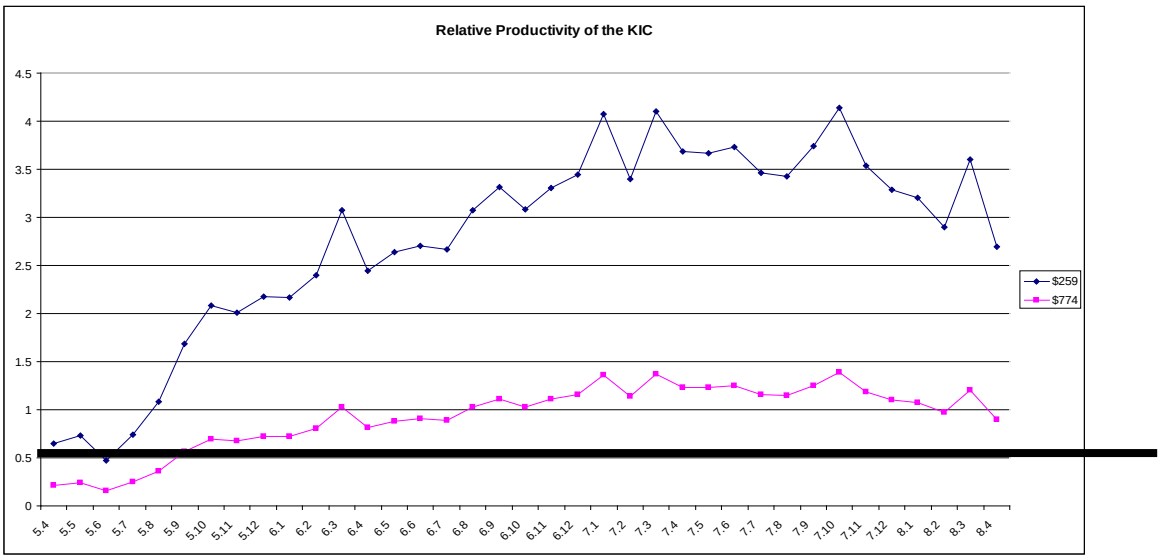

Figure 2.5. Relative productivity of the KIC

4.5. A Closed Economy? A Critical Assumption of the MSV Model

Last, but not unimportantly, the isolation of the KIC should be checked, because one of the very important aspects of the MSV model is that it assumes a closed economy with no trade. With rapid globalization, this assumption is unrealistic to many countries. However, North Korea is one of the most reclusive countries in the world, and there is more room to apply the MSV model in this research.

In order to check a closed economy, this paper provides the major countries' tariff

rates on North Korea. Even though the KIC is operated by South Korean firms, most production is carried out by North Korean workers in North Korean territory, thus, many countries still regard made-in-KIC goods as North Korean goods. For example, according the recent Free Trade Agreement (FTA) between South Korea and the United States, the U.S. government did not agree to approve KIC goods as South Korean goods. Unfortunately, North Korea is still categorized as a terrorist country, and North Korea's trades are sanctioned by many countries through very high tariff rates (see Table 2.9). This is not a favorable situation for the KIC itself, but it does create a workable environment for this research to preserve the assumption of a closed economy and to apply the MSV model.

Table 2.9. National tariff rates on South and North Korean goods

U.S.	S.Korea	Normal Trade Relations (NTR): Column 1 Tariff applied [clothing(0~32%); shoes(0~48%); bags(5.7~20%); toys(0%); accessories(0~11%); automobile parts(0~3%); computer parts(0%); electronic goods(0~15%)]
	N.Korea	Foreign Assets Control Regulations, Imposing economic sanctions since 1950 Column 2 Tariff applied [clothing(35~90%); shoes(20~84%); bags(40~90%); toys(70%); accessories(45~110%); automobile parts(25%); computer parts(35%); electronic goods(25~80%)]
Canada	S.Korea	General Preferential Tariff applied (0~7%)
	N.Korea	No economic sanctions, General Tariff applied (35%)
Japan	S.Korea	WTO member rate applied [clothing(9.1~10%); leather goods(3~15%);
	N.Korea	Export to North Korea prohibited, Uninsured North Korean ship not allowed to disembark: Statutory rate applied [clothing (11~16%); shoes(two times higher than WTO member rate); leather goods(4~20%)]
Other Countries	No differential tariff rate to North & South Korean goods: Countries examined (EU, Switzerland, Norway, Turkey, China, Taiwan, Singapore, India, Indonesia, Thailand, Philippines, Malaysia, Pakistan, Myanmar, Bangladesh, Australia, New Zealand, Brazil, Colombia, Peru, Chile, Mexico, Panama, Russia, Ukraine, UAE, Jordan, Egypt, Iran, Saudi	

Arabia, Nigeria, South Africa, Kuweit

Source: Ministry of Unification, Korea Trade Investment Promotion Agency (KOTRA)

In this not-so-favorable global environment, the proportion of exports among the total production in the KIC is declining. It was once peaked at 40% in June, 2007, but is now stuck somewhere 20% these days (see Figure 2.6). Most exports are biased toward the EU countries where no differential tariff rates are applied.

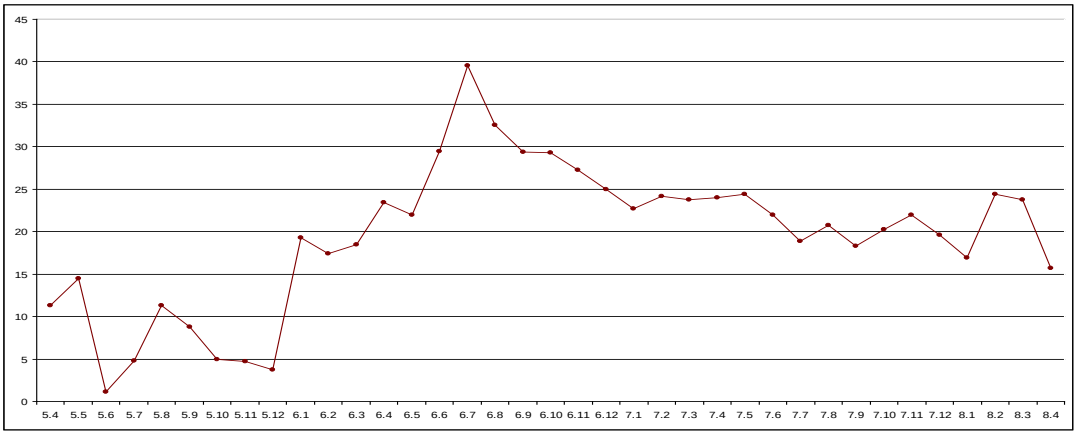

Figure 2.6. Portion of exports out of total production in the KIC (%)

5. Spillover Effect: another Maquiladora?

5.1. Factor Movements

Currently, approximately 10,000 North Korean people are working in the KIC (Hyundai Asan). This number is expected to increase up to 350,000 by the year 2012. Their wage is more than twice as much as other North Koreans ($57.5[27] and $25, respectively). Assuming that the KIC workers interact with people outside, wage

[27] For convenient reason, this wage is assumed to be $50, and in this paper, it is normalized to 2.

discrepancies will be more distinctive, a fact which may push the country toward wage equality.

Moreover, the policy of North Korean authority for the KIC is becoming more and more decentralized[28]. By working for South Korean firms and interacting with South Korean people, they are experiencing a market economy system.

Movement of physical capital is also important. Unlike South Korea, North Korea has abundant natural resources including iron ore and coal. Also, it has a moderate oil refinery industry[29] whose capacity is approximately four million tons per year. Utilizing this capital is pareto improvement to both Koreas; South Korean firms can use the resources with lower transportation cost, and the industry in the North related to these fields will gain positive profit.

5.2. Facilitation of Other Complexes (Rasin-Sonbong and Shinuiju)

The KIC is not North Korea's first attempt of industrial complex. In 1993, North Korea undertook its first attempt in the Rajin-Sonbong area, a remote Northeastern part of the country where the borders of Korea, China and Russia meet. A subsequent project followed in Shinuiju in 2002 to absorb Chinese capital (See Figure 2.7 for geographical explanation).

Unfortunately, these projects have not been successful. Low quality of infrastructure and a bad credit rating due to political insecurity drove risk-averse

[28] Currently, South Korean firms pay workers' wages in US dollars to a North Korean authority, and the workers receive ration tickets, such as food stamps, from the authority. However, it is suggested that South Korean firms directly give them wages. If it happens, a merit-based pay system will be expected to follow.

[29] The oil refinery industry is very important in a country's development. On top of the spillovers from the successful KIC, North Korea may gain another spillover by the development of the oil refinery industry, which has been observed by many countries in their process of development. See Isard (2005) for relevant case studies on Puerto Rico.

investors away.

So far, its third attempt in Kaesong has had much better result than those previous ones. If the KIC becomes very successful, there may be incentive to invest in complexes in Rajin-Sonbong and Shinuiju as well. Ideal situation will be such that industrialization of all of three places has a spillover effect on the country from every direction.

Figure 2.7. A Map of North Korea and Three Industrial Complexes

5.3. The KIC as another Maquiladora

Maquiladoras are the Mexican version of the KIC. A Maquiladora is a factory that imports materials and equipment and usually re-exports the assembled product to the originating country. With the end of the U.S. Bracero Program, which allowed Mexican immigrants to find temporary agricultural work in the United States (Wikipedia), the Mexican government was looking for subsitute industries to absord

the unemployed Mexican laborers. As a solution, Maquiladora industries were established in 1961 in border cities of Mexico, located within 20 km of the U.S. border, Maquiladoras' achievement was initially unimpressive. Since then, however, Maquiladoras has grown rapidly. Active investment from the U.S., cheap Mexican labor, geographic proximity to the U.S., and strong support from the Mexican government are major factors of their success. Maquiladoras' achievement brought a spillover effect to Mexico, and its industrial area expanded accordingly from some border cities to the entire country. According to Table 2.10, Exports of goods from Maquiladoras now explain more than 40% of total Mexican exports.

Table 2.10. Maquiladoras Industry

	number of firms	number of workers	exports ($million)	rate of exports(%)
1970	120	20,327	83	6.4
1975	454	67,213	332	10.8
1980	578	119,546	772	5.1
1985	789	217,544	1,268	5.8
1990	1,924	470,000	15,833	37.0
1995	2,265	648,263	14,151	37.0
2000	3,655	1,291,232	79,467	47.8
2004	2,811	1,111,801	87,547	46.4

Source: Mexican Statistical Agency (INEGI), requoted by Korea Institute for International Economic Policy

Considering Maquiladoras' success, the KIC is likely to have a bright future. North Korea's cheap labor, South Korean firms' active participation, and proximity from Seoul (1 hour drive) are very similar to the favorable conditions of Maquiladoras. Moreover, if the other two complexes in Rajin-Sonbong and Shinuiju are to be

successful as well, North Korea will also attract investment from China. Then, with South Korean firms from the south and China from the north, the reclusive country may reap great benefit throughout the country.

6. Conclusion

The KIC project is expected to shift North Korea's equilibrium from the current poverty trap to an efficient Walrasian level in which industrialization is initiated. However, this benefit is attainable only when North Korea makes maximum efforts to preserve the KIC and when the international community is supportive of this project. On North Korea's part, the country should lower its land leasing prices. According to Table 2.3, the price to rent land for 50 years, which is \$48/m,^{2} explains some of the firms' fixed costs. Theoretically, lowering the rent will increase the likelihood of the KIC's profitability and thus, it becomes highly likely that condition (10), $L>Fk$, would be satisfied. It is understandable that receiving higher rents is one of North Korea's goals in opening its land to South Korean firms. Still, North Korea must show its willingness to compromise in order to encourage further investment from the South and thus bring higher profits to the North in the long run. In addition, North Korea must avoid bringing nuclear weapons to the bargaining table. The nuclear test done by North Korea in February 2007 made the international community even more hostile to Pyongyang. So, Pyongyang needs to make every effort possible to reduce nuclear risks and take an active role in the six-party talks.

Conversely, other countries should support the KIC project; the products that they manufacture must be referred to as those made in South Korea. The country of origin, whether the KIC goods are made in North Korea or in South Korea, is a very important issue. Three countries, the United States, Canada, and Japan, all of which are imposing higher tariffs on North Korea (See Table 2.9), are reluctant to approve

the KIC. If they maintain their current hostile policies toward North Korea, the KIC goods will not be competitive in these countries.

The results in Section 4 predict that North Korea can benefit economically from the KIC project; the estimated α demonstrates that firms are likely to gain positive profits, and the MSV model predicts that the KIC is likely to be industrialized. However, the politically precarious relationship between North Korea and other countries is a stumbling block to economic gains. Isolation policies can never be a solution, because, without normal economic relationships, North Korea has little choice but to depend more heavily on nuclear weapons. The success of the KIC will be the key to ending this vicious circle and a significant step toward world peace.

APPENDIX: MODIFIED VERSION OF TABLE 3.3: UNIT ADJUSTMENT (SOUTH KOREAN WON)

Company Name	F_j	l_j	l_j - F_j	x_j
Samduk Trading	220,416	1,762,800	1,542,384	8,997,868
Shinwon	127,409	675,600	547,591	8,528,785
S.J.Tech	187,068	234,000	46,932	4,264,392
Jaeyoung SoluTech	126,386	231,600	105,214	5,330,490
Magic Micro	83,238	66,000	*	3,198,294
Munchang	139,369	802,800	663,431	5,714,286
Yong-in Elec	n.a.	178,800	n.a.	4,264,392
Daehwa F&P	81,276	217,200	135,924	5,415,778
Taesung Group	257,814	674,400	416,586	14,392,324
Hosan Ace	n.a.	90,000	n.a.	2,771,855
Sonoko CusineWare	59,660	504,000	444,340	4,797,441
Romanson	275,478	938,400	662,922	17,590,618
TS Precision	n.a.	64,800	n.a.	2,985,075
JC Com	n.a.	117,600	n.a.	4,584,222
Bucheon Ind	193,038	598,800	405,762	7,995,736
M&S	n.a.	n.a.	n.a.	5,010,661
Sunghwa Trading	n.a.	n.a.	n.a.	6,609,808
Cotton Club	n.a.	267,600	n.a.	2,771,856
Millions	n.a.	n.a.	n.a.	4,264,392
Rok Sec Garments	n.a.	n.a.	n.a.	1,279,318
Artrang	n.a.	n.a.	n.a.	6,396,588
Jason Group	n.a.	n.a.	n.a.	6,396,588
Ivory	n.a.	n.a.	n.a.	4,264,392
Sudo Corp	n.a.	n.a.	n.a.	3,731,343
Bedding Land	n.a.	n.a.	n.a.	n.a.

Note: Negative values of l_j - F_j , which are not meaningful from the perspective of the MSV Model, were deleted. For the firms that do not have F_j^2, only F_j^1 is considered.

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CHAPTER 3

REGIONAL INEQUALITY OF SOUTH KOREA

Abstract

This paper analyzes regional inequality in South Korea for the past two decades, using the Theil Index. Overall, regional inequality of the country has been growing. This paper further analyzes group-specific effects using the so-called 'between' and within' group decomposition. The first round of decomposition indicates that the inequality between Honam and non-Honam has been declining, repudiating the claim that Honam has been discriminated against by other regions. However, this paper argues that the mean income convergence between the two regions is also associated not only industrial development in Honam but with population decrease in the region. Additionally, two more decompositions were conducted, revealing that the inequalities between Gangwon and non-Gangwon and between rural and urban have been rising. The paper then provides follow-up econometric analyses to test what the main factors are that affect regional inequality. The time series regression shows that physical capital increases inequality and human capital decreases inequality, but panel regressions, both fixed and random effect, draw different conclusions. Additionally, while the *direct* effect of trade openness on regional inequality is ambiguous, its *indirect* effects, interacting with physical and human capital, are all positive. This result is related with the idea of "asymmetric gains from trade" or "coordinated investment".

1. Introduction

The relationship between economic growth and inequality has been addressed by many economists for a long time (Basu 2000). For example, Kuznets (1955) suggested the well-known inverted U-shaped curve such that economic inequality increases and then decreases over time with the country's growth. Williamson (1965) applied Kuznet's finding to the *regional* level and showed that regional inequality has the same inverted U-shaped relationship with economic growth. On the other hand, Alesina and Rodrik (1994) found a negative relationship between inequality and growth using data on income distribution and land in a number of countries.

This paper is about regional inequality of South Korea. The country has been one of the "champions" of economic growth, with per capita GDP growth of 6% per year on average, which resulted in "tensfold" of per capita GDP in the past 40 years. These accomplishments in the past four decades are "unmatched" in history (Barro 2003).

How has this dramatic growth affected regional inequality of the country? The World Bank's East Asian Miracle reported that the so-called eight high performing Asian economies (HPAEs) – Japan, the "Four Tigers" (Hong Kong, The Republic of Korea, Singapre, and Taiwan), and the three newly industrializing economies (NIEs) of Southeast Asia (Indonesia, Malaysia, and Thailand) – achieved unusually low and declining levels of inequality, contrary to historical experience and contemporary evidence in other regions found by Kuznets (p.30). However, each country is heterogeneous in terms of history, political background, location, and land size, so each one may show different patterns of regional inequality. For example, South Korea's economic development policies over the past decades have been biased toward Seoul region, Busan region, and the link between the two. These policies might have ignored other regions, which might have contributed increasing regional

inequality.

This paper examines the pattern of South Korea's regional inequality, which is measured the difference of mean income among groups living in different provinces. One of the widely used methods in measuring regional inequality is the Theil Index, because it can be additively decomposed into *within group inequality (W)* and *between group inequality (B)*. In many cases, this *between group inequality (B)* is the only available resource to measure regional inequalities, and thus, deserves particular attention.

Shorrocks and Wan (2005) conceptualized regional inequality by focusing on the theoretical foundations of the *between group inequality (B)*. Among the many interesting properties, a very important one is that *B* is between zero[30] and total inequality. *B* is zero if there is only one group and *B* is equal to the total inequality if the number of the group is actually all individuals. From this property, it can be conjectured that the expected value of *B* increases with the number of groups. Then, a question arises about what the meaningful number of groups is. For example, if we measure the regional inequality of the United States, do we need to measure inequality among different states? Or different counties? etc. Moreover, Sorrocks and Wan (2005) also argued that the share of *B* out of total inequality averages only 12%. If this is true, analyzing this 12% portion may not be very meaningful in understanding overall inequality.

In that light, this paper analyzes regional inequality and suggests a so-called *decomposition* method as an improved measurement to better capture the overall inequality. Based on Shorrocks and Wan's conclusion (2005) that regional inequality increases as more groups are included and on Kanbur and Zhang's observations (2000)

[30] It is true that one Theil element can have a negative value. For example, if a mean income of a region is lower than the weighted average, its log value is negative, so, Theil index is negative. However, even in this case, the overall value with summation of different elements will be positive.

on China, this paper re-groups the existing sub-regions of Korea based on its political and historical background and examines how regional inequality has changed.

More specifically, this paper is interested in the decompositions of Honam & non-Honam, Gangwon & non-Gangwon, and urban & rural. It is commonly believed that the Honam area, located in the southwest part of Korea, has fallen behind other regions because of political reasons. Gangwon Province is also behind in the process of economic development mainly due to geographic reasons. Last but not least, the urban-rural gap is also an important issue. All of these regional disparities will be considered in this paper in order to determine whether these decompositions serve as a better way of understanding overall inequality in the country.

This paper has the following findings: Overall, regional inequality in Korea has grown over the past two decades. However, decomposed inequality between Honam and non-Honam has been reduced, but further investigation shows that this declining gap is not only due to Honam's industrial development but also to its decreasing population. Other decomposed inequalities (Gangwon & Non-Gangwon, and rural & urban) have been increasing. The follow-up econometric analyses reveal that, among three major variables affecting regional inequality, (trade openness, physical capital and human capital), trade openness is the most important factor, directly and indirectly.

This paper is organized as follows. Section 2 conceptualizes regional inequality, with a focus on *between* group inequality, using the Theil Index. Section 3 discusses South Korea's overall regional inequality. Section 4 analyzes decomposition methods. Follow-up econometric analyses are provided in Section 5. Section 6 summarizes the research.

2. Regional Inequality: Conceptualization and Decomposition

The rationale for preferring Theil's T statistic is not that there is some inherent flaw with the other measures, but that Theil's T has a more flexible structure that often makes it relatively more appropriate. If a researcher always had access to complete data at the individual level, then measures like the coefficient of variation or the Gini coefficient would usually be sufficient for describing inequality. However, in reality, individual data is rarely available, and researchers are asked to deal with aggregated data. In this case, Theil's T statistic is often a more appropriate and theoretically sound tool (Inequality Project 2008).

The following formulae reveal the algebra behind Theil's T. While these particular equations use income as the variable of interest, Theil's T can address any number of quantifiable phenomena. When household data is available, Theil's T is:

$$T = \sum_{p=1}^{n} \left\{ \left(\frac{1}{n} \right) * \left(\frac{y_p}{\mu_y} \right) * \ln \left(\frac{y_p}{\mu_y} \right) \right\}$$

where n is the number of individuals in the population, y_p is the income of the person indexed by p, and μ_y is the population's average income. If every individual has exactly the same income, T will be zero. This represents perfect equality and is the minimum value of Theil's T. If only one individual has all of the income, this represents utmost inequality and is the maximum value of Theil's T statistic.

If members of a population can be classified into *mutually exclusive* and *completely exhaustive* groups, then Theil's T statistic is made up of two components, the *between* group element (*B*) and the *within* group element (*W*) (*T = B + W)*, where:

$$B = \sum_{i=1}^{m} \left\{ \left(\frac{p_i}{P} \right) * \left(\frac{y_i}{\mu} \right) * \ln \left(\frac{y_i}{\mu} \right) \right\}$$

where *i* indexes the groups, p_i is the population of group *i*, *P* is the total population, y_i is the average income in group *i*, and μ is the *population-weighted* average income across the entire population. When aggregated data is available instead of individual data, *B* can be used as a lower bound for the population's value of Theil's T statistic.

However, *B* is generically smaller than *T*, and the portion of *B* out of *T* fluctuates; on average, the portion is only 12% (Shorrock and Wan (2005)).Therefore, the definition of regions needs to be better conceptualized to better capture the current status of regional inequality of Korea. Decomposition - regrouping regions - is one way of doing so. Shorrock and Wan (2005) said that the method of decomposition accounts for regional inequality up to 78% in the case of China. Kanbur and Zhang (2003) also used the decomposition and re-grouped China's provinces into rural and urban areas. By doing so, they showed the improved pattern of *B* between rural and urban areas. Based on these studies, this paper analyzes the regional inequality of South Korea using various kinds of decompositions.

An interesting property of the Theil Index is that it is *relative*; Total Theil is a *between* group inequality in terms of individual citizens, but is a *total* inequality in a decomposition, meaning that decomposed inequalities are now *between* group inequality in terms of Total Theil.

Total Theil = W + B (Decomposed Group)

Therefore, the rates of *B* out of Total Theil indicate what portion of decomposed inequality explains total inequality, suggesting an idea of how important these

decompositions are. This approach was originally used in Kanbur and Zhang (2005) when they decomposed China into coastal and inland, and rural and urban areas. After measuring Total Theil of Korea, this paper uses the decomposition methods and regroups South Korea (Honam and the rest, Gangwon and the rest, urban and rural) to better capture the regional inequality of the country.

3. Overall Regional Inequality of South Korea

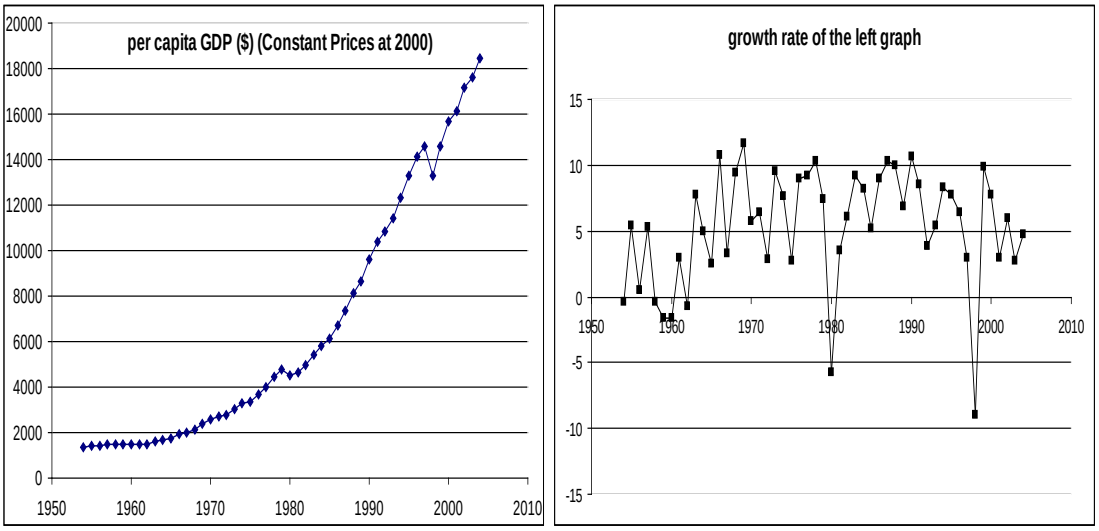

Figure 3.1. Per Capita GDP and Growth Rate of South Korea

Source: Penn World Table 6.2.

Before we move on to South Korea's regional inequality, let us focus on the growth pattern of its per capita GDP. Even though it shows a steadily increasing trend, its rate plummeted in 1960, 1979, and 1997 as a result of economic instability, reflecting Korea's modern history. Based on these three periods of instabilities, Korea's modern era since 1945 can be divided into four time periods.

The first period, 1945-1961, was when Korea became independent of Japan (1945),

South and North Korea established separate governments (1948), and the Korean War occurred (1950-53). Having been destroyed by the war, Korea had almost no industry and social infrastructure, and the main source for its GDP was from foreign aid. At the end of this first period, president Rhee Syngman was ousted after a corrupt presidential election, and the country was thrown into chaos. The second period is 1961-1979. In 1961, General Park Chunghee staged a military coup and took power as the leader of South Korea. President Park maintained strong government power based on export-oriented policies. At this time, Korea experienced rapid economic development with an average growth rate of 8%. His assassination in 1979 resulted in chaos in South Korea, and General Jeon Doohwan replaced him through another coup. In the third period (1979-1997), Jeon became a president (1981-1988), followed by Roh (1988-1993), and Kim (1993-1998). Korea, during this era, hosted the Olympic Games (1988), had a booming economy and stable growth. The fourth phase (1997-present) began with an unprecedented financial crisis in which Korea's financial system was devastated.

This paper focuses on the third and the fourth, because data on regional income in provincial level had begun to be collected only in 1985. To analyze regional inequality of South Korea, this paper uses these regional per capita GDPs for 15 sub-national regions (6 metropolitan city regions and 9 provinces). There are 16 sub-national regions in South Korea, seven of which are metropolitan regions, including Ulsan. However, this city was not considered in this paper because it became one of the metropolitan cities only in 1997. Based on the per capita mean GDP of each region, overall regional inequality was measured using Theil's *T* (more specifically, the equation *B* in Section 2). Appendix displays data and Figure 3.2 displays each region on a map. The result on Theil's T is displayed in Figure 3.3.

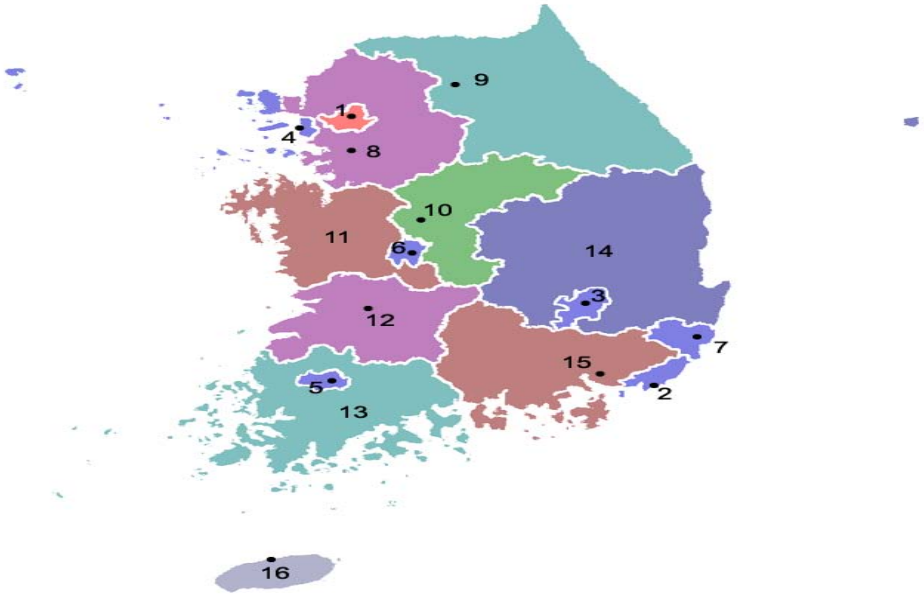

Figure 3.2. Map of South Korea

** Metropolitan Cities (1: Seoul 2: Busan 3: Daegu 4: Incheon 5: Gwangju 6: Daejeon 7: Ulsan)*
** Provinces (8: Gyeonggi 9: Gangwon 10: Chungbuk 11: Chungnam 12: Jeonbuk 13: Jeonnam 14: Gyeongbuk 15: Gyeongnam 16: Jeju)*

Note: In the next chapter where decomposition methods are used, Honam and Gangwon are paid special attention. In this map, Honam is the region 5, 12, and 13, and Gangwon is the region 9. Gangwon is the official province name, but Honam, not an official name, includes the provinces of Jeonbuk (12), Jeonnam (13), and Gwangju Metropolitan City (5), just like New England in the United States includes the state of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.

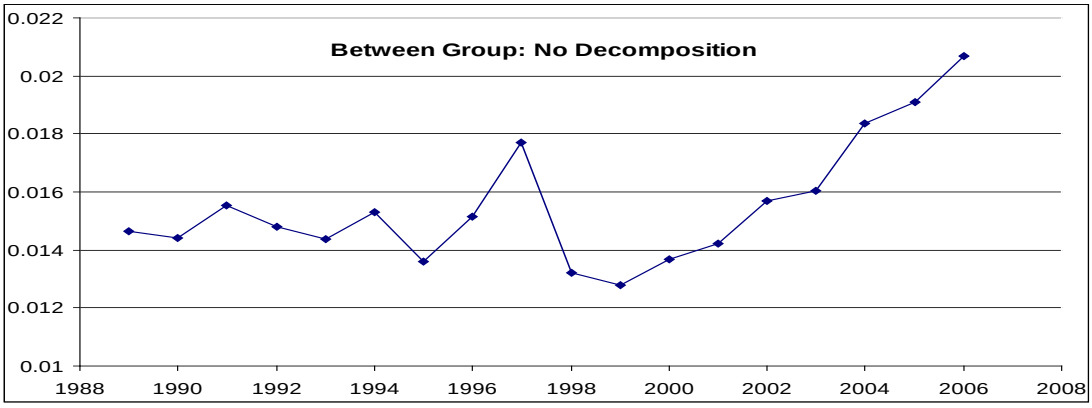

Figure 3.3. Theil's T of South Korea

The indices themselves do not mean anything generically. However, by comparing different indices over time, we can examine the trend of growing or declining regional inequality. This figure reveals that regional inequality of South Korea has increased over the past two decades. More specifically, it shows three patterns: a stable rate until 1995, a sudden fluctuation for the next couple of years, and a gradual increase since then. The increase in 1997 seems to be associated with the unprecedented financial crisis in the country. Decomposition methods in the following chapter will be used for better explanation for this pattern.

4. Decomposition

The following decomposition methods will be used; each has its own political or economic explanation.

4.1. Honam and Others

It is commonly believed that there has been discrimination against the Honam region, the southwestern part of Korea (5, 12, 13 from Figure 3.2). Considering Korea's modern political history, this belief is not groundless. Korea's politics can be summarized as the conflict between the Yeongnam-based ruling party and the Honam-based opposition party. As shown in Table 3.1, ever since Park Chunghee took power by a military coup in 1961, South Korean presidents were all from the Yeongnam region, the southeastearn part of the Korean peninsula (2, 3, 7, 14, 15 from Figure 3.2) until Kim Daejung, originally from Honam, became the president in 1998.

Table 3.1. South Korea's Presidents and Their Hometown

Name[31]	Presidency	Hometown
Rhee, Syngman	1948 – 1960	Hwanghaedo (now North Korea)
Yoon, Boseon	1960 – 1962	Asan, Chungnam
Park, Chunghee	1962 – 1979	Seonsan, Gyeongbuk, Yeongnam
Jeon, Duhwan	1980 – 1988	Hapcheon, Gyeongbuk, Yeongnam
Roh, Taewoo	1988 – 1993	Daegu, Yeongnam
Kim, Youngsam	1993 – 1998	Geoje, Gyeongnam, Yeongnam
Kim, Daejung	**1998 – 2003**	**Shinan, Jeonnam, Honam**
Roh, Moohyun	2003 – 2008	Gimhae, Gyeongnam, Yeongnam
Lee, Myungbak	2008 – Present	Pohang, Gyeongbuk, Yeongnam

Park's economic development plan focused on the development of the Capital Area and Yeongnam, and the connection between the two. The Capital Area was the first target because it already had an accessible social infrastructure required for developing industries. Additionally, many cities in Yeongnam, including Gumi, Ulsan, Pohang, Changwon, and Masan were industrialized by a variety of heavy industries (electronics in Gumi, shipping in Ulsan, steel in Pohang, etc). The Capital Area and Yeongnam were more closely interconnected when Gyeongbu Expressway, the first highway in South Korea, was opened in 1970. In this process of economic development, however, there was less investment in the Honam area.

Honam's falling behind is somewhat political. Kim Daejung, a well-known congressman from Honam, ran in the presidential election. Even though he was defeated by Park Jeonghee, Kim won almost as many votes as Park did. Alarmed by this, Park demolished the election system and declared himself to be a permanent president of Korea. At the same time, Kim was kidnapped, imprisoned, and even threatened to be killed, and Honam was isolated. For example, the portion of high-ranking public officials from Honam working in the national government in the 1970s

[31] Following the custom in Korea, Last name comes first.

was only 13%, even though population in this region is approximately 30% (Jeon 1990).

Discrimination against Honam became more serious in the 1980s. As soon as Jeon Doohwan took power by another military coup, there were nation-wide protests against his coup. In the midst of these protests, police shot protesters in Gwangju, the capital city in Honam, and officially, 224 people were killed (unofficially, more than 400). Since then, Gwangju and Honam had been isolated throughout Jeon's presidency (1981-1988). The portion of high ranking public officials in the national government originally from Honam dropped to 9.6% and the portion of CEOs in the government-funded companies who were originally from Honam was only 0.9% (Jeon 1990).

Things were improved when Kim Youngsam, the first non-military person since Park Jeonghee, was elected as the president of Korea in 1993, followed by Kim Daejung in 1998, the first president in South Korea, originally from Honam. It is commonly believed that the discrimination against Honam disappeared in the 1990s, especially since 1998.

How did this history affect the regional inequality of Honam and other regions? A completely satisfactory answer is not possible because, before 1989, there was a lack of data; the data on regional inequality was first released in 1985 and, in 1989, Gwangju was separated from Jeonnam Province to be considered an independent metropolitan unit. Working from available data, this section analyzes the inequality between Honam and other regions of Korea since 1989. Given the aforementioned history, the following hypothesis can be constructed.

Hypothesis 1: As discrimination against Honam has been eased, the regional inequality between Honam and non-Honam has declined.

Instead of formal "proof" of this hypothesis, this paper provides "smoking-gun

evidence". In order to investigate this hypothesis, this paper decomposes Korea into two parts: Honam and the rest of Korea, and measures the Theil Index between these two regions. The result is provided in Figure 3.4.

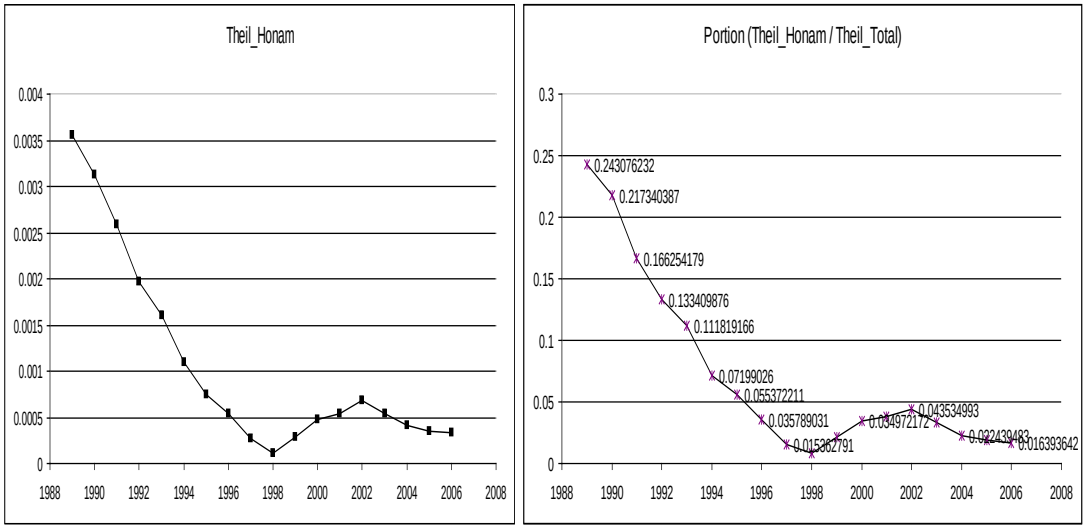

Figure 3.4. Theil's T for Decomposition Between Honam and Other Region & ThePortion of This Theil out of Total Theil of Korea

The left figure indicates the Theil Index for the decomposed group between Honam and the rest of South Korea, and the right figure displays the portion of this Theil Index out of the Total Theil of South Korea shown in Figure 3.4.

As this hypothesis predicts, the inequality between Honam and the rest of Korea has been decreasing overall. The portion dropped significantly from 24.3% in 1989 to 1.5% in 1998, suggesting that the per capita mean incomes in those two regions had dramatically been converging.

Two possible effects can explain this dramatic convergence: first, increasing total GDP and second, decreasing population in the Honam area. Since per capita GDP is total GDP divided by its population, these effects, combined together, may have

resulted in the soaring per capita income level of the Honam region, narrowing the gap between Honam and the rest parts of Korea.

First, Honam's total GDP, especially the output level in manufacturing sectors, has increased for the past years. It is true that there have been many Honam-friendly policies in the 1990s. For example, as shown in Table 3.2, almost all of national industrial complexes in Honam were opened in the 1990s and the 2000s, and the number of companies, the number of workers, and the volume of exports were all growing. In particular, exports more than doubled between 2001 and 2005.

Table 3.2. Industrial Complexes in Honam Area

Name	Location	Opened	Name	Location	Opened
Iksan	Honam	1974	Gwangyang	Honam	1992
Gunsan	Honam	1994	Daebul	Honam	1997
Gwangju	Yeongnam	2001	Yeosu	Honam	2002
Samil	Yeongnam	2005	Gunjang	Honam	2006

	# Complexes	# Companies	# Employee	Export ($Mil)
2001	35	2437	99374	12808
2002	35	2584	101999	13390
2003	35	2711	107203	21779
2004	34	2825	112745	22829
2005	35	3146	119407	28118

Source: Korea Industrial Complex Corporation
Note: The first table explains only national complexes and the second table includes both national and local complexes.

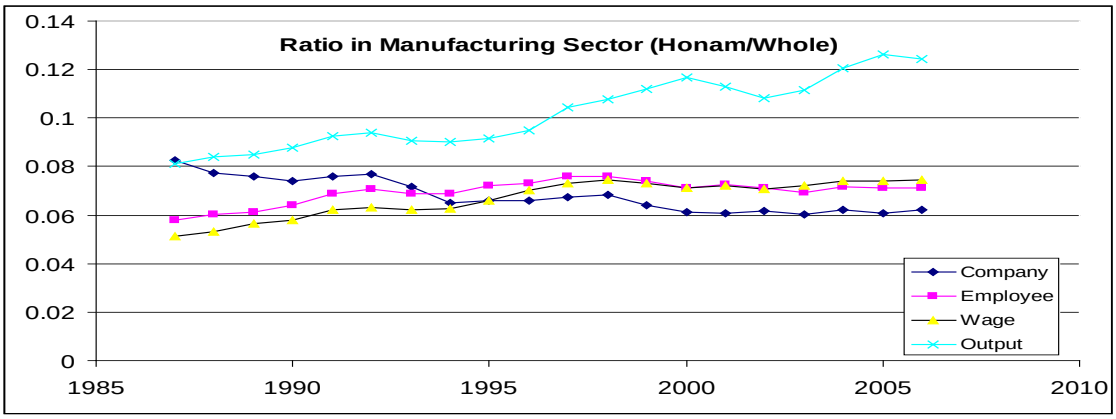

Figure 3.5. Manufacturing Sectors in Honam Relative to the Whole Region

As a result, the number of employees and the output level in the Honam region have been steadily increasing. In particular, the percentage of output level in the Honam area increased from 8% in 1987 to 12.5% in 2004. Additionally, the West Coast Highway, finally opened in 2001, connects major cities and industrial complexes in Honam area as far as Seoul. Increasing volume of trade between Korea and China also benefited Honam's growth. In 2008, trade volume between Korea and China was more than $100 billion, and Korea is China's 4th largest trading partner, followed by EU, US, and Japan. This fact is particularly favorable to Honam's growth because of its geographical proximity to China, being located in the West Coast of Korea.

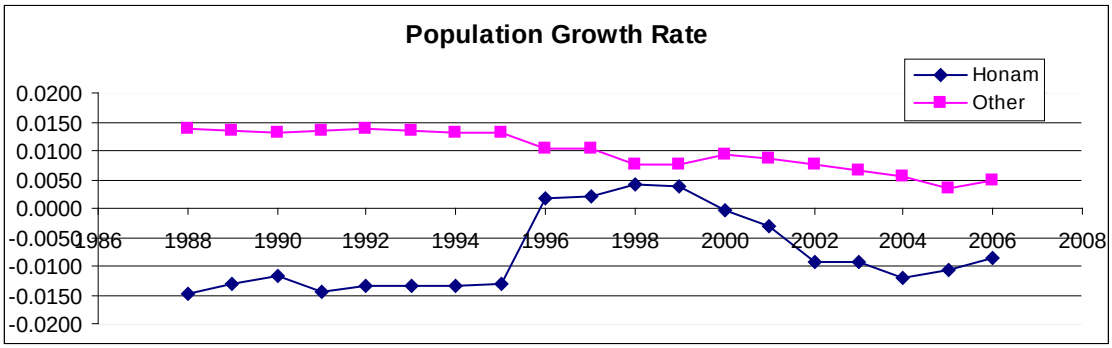

Figure 3.6. Population Growth Rate

Secondly, the decreasing population of Honam magnified the effect of increasing per capita GDP of Honam, thus contributing to the convergence between Honam and non-Honam. As shown in Figure 3.6, Honam's population growth rate has always been lower than other regions, and it even recorded negative rates for many years.

Overall, Honam has made some industrial progress recently; an increasing number of industrial complexes were constructed and the number of companies, the number of workers, and the export levels all have grown, which contributed to increasing output level. Per capital output level has even soared because population of the region has declined. Increasing output level in manufacturing sectors in spite of decreasing population indicates the fact that Honam's manufacturing sectors become more and more capital intensive, requiring more output per labor or less labor per output. It can be concluded from the decreasing Theil Index that regional inequality between Honam and non-Honam has decreased, but it cannot be concluded that this decreasing inequality is solely due to the industrial development and increasing total output level in the region.

4.2. Gangwon and Others

Like Honam, Gangwon is another region that has been isolated in the process of economic development of South Korea. In some sense, this region may be more discriminated against than Honam. The discrimination problem in Honam has been at least a "well known" issue among Koreans, and there have been some attempts to solve this problem. However, very little attention has been paid to Gangwon with respect to its lagging economic growth. As shown in Figure 3.7, Gangwon Province is located in the northeast mountainous part of South Korea. Due to its geographical constraints, this province has lacked growth both in industry and agriculture. As such,

there are no major cities in the province, and transportation networks have not been developed in this region. For example, thin lines in Figure 3.7 are highways. Gangwon has Yeongdong Highway (horizontal one) and Joongang Highway (vertical one). However, as shown in Table 3.3, compared with other highways, Yeongdong and Joongang Highways were not constructed until a few years ago, making Gangwon lag behind.

The same story can be applied to the Korea Train Express (KTX), which is drawn as thick lines in Figure 3.7. The KTX, Korea's first high speed train system with maximum speed of 200 miles per hour, opened on April 01, 2004. It takes only two hours to get from Seoul to Busan, and South Korea is now more closely interconnected because of this bullet train system. According to the Korean Railroad (KORAIL) (2008), regions where the KTX stops show rapid economic development, such as the $100 billion investment in Iksan Industrial Zone with 1,800 new employees from 22 different companies, and the $20 trillion investment in Cheonan-Asan Industrial Zone with 100,000 employees from Samsung Electronics. However, as shown in the map below, the KTX does not stop in a single part of Gangwon.

Table 3.3. Highways in Korea

Name	Connecting	Opened	Note
Gyeongbu	Seoul – Busan	1970	Connects the Capital Area and Yeongnam The first highway in Korea
Honam	Seoul – Gwangju	1973	Connects the Capital Area and Honam
Olympic	Daegu– Gwangju	1984	Connects Yeongnam and Honam
Jungbu	Seoul – Daejeon	1987	Aimed at solving congestion problems in Capital Area
Yeongdong	Seoul – Gangneung	1995	First opened in 1975, but only 2 way lanes. Expanded into 4 way lanes in 1995
Joongang	Chuncheon – Daegu	2001	Connects Gangwon and Yeongnam

Source: Korea Expressway Corporation

Note: There are 28 highways in Korea, as of 2008. Only some of them are introduced here.

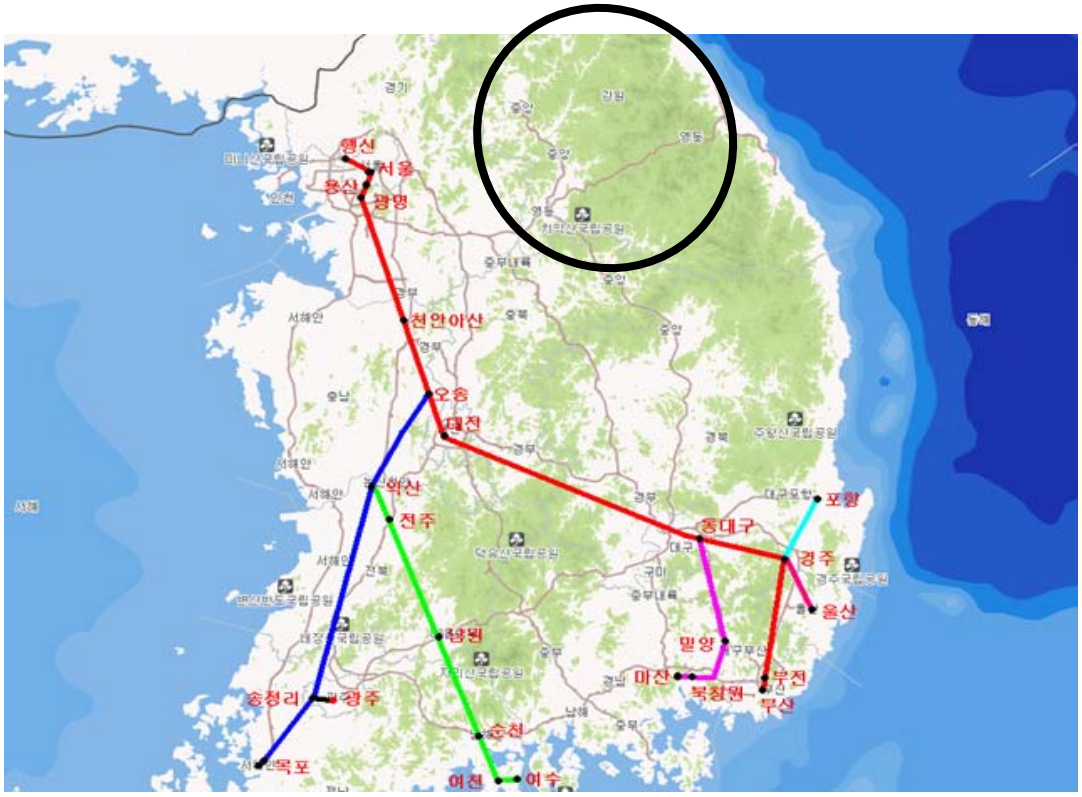

Figure 3.7. Highway and KTX Map of Korea (Gangwon area: Inside the Circle)

Based on the narrative above, the following hypothesis can be constructed.

Hypothesis 2: With less accessibility, industrial development in Gangwon Province is behind, and therefore, regional inequality between Gangwon and the rest of South Korea remains high for the past two decades.

In order to test this hypothesis, this paper decomposes Korea into two parts: Gangwon and the rest, and measures the Theil Index between these two regions. The result is provided in Figure 3.8.

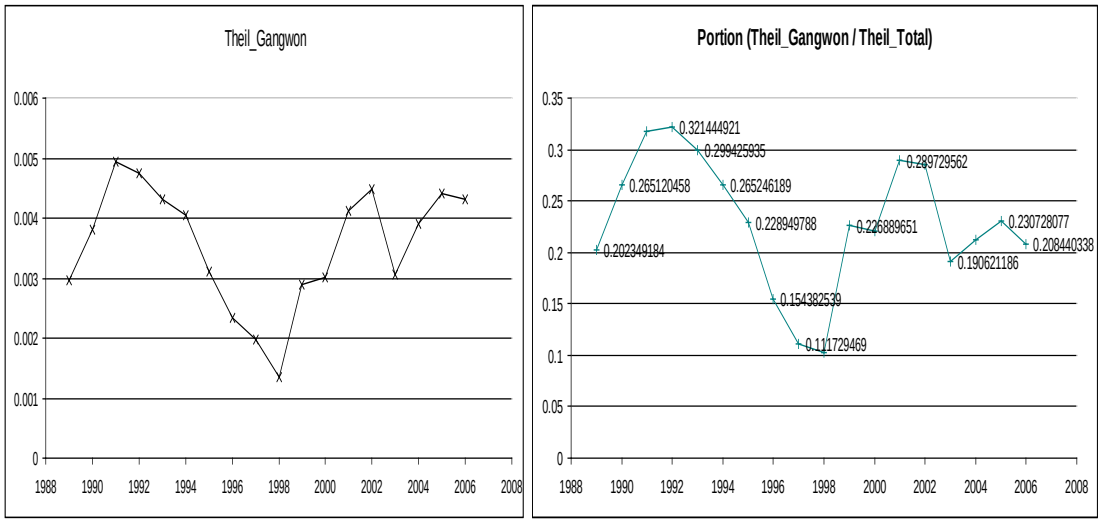

Figure 3.8. Theil's T for Decomposition Between Gangwon and Other Region & The Portion of This Theil out of Total Theil of Korea

This figure verifies that, unlike the Honam decomposition, there *is* a high level of income disparity between Gangwon and other provinces. Except for 1997-8 period where the capital area had a direct shock from the financial crisis, the portion of the Theil between Gangwon and the rest out of the total Theil has been over 20%. Given that the decomposition of Honam and non-Honam shows a converging pattern, it seem that the income disparity between Gangwon and non-Gangwon is one of the main reasons for increasing Total Theil of South Korea displayed in Figure 3.3.

The following figure confirms this disparity. The portion of Gangwon's GDP out of the entire country has decreased from 3.6% in 1989 to 2.7% in 2006, a much smaller portion than in Honam's case. Moreover, like Honam, the region shows a decreasing population for many years.

In some sense, the degree of "behind" is bigger in Gangwon than in Honam. The fact that it does not have a major industry makes future prospects even worse. In order to boost its economy and catch up with other provinces, it tried to host the Winter Olympics twice in Pyeongchang, the biggest ski area not only in Gangwon but also in

Korea. However, it was defeated by Vancouver, Canada in 2003, and Sochi, Russia, 2007. Since this province has a comparative advantage in tourism industry (mountains, hot springs, skiing, beaches, etc), the national government needs to support the local government to develop this industry in order to achieve a balanced economic growth over the entire country.

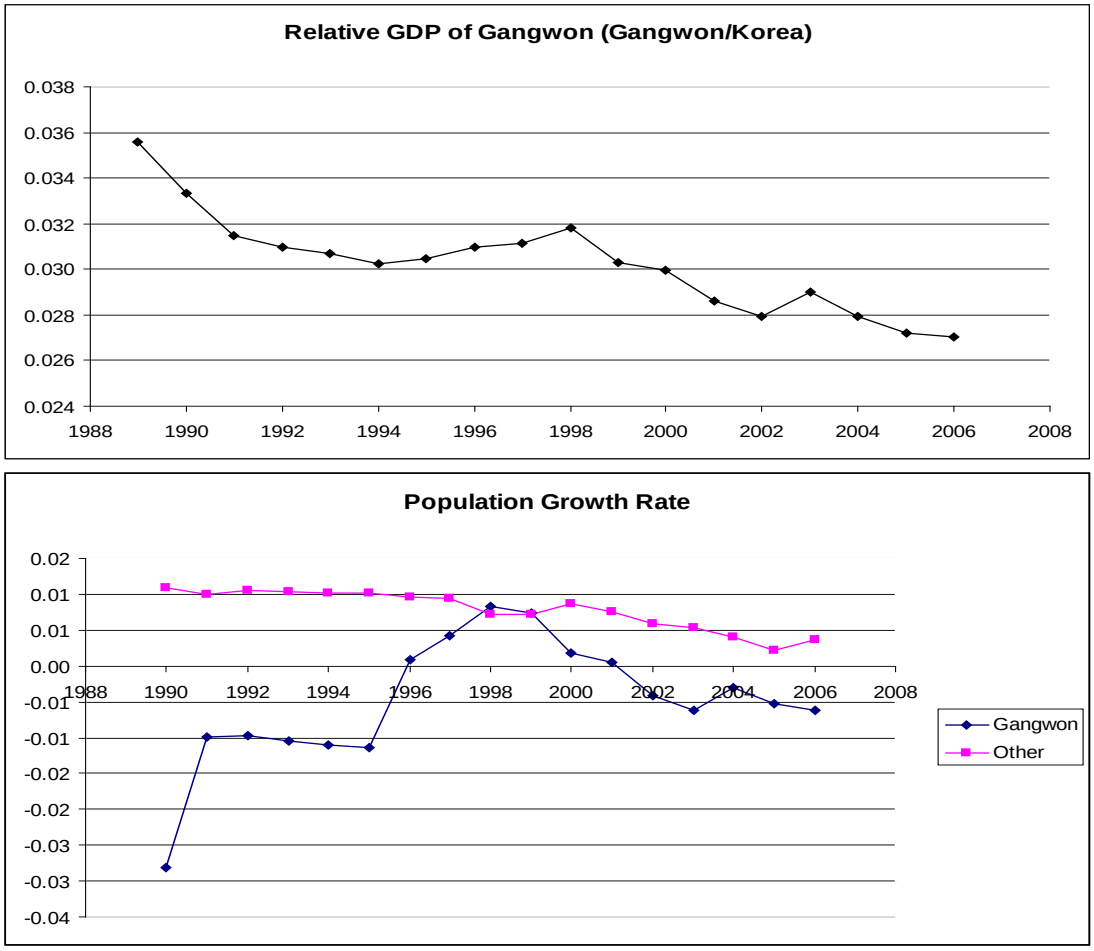

Figure 3.9. Relative GDP and Population (Gangwon & Other Area)

4.3.Urban and Rural

As Korea industrialized, it also became rapidly urbanized. According to Table 3.4, the urbanization rate in South Korea doubled from 40.7% in 1970 to 80.8% in 2005, higher than any of its neighboring countries.

Table 3.4. Urbanization Rate (Measured by Proportion of Urban Population)

	1970	1980	1990	1995	2000	2005
S.Korea	40.7	56.7	73.8	78.2	79.6	80.8
N.Korea	54.2	56.9	58.4	59.1	60.2	61.6
China	17.4	19.6	27.4	31.4	35.8	40.4
Japan	53.2	59.6	63.1	64.6	65.2	65.8

Source: Korea Statistical Information Service (KOSIS). National Statistical Office of the Republic of Korea

There have been numerous of studies addressing urban-rural issues. One of the most famous ones is the Harris-Todaro Model (1970), which focuses on migration between rural and urban areas depending on workers' expected incomes. Regarding income disparity between urban and rural areas, Kanbur and Zhang (2005) found that the urban-rural gap is increasing by showing that its portion out of total inequality has increased from 6.9% in 1952 to 13.9% in 2000.

In the same direction as Kanbur and Zhang, this paper examines the pattern of urban-rural income disparity using South Korean data. However, data problems arise here; in Korea, "urban area" is defined as a place with population of more than 100,000 (called *si*), and "rural area", as a population less than 100,000 (called *gun*). However, only four provinces (Gangwon, Gyeonggi, Gyeongbuk, and Gyeongnam) released income[32] data on their *si*s and *gun*s between 2000 and 2004. In this paper,

[32] All other descriptive statistics (population, gender, education, etc) are available. Only income variable was added recently.

urban and rural areas in these four provinces were decomposed in this way. For the remaining regions, however, this paper assumes that a metropolitan city region within a province is urban, and the surrounding province is rural. This is a reasonable assumption given that metropolitan cities all have populations of at least one million and the surrounding provinces (Chungbuk, Chungnam, Jeonbuk, Jeonnam, and Jeju) have relatively sparse population. The following table shows which are rural and which are urban areas.

Table 3.5. Urban and Rural Classification of South Korea

Urban	Rural
<Metropolitan Cities> Seoul, Busan, Daegu, Incheon, Gwangju, Daejon	<Unclassified Provinces> Chungbuk, Chungnam, Jeonbuk, Jeonnam
< *Si*s in Gyeonggi Province> Suwon, Seongnam, Bucheon, Anyang, Ansan, Yongin, Pyeongtaek, Gwangmyung, Siheung, Gunpo, Hwaseong, Icheon, Gimpo, Gwangju, Anseong, Hanam, Uiwang, Osan, Gwacheon, Goyang, Uijeongbu, Namyangju, Paju, Guri, Dongducheon	<*Gun*s in Gyeonggi Province> Yeoju, Yangpyeong, Pocheon, Yangju, Gapyeong, Yeoncheon <*Gun*s in Gangwon Province> Hongcheon, Hoengseong, Yeongwol, Pyeongchang, Jeongseon, Cheolwon, Hwacheon, Yanggu, Inje, Goseong, Yangyang
<*Si*s in Gangwon Province> Chuncheon, Wonju, Gangneung, Donghae, Taebaek, Samcheok	<*Gun*s in Gyeongbuk Province> Gunwi, Eiseong, Cheongsong, Yeongyang, Yeongdo, Cheongdo, Goryeong, Seongju, Chilgok, Yecheon, Bonghwa, Uljin, Ulleung
<*Si*s in Gyeongbuk Province> Pohang, Gyeongju, Gimcheon, Andong, Gumi, Yeongcheon, Yeongju, Sangju, Mungyeong, Gyeongsan	<*Gun*s in Gyeongnam Province> Uiryeong, Haman, Changnyeong, Goseong, Namhae, Hadong, Sancheong, Hamyang, Geochang, Hapcheon
<*Si*s in Gyeongnam Province> Changwon, Masan, Jinju, Jinhae, Tongyeong, Sacheon, Gimhae, Miryang, Geoje, Yangsan	

Given these data constraints, this paper measures the Theil Index between urban and rural areas. The result is provided in Figure 3.10. Because only five years of data are available, it may be premature to draw a conclusion, but these graphs definitely reveal an increasing inequality between urban and rural areas. The percentage itself may not be very big, but it has increased more than six times from 0.5% in 2000 to 3.2% in 2004.

These years (2000-2004) are mainly the period of President Roh Moohyun's regime. One of his policy priorities was Balanced Regional Growth. He even announced a decentralization plan of constructing a so-called administrative capital somewhere in Chungcheong, one of the rural areas, and moving a large segment of government ministries and their associated facilities to this area. However, much of his plan was diminished by strong objections, and the result in Figure 3.10 shows that his policies did not work. The next chapters on econometrics will examine what caused this growing inequality between the two groups.

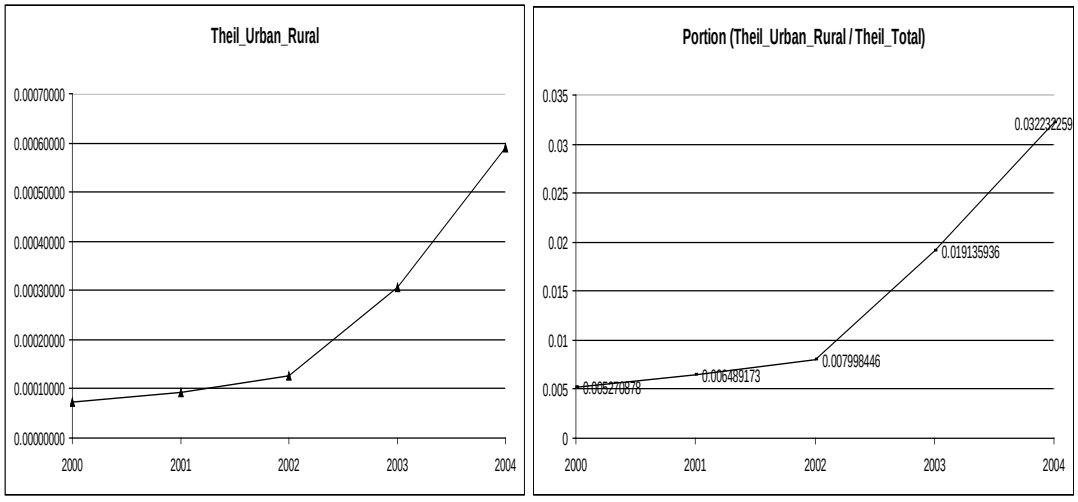

Figure 3.10. Theil's T for Decomposition Between Urban and Rural Area & The Portion of This Theil out of Total Theil of Korea

5. Econometric analyses

Econometric analyses are conducted in this part to figure out how Korea's regional inequality is affected. The three most important variables affecting regional inequality in this paper are, the level of *openness*, *physical capital*, and *human capital*. Openness was measured by the share of export out of GDP[33]. There are many different measurements for physical capital, and this paper focuses on the infrastructure, and measures the highway density (the length of highway divided by the land area). Regarding human capital, this paper uses the rate of the number of university students (undergraduate and graduate) out of the total number of students (elementary, junior high, high, and university). Among these three explanatory variables, openness is the most important one affecting regional inequality, as Korea's economic development has been based on export-oriented open trade policies.

As a dependent variable, not only the Total Theil, but also decomposed ones, including Honam & Non-Honam Theil, Gangwon & Non-Gangwon Theil, and Urban & Rural Theil will also be used. Except for the Total Theil, decomposed ones were measured by their fractions out of the total one instead of by their actual values. All variables are in logarithms, and one-period lagged values of the independent variables are used to minimize potential endogeneity problems. Once these first round of analyses are conducted, two interaction terms will be added to investigate interacted mechanisms through which openness affects regional inequality. The regression equation is as follows:

$$\ln(inequality) = a_1 + a_2 \ln(openness) + a_3 \ln(infrastructure) + a_4 \ln(education) + a_5 \ln(openness) * \ln(infrastructure) + a_6 \ln(openness) * \ln(education)$$

[33] Instead of using the ratio of the sum of export and import to the GDP ((*EX+IM)/Y*), a popular way of measuring openness, this paper uses the share of export out of the GDP (*EX/Y*) in order to be consistent with the national income accounting (*Y=C+I+G+EX-IM*).

More specifically, the first interaction term will test how openness affects inequality jointly with the level of infrastructure: does openness affect regions with higher level of infrastructure, which is normally high income regions, such that regional income disparity will increase? The second term will test how openness affects inequality jointly with the level of education; does openness affect regions with higher education level, which is normally high income regions, again, such that regional inequality will go up? etc.

Thirdly, a panel regression analysis is conducted to check whether the results in the time series and panel regression are consistent. Here, the following equation is used:

$$\ln(y_{jt}) - \ln(y_{jt-1}) = a_1 + a_2 \ln(openness_{t-1}) + a_3 \ln(infrastructure_{jt-1}) + a_4 \ln(education_{jt-1}) + a_5 \ln(openness_{t-1}) * \ln(infrastructure_{jt-1}) + a_6 \ln(openness_{t-1}) * \ln(education_{jt-1})$$

where *j* stands for each province, and *t* stands for time. The dependent variable is the percent change of mean income difference of region *j* between year *t* and *t-1*, which is actually the growth rate. This is not directly related with regional inequality, but it still indirectly captures the idea of regional inequality when it is used with interaction terms. That means the following: Suppose a_5 is positive. Since infrastructure is often developed in rich areas, it will be interpreted from this result that increasing trade openness is associated with increasing growth rates in high-income regions. This approach was used by Rivas (2007) when she researched Mexico's regional inequality. In this sense, the growth rate of a region can be used as a proxy for regional inequality, and this panel regression will verify whether the result of time series regression is consistent. Finally, The Chow Test is conducted to see whether there is a structural break before and after the Asian financial crisis in 1997. However, the *p*-values are all over 10%, suggesting that it is not necessary to break the periods into two. Moreover,

if the time periods are broken into the two, the number of observations in each period are two few, so this paper does not consider the structural break issue for any of the following regressions. The Breusch-Pagan Test and Durbin-Watson Test find that heteroskedasticity and autocorrelation problems are not very significant, but White heteroskedasticity consistent estimation will be provided anyway for robustness reason.

5.1. Results

Table 3.6. Time Series Regression with No Interaction Terms

	Total_T	Honam_T	Gangwon_T	RU_T
Openness	-0.388**	-2.836***	-1.237*	4.126
	(0.157)	(0.898)	(0.657)	(2.237)
Physical K	0.931***	3.346***	1.534**	-0.650
	(0.214)	(0.963)	(0.699)	(4.654)
Human K	-0.526***	-6.674***	-1.444	18.139
	(0.173)	(1.087)	(0.912)	(15.582)
Adj R^2	0.567	0.852	0.190	0.788
Chow-test *p*-value	0.166	0.158	0.1327	-
Breush Pagan *p*-value	0.020	0.197	0.464	0.690
Durbin-Watson value	1.510	0.962	0.823	3.334

*Notes: All the variables are in logarithmic form and independent variables have one-year lag. The Bruesh Pagan Test reveals that this regression is generally homoskedastic except for Total_T where p-value is 0.02. However, for robustness, this paper uses White heteroskedasticity consistent estimation, whose robust standard errors are provided in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. The Durbin Watson Test reveals that autocorrelation is not a serious problem; except for rural_urban case, the values are inside the so-called indecisive zone where we cannot conclude there is an autocorrelation problem. The rural_urban case has negative autocorrelation, but since the observation is very few (five), this problem is trivial. The null hypothesis of the Chow Test is that there is no structural break in 1997 (financial crisis), which is not rejected. The Chow Test results are all insignificant, so they will not be provided in the upcoming regressions.*

The beginning year of rural-urban decomposition is 2000, which makes this test impossible. Dependent variables for Honam_T, Gangwon_T, and RU_T are their portion relative to Total_T, which were discussed in Chapter 4. Openness was measured using export ratio out of total trade volume. Physical capital was measured using highway density. Human capital was measured using the rate of university students out of total number of students.

Table 3.7. Time Series Regression with Interaction Terms

	Total_T	Honam_T	Gangwon_T	RU_T[34]
Openness	7.958**	43.943***	41.774***	-
	(3.532)	(10.900)	(8.826)	
Physical K	3.300***	-15.654***	12.911***	-
	(0.934)	(2.900)	(2.305)	
Human K	-4.524	-10.023***	-4.287***	-
	(0.346)	(1.060)	(0.607)	
Openness*PhysicalK	2.060**	9.800***	9.118***	-
	(0.766)	(2.516)	(2.058)	
Openness*HumanK	0.063	2.400***	2.077***	-
	(0.160)	(0.594)	(0.363)	
Adj R^2	0.685	0.906	0.595	-
Breush Pagan p-value	0.731	0.222	0.995	
Durbin-Watson value	2.160	2.040	1.701	

*Notes: All the variables are in logarithmic form and independent variables have one-year lag. The Bruesh Pagan Test reveals that this regression does not have a heteroskedasticity problems. However, for robustness, this paper uses White heteroskedasticity consistent estimation, whose robust standard errors are provided in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. The Durbin-Waton Test reveals that autocorrelation is not a serious problem; Total_T and Honam_T are within 'not-rejecting' zone, and Gangwon_T is within 'indecisive' zone. There are no available data for physical capital and human capital in urban-rural level. Dependent variables for Honam_T, Gangwon_T, and RU_T are their portion relative to Total_T.*

Two results are provided. In Table 3.6, interaction terms are *not* included. That said, there are three explanatory variables (openness, physical capital, and human capital). In Table 3.7, two interaction terms (openness*physical capital & openness*human

[34] Data on physical capital and human capital are not known in rural-urban level.

capital) are included to capture the direct and indirect impact of trade openness on regional inequality.

An interesting observation can be made when we compare the signs of openness in both tables. The sign is negative[35] in Table 3.6, but positive in Table 3.7. It is revealed that trade openness contributes to *reducing* regional inequality when measured on its own, but *increasing* inequality when interaction terms are considered. The interaction terms themselves also have positive coefficients. This is consistent with Kanbur and Zhang (2005)'s result, one of whose findings is that "greater openness is associated with greater regional inequality in a spatially large country such as China." Although Korea is a spatially small country, the relationship between trade and regional inequality is positive both in China and Korea.

This result is related with *asymmetric* gains from trade. The WTO claims that benefits from trade tend to be biased toward a region with higher levels of physical and/or human capital. For example, it is known that there exists so-called the "learning by exporting" effect in a firm when they experience a variety of knowledge spillovers in the process of trade (World Trade Report (WTR) 2008), and a region with high quality of human capital has an advantage of absorbing these spillovers more efficiently, and may grow faster than other regions. For another example, the size of trade cost, one of the major determinants of gains from trade, is huge in an area with poor public transportation networks, meaning that an area with advanced physical capital tends to benefit more from trade.

Broadly speaking, this is consistent with the idea of *coordinated investment* or *balanced growth*, argued by Rosenstein-Rodan as old as in 1943 and Nurkse in 1953, formalized by Murphy, Shleifer, and Vishny in 1989, who argued that coordination

[35] Urban-rural Theil has positive sign, meaning that trade openness leads to increasing urban-rural gap. However, the observations are only five and the results are not significant, so it may be premature to draw a conclusion.

failure and no emergence of high tech industries in an economy would result in a low production trap, which eventually creates poverty trap. Their idea was further developed by Kremer (1993), whose famous “O-ring Theory” describes not only a low quantity trap but also a low quality trap that blocks industrialization. Coordinated investment on human and physical capital leads to a higher growth rate in a region, and this biased growth pattern widens the gap between high and low income areas, facilitating regional inequality of a country.

The results on the coefficients of physical and human capital (not the interaction terms) are a bit complicated; for physical capital, the signs are negative for Honam, but positive for the rest, and for human capital, the signs are all negative. Even though advanced human capital level facilitates regional inequality when it was interacted with trade openness, it itself contributes to reducing regional inequality, which is consistent with Rivas (2007).

The result in Table 3.7 is re-examined using a panel data with the same explanatory variables to compare the result and check the consistency. Here, the dependent variable is not the Theil Index itself, but the percent change of mean income difference of region *j* between year *t* and *t-1*, which is actually the same as the growth rate. Regional inequality will be measured indirectly by this variable. The mean income difference in each region can be a proxy for the overall regional inequality, so the result can be compared with that of the Total Theil in Table 3.7. Both the result of fixed effects and random effects are provided. Each fixed and random effects have different groups, regions and time. Therefore, there are four results in Table 3.8: region fixed effect, region random effect, time fixed effect, and time random effect.

Table 3.8. Panel Regression with Interaction Terms

	Region Fixed	Region Random	Time Fixed	Time Random
Openness	0.144	0.272*	0.484***	0.244**
	(0.154)	(0.151)	(0.139)	(0.115)
Physical K	0.026	-0.003	-0.001	-0.002
	(0.041)	(0.352)	(0.022)	(0.023)
Human K	-0.01287	0.128*	0.069*	0.068*
	(0.075)	(0.069)	(0.450)	(0.046)
Openness* Physical K	-0.013	0.005	0.006	0.005
	(0.027)	(0.027)	(0.168)	(0.017)
Openness* Human K	0.056	0.113**	0.053*	0.054*
	(0.056)	(0.054)	(0.035)	(0.036)
Within R^2	0.088	0.026	0.106	0.084
Between R^2	0.359	0.396	0.000	0.001
Overall R^2	0.001	0.044	0.002	0.007
N	255	255	255	255

Notes: The Hausman Test is conducted and the null hypothesis that random effect models are consistent is rejected (chi-square value is 25, and its p-value is 0.001), meaning that more attention needs to be paid to the fixed effect models. However, the both fixed and random effects provide similar results anyway.

These result on trade openness is consistent with the result in Table 7; openness has a positive effect on regional inequality, both directly (the variable by itself) and indirectly (the interaction terms). However, the effect of physical and human capital on regional inequality is rather opposite; unlike the result in Table 3.7 where the signs of physical and human capital are mostly positive and negative, the panel data has the opposite signs (negative and positive).

6. Conclusion

For the past four decades, South Korea has experienced a rapid economic growth. It was called one of the East Asian Tigers, and the World Bank even called this rapid

growth a ‘miracle’. However, even though the pie is getting larger, it is not necessarily equally distributed: a famous statement that the pareto efficiency does not guarantee equity can be applied here. National inequality and decomposed inequality fluctuate over time. Overall, regional inequality of Korea has grown over the past two decades (Figure 3.3). However, decomposed inequality between Honam and non-Honam has been reduced (Figure 3.4), but further discussion is made whether this declining gap is due to Honam’s industrial development or simply due to its decreasing population. Other decomposed inequalities (Gangwon and Non-Gangwon, and rural and urban) have been increasing. Empirical findings reveal that trade openness, associated with physical and human capital development, is positively related with regional inequality, meaning that gains from trade are better acquired in a region where physical and human capital are well established. As Basu mentioned (2000), a certain “coordination heave” is what is needed to overcome regional income gap of a country, and government should focus on reaching this goal in the most “cost-effective” way.

APPENDIX. GROSS REGIONAL DOMESTIC PRODUCT

($1,000, CONSTANT PRICE AT 2000)

Year	Seoul	Busan	Daegu	Incheon	Gwangju	Daejeon	Gyeonggi
1985	52411282	14430746	8779457	9293516	0	0	30010360
1986	59165592	16408907	10042467	10713344	0	0	35027026
1987	66206197	18467613	11374999	12064802	5236491	0	40202363
1988	72609785	20164255	12459309	13447381	6140721	0	45015459
1989	80269044	21096139	13240095	14836504	6710236	7581802	48227301
1990	88925802	23235544	14537975	16366412	7840124	8366175	53665445
1991	96072770	24861477	15368211	18290099	8398815	9465117	61778442
1992	104103792	25793456	16270405	19214230	9048684	10431265	66299616
1993	111837810	26716009	17055697	20114032	9670270	11159427	70936605
1994	120246336	29003285	18582242	21819412	10614885	11373870	77819629
1995	127110656	32500602	20364899	25247368	11386933	11617775	85755745
1996	130859446	34107584	21488264	26536853	11995806	12312442	90849435
1997	133742572	34022863	21598087	27298401	12353686	12890143	94045169
1998	121450056	29716875	18535147	22201627	10541305	11815295	83965776
1999	127750331	32100217	19521099	24691429	11575866	12619819	99613365
2000	138492266	33839838	20776260	26230654	12628813	13559020	111793461
2001	143087757	36091423	20808913	27427292	13007721	14053464	117654605
2002	154503088	37884530	21683831	29952167	14171608	14935439	130220977
2003	154943893	39579757	22120792	30788186	14271550	16026414	133648749
2004	156224159	39856004	22342909	31866182	14636628	16280876	146743122
2005	158304122	40815222	23000935	33219335	15431675	16442392	158694332
2006	163072704	41851087	23413727	34828545	15982772	16880705	171864410

APPENDIX (CONTINUED)

Gangwon	Chungbuk	Chungnam	Jeonbuk	Jeonnam	Gyeongbuk	Gyeongnam	Jeju
8047218	5881700	13862014	8190666	14241606	14484061	18686413	2068101
8792723	6403147	15808457	9103706	15846473	16387735	21093942	2176784
9699984	7046177	17106257	9714688	12913825	17939127	23507768	2430928
9885830	7847314	18930125	10861217	14233135	19460430	26316502	2662081
10845311	8898964	14393133	11317150	15200104	20917053	27970625	3175381
11067782	9540047	14900606	11763631	16329010	21728029	30770931	3236570
11512699	10655039	16222440	12851425	18090748	23633085	34736735	3631305
12122256	11603126	17802526	13571928	19537049	24856830	36645225	4058974
12695865	12764652	18860766	14274013	20265889	25362045	37543446	4114416
13638912	13810284	21171722	15596767	22211193	28242929	42331850	4385759
14800680	15153938	20941551	16819535	23929502	29586021	45360747	4917682
15991583	16755178	23981977	18053847	25900492	32063842	50233976	5165769
16715056	17828224	25870649	19105407	27858137	34022051	53650741	5324953
14718275	15771218	23504306	16441813	25294352	30853018	32869403	4729745
15391421	18010060	26834661	18099931	26078586	35124906	35921683	4885301
16462239	19521392	28962820	18977807	26907552	38445650	37728411	5289484
16391137	19531164	29787646	19298132	27621781	40976724	41083904	5691656
17216474	21042697	32430386	19909619	28613479	44073856	43066347	6003038
18449218	21817690	34877823	20918902	29400644	47305285	45518042	6193804
18634765	23690112	38074358	22018543	30751105	51353487	47723735	6276810
18888731	23900139	41403366	22564979	31675777	53902299	48961442	6501185
19699230	25475947	45268203	23892660	32569597	57049782	50587882	6615857

Source: Korea Statistical Information Service (KOSIS). National Statistical Office of the Republic of Korea

Note:

- *South Korea is divided into 16 sub-national region. Seven of them (Seoul, Busan, Daegu, Incheon, Gwangju, Daejeon, and Ulsan) are metropolitan city regions and nine of them (Gyeonggi, Gangwon, Chungbuk, Chungnam, Jeonbuk, Jeonnam, Gyeongbuk, Gyeongnam, and Jeju) provinces.*
- *Ulsan was discarded in this research because it became an independent metropolitan city only in 1997. It is too recent to be included in this research.*
- *The National Statistical Office have released data on sub-national GDP (Gross Regional Domestic Product : GRDP) since 1985.*
- *Gwangju belonged to Jeonnam Province until 1986. In 1987, Gwangju became an independent metropolitan city, separated from Jeonnam Province.*
- *Daejeon belonged to Chungnam Province until 1988. In 1989, Daejon became an independent metropolitan city, sepated from Chungnam Province.*

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