THE JOURNAL OF THE KOREAN ECONOMY, Vol. 1, No. 1 (Spring 2000), 53-82

From Capital-Driven to Knowledge-Driven Growth in Korea*

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Utilizing insights from new growth theory, Porter's competitive advantage theory, and Kojima's theory of DFI, this paper analyzes the overall growth mechanism of the Korean economy by integrating various dimensions, such as factor intensity changes, sectoral growth, trade performance, and direct foreign investment. This paper points out "knowledge accumulation" as one of the engines of growth in the Korean economy, and shows that although knowledge intensity has steadily increased over the last decade, Korean industrial growth is still dominated by physical capital accumulation. Then, the problem with the Korean economy is that the fast growing sectors are mostly capital, albeit not necessarily knowledge intensive sectors. This is not a desirable pattern of industrial change since high capital intensity eventually leads to declining profitability. Another problem is with weak national competitiveness, which is implied by the negative correlation between the value-added per worker of sectors and their shares in world export.

JEL Classification: O11, O40
Keywords: knowledge intensity, economic growth, Korean economy

1. INTRODUCTION

Korea's sudden economic crisis in late 1997 has raised, in Korea, the question of what has gone wrong despite its good "fundamentals." This paper,

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* I would like to thank professors Seung Kwan Baek, Dong Sung Cho, Chung H. Lee, Seong Whan Oh, Joon Yong Park, Hak K. Pyo, Changryong Rhee, Keunkwan Ryu, and an anonymous referee for useful comments, and Gil Lee and Jin-hee Lee for editorial assistance. All remaining errors are, of course, my responsibility.
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although not directly addressing the financial crisis, attempts to elucidate the background of the situation by analyzing the growth mechanism of the Korean economy with its strengths and weaknesses. For example, the results in this paper suggest that although high valued-added sectors are the fast growing sectors in Korea, the sectors that perform well, in terms of world export market shares, are low or medium value-added sectors. This fact indicates weak national competitiveness in light of Porter's framework (Porter, 1990). A large volume of literature written on the Korean economy, thus far, addresses the switch in industrial leadership, structural adjustment, role of the state, policy regimes, or selected industries or cases.[1] Somewhat ambitious aim of this paper is, however, to show the overall growth mechanism of the economy by integrating various dimensions of the economy, such as factor intensity changes, sectoral growth, trade performance, and even direct foreign investment, without focusing on any one aspect of the Korean economy.

One important feature of this paper, in this regard, is that it does not stop at an aggregate level analysis but utilizes sectoral data in addressing the growth issues. One important advantage of using sectoral data is that the relationships among productivity, labor intensity, knowledge intensity, profitability, export performance, outward direct foreign investment (DFI), and growth of the industrial sub-sectors can be more adequately addressed. Previous research that utilizes sectoral data, however, tends to be limited to estimating total factor productivity trends or determinants of outward direct foreign investment in Korean industries (Hong and Kim, 1996; Pyo *et al.*, 1993; Lee and Plummer, 1992). This study explains outward DFI, trade performance, and sectoral growth in a single integrated framework of growth and structural adjustment using a more rich and consolidated data pooling time series and cross-sectional data for a longer and updated period.

1) One of the often-heard characteristics of the Korean economy are the shifts in leading industries, such as the transition from labor intensive light industries to capital intensive heavy industries. This feature of the Korean economy has been discussed in the following literature (Amsden, 1989; Cho, 1994; Song, 1994). In particular, Cho (1994) describes the Korean case as "condensed growth," whereas Chang (1994) focuses on the role of the state. Corbo and Suh (1992) is an example of macroeconomic analysis of structural adjustment during the 1980s.

In terms of conceptual framework, this paper utilizes and synthesize insights from several works, such as the new growth theory literature (Arrow, 1962; Romer, 1986; Barro and Sala-i-Martin, 1995), Porter's theory of competitive advantages and the related stages of economic development, and Dunning and Kojima's theories of outward direct foreign investment and investment development path (Dunning, 1988, Ch. 5; Kojima, 1987; C. Lee, 1990). This paper will point out "knowledge accumulation" as one of the engines of growth in the Korean economy, which is consistent with the insights of the new growth theory. In Porter's model, raising national competitiveness or productivity is a critical factor.[2] In this regard, this paper shows that productivity is determined not only by factor intensity (capital-labor ratio) but also by knowledge intensity (of the labor force) of the sectors, and that knowledge intensity has steadily increased over the last decade in Korean manufacturing, but that Korean industrial growth is still dominated by physical capital accumulation. Taking up Dunning's question, from the point of view of developing countries, this paper investigates the relationships between outward DFI and several explanatory variables, such as trade performance, change in profitability, and factor and knowledge intensity of the sectors.[3]

The period covered in this paper is between the late 1980s and early 1990s. This interval can be considered the period of structural adjustment following the two preceding periods of stable growth (1981-1985) and of boom (1985-1988). The constructed database integrates industrial, trade, and direct foreign investment data from three different sources. Further explanations about the database are found in section 2. In section 3, using data, classified into 28 manufacturing sectors, two primary variables which characterize each sector were constructed, labor intensity and knowledge intensity. In sections 4 and 5,

2) Porter's theory of national competitive development identifies the following four stages of development: factor-driven, investment-driven, innovation-driven, and wealth-driven stages. According to this framework, Korea has entered the investment-driven stage and is having difficulties moving into the next stage of innovation-driven development.

3) Although Dunning has identified successive stages of investment development, such as stages when there were no foreign investment, inward foreign investment, building ownership advantages, and outward foreign investment, he has not explicitly explained the mechanism, nor sorted out critical explanatory variables for the stage transition. This is especially obvious in his examination of developing countries.

several secondary variables are introduced, such as value-added per worker, profitability, and shares in world exports. Finally, these secondary variables explain growth and structural adjustment by referring to the three sub-phenomena of sectoral growth, outward direct foreign investment, and national competitiveness. In section 6, as a synthesis of the results in the preceding sections, a mechanism of growth and structural adjustment in the Korean economy is summarized in a diagram. Section 7 discusses several policy implications based on the findings.

2. THE DATABASE

The database is constructed based on the raw data from the Industrial Census Yearbook and the Report of the Industrial Statistics Survey for the years: 1981, 1985, 1987, 1988, 1989, 1990, and 1991.[4)] In the database, manufacturing subsectors are classified into 28 subsectors (three digit codes) according to the Korean Standard Industrial Classification system. The variables include: total number of firms, value-added, value of shipments, wage sums, value of fixed capital, total employment, and total number of professionals and engineers for each sector. Sectoral price data, used to deflate nominal variables, are taken from the Economic Statistics Yearbook published by the Bank of Korea in 1992.

Next, the industrial census data is complemented by trade data. Raw data, originally in UN standard SITC three digit codes, have been re-classified into 28 sectors for the 1981 to 1992 period in order to be consistent with the industrial census data based on the Korean Standard Industrial Classification system. Finally, outward direct foreign investment data has been compiled

4) One problem is that the Korean Statistical Office changed the classification system in 1993 and applied this new system for the statistics regarding 1991 and after. For the three digit level, they now classified manufacturing into 60 sectors, compared with the earlier 28 sectors. To make a compatible database, I have had to re-classify the 1991 statistics. In this work, there were no great difficulties except for some new industries such as the recycling industry. Because there was no comparable industry in previous years, I have simply excluded this new industry in the database. Due to the partial incompatibility of data before and after 1991, I did not use 1991 industrial data in the regression analysis.

from the raw data provided by the Bank of Korea. This book provides, for every outward DFI case, the names of firms, kinds of products, invested and contracted amounts, dates, and destinations. More than 1400 cases of outward DFI records for the 1986 to 1992 period are classified into 28 sectors and added to the database.

3. THE BASIC FEATURES OF MANUFACTURING SUBSECTORS

In this section, using the basic variables from the database, two primary variables are constructed to characterize the manufacturing subsectors. The primary variables are labor (capital) intensity (number of employment divided by the value of fixed capital) and knowledge intensity. Knowledge intensity is measured, as in Hufbauer (1970), by the proportion of professionals and engineers in the total employment of each sector.[5)]

Table 1 presents the ranks in knowledge intensity and shares in world exports of sectors. The knowledge intensive sectors include, from the top, the petroleum product, other chemical, industrial chemical, printing, beverage, oil refinery, non-electric machinery, transportation equipment, electric and electronics industries. The knowledge scarce sectors include, from the bottom, the footwear, apparel, china, textile, tobacco, and wood product industries. A quick comparison indicates that Korean exports are, unfortunately, dominated by knowledge scarce industries.

Table 2 is a two-by-two classification of manufacturing subsectors according to both labor and knowledge intensity. The criteria are the average values of

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5) The industrial census book provides only the combined numbers of professionals, engineers, and white collar workers for each sex in each sector. The problem is that white collar workers include many unskilled workers, such as secretaries, who are mostly women. Thus, as an approximation to the number of professionals and engineers, I have used the number of male professionals, engineers, and white collar workers, assuming that the number of female professionals and engineers are negligible and much smaller in number than the number of unskilled female white collar workers.

Table 1 Ranks in Knowledge Intensity and World Export Shares of Industrial Sectors, 1991

Knowledge Intensity	Shares in World Export
1. Petroleum Product	1. Footwear
2. Other Chemicals	2. Leather
3. Industrial Chemicals	3. Apparel
4. Printing	4. Textiles
5. Beverages	5. Electric & Electronics
6. Oil Refinery	6. Primary Metals
7. Non-electric Machinery	7. Other Manufacturing
8. Transportation Equipment	8. Rubber
9. Electric & Electronics	9. China
10. Nonmetals	10. Fabricated metals
11. Basic metals	11. Plastics
12. Non-ferrous metals	12. Nonmetals
22. Other manufacturing	22. Paper products
23. Wood products	23. Printing
24. Tobacco	24. Tobacco
25. Textiles	25. Other chemicals
26. China	26. Wood products
27. Apparel	27. Beverages
28. Footwear	28. Petroleum product

Source: Constructed from the Author's database. See the text.

Table 2 Characteristics of Industrial Sectors

	Knowledge Scarce	Knowledge Intensive
Labor Intensive	Footwear, Apparel, Leather, Wood product, Furniture, China, Medical & Scientific Equipment, Other Manufacturing (8)	Printing (1)
Capital Intensive	Foods, Tobacco, Textiles, Paper products, Rubber products, Glass products, Plastics (7)	Beverages, Industrial Chemicals, Oil Oil refinery, Other Chemicals, Petroleum products, Other nonmetals, Basic metals, Non-ferrous Metals, Fabricated metals, Non-electric Machinery, Electric & Electronics, Transportation equipment (12)

Source: Constructed from the 1991 industrial census data.

labor and knowledge intensity in 1991. According to table 2, those important industries, which are sometimes called "hi-tech," such as the machinery, transportation equipment, electric and electronics, fabricated metals, and petrochemical industries, all belong to the knowledge and capital intensive group. Most of the labor intensive industries belong to the knowledge scare group, indicating that the majority of the employed were unskilled labor. It might appear that knowledge and capital intensity go together; however, it should be noted that there are many sectors, such as the plastics, glass, rubber, tobacco, textile, and food industries, which are capital intensive but knowledge scarce. Also, it should be kept in mind that knowledge intensity and

Table 3 Trend of Knowledge Intensity, 1981-1991

Sector codes & Names	1981	1985	1988	1990	1991
311 Foods	16.6%	17.1%	18.5%	17.9%	18.0%
313 Beverages	31.9%	36.4%	31.6%	32.3%	30.2%
314 Tobacco	10.8%	13.9%	13.2%	12.9%	12.8%
321 Textiles	7.2%	8.1%	9.2%	9.7%	10.7%
322 Apparel	5.9%	6.5%	7.5%	8.2%	8.3%
323 Leather	11.6%	11.3%	14.1%	15.7%	17.0%
324 Footwear	10.5%	10.9%	10.8%	12.9%	7.8%
331 Wood Product	11.5%	12.1%	11.6%	13.0%	13.0%
332 Furniture	10.5%	10.4%	10.4%	12.9%	14.6%
341 Paper Product	13.0%	17.2%	17.8%	18.1%	18.7%
342 Printing	25.2%	28.3%	27.8%	28.5%	30.4%
351 Industrial Chemical	22.0%	23.5%	22.6%	24.5%	31.0%
352 Other Chemical	30.9%	33.0%	30.6%	31.6%	31.5%
353 Oil Refinery	28.1%	34.5%	31.5%	37.1%	25.1%
354 Petroleum product	27.4%	30.2%	30.3%	29.6%	33.1%
355 Rubber product	7.2%	6.3%	7.7%	8.6%	16.0%
356 Plastics	10.7%	15.1%	17.0%	18.05	18.9%
361 China	5.4%	8.7%	8.7%	8.7%	8.4%
362 Glass product	13.5%	13.8%	13.4%	14.9%	14.5%
369 Nonmetals	14.0%	16.7%	18.4%	19.9%	21.3%
371 Basic metals	13.2%	17.4%	15.2%	20.3%	21.2%
372 Nonferrous metals	17.2%	16.9%	17.6%	18.6%	19.9%
381 Fabricated metals	14.3%	15.3%	17.9%	19.4%	19.9%
382 Non-electric Machinery	17.5%	20.2%	21.5%	22.6%	23.5%
383 Electric & Electronics	13.4%	17.2%	16.9%	19.1%	22.1%
384 Transportation equipment	20.8%	21.5%	23.7%	23.9%	22.9%
385 Medical & Scientific Equipment	11.3%	12.4%	16.8%	18.8%	18.1%
390 Other Manufacturing	9.3%	8.8%	10.7%	12.7%	13.2%
Average	15.4%	17.3%	17.6%	19.0%	19.4%

Source: Constructed using the author's data base. See the text.

Table 4 Ranks in Value-added per worker and Shares in World Exports of Industrial Sectors

	Value-added per Worker		World Export Shares
	1981	1991	1991
11 High Value-Added Sectors	1. Oil refinery 2. Tobacco 3. Beverages 4. Industrial Chemicals 5. Basic metals 6. Other chemicals 7. Petroleum product 8. Nonmetals 9. Paper products 10. Nonferrous metals 11. Transportation equipment	Tobacco Oil refinery Beverage Basic metals Industrial chemicals Other chemicals Nonmetals Transport. Equipment Glass product Petroleum product Nonferrous metals	Footwear Leather Apparel Textiles Elec. & Electronics Primary Metals Misc. Manufacturing Rubber China Fabricated Metals Plastics
7 Low Value-Added Sectors	22. Other manufacturing 23. Footwear 24. Wood products 25. Furniture 26. Rubber products 27. China 28. Apparel	Wood products Medical & Science products Textiles Other manufacturing China Apparel Footwear	Paper products Printing Tobacco Misc. Chemical Wood products Beverages Petroleum products

Source: Constructed from the author's database.

capital intensity are changing and the relative ranks are also changing and different across countries. In general, the overall trend is that both capital and knowledge intensity have been steadily increasing in most of the Korean manufacturing subsectors.

Table 3 presents the trends of knowledge intensity over the 1981 to 1991 period. The bottom row shows that the average knowledge intensity was 15.39 percent in 1981 and increased to 19.35 percent in 1991. The increasing trend was sharp during the more recent period of 1988 to 1991, which is the period of structural adjustment, as well as during the early 1980s. Among the subsectors, a rapidly growing industry, such as electronics, shows a bigger jump of 6 percentage points from 13.4 percent in 1981 to 19.1 percent in 1991. In contrast, a sunset industry, such as textiles, shows a very slow increase, from 7.2 to 9.7 percent.

Table 4 presents the ranks in terms of value-added per worker, as well as shares in world export markets. According to the 1991 ranking, high value-added sectors include, from the top, the tobacco, oil refinery, beverage, unfabricated metal, and chemical industries. It should noted that those leading industries of Korea, in terms of output shares, such as the electric and electronics, textiles, transportation equipment, and machinery industries, are all medium or low value-added sectors. Furthermore, the leading industries, in terms of export shares, such as apparel, footwear, and leather, are all low value-added sectors. One industry that shows a big jump in the value-added per worker is transportation equipment (including automobiles), which has recently emerged as the leading industry of Korea.

4. THE BASIC MODEL AND ITS ESTIMATION

In this section, the two primary variables are used in regression analysis to find out the determinants of several secondary variables that shape the basic industrial structure of the Korea economy. For this, initially, an estimation of production function of a Korean manufacturing industry is made. The production function is assumed to take the following standard Cobb-Douglas form.

$$Q_i = A_i L_i^a K_i^b \qquad i = 1, 2, ..., n \ , \qquad (1)$$

(From now on, the subscript *i*'s will be omitted for simplicity)

where Q is output in real terms, L labor service, and K capital service. The term A representing technological progress measures efficiency in the use of labor and capital input, and is assumed to be a function of the knowledge intensity of the labor force. Here, knowledge intensity is measured by the proportion of professional and engineering workers to total employment, such that

$$A = f\,(N/L) = B(N/L)^c \ , \qquad (2\text{-A})$$

where N denotes the number of professional and engineering workers, respectively.[6] Then, the equation (1) can be rewritten as follows.[7]

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6) See Barro and Sala-i-Martin (1995) for approaches to endogenous growth theory relying on the production function with both physical and human capital.

7) Thus, in this set-up, total labor (L) is the sum of knowledge intensive labor (N) and "ordinary" labor. Furthermore, the maximum level of production prevails when N is as large as L, namely all labor is knowledge intensive.

$$Q = B(N/L)^c L^a K^b \,. \tag{3-A}$$

Equation (3-A) can be considered as having been derived through the following process. First, we assume that the *A* term (technological progress) is a function of the effects of learning-by-doing which is assumed to be a function of physical capital stock and knowledge intensity of labor force, such that

$$A = f\,(N/L, K\,) = B(N/L)^c K^d \,. \tag{2-B}$$

This assumption follows Arrow (1962) and Romer (1986), and implies that learning-by-doing works through each firm's investment. As further explained in Barro and Sala-i-Martin (1995), an increase in a firm's capital stock leads to a parallel increase in its stock of knowledge. This process reflects Arrow's idea that knowledge and productivity gains come from investment and production, a formulation that was inspired by many empirical observations of the large positive effects of experience on productivity. Here, this idea is further extended by adding a parameter (knowledge intensity) which represents the idea that learning-by-doing is related not only with capital stock but also with the nature of the labor force. In other words, for a given amount of capital, the extent of learning-by-doing can be larger when the labor force is more knowledge intensive.

Furthermore, the level of knowledge intensity can be considered as representing the degree of specialization of the labor force, which should be one of the important determinants of technological innovation as specialization encourages investment in specific human capital. In other words, the idea is that a given amount of labor force can produce different amounts of outputs depending upon the characteristics of the labor force. When the nature of the labor force is more knowledge intensive, it might generate more output and have more capacity for innovation than a knowledge scarce labor force. Also, a more knowledgeable labor force would run a given amount of capital more efficiently.

If we put (2-B) into (1), we have

$$Q = B(N/L)^c L^a K^e \,, \qquad (3\text{-B})$$

where $e = b+d$. The equations (3-A) and (3-B) are basically the same equation in empirical estimation.

If production shows constant returns to scale with regard to labor and capital inputs such that $a+e = 1$, then equation (3-B) can be transformed into a new form such that

$$\text{VALB} = (Q/L) = B(N/L)^c(K/L)^e \,, \qquad (4\text{-A})$$

where VALB stands for value-added per worker.

Equations (3-B) and (4-A) were first estimated using the pooled time series and cross sectional data of the manufacturing subsectors between 1987 through 1990.[8] The pooled data covering the 4 years, 1987 through 1990, is used, and the special case of the petroleum refinery and tobacco sectors having a very small number of firms are excluded. Model 1 and Model 2 in table 5 presents the results of the estimations, respectively. However, the restriction that $a+e = 1$ is tested by the F-statistics and is rejected. Then, a joint hypothesis that $a+e = 1$ and $c+e = 1$ was tested, and the hypothesis was not rejected. In this case, equation (4-A) can be expressed as

$$\text{VALB} = (Q/L) = B(N/L)^{1-e}(K/L)^e \,, \qquad (4\text{-B})$$

which is equivalent to

$$\text{VANL} = (Q/N) = B(K/N)^e \,. \qquad (5)$$

To estimate the parameter e, equation (5) was estimated by regression analysis, and the results are presented in Model 3 in table 5.

Table 5 Valued-Added, Value-added per Worker and Profitability, 1987-1990

8) Barro and Sala-I-Martin also derives this production function of the form like (4-A). However, they have simply assumed constant returns to scale. This paper provides an empirical justification of that assumption for the case of Korea.

Human Capital Augmented Production Function

Model 1: Dependent Variable: Value-added

Constant Term	Knowledge Intensity	Employment	Capital Stock	Adjusted R Square	F-Statistics
5.50 (15.0)**	0.45 (7.7)**	0.62 (11.3)**	0.48 (15.5)**	0.95	618.8**

Model 2: Dependent Variable: Value-added per Worker

Constant Term	Knowledge Intensity	Capital Intensity	Adjusted R Square	F-Statistics
6.21 (15.0)**	0.48 (7.4)**	0.45 (13.2)**	0.86	320.4**

Model 3: Dependent Variable: Value-added per knowledge intensive labor

Constant Term	Capital to Knowledge Labor Ratio	Adjusted R Square	F-Statistics
6.08 (17.8)**	0.47 (15.7)**	0.71	247.8**

Model 4: Dependent variable: Profitability

Constant Term	Capital to Knowledge Labor Ratio	Non-labor Income Share	Adjusted R Square	F-Statistics
6.21 (14.4)**	-0.54 (15.4)**	1.08 (6.62)	0.70	119.1**

Note: 1) All variables are in log forms.
2) t-statistics are in the parentheses. The "**" denotes that the coefficient is significant at the 1 percent level.
3) The number of the observations is 104. Tobacco and petroleum sectors are excluded due to the very special nature (limited number of the firms) of the sectors.

Equation (4-B) and the estimated results show that the more knowledge intensive and capital intensive a sector is, the higher valued-added per worker a sector produces.[9] Another problem may be that the high value-addedness of a sector reflects some price effects associated with market imperfections or entry restrictions imposed by the government to protect the sector. In this

9) There does exist a negative (positive) correlation between labor (capital) intensity and knowledge intensity, however it turns out to be "not serious" according to the multicollinearity test of the SAS program.

Table 6 Growth Rates of Capital, Knowledge Labor, and Aggregate Labor (percentage, annual average)

	1981 - 1985	1985 - 1990	1981 - 1990
Aggregate Labor (*L*)	4.0	3.7	3.8
Knowledge Intensive Labor (*N*)	7.0	6.4	6.6
Capital Stock (*K*)	7.7	12.0	10.0
Knowledge Intensity (*N/L*)	3.0	2.7	2.8
Capital Intensity (*K/L*)	3.0	8.3	6.4
Capital to Knowledge Labor Ratio (*K/N*)	0.7	5.6	3.4

Note: Aggregate labor is defined as the total number of employees in each sector. Knowledge intensive labor is measured by the male professional and administrative workers as a proxy. 1985 values of capital stock are used to calculate annual growth rates.

light, an implicit assumption behind this regression model is that the degree of market imperfection is the same across the sectors. According to the estimated coefficient (e) in Model 3 of table 5, a one percent increase of knowledge intensity leads to a 0.53 percent increase of value-added per worker. Since the average value-added per worker is about 18,000,000 won per year in 1985 constant value, this increase amounts to 95,400 won per worker.

The restriction, $a+e=1$, implies that constant returns to scale applies with respect to labor and capital inputs. In this regard, a critical matter is what happens to labor intensity as labor increases. As the trend of labor intensity in table 3 shows, knowledge intensive labor increases faster than does average labor. In other words, for example, when labor and capital inputs double, labor intensity does not stay at the same level but increases and this increase leads to an additional gain in productivity. Here, knowledge intensity or knowledge accumulation plays the role of the "engine of growth," as in many theoretical models (Romer, 1996, Ch. 3).[10)]

Table 6 shows that knowledge intensive labor increased almost twice as fast as aggregate labor did over the 1981-1990 period, although it increased much slower than capital stock. Interestingly, the trend of increasing labor intensity seems to be slowing down, whereas the capital to both knowledge

10) Of course, there is a need for the concrete mechanism of knowledge accumulation to be specified, focusing on the relationship between growth of ordinary labor and that of knowledge intensive labor.

and aggregate labor ratios seem to be ever increasing.[11] This implies that whereas increasing knowledge intensity contributed to productivity growth, overall growth in Korean manufacturing is still dominated by physical capital accumulation. Thus, if we borrow Porter's terminology, Korean economic development is still at the stage of investment-driven development.

Next, profitability is defined as the ratio of gross profit (value-added minus labor costs) to the value of capital stock, such that

$$\begin{aligned} \text{PRCP} &= (Q - wL)/K \\ &= ((Q - wL)/Q) * (Q/K) \\ &= (1 - wL/Q) * (Q/K) \\ &= (1 - m) * (Q/K)\,, \end{aligned} \tag{6}$$

where w is real wage rates, m is the labor share of income, and PRCP is (capital) profitability. In other words, equation (6) expresses profitability as a function of capital productivity (Q/K) and non-labor share of income ($1- wL/Q$).

Under the condition of constant returns to absolute scale ($a+e = 1$) and relative scale ($c+e = 1$), equation (6) can be rewritten as follows:

$$\begin{aligned} \text{PRCP} &= (1- m)(Q/K) \\ &= (1- m)B(N/L)^{c}(K/L)^{e-1} \\ &= (1- m)B(N/L)^{1-e}(K/L)^{-(1-e)}\,. \end{aligned} \tag{7-A}$$

According to equation (7-A), profitability is a positive function of non-labor income share and knowledge intensity and a negative function of capital intensity. For regression purpose, the equation (7-A) is equivalent to

$$\text{PRCP} = (1- m)B(K/N)^{-(1-e)}\,. \tag{7-B}$$

11) The faster growth of knowledge intensive labor is an observed fact in the 1980s. But, our model is neither saying, nor is it based on the assumption, that it always grows faster than "ordinary labor."

This equation (7-B) is estimated and reported in Model 4 of table 5. The results show that a one percent increase of knowledge intensity leads to a 0.46 percent increase of profitability and a one percent increase of capital intensity leads to a 0.54 percent decrease of profitability. As table 6 shows, both knowledge and capital intensity increased over the 1980s, however capital intensity increased much faster than knowledge intensity. The consequence is a gradual decline in profitability as the ratio of capital to knowledge labor increases.

Also, the results show that a one percent increase in the non-labor income share leads to a 1 percent increase of capital profitability. The non-labor income share can be increased either by lowering the average wage or reducing employment at the same level of wage rates. In other words, since the labor share of income is equivalent to the ratio of real wage rates (w) to average labor productivity (Q/L, value-added per worker), this ratio or the gap between real wage rates and value-added per worker will likely affect profitability. If the market satisfies the conditions of perfect competition, the labor share of income (m) should be constant and equal to the elasticity parameter (a) in the original production, equation (3-A). However, as expected, the sample mean of the labor share of income is 0.32, which is quite different from the estimated value of parameter a (0.62) in model 1 of table 5.[12] In this sense, the difference between the labor share of income (m) and elasticity (a) measures the degree of market imperfection in Korean manufacturing. Due to this market imperfection, the wage rate is, on average, less than the marginal productivity of labor in Korean manufacturing.

The major findings with the basic model can be summarized as follows. The knowledge and capital intensive sectors tend to be high value-added sectors, but capital intensive sectors are not necessarily more profitable. In this light, Krugman's (1994) criticisms against high value-added sectors are misplaced because they are based on the assumption that high-value addedness can be reduced to high capital intensity. The results here show that the value-addedness of a sector is related not only to capital intensity but also

12) However, cross time variations of the mean are quite small; the sample mean of labor's shares of income were 0.32 in 1981, 0.32 in 1985, 0.30 in 1987, 0.31 in 1988, 0.34 in 1989, and 0.30 in 1990.

to knowledge intensity. However, simply promoting capital intensive sectors is bad because profitability is negatively affected, other things being equal.

5. NATIONAL COMPETITIVENESS, OUTWARD FOREIGN INVESTMENT, AND SECTOR GROWTH

Since 1993 with the change in government leadership, "national competitiveness" has emerged as the catch-phrase symbolizing a new direction in economic policy in Korea (EPB, 1993). Actually, the concept of "national competitiveness" or the "competitive advantage of nations" has become central in theoretical and policy debates not only in Korea but also in many countries including the US.[13] Above all, Porter (1990) argues that national competitiveness, if it can be meaningfully defined, can be reduced to productivity levels of industries within a nation, which can be measured as the share in world exports of sectors with high (labor) productivity.[14]

Table 7 presents the results of regression analysis relating the Korean share in world exports with value-added per worker and profitability in each of the manufacturing subsectors as in the following equation:

$$\text{EXSH} = f\,(\text{PRCP, VALB}) \qquad (8\text{-A})$$
$$= f\,(N/L,\ K/L)\ , \qquad (8\text{-B})$$

where EXSH stands for the Korean share in the world export market for each sector. Results of model 1 show that Korean shares are high in low value-added sectors with high profitability. Like before, since value-added per worker and profitability are functions of knowledge and capital intensity, I

13) For a good review on this concept, see the chapter on technology and competitiveness in OECD (1992).

14) According to Porter (1990, p. 9), "A rising share of world exports is tied to living standards when rising exports from industries achieving high levels of productivity contribute to the growth of national productivity.... However, the particular mix of industries that are exporting is more important than a nation's average export share."

Table 7 Sectors with High Shares in World Exports, 1987-1990

Dependent Variable: Korean Share in World Export by Manufacturing Sub-sectors

	Constant Term	Value-Added per Worker	Profitability	Adjusted *R* square	*F*-statistics
Model 1	0.25 (5.3)**	-0.03 (-5.6)**	0.04 (4.0)**	0.35	29.0**
	Constant Term	Knowledge Intensity	Capital Intensity	Adjusted *R* Square	*F*-Statistics
Model 2	0.13 (2.5)*	-0.02 (-2.74)**	-0.02 (-3.5)**	0.35	29.1**

Notes: 1) All variables are in log forms, except export shares and profitability.
2) *t*-statistics are in the parentheses. The "**" and "*" denote that the coefficients are significant at the 1 percent, and 5 percent level, respectively.
3) The number of the observations is 104. The tobacco and petroleum sectors are excluded due to the very special nature (limited number of the firms) of the sectors.

have estimated equation (8-B) in model 2 in table 7. It shows that Korean exports are still mostly from labor intensive and knowledge scarce sectors.

Although these models do not provide estimations of the standard export function itself, the results confirm the negative correlation between Korean export shares and value-added per worker. Thus, if we accept shares in world exports of high productivity sectors as representing national competitiveness, Korea's competitiveness is low, as its world export shares in high productivity sectors remain low.

The regression results in table 7 are consistent with the information contained in table 4. According to this table, the top 4 industries, in terms of world export shares, are all industries with low value-added per worker, such as footwear, apparel, leather goods, and textiles. None of the top 10 industries, in terms of value-added per worker in 1988 and 1991, ranks within the top 6 in terms of world export share. For example, the electric and electronics goods sector ranks fifth in terms of world export shares. However, this is only a medium value-added per worker industry and does not belong to the top 10 in terms of value-added per worker.

Although the commodity structure of Korean exports has been upgraded, shifting away from light to heavy-chemical industries —from labor intensive to capital intensive industries and from final goods to intermediate goods industries —the overall value-added per worker remains low and international competitiveness has declined recently. According to research by the Bank of Korea, which decomposed the growth of export values into price and volume effects, price increases accounted for only 14.9 percent during the 1989-1992 period, compared to 43.3 percent during the 1986-1988 period (Park and Kim, 1993). In contrast, volume increases account for 85.1 percent during the 1989-1992 period, compared to 56.7 percent during the 1986-1988 period. These indicate the continuation of an undesirable export structure that depends on the volume increase of cheap and medium priced goods, but without upgrading into high value-added items.

The same research finds that both indices of the average value-added per worker in exports and the average value-added inducement of exports have declined or stagnated recently after an increase during the 1986 to 1988 period. For example, one dollar's worth of exports induced 0.67 dollars of value-added in 1988, which was an improvement when compared to 0.63 dollars in 1986. However, in 1990, there was no increase from the 1988 level.

Besides delayed upgrades, the weakening of international competitiveness has also been pointed out by Park and Kim (1993). Table 8 decomposes the growth of export values into three factors of demand expansion, demand composition changes, changes in price competitiveness and the commodity composition of exports. According to this table, export growth rates declined from 26.1 percent for the 1986-88 period to a mere 6.0 percent for the 1989-92 period. The main reason for this change was the weakening of price competitiveness, causing a drop from a positive 15.4 percent to a negative 3.1 percent.

Table 8 Decomposed Contributions to Export Growth

Contributions in % points

	Growth Rates of Exports(%)	Changes in Demand	Changes in Demand Composition	Change in Prices
1980-1985	12.4	2.2	1.5	8.7
1986-1988	26.1	12.0	-1.3	15.4
1989-1992	6.0	8.2	0.9	-3.1

Source: Taken from Park and Kim (1993); Originally calculated using data from the various issues of the Balance of Payments (Bank of Korea) and Direction of Trade Statistics (IMF).

As is well known, the weakening of price competitiveness is related to the rise in wage rates during this period. However, wage rates in Korean industries are still low, compared to those in advanced countries, although they have increased sharply. In other words, the problem does not lie in the rise of wage rates but in the slower rise of value-added per worker. The wave of wage rate hikes has revealed the Achilles' heel of the Korean industry, the low value-addedness per worker. The eroding of competitiveness was most serious in the leading export industries, mainly in labor intensive sectors. Thus, one form of structural adjustment for these industries was direct foreign investment in low wage countries in Asia.

Table 9 presents the results of regression analysis to find out which sectors tended to generate more outward direct foreign investment flows in Korea. The dependent variable is the tendency of a sector to conduct outward DFI, measured by the number of the cases of outward investment divided by the total number of firms in each sector.[15] The regression models relate the outward DFI propensity with world export shares, profitability, export growth, and change in profitability as follows:

$$\text{OUTDFI} = f\,(\text{EXSH}, \text{PRCP}, \text{MARKET}, \text{EX}_g, \text{PRCP}_g)\,, \qquad (9)$$

where OUTDFI stands for outward DFI tendency, MARKET is a dummy variable for the three sectors, industrial chemical, miscellaneous chemical, and electric and electronics, and EX_g and PRCP_g stand for change in export volume and change in profitability, respectively. Justification for such a regression model is as follows.

In the so-called eclectic paradigm of international production (Dunning, 1988), one of the most fundamental conditions for outward DFI is the possession of certain ownership advantages. We can expect that before going abroad to invest, a firm's ownership advantage should be reflected in their export performance in the world market. When their ownership advantage is

15) In the regression models, outward DFI propensity is measured over the 1988-1992 period by dividing the number of approved investment projects by the total number of firms in each sector. It is assumed that this year's economic situation motivates firms to make outward DFI decisions in the next year.

Table 9 Determinants of Outward Direct Foreign Investment in Korea, 1987-1990

Dependent Variable: Outward DFI Propensity

	Model 1	Model 2	Model 3	Model 4
Constant Term	0.002 (1.6)	0.003 (4.3)**	0.01 (1.7)	0.02 (4.4)**
Share in World Exports	0.06 (4.6)**	0.06 (5.9)**		
Profitability	0.001 (0.6)			
MARKET	0.004 (3.5)**	0.004 (3.7)**	0.01 (3.9)**	0.005 (3.8)**
Capital Intensity			-0.001 (2.0)*	-0.002 (-3.5)**
Knowledge Intensity			-0.001 (-1.2)	
Change in world Exports volume	-0.004 (-2.2)*	-0.004 (-2.3)*	-0.004 (-2.2)*	-0.005 (-2.6)*
Change in profitability	-0.002 (-0.6)		-0.002 (-0.5)	
Adjusted *R* Square	0.31	0.32	0.18	0.19
F-statistics	9.9**	16.5**	5.2**	8.2*

Note: 1) The total number of observation has changed to 100 due to missing values.
2) Outward DFI propensity is measured by the number of DFI cases divided by a total number of firms in each sector in each year.
3) MARKET is a dummy for the following three sectors: industrial chemical, miscellaneous chemical, and electric and electronics.
4) Logged values of capital intensity and knowledge intensity are used in regressions.
5) *t*-statistics are in parentheses. The "**", and "*" denote that the coefficients are significant at the 1 percent, and 5 percent level, respectively.

strong, their share in the world market should be high. In our model, the variable representing the Korean share in the world market for each sector (EXSH) is included to represent the ownership advantages or competition advantages of Korean firms in that sector. In Lee and Plummer (1992), Balassa's RCA (Revealed Comparative Advantages) index is used. However, in regressions, export share and RCA are equivalent since the Korean share in world exports in each sector is the RCA of each sector times a constant (amount of total Korean exports divided by amount of total world exports). The use of export shares instead of RCA can be also justified in terms of our interest in Porter's concept of national competitiveness, explained above. The variable of change in export volume is included to test whether or not change in export volume (for example, reduction) affects a firm's decision to conduct outward DFI.[16)]

The relationship between outward DFI and the profitability of a sector has long been a subject of investigation. Lee and Plummer (1994) used the term, "profit advantage," to explain the idea that firms will initiate international production when the profit rate in international production is at least higher than that in domestic production, although this is not a sufficient condition. A simple hypothesis can be that outbound sectors should have some financial resources supported by high profitability and be motivated to invest abroad by declining profitability. Inclusion of profitability and its change variables in regression models tests this hypothesis.

A dummy variable (MARKET) is included for the three sectors, industrial chemical, miscellaneous chemical, and electric and electronics, because these sectors have somewhat different incentives when compared with labor intensive sectors to go abroad. Many surveys of Korean firms conducting outward DFI have found that these three sectors are local market-oriented, rather than cheap labor-oriented, in their DFI projects (KEIB, 1992; IITMR, 1991). This pattern is true not only in the Asian market but also in the OECD market. Since the variable of EXSH mainly represents DFI from the leading exporters of labor intensive industries, I thought that inclusion of a dummy for the above three sectors was necessary.

Results from model 1 in table 9 indicate that those sectors most likely to go abroad are the leading export sectors, reflected in their high world market shares, but they have experienced a decline in export volumes. The coefficient for the MARKET dummy is also significant. The results are basically consistent with the findings of Lee and Plummer (1992). The importance of profitability and its change in explaining the outward DFI tendency is not confirmed by the results, as their coefficients are not significant. However, their signs tell us that those sectors with financial resources, as measured by higher profits, which have experienced declining profitability (perhaps due to rising wage rates), tend to go abroad.

16) A more natural variable to be included is the change in the share of world exports so that we may test whether firms would respond to changes in their competition advantage. However, in actual regressions, this variable is not significant. This indicates that from the firm's perspective, change in export volume, rather than change in export shares is a more direct and important measure of its changing competitiveness.

As before, since both the world export share and profitability are functions of capital intensity and knowledge intensity, in models (3) and (4) these two variables replace the variables of world export share and profitability. The adjusted *R* squares are not substantially reduced. Regardless, the results are consistent with the preceding ones, indicating that labor intensive sectors that experience declining exports tend to go abroad.

Industrial structure is often identified with the relative shares of industrial subsectors, which is determined by the growth of the output values of each sector. Regression models presented in Table 10 attempt to find out which are the fast growing sectors. Three relationships are examined. First, the question of whether or not fast growing sectors are also high valued sectors is examined by adding the value-added per worker variable as a regressor in the model. Second, the question of whether or not highly profitable sectors are also growing fast is examined by trying the profitability variable as a regressor. Third, the question of whether internationally competitive sectors are also growing fast is examined by inserting the share in world exports variable as a regressor. Thus, the basic estimation model is expressed as,

$$\text{GROWTH} = f\,(\text{VALB, PRCP, EXSH})\ . \qquad (10\text{-A})$$

Since the relationships between output growth and changes in valued-added per worker, profitability, and export growth, respectively, are also interesting, these three variables were tried as well. In this case, the estimation model becomes

$$\text{GROWTH} = f\,(\text{VALB, PRCP, EXSH, VALB}_g, \text{PRCP}_g, \text{EX}_g\,)\ . \qquad (10\text{-B})$$

As before, since valued-added per worker (VALB), profitability (PRCP), and share in world exports (EXSH) are all functions of capital and knowledge intensities, the following regression model, which is equivalent to the reduced form of (10-B), was also estimated,

$$\text{GROWTH} = f\,(K/L,\ N/L,\ \text{VALB}_g,\ \text{PRCP}_g,\ \text{EX}_g)\ . \qquad (10\text{-C})$$

Table 10 Determinants of Growth of Value-Added in Korea Manufacturing Sectors, 1987-1990 (N = 100)

Dependent Variable: Growth rates of Value-added

	Model 1	Model 2	Model 3
Constant term	-1.02 (-4.4)**	-0.74 (-4.1)**	-0.75 (-4.9)**
Value-added per worker	0.11 (4.7)**	0.08 (4.2)**	0.08 (5.2)**
Profitability	0.10 (2.1)*	0.03 (0.7)	
Share in World Export	-0.56 (-1.4)	-0.29 (-0.9)	
Change in Value-added per worker		0.39 (5.6)**	0.32 (5.1)**
Change in Profitability		0.38 (5.7)**	0.43 (6.8)**
Change in export volume		0.09 (1.9)*	
Adjusted *R* Square	0.25	0.59	0.58
F-statistics	12.2**	24.9**	46.7**
	Model 4	Model 5	Model 6
Constant term	-0.41 (-1.8)	-0.38 (-2.3)*	-0.44 (-4.4)**
Capital Intensity	0.06 (3.2)**	0.05 (3.3)**	0.05 (4.8)**
Knowledge Intensity	0.03 (0.8)	0.02 (0.7)	
Change in Value-added per worker		0.44 (6.5)**	0.38 (6.1)**
Change in profitability		0.37 (5.6)**	0.41 (6.3)**
Change in export volume		0.09 (2.1)*	
Adjusted *R* Square	0.19	0.58	0.57
F-statistics	12.4**	28.5**	44.2**

Note: 1) The total number of observations is 100.
2) The logged values of the following variables of valued-added per worker, capital intensity, and knowledge intensity are used in regressions.
3) *t*-statistics are in parentheses. The "**" and "*" denote that the coefficients are significant at the 1 percent, and 5 percent level, respectively.

Regression results from model (1) in table 10 are an estimation of equation (10-A). They show that while high valued-added and profitable sectors are growing fast, internationally competitive sectors are not. However, only the relationship between output growth and valued-added per worker turns out to be significant and stable. The coefficients of profitability and world export share variables are either insignificant or unstable, as shown by model (2). The results in model (2) along the equation (10-B) indicate that fast growing sectors are also those whose valued-added per worker and profitability are increasing over time. Although the coefficients of export growth are significant in model (2), they did not pass some sensitivity tests.[17] Thus, model (3) is the only one with results which have both significant and stable variables included in the regression. Models (4), (5), and (6) are estimations along equation (10-C). The coefficient of the capital intensity variable is significant, whereas that of the knowledge intensity variable is not significant. The basic message from these results is that the fast growing sectors are mostly capital intensive but not necessarily knowledge intensive.

The findings of this section can be summarized as follows. Labor and knowledge intensive sectors in Korean manufacturing industry tend to enjoy higher profitability, and capital and knowledge intensive sectors have high valued-added per worker. In other words, knowledge intensity is something that is always good, but capital intensity is a mixed blessing. In Korean industry, those sectors growing rapidly tend to be high value-added sectors and capital intensive but not knowledge intensive sectors. Furthermore, the national competitiveness of Korea is low because those sectors with high world export shares are low value-added sectors, and the internationally competitive sectors are, as yet, knowledge scarce and labor intensive sectors.

6. THE MECHANISM OF GROWTH AND STRUCTURAL ADJUSTMENT: A SYNTHESIS

17) Failure to pass the sensitivity test here means that omitting or adding such variables as change in value-added per worker and change in profitability affects seriously the level of significance of the variable of change in profitability.

A synthesis of the analyses in sections 3, 4, and 5 can derive the mechanism of growth and structural adjustment in Korean industries. Figure 1 presents a sketch of the mechanism, which is a summary of all the functional relationships verified by the regression analyses.

The mechanism first designates the two primary variables, capital intensity and knowledge intensity, which characterize each sector of the Korean manufacturing industry. Then, several secondary variables are derived from primary variables, such as value-added per worker and profitability. Finally, these secondary variables explain growth and structural adjustment by referring to the three sub-phenomena of changes in sectoral output shares, outward direct foreign investment, and national competitiveness.

A brief explanation of the main linkages in the mechanism is as follows. First, the two primary variables, capital intensity and knowledge intensity, determine the level of both value-added per worker and capital profitability. The positive or negative signs in the arrows indicate a positive and negative

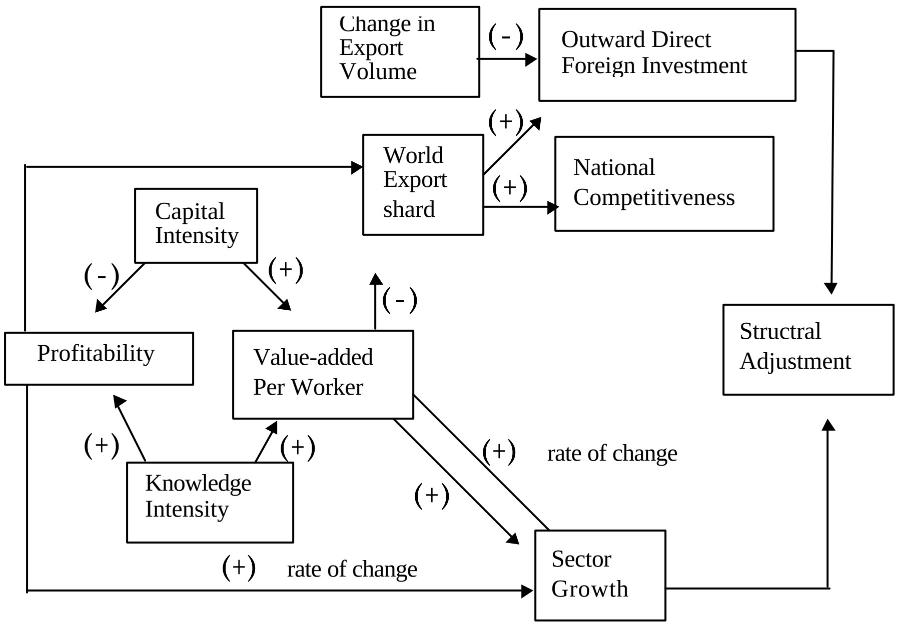

Figure 1 The Mechanism of the Growth and Structural Adjustment in

the Korean Economy

impact, respectively. According to the diagram, first, the more knowledge and capital intensive, the higher value-added per worker, and, second, the more knowledge and labor intensive, the higher the profitability. The high valued-added sectors are also the faster growing sectors experiencing an increase in value-added per worker and profitability but not necessarily currently high profit sectors.

The problem is that the fast growing sectors are mostly capital, albeit not necessarily knowledge intensive, sectors. This is not a desirable pattern of industrial change since high capital intensity eventually leads to declining profitability. Another undesirable aspect of the Korean economy has to do with national competitiveness, which is implied by the negative correlation between value-added per worker and shares in world exports. In other words, those sectors performing well in world export markets are not high value-added sectors but low or medium value-added sectors, which signifies weak national competitiveness according to Porter. The leading export industries of Korea have a strong tendency to outward DFI. Their aim was not so much to respond to change in profitability as to defend their export market by transferring their production sites to the protected markets, like in the EU or NAFTA, or low wage sites in Southeast Asia and China.

7. POLICY IMPLICATIONS

The growth mechanism of the Korean economy, summarized in the previous section, has several policy implications. Enhancing Korea's national competitiveness, and increasing its share of world exports in high value-added products, can be accomplished in two ways. One way is to make the current leading export industries higher value-added. Another is to promote exports from currently high value-added industries.

The former option implies transforming footwear, apparel, and textiles from labor-intensive industries into knowledge-intensive industries. This means shifting away from assembly-oriented production based on unskilled labor into design, material processing and development-oriented production, utilizing skilled labor and professionals (Kang, 1992). Such transformation requires greater investment in national and firm-level education and a training system as well as their reform.[18)]

Structural adjustment in labor intensive industries should take dual tracks combining the overseas production of low value-added products and domestic specialization in high value-added products (Kim, Kim and Han, 1992). Domestic specialization in high value-added products requires reductions in the weight of OEM production and the development of indigenous brand and product differentiation, whereas overseas production should concentrate on Korean brand products.

The latter option of export promotion in currently high value-added industries should be taken cautiously. In the current Korean industrial structure, the top high value-added industries include petroleum refinery, tobacco, and beverages, and not the so-called high-tech industries. Those industries having higher technological opportunities and belonging to the top high value-added industries in the advanced countries usually include fabricated metals, machinery, electronics, and transport equipment. In Korea, however, they are not high value-added but only medium value-added industries. Therefore, Korea's first task is to make these industries high value-added as in the advanced economies. Only when this occurs will it then be possible to export successfully in world markets. The feasibility of this option, of course, depends on the R&D and innovations in these sectors.

It is true that high value-added sectors have grown faster, and that in every sector, the value-added per worker is increasing in constant terms. However, the relative output shares between high and low value-added sectors are not changing as rapidly. Specifically, the growth rates of labor productivity in high value-added sectors are not much higher than those in low value-added sectors. This fact may be an indication of the ineffectiveness of various policy measures to promote high value-added industries as well as inefficient and unnecessary government regulations.

Also, the results have shown the degree of market imperfectness in Korean

18) Of course, simply investing more in education would not be sufficient. The way to educate people should be changed so as to nurture creativity, which is crucial for high-tech industries.

manufacturing. If markets function well, resource allocation across sectors should be sensitive to relative profitabilities and, thus, profitability should equalize across sectors. However, the sectoral variance of profitability is, although reduced recently, still relatively high in Korea, at 3.86 compared to 2.66 in Japan (K.T. Lee, 1993), and fast growing sectors are not necessarily highly profitable.[19] This may be due to the existence of various regulations on the market mechanism which implies that a more stringent reduction of government regulations are a necessity.

Relatedly, it can be said that Krugman's (1994) criticisms against high value-added sectors are wrong because high-valued addedness cannot be simply reduced to high capital intensity. To the extent that the high value-addedness of a sector originates from its knowledge intensity rather than its capital intensity, promotion of high value-added sectors makes sense as industrial policy, especially when profitabilities are not equalized across sectors due to market imperfections.

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19) Sectoral variance of profitability has steadily decreased, reflecting a reduction in market distortions; whereas in 1981, the standard deviation of (capital) profitability was 0.53, it was reduced to 0.31 in 1985, and to 0.21 in 1989.

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