KDI 政策硏究
第26권 第2호(통권 第94호)

# 생산성과 무역패턴: 1990년대의 한국경제의 경험

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# Productivity and Patterns of Trade: The Experience of Korea in the 1990s

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* Parts of this paper were originally prepared for the project entitled "Industrial Competitiveness of Korea", organized by the Department of Industrial and Corporate Affairs at the KDI, and presented to the 2004 KDI-KAEA Conference. The author is grateful to Chunsik Woo, Chin-Hee Hahn, Dongseok Kim, Jaeho Lee, Joonghae Suh, participants to the conference and two anonymous referees for their helpful comments and encouragement. In particular, Dongseok Kim and Jaeho Lee provided invaluable advice on productivity and trade performance, respectively. Assistance from Jungmi Kim and Kwangsung Kim is greatly appreciated.

• Key word : Total factor productivity, Total factor input, Competitiveness, Revealed comparative advantage
• JEL code : F14, O47

# ABSTRACT

This paper analyzes the industrial growth of Korea in the 1990s and its relationship with the nation's export performance. The result shows that total factor productivity (TFP) played a significant role in the growth of some industries, where in particular a sharp increase in TFP was observed in the electrics and electronics industry and the automobile industry in the late 1990s. While CEPII RCA indexes for the Korean industries such as IT industry and automobile industry significantly increased since 1998, only limited evidence was found that TFP or TFI influenced RCA. Investigating Korea's export performance in the Northeast Asian context, this paper shows that, in the 1990s, the growth of Korea's exports to Japan was led by industries that recorded relatively fast growth in total factor input (TFI). In contrast, that to China was almost equally contributed by industries that experienced relatively fast growth in TFP or TFI. This paper also investigates competition between Korea and China, and Korea and Japan in the world market. The competition between Korea and China was relatively stronger for the Korean industries to whose growth TFI made a more significant contribution. While no decisive evidence is found for the relationship between TFP growth in Korean industries and their competition against Japan in the world market, it is revealed that the competition between Korea and Japan became less intense for the Korean industries to whose growth TFI made a stronger contribution. In this regard, the paper supports the view of 'nut-cracking' that the Korean economy has lost its competitiveness in the sectors where it maintained comparative advantage, but failed to catch up more advanced countries such as Japan by gaining competitiveness in more capital or technology intensive sectors.

1990년대의 한국경제는 여러 가지 극적인 변화를 경험하였다. 가장 극적이었던 경제위기와 그로부터의 회복에 가려지기 쉽지만, 우리 경제가 겪은 가장 중요한 변화 중의 하나는 총요소생산성이 산업성장의 주요 동력으로 자리매김한 것이다. 본 연구는 이 기간 동안의 산업성장동력의 변화가 무역성과에 미친 영향을 특히 한국-중국-일본의 구도 속에서 분석한다. 무역성과의 분석을 위해서는 산업별 수출성과, CEPII 현시비교우위지수, 경합도 등이 사용되었다. 분석결과, 한국이 거의 모든 산업, 특히 노동집약적인 분야에서는 중국의 추격을 허용한 반면, 자본집약적이거나 기술집약적인 부문, 즉 총요소생산성의 증가가 성장을 주도한 산업에서는 일본을 극히 제한된 부문에서만 따라잡는 것으로 나타나, 저간에 회자되는 'nut-cracking'의 우려가 1990년대부터 발생하였음을 보이고, 이로부터 벗어나는 것이 더 이상 미룰 수 없는 심각하고 시급한 과제임을 역설한다. .

# I. Introduction

Korea has been one of the most important players in Asia since the early 1960s, contributing to the world's economic growth and dynamism. While each and every stage in the Korean economy's development process since the early 1960s has been dramatic, one of the most significant turning points of the Korean economy was the ambitious launching of the heavy and chemical industry oriented policy by the government in 1972. This policy of encouraging six strategic industries - steel, petrochemicals, non-ferrous metals, shipbuilding, electronics and machinery - has been criticized for having distorted markets. Nevertheless, it is also observed that the industries protected or subsidized by this policy grew up to lead the nation's economic growth, at least up to the crisis in 1997.

While the Korean economy recorded remarkable growth until 1997, Kim (2001) and Kwack (2001) point out that the economy in fact had lost its competitiveness in the run up to the outbreak of the economic crisis, through unnecessary compromise of the Roh government (1988-1993) over the demands of workers. They also argue that large-scale economic reform without prudent economic considerations by the successive Kim government (1993-1998) worsened the situation. As a result, costs such as material costs, labor costs, and borrowing costs had been consistently increasing, which was accompanied with a substantial increase in the unit value of exporting goods until 1995 (Tcha and Lee, 2003). KDI's (2003) study on the competitiveness of the Korean industries also revealed that total productivity of Korean industries during the first half of the 1990s fell short of that before and after the period.

The 1990s was a period of storm and stress for the Korean economy. Though the economy faced various challenges, it broke through US$10,000 of GDP per capita entering a new era, joined the OECD, but shortly after, was engulfed in a crisis. Nonetheless, the years of 1999 and 2000 demonstrated unprecedented recovery from the crisis. This paper investigates the Korean economy during this critical period, in particular, concentrating on growth of the industry and changes in certain aspects of trade. In analyzing the aspects of trade, the nation's relationship with China and Japan is particularly focused.

Section II of this paper analyzes the structural changes in the industries by concentrating on their growth. In particular, based on growth accounting, the contribution of total factor inputs (TFI) and total factor productivity (TFP) to growth is analyzed for 17 manufacturing sectors using the KDI multisectoral data. Section III discusses structural changes in trade in the 1990s. Revealed comparative advantage (RCA) indexes developed by Centre d'Etudes Prospectives et d'Information Internationales (CEPII) are calculated for each industry to find structural changes in relative advantage of the nation. In addition, the export similarity index (ESI) is used to discuss competition between Korea, China and Japan in the world market. The evolution of the nation's export pattern during this period is also discussed. The findings from Sections II and III are integrated in Section IV. The relationship between growth of TFI and TFP, and certain aspects of trade – RCA and ESI – in each industry is analyzed. Further, it is investigated whether each industry's RCA and its experience of competition against Japan and China is inter-related. The major findings in this study are consistent with Heckscher-Ohlin Crowding Hypothesis (Leamer and Lunborg, 1995), which is well known as "nut-cracking" effect in more popular terms. Heckscher-Ohlin Crowding Hypothesis explains the situation where one economy is caught up by late-comers and loses comparative advantage for the sectors that it conventionally maintained comparative advantage, and at the same time, cannot construct strong comparative advantage for more advanced sectors. This study confirms that in general, the competition between Korea and China was getting severe in the sectors where Korea traditionally possessed comparative advantage, but Korea failed to gain competitiveness against Japan in the sectors where Japan maintained comparative advantage. The paper concludes with Section V.

# Ⅱ. The Changes in Industrial Structure in Korea

## 1. The Changes in Industrial Structure - Overview

In 1990, as reported in Table 1, Korea's total GDP was 178,797 billion won (nominal), where the contribution from manufacturing reached 55,681 billion won, or 31.1% of GDP.[1] This fell slightly to about 30.9% of GDP in 1992 and remained stably within the range of 30-31% until 1997. The year of 1998 witnessed a rapid growth in manufacturing, and the sector bounced back to explain more than 32% of GDP, producing 156,877 billion won.

While manufacturing stably explained about 30-32% of GDP throughout the period of the 1990s, some dramatic changes in the structure inside of the manufacturing sector was observed. The most prominent change is, as shown in Table 1, the sharp decrease in the

[1] Most figures used in this paper are from KDI (2003) unless otherwise informed.

share of textile & apparel (T&A) in manufacturing which fell from 10.7% in 1990 to 4.3% in 2000. The value of product from this industry during the period in fact increased until 1994 in both nominal and real terms, nevertheless, the industry's growth rate was far behind that of the entire manufacturing sector, subsequently shrinking relative to other industries. Similarly, the chemical products and automobile industries experienced slight decreases in their shares during the period, which respectively ranged about 11-13% and 8-10% of the entire manufacturing. General machinery explained about 7.6% of manufacturing on average, and maintained a share of 7-8% throughout the period, ending up with 7.2% in 2000. The electric & electronics (E&E) industry, which contains four sub-industries – semiconductors, electronics and parts (E&P), IT equipments and home appliances – experienced the most dramatic increase in product value and share. The industry produced 7,956 billion won or 14.3% of manufacturing in 1990, which increased by more than four times to reach 32,663 billion won or 18.5% of manufacturing in 2000.

In summary, the total value of products and shares increased for all five major manufacturing industries[2], except for T&A, for which the share rapidly decreased. The share of E&E increased most significantly, and the shares for the remaining three industries – chemical products, general machinery and automobiles - were by and large maintained or slightly declined with mild fluctuations.

Looking inside of E&E revealed that the four sub-industries in this category experienced different growth patterns. For example, semiconductor industry grew more than seven folds for five years since 1990, and explained 5.8% of manufacturing products in 1995. Since then, growth has been retarded and the share has fallen to 3.8% in 2000. The growth of IT equipment showed an opposite trend. Larger than the semiconductor industry by almost four times in 1990, despite the rapid growth, its size fell behind semiconductors industry in 1995, accounting for 5.7% of manufacturing output. However, the industry grew very rapidly in late 1995, and regained its position as the largest E&E sub-industry in 2000, with a share of more than 49% in E&E or 9.2% of manufacturing. E&P and home appliances also recorded substantial growth during the period, however, their growth rates were lower than the other two industries, and subsequently their shares in total manufacturing were relatively stable.

[2] These five major industries include T&A, E&E, chemical products, general machinery and automobile industries as shown in Table 1. As E&E in turn disaggregates into four industries, these five major industries are in fact eight industries in the classification by the KDI (2003). They explained major portions of employment, total output and exports throughout the 1990s.

**<Table 1> Total Product and Manufacturing Share for Major Industries in Korea**

(unit: billion won, %)

| | 1990 | 1995 | 2000 |
|---|---|---|---|
| Textile & Apparel | 5,979 | 7,833 | 7,549 |
| | (10.7) | (6.7) | (4.3) |
| Chemical Products | 7,422 | 15,057 | 20,232 |
| | (13.3) | (12.9) | (11.5) |
| General Machinery | 4,147 | 9,385 | 12,798 |
| | (7.4) | (8.1) | (7.2) |
| Electricity & Electronics | 7,956 | 19,221 | 32,663 |
| | (14.3) | (16.5) | (18.5) |
| Semiconductors | 947 | 6,775 | 6,642 |
| | (1.7) | (5.8) | (3.8) |
| Electronics & Parts | 2,837 | 5,271 | 8,428 |
| | (5.1) | (4.5) | (4.8) |
| IT Equipment | 3,690 | 6,582 | 16,155 |
| | (6.6) | (5.7) | (9.2) |
| Home Appliances | 482 | 593 | 1,438 |
| | (0.9) | (0.5) | (0.8) |
| Automobiles | 5,675 | 11,787 | 14,486 |
| | (10.2) | (10.1) | (8.2) |
| Others | 24,502 | 53,200 | 88,806 |
| | (44.0) | (45.7) | (50.3) |
| Total Manufacturing (A) | 55,681 | 116,483 | 176,534 |
| | (100.0) | (100.0) | (100.0) |
| GDP (B) | 178,798 | 377,350 | 521,959 |
| A/B | (31.1) | (30.9) | (33.8) |

*Source* : Rearranged from KDI (2003).
*Notes* : Numbers in parentheses are the manufacturing share of each industry.

## 2. Total Factor Inputs (TFI) and Total Factor Productivity (TFP)

In conventional economic analysis of economic growth, total output is determined by a combination of factors, in particular, capital and labor. Therefore, the growth of output is contributed by the growth of factor inputs and total factor productivity. Total factor productivity used in this paper is obtained from KDI (2003), where each manufacturing industry's TFP was calculated based on growth accounting.

According to Solow (1957) and Griliches (1994), the objective of growth accounting is to break down the growth rate of aggregate output into contributions from the growth of inputs and the growth of technology. Using a conventional neoclassical production function, this aggregate relationship at time *t* is,

$$Y(t) = A(t) \cdot F[K(t), L(t)],$$

where *Y* is output[3], $A(t)$ is and index of the level of technology, or is called total factor productivity (*TFP)*[4], and *K* and *L* represent capital and labor respectively. To take logarithms of both sides and time derivatives produces the growth rate of aggregate output,

$$\dot{Y}/Y = \dot{A}/A + \left(\frac{AF_K}{Y}\right)\cdot \dot{K} + \left(\frac{AF_L}{Y}\right)\cdot \dot{L} \ ,$$

where $\dot{X}$ stands for changes in X over time, and $F_i$ means the first order derivative of *F* with respect to input *i* ($i$ = *K, L*). Therefore $AF_i$ is the marginal product of input *i*. Multiply and divide the expression in the first set of brackets by *K* and the expression in the second set of brackets by *L* to obtain

$$\dot{Y}/Y = \dot{A}/A + \left(\frac{AF_K K}{Y}\right)\cdot (\dot{K}/K) + \left(\frac{AF_L L}{Y}\right)\cdot (\dot{L}/L) \ .$$

If the factor markets are competitive, then the marginal product of each input equals its factor price, so that $AF_K$ equals the rental rate on capital, *R*, and $AF_L$ equals the wage rate, *w*. Therefore, the term

[3] Total value added was used as Y in KDI (2003).

[4] To simplify the algebra, it is assumed that technology is Hicks neutral (or output augmenting).

$AF_K K/Y$ is the share of the rental payments to capital in total income, and the expression $(AF_L L)/Y$ is the share of wage payments to labor in total income.

Under the assumption of constant returns to scale, the capital share and the labor share add to 1 ($AF_K K/Y + AF_L L/Y = 1$). If $\alpha(t)$ is the capital share (= $AF_K K/Y$)[5], then the growth can be decomposed as,

$$\dot{Y}/Y = \dot{A}/A + \alpha(t)\cdot(\dot{K}/K) + [1-\alpha(t)]\cdot(\dot{L}/L).$$

In other words, the growth rate of aggregate output equals $\dot{A}/A$ (the growth rate of TFP), plus $\alpha(t)\cdot(\dot{K}/K)+[1-\alpha(t)]\cdot(\dot{L}/L)$, a weights average of the growth rates of the two inputs, where the weights are the corresponding input shares. KDI (2003) collated data on the quantities, $Y$, $K$, and $L$, and total labor income for each industry. The share of labor, $\alpha(t)$, was computed from total labor income and total value added, and the share of capital was calculated as $(1- a(t))$. As the growth rates, $\dot{Y}/Y$, $\dot{K}/K$, and $\dot{L}/L$ were all directly obtained from the dataset, the only term in growth accounting that could not be measured directly was the growth rate of technology, $\dot{A}/A$. Using the equation mentioned above, the growth rate of technology or TFP, $\dot{A}/A$, was indirectly obtained from

$$\dot{A}/A = \dot{Y}/Y - \{\alpha(t)\cdot\dot{K}/K + [1-\alpha(t)]\cdot\dot{L}/L\}.$$

In other words, we measured the TFP growth rate — or the rate of technological progress — as a residual; we subtracted from $\dot{Y}/Y$ the part of this growth rate that could be accounted for by the growth rate of the inputs, $K$ and $L$.[6]

Table 2 breaks down the growth of value added as contributions from TFI and TFP for selected periods.[7] For 1985-2001, the average annual growth of value-added in manufacturing was 10.60%. While the annual growth rate was 15.64% in the late 1980s, it decreased to 9.40% in the 1990s and then rose up to 17.47% after the crisis. Hahn (2003) also points out that TFP for the Korean manufacturing de-

[5] For a Cobb-Douglas technology, $Y = AK^{\alpha}L^{1-\alpha}$, the input shares are constant at $\alpha$ and $1-\alpha$, respectively.

[6] KDI's (2003) study used real values for all the variables, where the base year was 1990.

[7] KDI (2003) also computed TFP using the multisectoral index method as suggested by Caves, Chritensen and Diewert (1982) and developed by Good, Nadiri and Sickles (1997). For more information, please see KDI (2003).

## <Table 2> Decomposition of Industrial Growth (selected years)

| year | 1985-2001 | | | | | | | | 1985-1989 | | | | | | | | 1998-2001 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| year | Avg.Annual Growth(VA) | | | | Contribution (%p) | | | | Avg. Annual Growth (VA) | | | | Contribution (%p) | | | | Avg. Annual Growth (VA) | | | | Contribution (%p) | | | |
| year | VA | L | K | TFP | TFI | L | K | TFP | VA | L | K | TFP | TFI | L | K | TFP | VA | L | K | TFP | TFI | L | K | TFP |
| Food Prod. & Bev. | 5.68 | -1.10 | 6.93 | 1.01 | 4.67 | -0.29 | 4.96 | 1.01 | 9.51 | 0.48 | 10.37 | 1.95 | 7.53 | 0.14 | 7.39 | 1.98 | 4.72 | 1.71 | 3.50 | 1.42 | 3.28 | 0.41 | 2.87 | 1.44 |
| Textiles & Apparels | 0.00 | -4.37 | 3.97 | 1.07 | -0.18 | -0.46 | 0.28 | 0.18 | 9.29 | 1.95 | 12.23 | 2.86 | 6.37 | 1.06 | 5.31 | 2.92 | 6.90 | 1.36 | 4.55 | 4.11 | 2.72 | 0.80 | 1.92 | 4.18 |
| Paper Prod.,Printing,Pub. | 6.21 | 0.82 | 10.13 | 1.50 | 4.70 | 0.48 | 4.22 | 1.52 | 12.00 | 3.26 | 12.78 | 4.35 | 7.53 | 1.97 | 5.56 | 4.47 | 8.91 | 6.93 | 8.73 | 0.97 | 7.93 | 3.87 | 4.06 | 0.98 |
| Chemical Products | 10.64 | 2.69 | 12.51 | 1.94 | 8.67 | 1.10 | 7.57 | 1.97 | 17.01 | 7.67 | 16.65 | 3.47 | 13.45 | 2.92 | 10.53 | 3.57 | 7.31 | 5.68 | 4.79 | 1.91 | 5.36 | 2.23 | 3.14 | 1.94 |
| Petroleum & Coal | 9.00 | 1.83 | 15.48 | -4.29 | 13.02 | 0.14 | 12.89 | -4.02 | 9.13 | 0.54 | 17.77 | -6.06 | 14.60 | 0.05 | 14.55 | -5.47 | 4.34 | -1.02 | 5.91 | -1.14 | 5.46 | -0.05 | 5.51 | -1.12 |
| Non-metallic Min. Prod. | 6.60 | -2.18 | 7.97 | 3.56 | 2.99 | -1.06 | 4.05 | 3.62 | 16.46 | 1.92 | 11.65 | 8.47 | 7.66 | 0.88 | 6.78 | 8.80 | 9.56 | -0.26 | 0.47 | 9.34 | 0.20 | -0.15 | 0.34 | 9..36 |
| Basic Metals | 9.73 | -0.12 | 9.21 | 2.95 | 6.72 | -0.04 | 6.76 | 3.01 | 15.33 | 3.05 | 16.79 | 1.64 | 13.67 | 0.83 | 12.84 | 1.66 | 5.86 | 0.84 | 6.60 | 0.74 | 5.12 | 0.22 | 4.90 | 0.74 |
| Metals | 6.92 | 3.09 | 8.97 | 1.08 | 5.83 | 2.13 | 3.70 | 1.09 | 22.11 | 8.15 | 16.49 | 8.12 | 13.58 | 4.27 | 9.31 | 8.53 | 5.21 | 6.62 | 6.75 | -1.33 | 6.52 | 4.38 | 2.14 | -1.31 |
| General Machinery | 12.99 | 3.44 | 10.88 | 4.84 | 8.01 | 1.45 | 6.56 | 4.98 | 24.37 | 9.98 | 18.49 | 8.35 | 15.58 | 4.23 | 11.35 | 8.79 | 19.82 | 7.20 | 8.12 | 11.23 | 8.08 | 2.93 | 5.14 | 11.75 |
| Semiconductors | 28.91 | 7.29 | 24.25 | 9.32 | 19.03 | 2.73 | 16.29 | 9.89 | 45.51 | 20.07 | 29.19 | 15.37 | 28.64 | 10.07 | 18.58 | 16.86 | 20.44 | 0.44 | 5.42 | 16.56 | 3.42 | 0.12 | 3.30 | 17.02 |
| Electronics & Parts | 21.13 | 3.74 | 15.77 | 9.76 | 10.88 | 1.61 | 9.27 | 10.25 | 24.27 | 9.86 | 27.29 | 4.25 | 19.87 | 4.45 | 15.42 | 4.40 | 38.79 | 9.84 | 14.89 | 22.88 | 14.02 | 3.92 | 10.10 | 24.77 |
| IT Equipment | 19.96 | 0.66 | 8.65 | 14.01 | 5.41 | 0.29 | 5.12 | 14.55 | 28.56 | 11.13 | 18.45 | 11.88 | 15.89 | 5.41 | 10.49 | 12.67 | 40.02 | 7.01 | 11.20 | 27.50 | 10.53 | 3.08 | 7.45 | 29.49 |
| Home Appliances | 11.95 | 0.86 | 8.52 | 6.87 | 4.89 | 0.49 | 4.40 | 7.06 | 29.46 | 16.83 | 25.52 | 7.01 | 22.08 | 9.00 | 13.08 | 7.38 | 21.79 | 3.33 | 5.84 | 16.55 | 4.66 | 2.14 | 2.52 | 17.14 |
| Automobiles | 14.56 | 5.22 | 16.12 | 2.98 | 11.51 | 2.43 | 9.08 | 3.05 | 27.04 | 17.21 | 29.58 | 2.35 | 24.64 | 7.28 | 17.36 | 2.40 | 20.00 | 1.61 | 3.12 | 17.11 | 2.53 | 0.78 | 1.75 | 17.48 |
| Other Trans. Equipment | 10.61 | 0.82 | 8.11 | 5.60 | 4.87 | 0.41 | 4.46 | 5.74 | -6.96 | -7.45 | 1.40 | -3.76 | -3.26 | -3.76 | 0.50 | -3.70 | 24.57 | 4.82 | 1.73 | 20.77 | 3.23 | 2.22 | 1.02 | 21.34 |
| Precision Instruments | 7.17 | 0.75 | 8.16 | 1.49 | 5.66 | 0.26 | 5.40 | 1.51 | 25.01 | 8.02 | 23.33 | 5.81 | 18.94 | 3.03 | 15.91 | 6.07 | -1.06 | 4.71 | -3.15 | -0.42 | -0.64 | 1.26 | -1.90 | -0.42 |
| Other Manufacturing | 4.31 | -2.81 | 6.18 | 3.29 | 1.00 | -1.27 | 2.27 | 3.31 | 17.34 | 3.77 | 13.78 | 8.116 | 8.84 | 2.13 | 6.71 | 8.50 | 11.92 | 4.71 | 7.32 | 5.46 | 6.31 | 2.23 | 4.07 | 5.61 |
| Manufacturing | 10.60 | 0.12 | 10.40 | 4.33 | 6.16 | 0.05 | 6.11 | 4.44 | 15.64 | 5.10 | 15.55 | 4.14 | 11.38 | 2.18 | 9.20 | 4.26 | 17.47 | 4.34 | 5.68 | 11.68 | 5.37 | 1.69 | 3.68 | 12.10 |

*Source* : Rearranged from KDI (2003).

creased in 1995- 1998, compared to 1990-1995. These figures support Kim (2001) and Kwack (2001) who argue that the competitiveness of the Korean economy eroded in the early 1990s, although some fundamentals of the economy appeared to be healthy. The resurgence of a high growth rate after the crisis is considered to be largely due to the death and exits of inefficient firms during the crisis, and the birth of young and efficient firms since then, together with the better allocation of resources. This view is in line with the rapid increase in TFP after the crisis, as will be discussed later.[8] Overall, machinery, E&E and automobile industries experienced higher growth whereas T&A did not grow at all.

Though not reported in Table 2, it is noteworthy that the KDI study (2003) revealed that the leaders of growth changed from small firms to large firms during this period.

It is well known that Korea started its economic growth in the 1960s by concentrating on the industries that had comparative advantage, i.e. simple labor-intensive industries such as T&A. The fast accumulation of factors is regarded as being one of the most crucial sources of rapid economic growth, since the launch of the development plans in the early 1960s. Table 2 shows that for most industries, both labor and capital input kept increasing during 1985–2001. Three more observations regarding TFI and industrial growth are clear from the table:

(i) During the period, industries traditionally using relatively more labor (labor-intensive industries) did not grow as fast as capital-intensive industries;
(ii) The growth rate of labor input in each industry overall decreased throughout the period in general;
(iii) The growth rate of labor input in each industry was, in general, lower than that of capital. As a result, for the whole manufacturing sector for the entire period (1985-2001), labor and capital increased by 0.12% and 10.40%, respectively on average each year.

As a result, GDP (or manufacturing) share of labor-intensive industries decreased and the capital-labor ratio in each industry increased. In other words, the whole manufacturing sector was oriented towards more capital-intensive industries, and the production technology for each industry itself became more capital intensive. It is noteworthy that the semiconductor industry led the growth of labor

[8] A referee pointed out that the exit and entry are usually observed during the cyclical downturns rather than upturns, while the period of 1998-2001 should be regarded as the cyclical upturns. The author agrees to her/his opinion. The major reason of TFP growth during this period needs more investigation.

input, recording 7.29% of annual growth of employment whereas it also led the increase of capital input with 24.25% of annual growth. The growth of TFI became slow after the crisis (1998-2001) compared to the late 1980s. The role of capital accumulation has been substituted by higher growth rates of TFP in leading the growth since the late 1990s.

Table 2 also provides crucial information regarding TFP growth and industrial growth. The table shows that the average annual growth rate of TFP for the whole manufacturing was only 4.33% for the entire period of 1985-2001, which soared up sharply over the crisis; for 1998 – 2001, the growth rate of TFP was as high as 11.68%. Before the 1990s, the contribution of TFP growth to the growth of manufacturing was 27%, which increased to 70% after the crisis. While it may indicate that firms improved their production technology, at the same time, as suggested above, such a change might be the result of inefficient firms not being able to survive the crisis, and as new firms with greater efficiency entered the market after the crisis.

It should be also noted that, in general, the industries that grew fast showed high growth of TFP as shown from IT equipment, semiconductors, E&P, automobiles and home appliances industries, which supports the view that TFP became an important source of growth in Korean manufacturing. In particular, in the late 1990s, the growth rates of general machinery, E&E and automobile industries were far higher than the manufacturing average, where rapid increase in TFP was observed in E&E and automobiles.

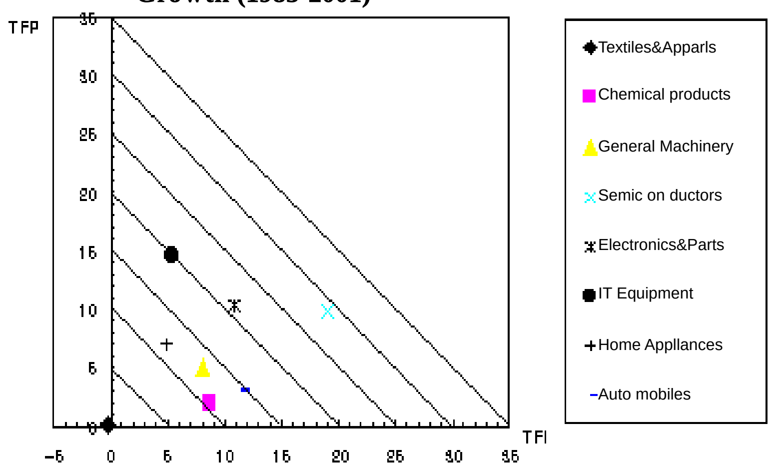
In summary, the industries with a relatively large share in manufacturing and high growth rate, such as E&E and automobile industries, led the growth of manufacturing since the late 1980s. It is also noteworthy that industries with large firms and high TFP became the engines of growth over time, in particular, since the crisis.

## 3. Contributions of TFI and TFP to the Growth of Manufacturing Sector

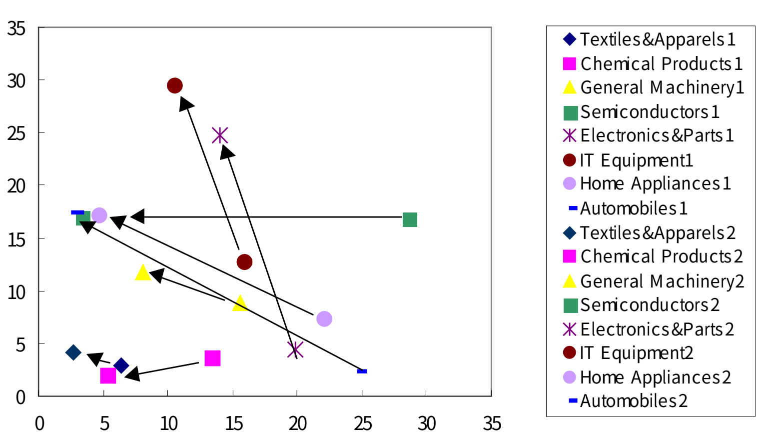
For the period of 1985-2001, the contribution of TFI to growth of the manufacturing sector reached about 58.10% while TFP was 41.90% (KDI, 2003). TFP contribution was particularly high in IT equipment (72.89% or 14.55%p out of 19.96%) and home appliances (59.10% or 7.06%p out of 11.95%). Conversely, TFP contribution was relatively low in automobiles (20.95% or 3.05%p out of 14.56%) and chemical products (18.48% or 1.97%p out of 10.64%). In the late 1990s, however, TFP became substantially high in these industries as well; the contribution of TFP to growth increased from 27.24% in the late 1980s to 69.26% after the crisis (1998-2001) for the entire manufacturing sector including industries such as semiconductors (83.28% or 17.02%p out of 20.44%), automobiles (87.37% or 17.48%p out of 20%), home appliances (78.62% or 17.14%p out of 21.79%) and IT equipment (73.68% or 29.49%p out of 40.2%).

Figure 1 shows the average annual growth rate of some major industries and contributions from TFI and TFP growth for 1985-2001 based on KDI (2003). The straight line connecting the same numbers in each axis indicates the iso-growth curve, where any point on the

**[Figure 1] Decomposition of Contribution from TFP and TFI to Growth (1985-2001)**




**[Figure 2] Changes in Contribution from TFP and TFI to Growth (From 1985-1989 to 1998-2001)**



line represents the same growth rate. For example, the growth point for IT equipment lies around the line connecting 20% growth of TFI and TFP, respectively, meaning that the industry experienced about 20% of annual growth during the period. Furthermore, the accurate position of the point explains the contribution of TFI and TFP to growth. For instance, the figure shows that for IT equipment industry that recorded about 20% of annual growth, 5%p of growth (or about 25% of total growth) was due to factor accumulation, while 15%p (or about 75% of total growth) was due to TFP growth. The figure illustrates that while the overall growth rate was the highest in semiconductors, a large portion of the growth was due to factor accumulation. The three industries that recorded the highest growth rates (semiconductors, E&P and IT equipment) received a larger contribution from TFP in absolute terms. However, in relative terms, the contribution from TFP to growth was the highest in semiconductors followed by home appliances. The contribution of TFP to growth was relatively low for automobiles, chemical products and T&A.

The dynamics of the growth, as summarized in Figure 2, provides substantially different features from Figure 1. The arrows in the figure represent the move of the average annual growth for each industry from 1985-1989 to 1998-2001. Four findings should be highlighted:

(i) For all the concerned industries, except chemical products, the arrows point in a northwest direction; meaning that over the period, the industries' growth became more dependent on TFP growth;

(ii) The growth points of industries such as IT equipment and E&P moved up, indicating that they grew faster in the late 1990s than in the late 1980s;

(iii) While the contribution of TFP to growth increased, the growth rate of each industry, in general, decreased except for IT equipment and E&P.[9] KDI (2003) reported that the growth rates of the industries were particularly low in the early and mid 1990s, up to the crisis. Therefore, these low growths for 1998-2001 should be regarded as what recovered from the growth rates for the mid 1990s;

(iv) Contrast to our common belief, semiconductors, one of the representative exporting commodities of Korea, experienced a huge decline in the rate of growth. This decline is found to be a result of a decrease in the contribution from factors, while TFP's contribution was still maintained.

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[9] While it is not shown in Figure 1, "Other Transport Equipment" recorded 24.57% of annual growth for 1998-2001, from –6.96% in the late 1980s. This is provided in Table 2.

# III. The Relationship between Industrial Structure and Trade Structure

## 1. Changes in the Structure of Trade[10]

For nine years since 1992, the Korean manufacturing sector increased its exports to the world substantially, as summarized in Table 3. The fastest growing market for Korea during the period was China. While Korea's export of manufacturing goods to the world increased 11% on average annually, those to China recorded an annual growth of about 27%. Korea's exports to Japan grew slower compared to the world, recording an annual growth of 8%.

Table 3 also shows that most industries in Korea recorded double-digit growth in their exports to China. In particular, exports of semiconductors expanded as much as 85%, IT equipment 48%, and precision instruments 50%, annually. Korea's exports to Japan were also led by E&E; 22% of annual growth of exports of IT equipment, 20% of semiconductors, and 18% of home appliances were observed. However, the growth rate of E&P is considerably low, which implies that the patterns of regional division of trade that Korea imports parts from Japan was strong, and it was hard for Korea to penetrate the Japanese market with E&P. This finding is consistent with Ko, Cho, Lee, Lee, and Lee (2003). While the annual growth of automobile exports to China increased by 32%, exports to Japan increased by only 1%. Also, exports of petroleum and coals, chemical products and paper products to Japan recorded relatively high growth rates.

## 2. Revealed Comparative Advantage

The comparative advantage that firms or industries can acquire originates in various ways. Lafay (1992) categorizes them as follows:

i) favorable natural resource endowment of the territory concerned;
ii) lower relative costs through the choice of segment that are best suited to the macroeconomic factors of production;
iii) lower relative costs through innovation at microeconomic level in the production process;

[10] All the trade data used in this section are from KDI (2003), which modified PC/TAS by UNCTAD/WTO.

**<Table 3> Annual Average Growth Rate of Korea's Exports (1992-2000)**

| | Korea to China | Korea to Japan | Korea to world |
|---|---|---|---|
| Food Products & Beverages | 0.43 | 0.02 | 0.03 |
| | (1.56) | (0.27) | (0.26) |
| Textiles & Apparels | 0.27 | -0.08 | 0.00 |
| | (0.97) | (-1.05) | (0.03) |
| Paper Products, Printing, Publishing | 0.20 | 0.22 | 0.17 |
| | (0.74) | (2.84) | (1.61) |
| Chemical Products | 0.28 | 0.10 | 0.12 |
| | (1.00) | (1.27) | (1.09) |
| Petroleum & Coal | 0.47 | 0.25 | 0.24 |
| | (1.71) | (3.27) | (2.24) |
| Non-metallic Mineral Products | 0.42 | -0.04 | 0.07 |
| | (1.53) | (-0.58) | (0.62) |
| Basic Metals | 0.09 | 0.01 | 0.07 |
| | (0.34) | (0.09) | (0.65) |
| Metals | 0.18 | 0.09 | 0.06 |
| | (0.66) | (1.16) | (0.56) |
| General Machinery | 0.31 | 0.12 | 0.14 |
| | (1.12) | (1.59) | (1.31) |
| Semiconductors | 0.85 | 0.20 | 0.15 |
| | (3.08) | (2.62) | (1.43) |
| Electronics & Parts | 0.41 | 0.07 | 0.15 |
| | (1.50) | (0.95) | (1.36) |
| IT Equipment | 0.48 | 0.22 | 0.17 |
| | (1.74) | (2.91) | (1.60) |
| Home Appliances | 0.39 | 0.18 | 0.10 |
| | (1.41) | (2.40) | (0.91) |
| Automobiles | 0.32 | 0.01 | 0.17 |
| | (1.17) | (0.12) | (1.60) |
| Other Transport Equipment | -0.11 | 0.13 | 0.09 |
| | (-0.39) | (1.76) | (0.87) |
| Precision Instruments | 0.50 | 0.08 | 0.09 |
| | (1.83) | (0.99) | (0.81) |
| Other Manufacturing | 0.29 | -0.02 | 0.00 |
| | (1.05) | (-0.24) | (0.03) |
| Total Manufacturing | 0.27 | 0.08 | 0.11 |
| | (1.00) | (1.00) | (1.00) |

*Source* : Rearranged from KDI (2003).
*Notes* : Numbers in parentheses are the ratio of annual growth rate of each industry's exports to that of total manufacturing exports.

iv) the acquisition of monopoly elements through the microeconomic creation of new products.

Therefore, changes in both resource endowments and technology affect comparative advantage of producers. TFP may be related to microeconomic innovation in the production process (iii) or product creation (iv), and change comparative advantage. This concept of comparative advantage is often confused with competitiveness. The two essential differences between the two concepts are, according to Lafay (1992):

i) whereas competitiveness is measured between countries, for a given product, comparative advantage is measured between products for a given country;
ii) whereas competitiveness is subject to changes in the macroeconomic situation, comparative advantage is structural in nature.

As it is impossible to measure comparative advantage, which can be defined in the autarky in a very strict sense, there have been efforts in the field of economics to find comparative advantage revealed through economic activities, in particular, from transaction of commodities between countries. While one of the most significant contributions for these revealed comparative advantage (RCA) was proposed by Balassa (1963, 1979)[11], it has been widely criticized that most indexes, including Balassa's, distorted the real figures of comparative advantage as they ignore domestic consumption and production (and therefore trade balance), and take into account the flow of the relevant commodity only (for example, see Ballance, Forstner and Murray, 1987; Webster 1991). In this regard, RCA index proposed by CEPII (Lafay, 1992), which adopted a weighted indicator to reflect the contribution of trade balance and each product's importance for the coun try's total trade, is recognized as a proper index. This index $f_{ik}$ for industry $k$ in country $i$ (hereafter a weighted RCA index or CEPII RCA index) is defined as

$$f_{ik} = y_{ik} - z_{ik}$$

where $y_{ik}$ is balance in relation to GDP ($=1000\times(X_{ik}-M_{ik})/Y$) and $z_{ik}$ is attributed balance to industry $k$

[11] KDI (2003) presents RCA indexes for the Korean industries using the Balassa methods.

$( = \frac{X_{ik} + M_{ik}}{\sum_k (X_{ik} + M_{ik})} \cdot y_{ik} )$.[12] In other words, this weighted RCA index for a specific industry is obtained by correcting the conventional RCA utilizing relative balance and the attribution of the balance to the industry. Rewriting this index gives

$$f_{ik} = \frac{1000}{Y_i} \cdot \frac{2(X_{ik} M_{i.} - X_{i.} M_{ik})}{X_{i.} + M_{i.}}$$

where the subscript . stands for the flow of commodities to a reference zone (such as the world). The RCA status of an industry can be classified as:

Country *i* has RCA in industry *k* *iff* $f_{ik} > 0$,
Country *i* has RCD[13] in industry *k* *iff* $f_{ik} < 0$,
Country *i* has neither RCA nor RCD in industry *k* *iff* $f_{ik} = 0$.

Different from most RCA indexes, the absolute value of this $f_{ik}$ can be larger than one. Table 4 and Figure 3 summarize the weighted RCA indexes for Korean industries for the period from 1992 to 2000. The general trends of the indexes in the table and figure show that, in spite of relatively large fluctuations in the indexes for some industries, only P&C industry moved from the range of revealed comparative disadvantage (RCD) to RCA over the eight years, and semiconductor industry is the only one that changed its position from RCA to RCD. As of 2000, IT equipment, automobile and T&A industries possessed a strong RCA: the indexes for IT equipment and automobile industries increased and that for T&A industry decreased dramatically, but remaining positive. Overall, in 2000, Korea maintained RCA for seven industries – P&C (though very close to zero), T&A, home appliance, IT equipment, metal products, automobiles and other transport equipment industries. It is worth noting that semiconductor industry, which has been regarded as one of the most important exporting sectors of Korea, recorded a very high level of RCA in 1995 and then lost its revealed comparative advantage. In 1998, the industry recorded RCD first time in the 1990s, and the degree of disadvantage became deeper since then.

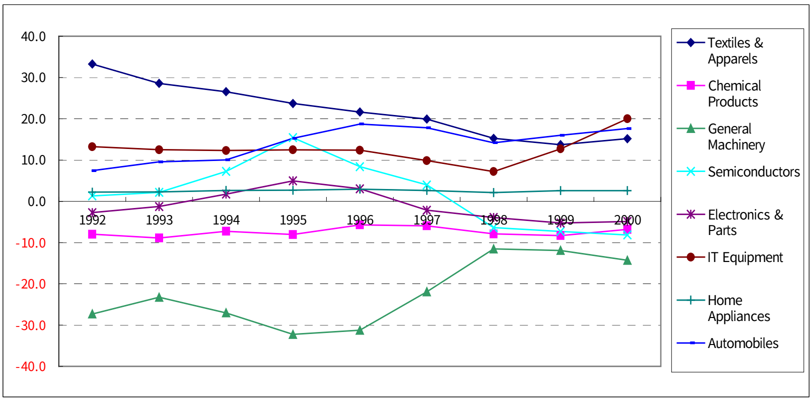
[12] *Y* is GDP, *X* is exports and *M* is imports
[13] RCD stands for revealed comparative disadvantage.

**<Table 4> CEPII RCA Indexes for Korean Industries (1992, 1996, 2000)**

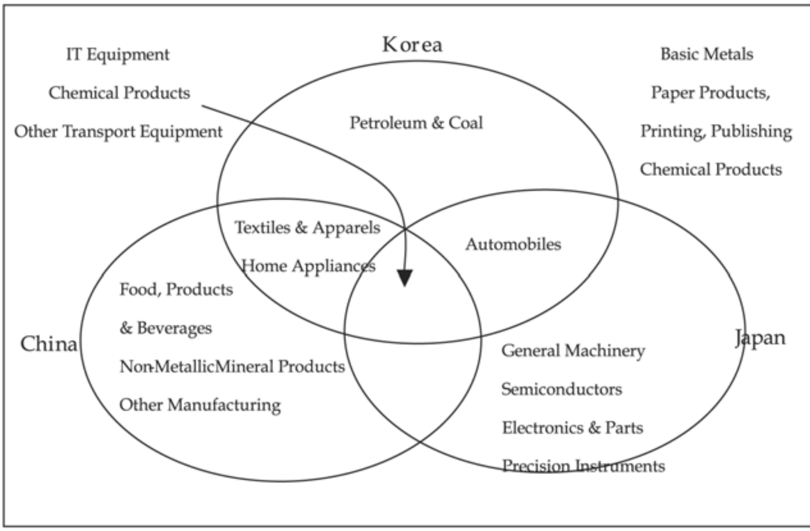
| | 1992 | 1996 | 2000 |
|---|---|---|---|
| Food Products & Beverages | -6.2891 | -7.2793 | -8.4938 |
| Textiles & Apparels | 33.2642 | 21.6454 | 15.1646 |
| Paper Products, Printing, Publishing | -3.1205 | -2.3753 | -3.8737 |
| Chemical Products | -7.9924 | -5.7064 | -6.8058 |
| Petroleum & Coal | -3.9165 | -1.8785 | 0.3701 |
| Non-metallic Mineral Products | -1.5673 | -1.9944 | -1.3128 |
| Basic Metals | -4.2772 | -11.4629 | -9.5031 |
| Metals | 1.2685 | 1.0982 | 1.2282 |
| General Machinery | -27.3191 | -31.2455 | -14.2997 |
| Semiconductors | 1.3044 | 8.3993 | -8.1473 |
| Electronics & Parts | -2.7402 | 3.0339 | -4.8919 |
| IT Equipment | 13.2469 | 12.3974 | 20.0207 |
| Home Appliances | 2.2241 | 2.9467 | 2.6003 |
| Automobiles | 7.4267 | 18.7344 | 17.6350 |
| Other Transport Equipment | 2.4981 | 4.7563 | 9.4857 |
| Precision Instruments | -5.6289 | -9.7698 | -10.4158 |
| Other Manufacturing | 1.6176 | -1.2975 | -0.6589 |

*Source* : Calculated from KDI (2003).

**[Figure 3] CEPII RCA Indexes for Selected Korean Industries (1992~ 2000)**



**[Figure 4] RCA nad RCD for Korea, China and Japan**




The average RCA and RCD of the Korean industries in the 1990s are compared to those of China and Japan in Figure 4.[14] Including P&C industry, Korea has RCA in seven industries,[15] China in eight industries and Japan also in eight industries. For three industries such as IT equipment, metal products and non-automobile transport, the three economies share RCA. In addition to these three industries, Korea and Japan have RCA for automobile industry, and Korea and China share RCA for T&A and home appliances. There is no industry that only Japan and China share RCA. In addition, no country has RCA against the world for basic metal industry. More findings from RCA analysis are summarized as the following.

i) Excluding P&C industry (where the RCA index of Korea is almost zero), at least either China or Japan has RCA for all the industries that Korea has RCA. This indicates that all the exporting commodities that Korea has structural strength are likely to face challenges from China and Japan in the world market. Further, the industries that Korea has RCA consist of both labor intensive and capital (or technology) intensive industries.

[14] Weighted RCA indexes for China and Japan's industries are available from the author on request. KDI (2003) contains Balassa's RCA indexes for the industries for the three economies.

[15] In 2000, Korea appeared to have comparative advantage in Petroleum and Coal, where it used to have comparative disadvantage. The data indicated a sudden increase in export of this commodity group in 1999 and 2000. The reason of this rapid increase needs more investigation.

ii) Japan is the only country that has RCA for some capital or technology intensive sectors such as machinery, semiconductor, E&P and precision machinery industries. It also has RCA for automobile, IT equipment, metal products and other transport equipment industries, for which Korea and/or China also have (has) RCA.
iii) China is the only country that has RCA for F&B and NMMP industries. In T&A and home appliances industries, it may compete with Korea as both countries share RCA for these two industries.

## 3. ESI for Korea-China and Korea-Japan

A variety of indexes related to trade have been developed and utilized in the previous literature. These indexes have different definitions and investigate different aspects of trade. This section reviews the trade performance of Korea using the index that investigates the extent of competitiveness of commodities exported from Korea in specific markets, in comparison with those from other countries. This index, labeled as the export similarity index (ESI), quantifies the similarity of trade structures between two countries in the same market under the assumption that the possibility of competition is higher when the trade structures for two countries are similar. ESI is computed by summing up the minimum values of each country's ratio of export of a specific commodity to a specific commodity group as

$$ESI = \sum_{k=1}^{n} \min \left( \frac{M_{ih}^{k}}{M_{ih}^{K}}, \frac{M_{jh}^{k}}{M_{jh}^{K}} \right) ,$$

where

$M_{ih}^{k}$ = market h's imports of commodity k (in commodity group K) from country i,

$M_{ih}^{K}$ = market h's total imports of commodity group K from country i,

$M_{jh}^{k}$ = market h's imports of commodity k (in commodity group K) from country j, and

$M_{jh}^{K}$ = market h's total imports of commodity group K from country j.[16]

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[16] Accordingly, the industries in subcategories are investigated to calculate ESI. For more

In this study, the entire world market is used as a destination. When two competing countries in a market are compared, if the index is zero for a specific goods, the two countries do not compete for the market with the product as one country does not export the relevant goods at all. If the index is one, then for each commodity, the trade structures of two countries are exactly the same, and they compete very intensively. Table 5 shows ESI for each industry in 1992 and 2000 computed for Korea-China and Korea-Japan. The last row of the table presents unweighted arithmetic average of ESI for each industry. Therefore, while it can provide a big picture for competition in the entire manufacturing sector, it does not tell specific information about competition between countries in industries. For example, while the ESI for total manufacturing changed more significantly for Korea-Japan, the changes of ESI for disaggregated industries tell that the fluctuation was more serious for Korea-China. The last column for each case is the growth of ESI. As of 2000, there was almost the same extent of competition measured by ESI between Korea and China overall, as in 1992. This finding does not indicate that the competition between the two countries was unchanged: there were some substantial changes in competition structure over the period. For example, competition between Korea and China in the semiconductor market significantly increased from 0.30 in 1992 to 0.68 in 2000 in ESI. It reveals that China has already become a competitor of Korea in the world semiconductor market as more foreign firms invested and produced in China. In comparison, competition between the countries in automobile industry sharply decreased from 0.43 in 1992 to 0.17 in 2000. This change implies that Korea's superiority in automobile industry has accelerated during the period, and China's automobile industry has failed to catch up Korea's in the 1990s. $ESI_{K\text{-}C}$ also significantly decreased for NMMP and T&A industries, meaning that Korea has lost its competitiveness in these two industries. For home appliances and general machinery, the index stably moved in the range of 0.50 and 0.65 throughout the period. The change for these industries over the period was insignificant, indicating that the competition structure for these goods for the two countries did not change notably. For E&E industries (except semiconductor industry) such as E&P, home appliances and IT equipment, the competition between the two economies were overall high showing intense competition has been maintained in these industries throughout the period.

Table 5 also reports export similarity indexes in 1992 and 2000 computed for Korea and Japan. It is noteworthy that overall $ESI_{K\text{-}J}$ substantially increased for the period for the two countries from 0.43

information regarding sub-industries for each industry, please see KDI (2003).

**<Table 5> ESI of Korean Industries against China and Japan**

| | $ESI_{K-C}$ (Korea-China) | | | $ESI_{K-J}$ (Korea-Japan) | | |
|---|---|---|---|---|---|---|
| | 1992 | 2000 | Change* | 1992 | 2000 | Change* |
| Food Products & Beverages | 0.35 | 0.48 | 0.13 | 0.53 | 0.58 | 0.05 |
| Textiles & Apparels | 0.54 | 0.40 | -0.14 | 0.49 | 0.58 | 0.09 |
| Paper Products, Printing, Publishing | 0.49 | 0.39 | -0.10 | 0.55 | 0.49 | -0.06 |
| Chemical Products | 0.34 | 0.37 | 0.03 | 0.54 | 0.56 | 0.02 |
| Petroleum & Coal | 0.39 | 0.44 | 0.05 | 0.65 | 0.54 | -0.11 |
| Non-metallic Mineral Products | 0.58 | 0.40 | -0.18 | 0.50 | 0.60 | 0.10 |
| Basic Metals | 0.32 | 0.35 | 0.03 | 0.54 | 0.66 | 0.12 |
| Metals | 0.61 | 0.62 | 0.01 | 0.44 | 0.48 | 0.04 |
| General Machinery | 0.48 | 0.50 | 0.02 | 0.62 | 0.62 | 0.00 |
| Semiconductors | 0.30 | 0.68 | 0.38 | 0.82 | 0.77 | -0.05 |
| Electronics & Parts | 0.63 | 0.57 | -0.06 | 0.55 | 0.57 | 0.02 |
| IT Equipment | 0.64 | 0.69 | 0.05 | 0.67 | 0.69 | 0.02 |
| Home Appliances | 0.74 | 0.67 | -0.07 | 0.75 | 0.71 | -0.04 |
| Automobiles | 0.43 | 0.17 | -0.26 | 0.71 | 0.88 | 0.17 |
| Other Transport Equipment | 0.51 | 0.49 | 0.02 | 0.42 | 0.45 | -0.02 |
| Precision Instruments | 0.52 | 0.62 | 0.10 | 0.62 | 0.64 | 0.02 |
| Other Manufacturing | 0.51 | 0.49 | -0.02 | 0.42 | 0.45 | 0.03 |
| Manufacturing | 0.42 | 0.40 | -0.02 | 0.43 | 0.53 | 0.10 |

*Source* : Computed and rearranged from KDI (2003)
*Note* : * denotes the change of the index.

to 0.53 indicating that competition between them intensified in the 1990s. The competition became significantly severe for automobile, basic metals, NMMP and T&A industries while became less intense for P&C, PPP and semiconductor industries. An increase of $ESI_{K-J}$ for automobile industry is most dramatic reaching as high as 0.88 in 2000. This shows enormous contrast to a sharp decrease in $ESI_{K-C}$ for the same industry for Korea and China. For automobile industry, Korea far exceeded China and grew up to be a significant competitor of Japan in the world market. T&A is another industry that shows prominent contrast of ESI between Korea-China and Korea-Japan. While ESI for Korea-China for T&A industry decreased from 0.54 to 0.40 in the

1990s, that for Korea-Japan increased from 0.49 to 0.58 in the same period. While it needs further investigation with more disaggregated data, nevertheless, it indirectly proves that the Korean T&A industry moved its focus from labor-intensive, low-price goods to more technology-intensive and high-quality goods, and, in consequence, competition between Korea and Japan intensified. While $ESI_{K\text{-}J}$ for home appliances and semiconductor industries decreased, those for E&P and IT equipment industries increased only marginally. For E&P, the competition index between the two countries is also very stable around 0.55-0.57, and the extent was about the same as or slightly lower than that of Korea-China. Nevertheless, the continuous decrease in the index for semiconductors and home appliances (1% per year respectively) is observed, which might be due to the relocation of production bases from the two countries to China.

In summary, the overall competition between Korea and Japan intensified in the 1990s. Nevertheless, there were substantial changes in competition between Korea and China in selected industries. Competition between Korea and China increased very rapidly in the semiconductor industry, due to the catch up process of China. In contrast, in the automobile industry, Korea has increased the gap between the two countries as proven by decrease in $ESI_{K\text{-}C}$. Korea's automobile industry grew relatively successfully, stably increasing its competitive edge against Japan (say 3% per year as measured by the ESI).

## IV. Effects of TFP growth on Trade

### 1. Introduction

This section investigates the effect of TFP growth on some aspects of trade that the Korean economy experienced in the 1990s. The aspects of trade to be investigated include export growth to China and Japan (and the world), RCA and ESI. While this section is, in particular, interested in the effects of TFP growth, the effects of other variables such as TFI growth and overall industrial growth are also analyzed. As a result, it will reveal how structural changes in industries can be interpreted in the context of international competition and revealed through trade.

More specifically, this section analyzes the relation between each industry's TFP growth and export growth followed by the relation between each industry's TFI growth and export growth. These will show how the export structure of Korea, in particular, exports to China and Japan, was affected by the growth of TFI and TFP. Second, each industry's TFP and TFI growths are compared with each industry's competition against China and Japan. This will reveal how competitiveness of Korean industries in the world market was influenced by the growth of TFP and TFI. It is also one of the major concerns of this section how the change in RCA is affected by TFI and TFP growth, and how it is related to export performance and ESI.

## 2. Growth of TFP, TFI and Exports

Previous sections investigated structural changes in Korea's industries in the 1990s, and found which industries contributed to economic growth, increasing its share in manufacturing and GDP. The contribution of TFP and TFI to industrial growth and annual growth of exports were also investigated. It is believed that the growth of TFP and TFI are related to the changes in Korea's RCA, growth in exports, and competition against China and Japan. Table 6 summarizes the correlation coefficients between the sources of each industry's growth and export growth, ESI changes, and RCA changes.

First of all, it is striking that the changes in RCA were not contributed by either source of industrial growth. Changes in RCA are positively related to TFI growth only (ρ = 0.091), but the magnitude is negligible. This result cast an important question regarding

the RCA fluctuation for the Korean industries in the 1990s. The RCA index is by definition the measure of comparative advantage revealed through trade. If neither TFI nor TFP growth (and even the industrial growth itself!) explains the fluctuation of RCA, it indicates that domestic consumption pattern also substantially changes and in consequence changes in comparative advantage may not be properly reflected in trade performance. It needs further investigation whether there is any other reason that can explain why the industrial growth is not related with RCA in the 1990s. In fact, RCA does not explain Korea's export performance to China and Japan. The growth in each in-

**<Table 6> Industrial Growth and Trade Performance: Correlation Coefficients (1992-2000)**

| | $X_C$ | $X_J$ | $X_W$ | $ESI_{K\text{-}C}$ (Korea-China) | $ESI_{K\text{-}J}$ (Korea-Japan) | RCA |
|---|---|---|---|---|---|---|
| GIP | 0.578 | 0.454 | 0.498 | 0.564 | -0.242 | -0.015 |
| TFI | 0.336 | 0.436 | 0.528 | 0.625 | -0.326 | 0.091 |
| TFP | 0.533 | 0.282 | 0.259 | 0.245 | -0.056 | -0.014 |
| TFI-TFP | -0.156 | 0.116 | 0.205 | 0.279 | -0.202 | -0.124 |
| RCA | -0.052 | -0.049 | -0.119 | -0.138 | 0.122 | 1 |

dustry's RCA is not correlated with the growth of Korea's export to the two countries. This finding supports the view that domestic consumption pattern might change substantially during the period. While the magnitudes of figures are still small, the changes in RCA is negatively related to ESI for Korea-China ($\rho$ = - 0.138) and positively related to that for Korea-Japan ($\rho$ = 0.122). It implies that the Korean industries, which experienced relatively large extent of RCA improvement, faced slightly less competition from China and more competition from Japan in the world market. This finding is reasonable considering that in Korea RCA indexes increased significantly for leading industries such as automobile and E&E in the 1990s, which were in the frontline of catching up with more advanced Japan's industries.

Second, the table indicates that all correlation coefficients for growth in industrial output (value added is used here) and export growth are positive. The industries that experienced higher growth in output, in general, experienced higher growth in exports to the world market, including both Chinese and Japanese markets. It is noteworthy that the correlation coefficient between the growth rates of TFP and exports ($\rho$ = 0.533) is substantially larger than that between the growth rates of TFI and exports to China ($\rho$ = 0.336). In other words, the Korean industries with relatively higher TFP growth are more likely to increase their export to China compared to those with relatively higher TFI growth. In contrast, the correlation coefficient for TFP growth and export growth ($\rho$ = 0.282) is substantially smaller than that for TFI growth and export growth for Korea's exports to Japan ($\rho$ = 0.436), indicating that Korea's exports to Japan were more closely related to TFI growth rather than TFP growth. This result may reflect that Korea has comparative advantage against China in the industries with higher TFP growth, and against Japan in those with higher TFI growth.

Third, it is also noteworthy that the correlations between the growth rate of TFP and exports to China or exports to Japan are larger than that to the world. In contrast, the correlations between the growth of TFI and exports to China or Japan are smaller than to the world. In the world market, Korea's export growth was more closely related to TFI accumulation rather than TFP improvement during the 1990s. The appropriateness of these analyses may be questioned as the industries with higher TFP growth could experience higher TFI growth as well. However, the correlation coefficient for TFP growth and TFI growth is only 0.142 during the period, showing that the two growth rates for each industry are fairly independent. Nonetheless, this study also calculates the correlation coefficient between the difference between TFI growth and TFP growth and export growth; the results support previous findings, showing that it is negative for growth of exports to China and positive for that to Japan. The industries with relatively higher TFI growth than TFP growth are more likely to penetrate the Japanese market successfully, while they are less likely to penetrate the Chinese market.

## 3. Growth of TFP, TFI and ESI

The comparison of the correlation coefficients between the industrial growth, growth of TFP and TFI, and ESI results in some interesting findings. First, the average annual growth rates of industry's output, TFP and TFI are all positively correlated with ESI between Korea and China, and negatively correlated with ESI between Korea and Japan. For a Korean industry, which experienced a higher growth in industry's output, TFP, and TFI during the 1990s, competition between Korea and China in the world market increased ($\rho$ = 0.564 for GIP-$ESI_{K\text{-}C}$, $\rho$ = 0.245 for TFP-$ESI_{K\text{-}C}$ and $\rho$ = 0.625 for TFI-$ESI_{K\text{-}C}$ respectively), while competition between Korea and Japan decreased ($\rho$ = - 0.242 for GIP-$ESI_{K\text{-}J}$, $\rho$ = - 0.056 for TFP-$ESI_{K\text{-}J}$ and $\rho$ = - 0.326 for TFI-$ESI_{K\text{-}J}$ respectively). The positive correlations for Korea-China imply that China also increased its exports of the commodities that grew rapidly in Korea, and consequently, competition intensified. It is interesting that competition between the two countries has the highest correlation with the growth of TFI; the Korean industries, which recorded higher growth of TFI had to deal with more intense competition from China. In contrast, the correlation between the growth rates of TFP or TFI and changes in ESI for Korea-Japan decreased for the period, indicating that competition between Korea and Japan became less intensive in the industries that grew fast in Korea. Three kinds of answers, which are completely opposite to each other, may be suggested for the Korea-Japan case:

(i) Those industries that grew fast in Korea might grow even faster in Japan and, as a result, Japanese firms were able to capture more of the growing world market;

(ii) Some Korean industries might completely catch up with Japanese industries, which would lead to a decrease in Japan's share such as memory semiconductors (in particular DRAM);

(iii) Alternatively, as KDI (2003) points out, the acceleration of relocation of production bases for these industries to foreign countries such as China, would induce a decrease in competition between Korea and Japan.[17]

[17] The three suggestions should be applied with care, especially when TFP is considered, as

Second, the correlation between TFP growth and ESI for both Korea-China and Korea-Japan is weaker than that between TFI growth and ESI for both cases. The industries whose growth was based on TFI faced more severe competition from China as aforementioned. In other words, competition from China was relatively weaker for the Korean industries that achieved a high rate of TFP growth. On the other hand, competition between Korea and Japan decreased more significantly for the industries with a relatively higher growth rate of TFI than TFP. In other words, the industries that had more contribution from TFI growth (than TFP growth) to their output growth faced less competition from Japan.

The size of the correlation coefficients for Korea and Japan requires further discussions. First of all, competition between Korea and Japan in the world market was not stable in aggregated data for selected industries. Nevertheless, the changes of ESI for many industries were insignificant. The coefficient for the growth of TFP and change in ESI for Korea-Japan is also very close to zero, which implies that TFP improvement in the Korean industries may not be sufficient to gain the competing edge from Japan in the world market. Over the period, while six Korean industries experienced very rapid growth in TFP including E&E, automobiles and other transport equipment, only one of these six industries, automobile industry, recorded substantial and positive increase in ESI against Japan. For most of these industries, notwithstanding the rapid growth, Korea still seems to have failed to catch up to Japan in the world market except for a few commodities such as DRAM.

In summary, it can be concluded that the Korean industries faced challenges from China in the 1990s, where the challenge was relatively stronger for the industries with higher TFI growth. This implies that the industries that grew fast in Korea based on factor accumulation also grew rapidly in China, possibly even faster than those in Korea. The overall competition between Korea and Japan in the world market became less intense for the Korean industries that enjoyed fast growth in TFP or TFI. More specifically, while the effect of TFP is negligible, competition was significantly reduced for the Korean industries, which were largely contributed by growth in TFI. This is consistent with the phenomena that Japan has moved from the industries dependent on TFI to those dependent on TFP, and left more room for the Korean industries supported by TFI growth. The growth of TFP is found not to have influenced competition between Korea and Japan.

the correlation between TFP growth and ESI growth is almost zero. Also a referee explained that the low correlation between TFP and ESI for Korea-Japan might be interpreted that the level of competition is structurally independent of TFP, rather than Korea did not gain competitiveness in spite of TFP growth. While this argument is plausible, the fact that Korean did not gain competitiveness is still valid. For the reason of insignificant correlation, further analysis is needed.

The relocation of production bases offshore or relatively fast growth of Japan's industries may be the cause of this phenomenon as discussed earlier.

## 4. Further Considerations

While this study investigates the growth of industries in Korea by disaggregating the sources into TFI and TFP, and analyzes their relationship with selected trade figures and indexes, there is no reason to limit our discussion to only those trade figures used in this study. For example, some other trade-related indexes such as trade specialization index, or other RCA indexes may provide invaluable information from different angles. This study analyzes the relationship between industry' growth, RCA and ESI by investigating correlation coefficients between relevant figures. More rigorous quantitative analyses could be performed when longer time series data and the information regarding sources of industrial growth for China and Japan are available. For example, $ESI_{K\text{-}C}$ is considered to depend on variables of the two countries, Korea and China, where certain variables such as TFP and TFI for China are not available at present. In this regard, to run regression using only available data will estimate parameters with bias, which will render the entire estimation meaningless. This is one of the major reasons that this study does not perform regression analysis to find the effect of TFP and TFI on competition. Nonetheless, even with the simple quantitative analyses, this study presents many interesting results, where most of them are consistent with intuition. Omission of discussion on any change in trade policy at Korea's export destinations such as China and Japan and the patterns of intra-industry trade also remains as a limitation of this study in providing more affluent and accurate information. Further studies are planned for service industries as well as manufacturing industries, and utilization of more variables such as TFP, TFI and some trade figures for relevant countries including Japan and China will enable a more direct and implicative analysis of the structural relationship between Korea, China and Japan. Furthermore, a close investigation of firm level data would supplement this study that is based on industry level data, as aggregation may distort some real figures. Also, although there is a consensus on the stylized fact that TFP or TFI growth causes changes in patterns of trade, causality between structural changes in production and trade should be further confirmed as more data are compiled.

# V. Summary

This study disaggregates the industrial growth that progressed in the 1990s in Korea into contributions from TFI and TFP growth by using data collated for KDI's multi-sectoral model. These findings are applied to the exploration of the relationship between different sources of growth (TFP and TFI) and trade performance, such as RCA and ESI.

In the process of restructuring in the 1990s, it was found that capital accumulated faster than labor in proportion in most industries. In consequence, the entire manufacturing sector was restructured towards more capital intensive, and even the labor-intensive industry used more capital-intensive production technology. TFP played a significant role in growth for select industries, and a sharp increase in TFP was observed in the late 1990s, especially for E&E and automobiles. The contributions of TFP and TFI to the growth of industries varied considerably across industries. In the 1990s, Korea's exports to China dramatically increased at an average annual growth of 27%, which is far higher than the average growth rate of exports to the world, 11%. E&E industries led Korea's exports, in particular to China, recording 40-85% of annual growth. While the industry overall led its exports to Japan as well, growth rates were lower, and exports of E&P to Japan grew very slowly, 7% per year. However, if these performance are standardized by considering the slow expansion of exports to Japan, Korea's exports of IT equipment and home appliances to Japan grew relatively faster than those to China. Overall, TFP was more closely related to Korea's export performance to China and TFI for Korea's exports to Japan.

Furthermore, it is striking that competition between Korea and China became more intense regardless whether the Korean industries experienced a fast increase in TFI or TFP. For the Korean industries that experienced fast growth in TFI, the competition against Japan became weaker. The more intense challenges from China indicate that some industries, which grew fast in Korea also grew fast, probably even faster, in China. The extent of challenges from China was relatively weaker for the Korean industries, which recorded relatively higher contribution from TFP growth. While no decisive evidence is found for the relationship between the growth of TFP and competition with Japan, it was revealed that the industries experiencing the high growth of TFI faced less competition from Japan. This pattern partly reflects that the industries whose growth depended on TFI accumulation significantly declined in Japan. It is noteworthy that this finding confirms the general concern possessed by the Korean people, from a new angle, that the Korean industries are nut-cracked between developing countries (such as China) and developed countries (such as Japan). Nevertheless, there is also a mild clue that the Korean industries climbed up the ladder to compete the Japanese industries, concentrating on the industries with higher improvement in RCA. It was found that the Korean industries that achieved higher improvement in RCA competed against Chinese industries less severely, whereas they faced more intense competition against Japanese industries throughout the 1990s.

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