CHANGING PATTERNS IN PRODUCTION AND TRADE IN KOREA – FINDINGS AND IMPLICATIONS

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This paper analyzes growth of the Korean economy in the 1990s, and its relationship with the nation's export performance. Total factor productivity (TFP) played a significant role in growth for select industries, and a sharp increase in TFP was observed in the late 1990s in Korea, especially for the electrics and electronics industry and automobile industry. In the 1990s, overall, TFP and total factor input (TFI) was more closely related to Korea's exports growth to China and Japan respectively. Furthermore, it is striking that competition between Korea and China became more intensive for the industries for which a fast increase in TFI and TFP was observed in Korea. The extent of challenges from China was relatively weaker for the Korean industries with relatively higher contribution from TFP. 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.

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I. INTRODUCTION

Korea has been one of the most important players in Asia, contributing to the world's economic growth and dynamism. While each and every moment in the Korean economy's development 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. However, 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 an increase in the unit value of exporting goods until 1995 (Tcha and Lee, 2003).

The 1990s was a period of storm and stress/trials and tribulation for the Korean economy. Though the economy faced various challenges, it broke through $10,000 of GDP per capita entering a new era, joined the OECD, but shortly after, was engulfed in

a crisis. This paper investigates the Korean economy during this critical period, in particular, concentrating on growth of the industry and trade.

Section II of this paper analyzes the structural changes in the industries by concentrating on growth. In particular, based on growth accounting, the contribution of total factor inputs (TFI) and total factor productivity (TFP) to industrial growth is analyzed. Section III discusses structural changes in trade. The export similarity index (ESI) is used to discuss competition between Korean, China and Japan. The evolution of the nation's trade pattern during this period is also discussed. The findings from Sections II and III are integrated in Section IV, and the relationship between the industry's structural changes and patterns of trade is analyzed. The paper concludes with Section V.

II. THE CHANGES IN INDUSTRIAL STRUCTURE IN KOREA

1. The Changes in Industrial Structure

In 1990, Korea's total GDP was 178,797 billion won, where the contribution from manufacturing reached 55,681 billion won, or 31.1% of GDP.[1] This fell to about 30.9% of GDP in 1992 and remained 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.

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

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)
Total Manufacturing	55,681	116,483	176,534
	(100.0)	(100.0)	(100.0)

Source: Rearranged from KDI (2003).

Notes: Numbers in parentheses are the manufacturing share of each industry.

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 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 the five major manufacturing industries[2], except for T&A, for which the share rapidly decreased. This was partly offset by the increase in the share of E&E. The shares for the remaining three industries were by and large maintained or slightly declined with mild fluctuations – chemical products, general machinery and automobiles.

Looking inside of E&E revealed that the four sub-industries in this category experienced different growth patterns. For example, the 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 distorted 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, in spite of 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

[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 8 industries in the classification by the KDI (2003). They

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 were relatively stable.

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, or $\dot{Y} = T\dot{F}P + T\dot{F}I = T\dot{F}P + \dot{K} + \dot{L}$. KDI (2003) estimated TFP for each industry using growth accounting methods, where value added is used as total products, and capital and labor are used as inputs.[3] Table 2 breaks down the growth of value added as contributions from TFI and TFP for selected periods.[4]

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

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explained major portions of employment, total output and exports throughout the 1990s.

[3] 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).

[4] For more information, please see KDI (2003), pp.151-178.

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).

pointed out that TFP for the Korean manufacturing decreased in 1995-1998, compared to 1990-1995. These figures support Kim (2001) and Kwack (2001) who argued 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 sine 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. Overall, machinery, E&E and automobile industries experienced higher growth whereas T&A did not grow at all. While it is 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.

Korea started its economic growth by concentrating on the industries that had a 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 of the industries, both labor and capital input kept increasing during 1985–2001. Three more observations are clear from the table regarding TFI and growth:

(i) During the period, industries using relatively more labor input (labor intensive industries) did not grow as fast as capital intensive industries;

(ii) The growth rate of labor input in each industry decreased during 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 manufacturing sector for the entire period

(1985-2001), labor and capital increased by 0.12% and 10.40% respectively each year.

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, where each industry itself became more capital intensive. It is noteworthy that the semiconductor industry led the growth of labor input, recording 7.29% of annual growth of employment. The industry also led the increase of capital input with 24.25% of annual growth. It is noteworthy that TFI grew at a slower rate 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 total factor productivity and 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 during 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. As suggested above, such a change might be as 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 with high growth showed high growth of TFP as shown from IT equipment, semiconductors, E&P, automobiles and home appliances, 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, TEP contribution was relatively low in automobiles (20.95% or 3.05%p out of 14.56%), semiconductors (34.20% or 9.89%p out of 28.91%) and chemical products (18.48% or 1.97%p out of 10.64%). In the late 1990s, TFP became substantially high; 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% 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. Decomposition of Contribution from TFP and TFI to Growth (1985-2001)

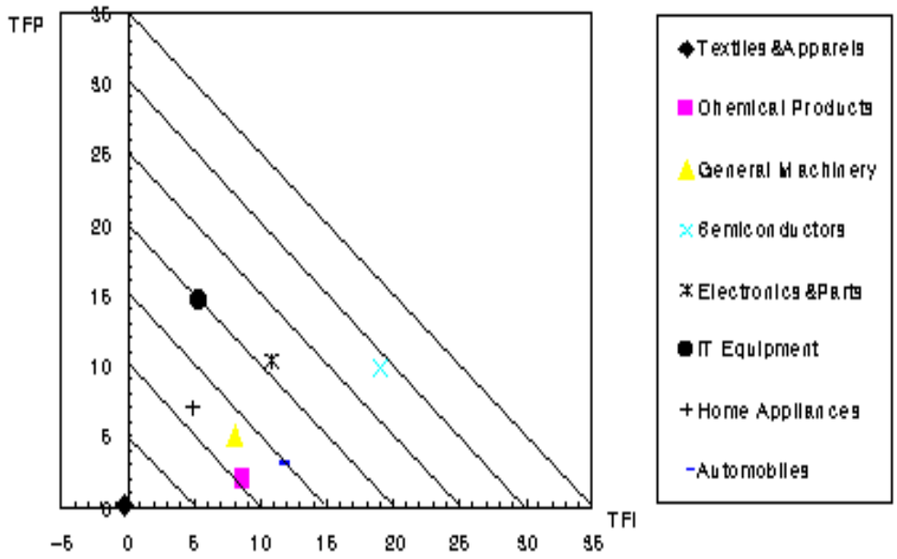
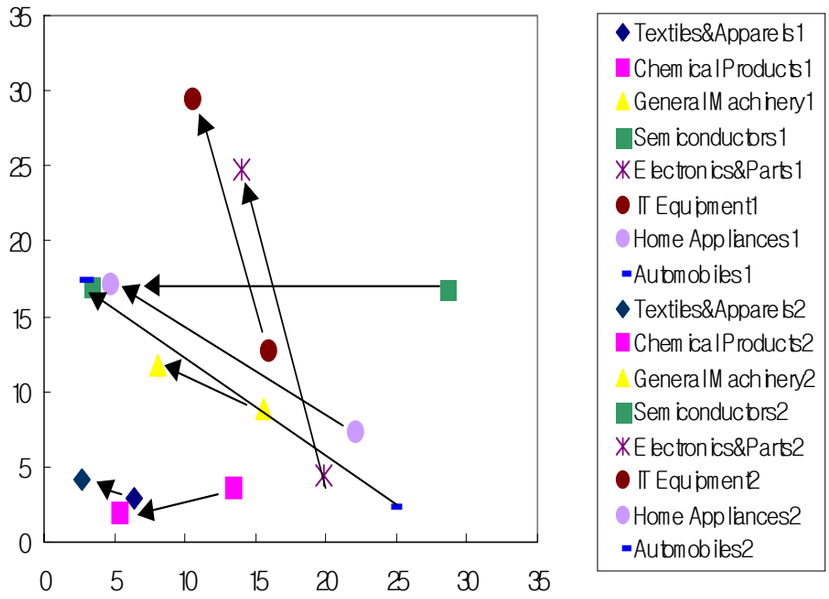


Figure 1 shows the average annual growth rate of some significant industries and contributions of TFI and TFP growth for 1985-2001, based on KDI (2003). The straight line connecting the same numbers in each axis indicates the iso-growth curve, where any point on the line represents the same growth rate. For example, the growth point for IT equipment lies around the line connecting at 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 the IT equipment industry, 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

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



large portion of the growth was due to factor accumulation. The three industries which 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 of 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.[5] 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 contributing factors, while TFP's contribution was still maintained.

III. THE RELATIONSHIP BETWEEN INDUSTRIAL STRUCTURE AND TRADE STRUCTURE

[5] 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.

1. Changes in the Structure of Trade[6]

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 85%, IT equipment 48% and precision instruments 50% annually. Korea's exports to Japan was 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 regional division of trade that Korea imports parts from Japan was strong, and it was hard for Korea to penetrate the Japanese market (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 recorded relatively high growth rates.

[6] 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-China	Korea-Japan	Korea-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 industrial's export to that of total manufacturing exports.

2. 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

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

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.

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 good, the two countries do not compete for the market with the product, as one country does not

Table 4. ESI of Major Industries in Korea

	ESI(Korea-China)			ESI(Korea-Japan)		
	1992	2000	Avg. Growth	1992	2000	Avg. Growth
Metals	0.61	0.62	0.00	0.44	0.48	0.01
Home Appliances	0.74	0.67	-0.01	0.75	0.71	-0.01
Automobiles	0.43	0.17	-0.11	0.71	0.88	0.03
Other Transport Equipment	0.39	0.41	0.01	0.61	0.59	0.00
Chemical Products	0.34	0.37	0.01	0.54	0.56	0.00
Petroleum & Coal	0.39	0.44	0.02	0.65	0.54	-0.02
Electronics & Parts	0.63	0.57	-0.01	0.55	0.57	0.00
Paper Products, Printing, Publishing	0.49	0.39	-0.03	0.55	0.49	-0.02
Non-Metallic Mineral Products	0.58	0.40	-0.05	0.50	0.60	0.02
General Machinery	0.48	0.50	0.00	0.62	0.62	0.00
Precision Instruments	0.52	0.62	0.02	0.62	0.64	0.00
Textiles & Apparels	0.54	0.40	-0.04	0.49	0.58	0.02
Semiconductors	0.30	0.68	0.11	0.82	0.77	-0.01
IT Equipment	0.64	0.69	0.01	0.67	0.69	0.00
Other Manufacturing	0.51	0.49	0.00	0.42	0.45	0.01
Food, Products & Beverages	0.35	0.48	0.04	0.53	0.58	0.01
Basic Metals	0.32	0.35	0.01	0.54	0.66	0.03
Manufacturing	0.42	0.40	-0.01	0.43	0.53	0.03

Source: Computed and rearranged from KDI (2003)

export the relevant good 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 4 shows ESI in 1992 and 2000 computed for Korea-China and Korea-Japan. The last column for each case is the annual average growth rate of ESI. ESI is prominent for Korea and China; in that competition in the semiconductor market significantly increased, measured as 11% of annual growth in the ESI. The ESI for semiconductors, which was only 0.30 in 1992, reached 0.68 in 2000. China has already become a competitor of Korea in the world market, as more foreign firms invested and produced in China. As of 2000, there was a high extent of competition between Korea and China

in IT equipment (0.69), however the average annual growth of the ESI index was only 1%. This indicates that competition was already high in 1992, increasing mildly throughout the decade. The automobile industry shows a very rapid decrease in the index (-11%), implying that Korea's superiority in this industry has accelerated. For T&A, the index decreased from 0.54 in 1992 to 0.40 in 2000, or an average decrease of 4% per year, indicating that Korea had lost its competitive edge in this industry. For home appliances and general machinery, the index stably moved in the range of 0.65 and 0.5 throughout the period. The average annual change for these industries over the period was almost nil, meaning that the competition structure for these goods for the two countries did not change significantly. It is noteworthy that for the other E&E industries, about the same levels of competition were maintained over time, but the extent of competition was already fairly high.

Table 4 also reports ESI in 1992 and 2000 computed for Korea and Japan. In contrast to the Korea-China case, no dramatic change in the index was found. The two countries' ESI for the T&A industry increased on average 3% per year, or from about 0.5 in 1992 to 0.6 in 2000, meaning that competition between the two countries in the world T&A market became more intensive over the period. The competition between the two countries in the general machinery industry was very stable, moving around 0.62, and the average annual growth was zero. 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. The index for automobiles substantially increased over the period, indicating intensifying competition between the two countries in this industry in the world market.

Overall, there were more substantial changes in competition between Korea and China, rather than Korea and Japan. 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 ESI decreased. For other major exporting commodities of Korea, fluctuations of indexes were not significantly large. In case of Korea-Japan, no dramatic changes in ESI were observed. Korea's automobile industry was relatively successful, stably increasing its competitive edge against Japan, say 3% per year as measured by the ESI.

IV. IMPLICATIONS

1. Overview

This section investigates growth of VA, decomposed into the growth of TFI and TFP in conjunction with changes in trade performance, in particular for the five major industries. This will reveal how structural changes in industries can be interpreted in the context of international competition.

First, the study 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 are compared with each industry's ESI for Korea-China and Korea-Japan. This will reveal how competition of Korean industries in the world market was influenced by the growth of TFP and TFI.

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 and increased 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 growth of Korea's exports and competition with China and Japan. Table 5 summarizes the correlation coefficient between the sources of each industry's growth and export growth. First of all, the table indicates that all correlation coefficients are positive. The industries that experienced more contribution from TFP or TFI to growth performed better in the world market, including both in the Chinese and Japanese markets. Secondly, the correlation coefficient between the growth rate of TFP and exports is substantially larger than that between the growth rates of TFI and exports to China. In contrast, the former is smaller than the latter for the growth rate of Korea's exports to Japan. It may be concluded that Korea's export growth to China may have been more closely related to or better explained by the increase in TFP, rather than improvement of factor accumulation. However, Korea's exports to Japan were more closely related to TFI rather than TFP. This result may explain that Korea has a comparative advantage in the industries with higher TFP against China, and those with

Table 5. Correlation between TFP, TFI, ESI and Export Growth (1992-2000)

	Export Growth (destination)			ESI	
	China	Japan	World	Korea-China	Korea-Japan
TFP	0.53	0.28	0.26	0.23	-0.04
TFI	0.39	0.42	0.49	0.54	-0.33

Source: Computed from KDI (2003)

higher TFI against Japan. Thirdly, it is also noteworthy that the correlations between the growth rate of TFP and exports to China or exports to Japan are larger than 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, exports growth was more closely related to TFI accumulation rather than TFP improvement during the 1990s. In addition, compared to the world market, Korea's exports to China or Japan were relatively more related to TFP improvement and less related to TFI accumulation.

3. Growth of TFP, TFI and ESI

The comparison of the correlation coefficients between the growth of TFP and ESI, and that of TFI and ESI results in some interesting findings. First, the average annual growth rates of TFP and ESI, and that of TFI and ESI for each industry for Korea-China have a positive relationship while those for Korea-Japan have a negative relationship. This means that for an industry in Korea which experienced a higher growth of TFP and TFI during the 1990s, competition between Korea and China in the world market increased ($\rho = 0.23$ for TFP-ESI and $\rho = 0.54$ for TFI-ESI respectively), while competition between Korea and Japan decreased ($\rho = -0.04$ for TFP-ESI and $\rho = -0.33$ for TFI-ESI 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. In contrast, the correlation between the growth rates of TFP or TFI and 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 of 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) Aternatively, as KDI (2003) pointed 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.[7]

Second, the correlation between TFP growth and ESI for both Korea-China and Korea-Japan is weaker than between TFI growth and ESI for both cases. The industries whose growth was based on TFI faced more severe competition from China. 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

[7] The three suggestions should be applied with care, especially when TFP is considered, as the correlation between TFP growth and ESI growth is almost zero.

TFI than TFP. In other words, the industries that had more contribution from TFI growth (than TFP growth) to their VA growth faced less and 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 rather stable in aggregated data. The growth rate of ESI for the industries ranged around zero, where several of them are very close to zero. The coefficient for the growth of TFP and ESI for Korea-Japan is also very close to zero, which implies that TFP improvement for the Korean industries may not be sufficient to change the competing situation with Japan in the world market. Over the period, the 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 positive growth 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 growth rates in TFI. This implies that the industries that grew fast in Korea based on factor accumulation also grew rapidly in China, possibly even faster. The competition between Korea and Japan in the world market became less severe for the industries that Korea enjoyed fast growth in TFP and TFI. More specifically, competition was weaker for the Korean industries which were largely helped by growth in TFI. This indicates that Japan might have moved from the industries

dependent on TFI to those dependent on TFP. The growth of TFP is found to not have influenced competition between Korea and Japan. The relocation of production bases offshore may be the cause of this phenomenon.

4. Limitations

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 indexes such as trade specialization, or more sophisticated indexes for RCA may provide invaluable information from different angles. Omission of discussion on the patterns of intra-industry trade also remains as a limitation of this study in providing more affluent information. Further studies 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 based on industry level data, as aggregation effect may distort real figures in this study. Also, causality between structural changes in production and trade should be further investigated.

V. SUMMARY

This study disaggregates the industrial growth that progressed in the 1990s in Korea

into contributions from TFI and TFP 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.

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 industries, 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%, let alone to Japan, 8%. All E&E industries led Korea's exports 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 performances are standardized by considering the slow growth 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 intensive for the industries for which a fast increase in TFI and TFP was observed in Korea. For the Korean industries that experienced fast growth in TFP and TFI, the

challenge from China became more intensive while competition between Korea and Japan became weaker. The more intensive challenges from China indicate that the industries which grew fast in Korea also grew fast in China, probably even faster. The extent of challenges from China was relatively weaker for the Korean industries with relatively higher contribution from TFP. 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 implies that the industries whose growth depended on TFI accumulation significantly declined in Japan. It needs further research with more disaggregated data, hopefully at the firm level, why competition between Korea and Japan was stagnated for the industries that Korea achieved a high rate of TFP growth.

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