CHANGING PATTERNS OF KOREAN INDUSTRY'S INTERNATIONAL COMPETITIVENESS AND THEIR IMPLICATIONS[1]

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STRUCTURAL CHANGES IN KOREAN INDUSTRY

The industrial structure of the Korean economy has changed gradually since the 1980s; as the industrialization process matured, the share of manufacturing became saturated while service sectors as a whole tended to take a larger portion of gross economic activity. The manufacturing sector started to account for smaller shares in the late 1980s. However, its share recovered to the previous level after starting to increase in the second half of the 1990s: the manufacturing sector has shown a high growth rate since the mid-1990s. And productivity in the manufacturing sector has improved greatly; particularly high productivity increases are found in manufacturing firms that survived the financial crisis through successful restructuring.

Over the long term, the manufacturing sector maintained a stable level, whereas the service sector has been stagnant. Above all, productivity in the service industry is lower than in manufacturing. In this regard, even though the service industry takes a larger share in terms of employment, its share is constant in terms of added value. This fact implies that enhancing productivity in the service sector is the crux of raising the overall economic growth rate.

Within the manufacturing industry, differences by scale of business have widened both within and between sectors. The expanding gaps by size of enterprise are the most evident in inter-sectoral

1. This paper is based on a Korea Development Institute study, "A Comprehensive Analysis of Korea's Industrial Competitiveness," which is in process. An abridged version will be available in English in April 2004.

differences in growth rates and total factor productivity (TFP) growth. The electronics and automobile sectors contribute significantly to the growth rate of the manufacturing industry and to TFP growth. Especially, these growth rates are ascribable to rapid productivity increases mainly by large conglomerates since the 1990s. Furthermore, analysis of manufacturing productivity by sub-sector and by five categories of firm-scale, found the higher growth rates in electronics and automobiles, with the larger share of conglomerates. And these conglomerate firms make a higher contribution to the growth rate of productivity and increasing productivity. These results show that large conglomerates are expected to maintain the leading role in the growth of the manufacturing industry for the time being. In contrast, except for the cohort of the smallest firms(those with less than 10 employees) smaller firms show poor records in productivity growth. Productivity improvement in smaller firms is an important task for sustainable growth and improvement of the competitiveness in manufacturing in general.

The phenomenon of widening gaps between sectors and between firms, which we call bifurcation or polarization, is also identified in the analysis of financial structure. According to the analysis of financial stability and profitability from 1990 to 2002, while both total assets and tangible asset investments have been on a downward trend since the financial crisis, the gap between large conglomerates and SMEs has widened. In addition to this deepening polarization, signs of a decrease in the rate of growth in tangible assets give rise to apprehension in light of an expansion of growth potential. However, as the chapter of the KDI study reviewing R&D activities of firms notes, we found a positive sign that Korea's economy is transforming into an innovation-driven economy, as the number of technology-intensive SMEs increased dramatically since the financial crisis.

The KDI study estimated productivity indices for the various industries in the manufacturing sector using plant-level manufacturing survey data for 1984-2001 compiled by the National Statistical Office. The data were re-compiled according to the 29-sector classification system of the KDI Multi-Sector Model, and, for five major industries, the data were rearranged into sub-industries according to each industry's supply chain. The plants were classified into five categories according to the number of workers, and the analysis was performed for three sub-periods; 1985-89, 1989-97 and 1998-2001. The study estimated both single-factor productivity, such as labor productivity and capital productivity, and total factor productivity (TFP), which was estimated by both the growth accounting method and multi-lateral method.

Labor and Capital Productivity

The results showed huge gaps in labor productivity among industries and among size groups. Labor productivity was high in the basic metals and electronics industries and low in the textiles and garments, metal products, and precision instruments industries. Also, throughout the period, labor productivity was higher in larger plants, and the gap with smaller plants was widening.

Analysis of the growth rate of labor productivity showed a similar pattern. Specifically, labor productivity grew most rapidly in the electronics industry as well as the machinery and transportation equipment industries, while it lagged in the textiles and garments, paper products and publishing, and metal products industries. The overall growth rate of labor productivity has risen persistently from an exceptionally low rate right after the economic crisis. Analysis of the growth rate of labor productivity by plant size reveals an important result. Over the entire period, larger plants recorded higher growth rates. In addition, we found that in the first sub-period (1985-89) labor productivity growth in smaller plants outpaced that in larger plants, but this trend reversed in the second sub-period (1989-97), and the gap between large and small firms widened in the third sub-period (1998-2001) when productivity growth was led mostly by large firms.

Capital productivity has been relatively stable over time, and differences in capital productivity between industries and by firm size are narrowing, except for several industries. By plant size, capital productivity shows an “inverted U” shape, with medium-sized plants having the highest capital productivity.

Total Factor Productivity (TFP)

For the entire manufacturing sector, the annual average growth rate of TFP, computed by the growth accounting method, was estimated to be 4.33 percent for 1985-2001. Estimated TFP growth was slightly above 4 percent until the late 1990s, and rose sharply to 11.68 percent since the economic crisis. The food and beverage, textiles and garments, and precision instrument industries showed slow TFP growth for the entire period, while the electronics industry showed an extremely high TFP growth rate, high enough to lead the entire manufacturing sector in total factory productivity growth. In addition to the electronics industry, the machinery and transportation equipment industries also recorded high TFP growth rates, particularly in the late 1990s. The growth pattern of TFP by plant size is similar to the trend in labor productivity. That is, TFP growth rates were higher among smaller firms in the first sub-period, but the trend reversed in the second sub-period, and the gap widened in the third sub-period. Productivity estimates produced by the multilateral index method showed almost the same patterns.

In conclusion, the electronics and automobile industries, and, in particular, the fast productivity growth of large firms in the 1990s led the growth and technological progress of Korea's manufacturing sector. This can be explained by the fact that the large firms have relatively big shares of industries where productivity growth has been fastest.

It is expected that the growth pattern of the manufacturing sector led mostly by large firms will persist for the time being. At the same time, however, it is necessary to pay special attention to the increasing share of firms in the smallest size category and to the slow productivity growth of medium-size firms (with 100 to 300 workers), since it would be impossible to sustain a high growth rate and improved competitiveness in the manufacturing sector without sufficient productivity growth of small- and medium-size firms.

CHANGES IN TRADE PATTERNS

The KDI study includes a comprehensive analysis of Korea's foreign trade patterns from 1992 to 2000 based on time-series data classified by the KDI multi-sector (29 sectors) model. These data were used to calculate market share, export similarity indices (ESI), revealed comparative advantage (RCA), and trade specialization indices (TSI). Market share and ESI indicate the status of Korean industry in the global market and its competitive position with respect to China and Japan.. The study categorizes industries by whether they are in comparative advantage or comparative disadvantage, based on the theory of RCA, which argues that trade patterns reveal each nation's comparative advantage. It employs TSI to identify dynamic changes in industrial competitiveness. To complement the analysis of inter-industry trade patters, the study also analyzes transactions in "similar" goods, that is, intra-industry trade patterns.

Korea, China and Japan have both competitive or confrontational and complementary areas in the composition of their industrial exports. The areas of competition are clear from the composition of each country's industrial exports (Table 1). IT equipment, semiconductors, textiles and garments, and chemical products make up a large share of Korea's exports, while China's exports are concentrated in textiles and garments and IT equipment, Japan's are comprised largely of automobiles, machinery, IT equipment, and chemical products. For Korea, the export share of textiles and garments, one of its main export goods, fell radically from 26% to 12% between 1992 and 2000, while the share of IT equipment increased from 13% to 20% and the share of semiconductors rose from 9% to 12%. Showing a similar pattern of change, the share of the textile and garments industry in China's exports also declined radically, from 42% to 28% while the export share of IT equipment climbed from 7% to 16% During this period, the share of IT equipment in Japan's exports fell from 18% to 14%.

Table 1: Composition of Manufacturing Exports of Japan, China, and Korea by Sector, 1992 and 2000

(Percent)

	Japan		China		Korea	
	1992	**2000**	**1992**	**2000**	**1992**	**2000**
03. Food & beverage	0.59	0.47	8.67	4.50	2.63	1.46
04. Textile & apparel	2.45	1.70	42.05	28.37	26.25	11.97
05. Paper & publishing	0.81	0.68	0.69	0.77	0.81	1.27
06. Chemicals	9.25	10.96	8.20	8.13	10.06	10.79
07. Petroleum & coal prod.	0.47	0.31	1.47	1.43	2.22	5.47
08. Non-metal products	1.10	1.08	2.03	1.72	0.76	0.56
09. Basic metals	4.79	4.44	2.70	3.25	6.67	5.09
10. Metal products	1.88	1.56	3.10	3.57	2.79	1.98
11. Machinery	15.44	16.42	3.13	4.33	4.25	5.40
12. Semi-conductor	4.09	8.42	0.28	1.88	8.98	12.41
13. Electronic components	7.62	9.90	4.29	7.84	3.96	5.22
14. IT hardware	18.39	14.25	6.57	15.96	12.72	19.98
15. Home elect. appliances	0.45	0.18	0.99	1.70	1.48	1.38
16. Automobiles	21.94	17.7	0.79	1.71	5.69	8.94
17. Other transportation equip.	4.15	4.07	1.86	2.02	5.98	5.39
18. Precision equipment	4.78	6.23	2.92	2.98	1.31	1.13
19. Other manufacturing	1.80	1.63	10.26	9.83	3.44	1.57

Source: Korea Development Institute, 2003.

Looking at their exports to the world market Korea, China, and Japan all have a high share in the electronics sector, which means fierce competition looms in this industry. Japan's share of the world market is highest among the three countries in automobiles (16.7%), precision equipment and semiconductors (16% each), and machinery (14.4%), which are its traditional competitive industries, and it also has the highest share of the world market in such technology-based industrial groups as electronics (Table 2). Since 1992 Korea's market share in textiles and garments products, which are traditionally among Korea's major export products, declined while its share of the electronics sector increased as did its shares of the world market in transportation equipment (automobile, ships), chemical products, and petroleum and coal. On the other hand, China's share of the global market in textiles and garments increased to 19.5% and its share of the global electronics sector excluding semiconductors expanded more rapidly than Korea's.

Table 2: World Market Share of Manufacturing Exports from Japan, China, and Korea, 1992 and 2000

(Percent)

	Japan		China		Korea	
	1992	**2000**	**1992**	**2000**	**1992**	**2000**
Manufacturing total	11.6	10.1	2.6	5.2	2.6	3.7
03. Food & beverage	0.8	0.8	2.7	3.8	0.8	0.9
04. Textile & apparel	3.0	2.3	11.9	19.5	7.4	5.8
05. Paper & publishing	2.7	2.3	0.5	1.4	0.6	1.6
06. Chemicals	7.7	7.9	1.6	3.0	1.9	2.9
07. Petroleum & coal prod.	2.7	1.8	1.9	4.3	2.9	11.7
08. Non-metal products	8.0	8.3	3.4	6.8	1.3	1.6
09. Basic metals	10.0	9.2	1.3	3.5	3.2	3.9
10. Metal products	7.7	6.0	2.9	7.1	2.6	2.8
11. Machinery	14.4	14.4	0.7	2.0	0.9	1.7
12. Semi-conductor	22.2	16.0	0.3	1.8	11.0	8.7
13. Electronic components	18.1	15.7	2.3	6.4	2.1	3.1
14. IT hardware	24.7	11.4	2.0	6.6	3.9	5.9
15. Home elect. appliances	6.2	2.3	3.1	11.7	4.6	6.8
16. Automobiles	22.0	16.7	0.2	0.8	1.3	3.1
17. Other transportation equip.	11.1	12.0	1.1	3.1	3.6	5.9
18. Precision equipment	15.7	16.0	2.2	4.0	1.0	1.1
19. Other manufacturing	4.3	3.7	5.7	11.7	1.9	1.3

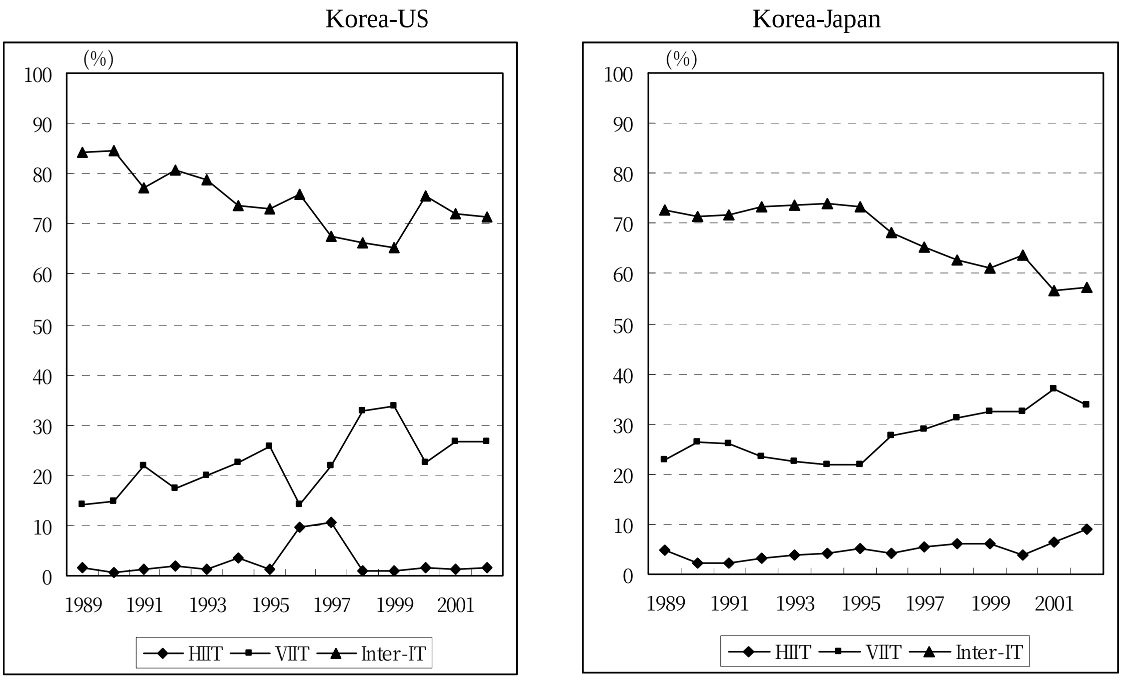
In this regard, there is a highly competitive relationship among the three nations in the electronics sector. Additionally, Korea's relationship with Japan and China is highly competitive in the precision equipment sector. The study found that the automobile industry has the highest similarity index (0.88) between Korea and Japan. Fierce competition is found in electronics as well as primary metals, and precision equipment and general machinery. Meanwhile, Korea and China compete intensely in the electronics sector and also in fine machinery and metal products. China and Japan has the fiercest competition in electronics. Especially, since 1995, competition in the shipping sector has intensified, as China has made swift inroads into such Japanese shipping sectors with low value added division as bulk carriers, which rely on relatively standardized processes. On the other hand, as MNEs have aggressively built manufacturing bases in China and expanded their exports since 1990s the competition in the electronics industry has intensified among three nations.

According to the RCAs calculated in the KDI study, all three nations have comparative advantage in the electronics industry. Whereas Korea has comparative advantage in semiconductors, IT equipment, coal and petroleum, and textiles and garments, it has a comparative disadvantage in food products and beverages, precision equipment, machinery, and metal products. Japan‘s comparative advantages lie in automobiles, semiconductors, electronic parts, IT equipment, precision equipment, and machinery, while its comparative disadvantages are in food products and beverages, petroleum and coal, home electronic appliances, and other manufacturing. China has comparative advantages in textiles and garments, home electronic appliances, IT equipment, electronic components, and other manufacturing with comparative disadvantages in automobiles, semiconductors, machinery, chemicals and precision equipment.

The KDI study also calculated TSIs to analyze temporal changes in industrial competitiveness in each industry. According to the study results China’s competitiveness has improved in almost every industrial sector, while Japan has lost competitive edge except in chemical products. More of Korea’s industries show enhanced competitiveness than of Japan’s. China sharpened its competitive edge in exports such as home electronic appliances, other manufacturing, and metal products. It changed from export to import specialization in IT equipment, automobiles, and shipping, while its import specialization in chemicals, semiconductors, electronic components, machinery and precision equipment, and primary metals weakened. In contrast, Japan improved export specialization in only one category, chemical products. While Japan decreased its import dependence in the other manufacturing category, its competitiveness in other industries either weakened or transformed from export to import specialization. For Korea, export specialization in items such as metal products, home electronic appliances, automobiles, and shipping increased in competitiveness, while chemicals, coal and petroleum, and electronics changed into import specialization from export specialization. Meanwhile, the index for textiles and garments, semiconductors, IT equipment, and other manufacturing products declined, in spite of their export specialization status. And intensified import specialization is found in food products and beverages and primary metal products.

The intra-industry trade index reveals characteristics of trade that analysis of trade by industrial category does not provide (Figure 1). In Korea's transactions with the United States and Japan VIIT (vertical intra-industry trade) overwhelms HIIT (horizontal intra-industry trade). This trend indicates that Korean products lag behind those of the United States and Japan in quality and price, even though Korea produces and exports products in the same industry categories. There is no evidence that this gap is narrowing. The portion of HIIT in Korea's trade with China has increased considerably since the mid 1990s. This suggests that among groups of similar products Chinese products are approaching the quality and price level of Korean products. In the case of trade between Korea and ASEAN, on the other hand, the proportion of HIIT has not increased.

Figure 1: Patterns of Intra-Industry Trade, All Manufacturing



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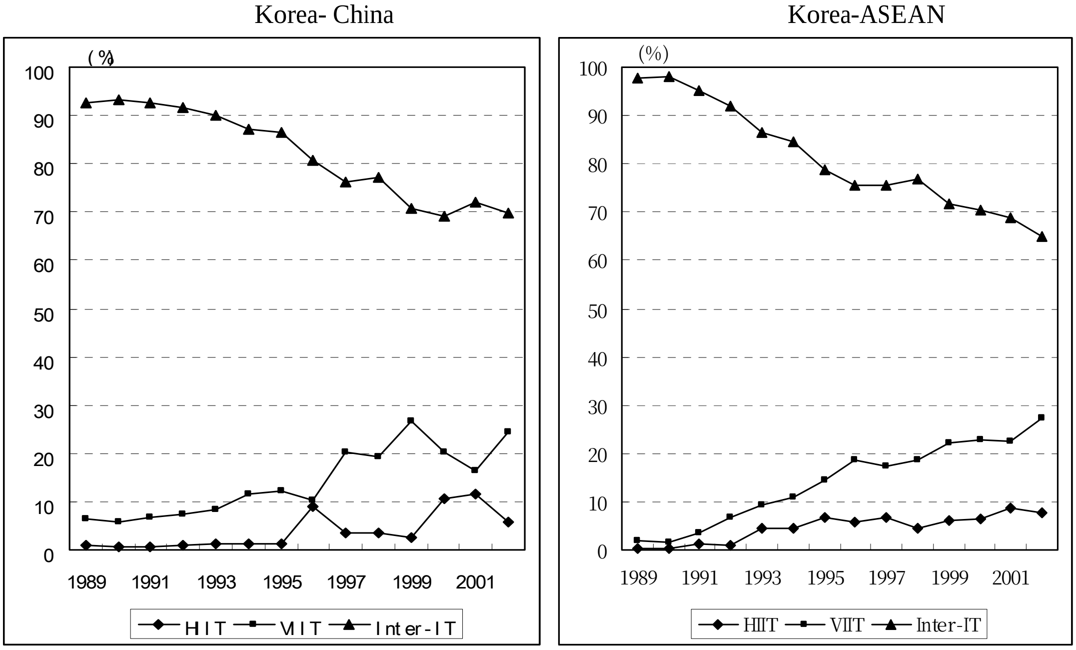


Note: HIIT denotes horizontal inter-industry trade and VIIT denotes vertical inter-industry trade.
Source: Korea Development Institute, 2003.

Changes in Business R&D Activities

Research and development (R&D) activities are one of the strategic tools that enable business enterprises to acquire competitive advantage, but organized R&D activities are a recent phenomenon in Korea's industrial history. The scale and scope of industrial R&D activities has increased greatly and broadened as the industrial structure has changed over the years. As time passes, industries come to produce more and more advanced products that are earlier in the product life cycle. Consequently, technological requirements become more sophisticated and demanding. Backed by government's initiatives to support industrial R&D activities, the number of corporate R&D centers has increased rapidly.[2]

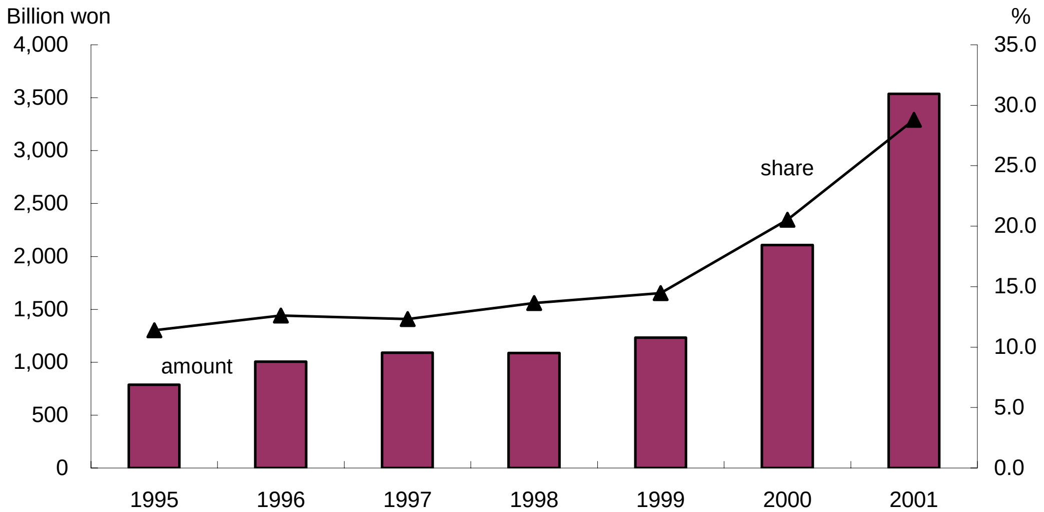
In the past years, large firms played a leading role in industrial R&D activities. Since the early 1980s, private enterprises began to establish in-house R&D centers, and most at that time were established by large firms. For example, the *Directory of Korean Technology Centers* published by Korea Industrial Research Institutes in 1985 listed 141 industrial R&D centers, out of which only 15

2. For a more comprehensive review of the process of Korea's industrial R&D activities, see OECD (1996)

belonged to SMEs. Another characteristic of industrial R&D activities in the past is their mostly adaptive nature. This was mainly because R&D activities were to assist the production of mature products. Technologies invented elsewhere were transferred by licensing contracts or other means , and the major goal of industrial R&D activities was adapting those transferred technologies to the requirements of the production process.

The trend has changed, particularly since the financial crisis in 1997. As shown in Figure 2 although SMEs are still responsible for less than one-fifth of total R&D expenditures, their spending is increasing more rapidly than that of large enterprises (LEs), which results in an increase in SMEs' share (Figure 2). During the period 1995 and 2000, SMEs' share of total industrial R&D expenditures has doubled. Do the increased R&D spending by SMEs and their increased R&D share imply that the role of SME in industrial innovation activities is also increasing?

Figure 2: R&D Expenditure by SMEs and its Share of Total R&D Expenditure



Source: Ministry of Science & Technology, *Report on the Survey of Research and Development in Science and Technology*, each year.

Changes since the financial crisis

The financial crisis in 1997 and the restructuring efforts afterwards had an unexpected effect on

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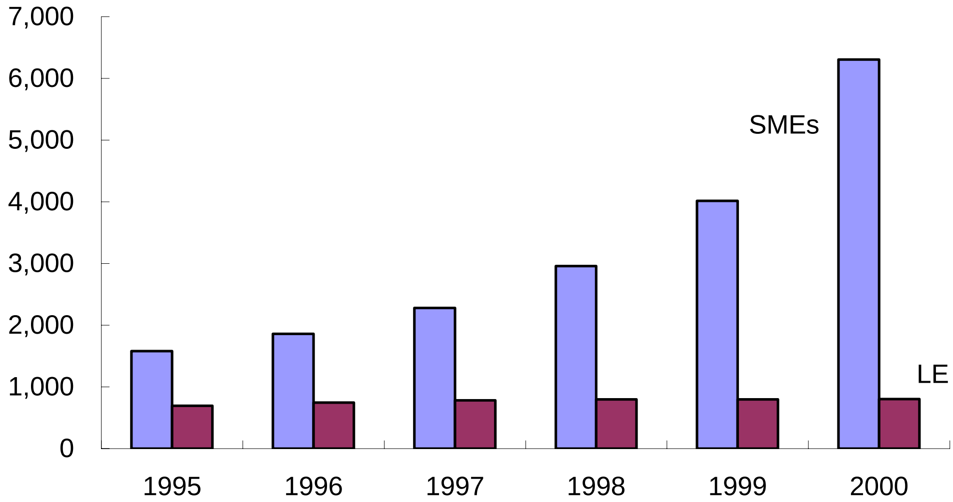
chapters VII & VIII. Suh (2000) gives an overview of Korea's innovation system.

Korean business. Profitability came to be recognized as more important than market expansion. Firms' spending for technological development is no exception. Companies, particularly large firms, have endeavored to downsize and streamline their R&D laboratories in line with business restructuring. Downsizing forced many R&D personnel to leave large firms; and many of these displaced professionals have established small-scale, specialized R&D laboratories or technology-based small firms. As shown in Figure 3, the number of corporate R&D centers increased rapidly since the financial crisis, and most of the newly established corporate R&D centers are small in size.[3]

Figure 3: Number of Corporate R&D Centers



Source: Korea Industrial Technology Association

The increasing number of small-scale, specialized R&D centers or technology-based small firms will change the industry's landscape. First, a direct effect is the increase in R&D expenditure and intensity by SMEs. Second, the existence of technologically agile small firms will lead to changes in business relationships, particularly between large and small firms.

These expectations are supported by a number of statistics. Total R&D expenditures by SMEs in manufacturing more than doubled between 1997 and 2001, whereas expenditures by large

3. In addition to the restructuring of large firms, other factors contribute to the increase in small-sized corporate R&D centers. The government's drive to create "venture" companies and changed capital market conditions for

enterprises increased by less than 20% (Table 3). The increase in total R&D expenditures by SMEs is partly due to the increase in the number of SMEs that spend on R&D activities, as manifest by the sharp rise in the number of SME R&D centers. But the R&D intensity of SMEs, defined as the ratio of R&D expenditures to sales, also increased, from 2.8% in 1997 to 3.7% in 2001. In contrast, the R&D intensity of large enterprises decreased from 2.1% in 1997 to almost 2% in 2001. In sum, not only is the number of SMEs that spend on R&D increasing, but also SMEs are intensifying their R&D activities since the financial crisis.

Table 3: Intramural R&D Expenditure by Size of Enterprise

(Million won, %)

	Small & Medium-sized Enterprises				Large Enterprises			
	1997		2001		1997		2001	
	R&D	**R&D / Sales**	**R&D**	**R&D / Sales**	**R&D**	**R&D / Sales**	**R&D**	**R&D / Sales**
Agriculture, forestry & mining	9,876	3.96	7,491	3.78	9,486	0.23	35,996	0.98
All manufacturing	891,520	2.70	2,586,281	3.18	6,522,320	2.56	7,625,798	2.17
Food, beverage & tobacco	14,302	0.69	55,676	1.52	91,824	0.48	121,810	0.51
Textile, leather & footwear	12,078	1.44	40,940	1.47	31,076	0.70	42,581	0.80
Wood and wood product	70	0.29	2164.4	1.43	2,125	0.26	14442	1.74
Pulp, paper and printing	4,283	0.81	8,713	1.69	40,507	0.89	17,488	0.51
Chemicals	113,620	2.20	264,188	2.23	594,881	0.93	605,864	0.75
Medicine & pharmaceuticals	39,785	2.69	127,053	5.48	82,362	3.65	146,285	4.47
Non-metallic products	13,246	1.82	32,739	1.60	86,434	1.16	28,612	0.39
Primary metal	15,630	1.11	35,152	2.23	155,333	0.60	122,448	0.36
Fabricated metal products	28,125	1.96	54,152	2.36	7,456	0.78	13,597	3.63
Machinery & equipment	96,892	2.99	305,852	4.82	214,274	1.98	196,350	2.70
Electrical products	78,576	3.15	148,075	1.17	81,519	1.08	77,971	1.68
Computer & office products	47,255	4.04	130,487	5.39	102,948	3.32	824,186	3.72
Semiconductors& elect. parts	63,406	2.96	291,679	7.63	2,479,632	5.94	3,245,746	5.59
Comm. & media equipment	134,226	6.05	637,722	4.28	410,772	3.27	266,435	1.70
Precision instruments	68,267	5.51	165,158	8.57	7,013	3.3	5,972	1.57
Automobile & parts	148,577	2.34	196,149	2.35	1,829,798	5.26	1,215,420	2.34
Ships & boats	1,665	2.57	4,278	0.52	176,174	1.45	118,388	0.77
Railroad equipment	3,311	4.98	3,144	6.64	-	-	467,172	4.53
Aerospace	427	15.01	14711.41	2.53	121,171	7.23	40331	3.25
Other manufacturing	7,779	2.29	60,755	2.76	7,021	0.59	18,704	1.26
All services	188,850	3.41	6,122,893	3.45	1,224,234	1.03	16,362,765	2.07
Electricity, gas & water	2,527	2.89	5,884	1.43	200,800	0.92	128,822	1.61
Construction	29,785	1.08	85,143	1.81	403,763	0.63	294,626	0.83
Communication	15,234	5.59	34,952	7.66	402,770	2.92	337,742	1.57
Business services	121,973	7.19	784,343	9.53	153,947	2.00	192,412	1.94
Other services	19,331	2.67	40,010	7.02	62,954	0.54	157,566	1.24
Total	1,090,246	2.81	7,073,225	3.69	7,756,040	2.05	17,473,933	1.99

Source: Ministry of Science and Technology, *Report on the Survey of Research and Development in Science and Technology*, each year.

start-up companies are among them.

Similar observations and conclusions apply to the case of researchers. From 1997 to 2000, SMEs strengthened their R&D activities by sharply increasing the number of researchers they employed, whereas the number of researchers at large enterprises remained almost unchanged during this period (Table 4).

Table 4: Number of Researchers by Size of Enterprise, 1997 and 2000

	Small & medium-sized Enterprises				Large Enterprises			
	1997		2000		1997		2000	
	All	PhDs	All	PhDs	All	PhDs	All	PhDs
Agriculture, forestry, & mining	125	16	88	19	149	33	252	72
All manufacturing	13,944	343	25,167	1,048	49,456	2,842	51,184	3,201
Food, beverage & tobacco	378	15	679	52	1,441	124	1,372	128
Textile, leather & footwear	179	2	431	8	379	40	489	33
Wood and wood product	4	0	-	-	55	0	24	0
Pulp, paper and printing	73	1	152	4	370	21	282	10
Chemicals	2,311	58	3,232	171	5,461	647	4,876	612
Medicine & pharmaceuticals	797	64	980	114	796	101	788	103
Non-metallic products	214	9	391	23	598	57	316	30
Primary metal	236	6	320	14	834	144	494	122
Fabricated metal products	352	6	710	18	96	2	167	6
Machinery & equipment	1,420	26	2,458	79	2,128	58	1,723	75
Electrical products	1,165	15	1,667	45	928	60	458	33
Computer & office prod.	753	16	1,218	33	1,137	12	4,206	184
Semiconductors. & elect. parts	894	28	2,522	178	18,749	1,066	5,181	455
Comm. & media equipment	1,810	35	5,583	144	4,550	134	20,178	1,086
Precision instruments	1,057	39	1,511	105	70	1	223	3
Automobile & parts	2,112	18	2,591	22	9,525	205	8,248	195
Ships & boats	14	0	37	2	1,293	103	929	100
Railroad equipment	60	1	57	1	-	-	228	3
Aerospace	10	0	61	9	907	64	657	20
Other manufacturing	105	4	567	26	139	3	345	3
All services	3,634	115	11,239	476	7,385	738	6,403	605
Electricity, gas & water	28	0	52	3	933	189	707	157
Construction	245	6	741	36	1,155	149	812	94
Communication	160	2	123	4	1,799	191	1,334	111
Business services	2,820	89	9,667	409	2,973	145	2,710	172
Other services	381	18	656	24	525	64	840	71
Total	17,703	474	36,494	1,543	56,990	3,613	57,839	3,878

Source: Ministry of Science and Technology, Report on the Survey of Research and Development in Science and Technology, each year.

The effects of the financial crisis on the R&D activities of SMEs vary by industrial sector. R&D expenditures have increased in almost all sectors, except ships and boats, railroad equipment, and communication services. In terms of R&D intensity, chemicals, including medicine and pharmaceuticals, electrical products, transportation equipment, including automobiles and parts, ships and boats, railroad equipment and aerospace, and services in electricity, gas and water and communication show decreases. Note that R&D intensities of SMEs in Korea's 'flagship industries,' such as chemicals and transportation equipment, decreased by a significant amount. In contrast, R&D

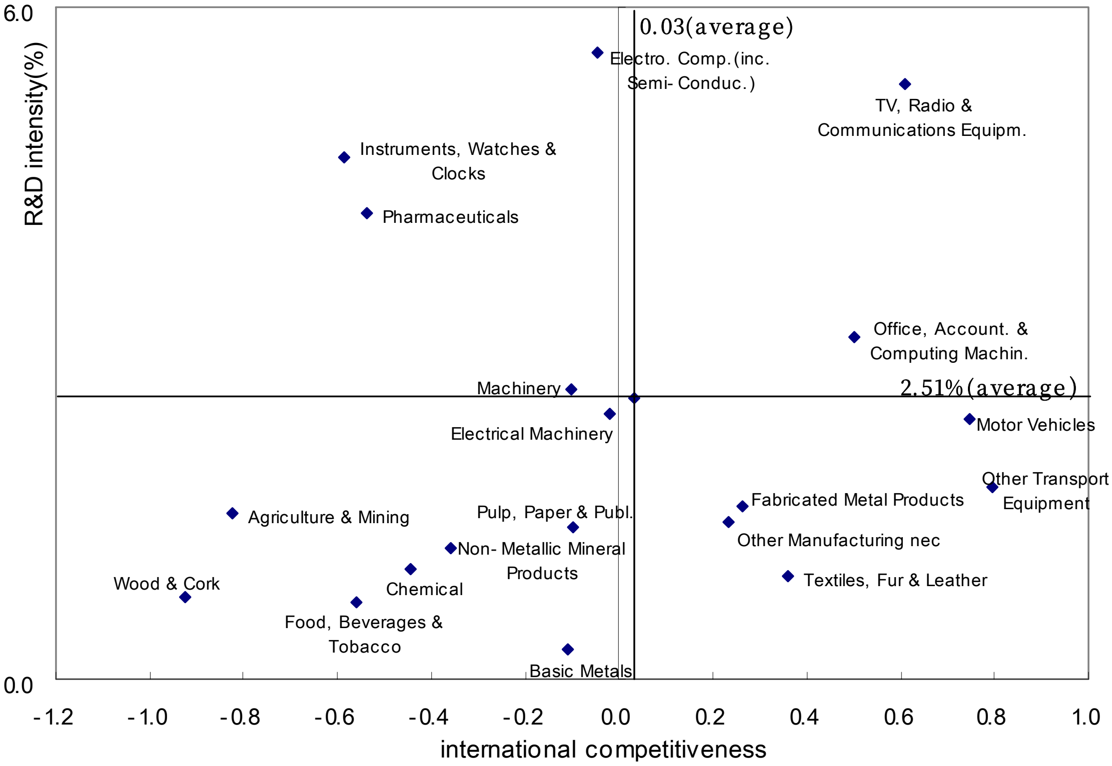
expenditures or intensity increased by large amounts in IT-related sectors such as computers and office equipment, semiconductors and electronic parts, and communication and media equipment. The different pattern in R&D expenditures across industrial sectors is also to be found in the pattern of changes in the number of researchers in different industrial sectors. Particularly striking are the semiconductors and electronic parts, communication and media equipment, and the business services sectors, where the number of researchers including Ph.D.s and R&D expenditures increased more than three times. These are sectors in which specialized, small R&D centers are burgeoning; and therefore, networking and collaboration could be expected to be more prevalent than other sectors.

R&D Activities and Industrial Competitiveness

Korea's industrial R&D spending is highly concentrated within a small number of industries (Figure 4). ICT sectors (communications equipment, semiconductors, computers, and electrical and electronic products) account for 57.6% of the total manufacturing R&D expenditure, followed by the automotive sector (19.6%), chemicals (9.8%), machinery (3.9%), and iron and steel (3.8%). All of these industries, except for chemicals and machinery, make a positive contribution to the trade balance. Furthermore, Korea is one of the major exporters of high-tech products, although the value-added content of Korea's exports, including high-tech products, is still low. For instance, Korea's up-market share in EU-15 countries is below the OECD average, while its down-market share is one of the highest, exceeded only by that of Turkey, the Czech Republic, and Poland.[4] Korean industries, despite their high R&D intensity, have not yet been successful in harnessing R&D potential to added value in their products.

4. For more information, see OECD STI Scoreboard 1999.

Figure 4: R&D intensity and international competitiveness in Korean Manufacturing



Note: International competitiveness is defined as (exports - imports)/(exports + imports) for each sector. Numbers in parentheses give the sector's share of total manufacturing R&D expenditures.

Overview of Korea's Industrial Competitiveness

Electronics

The Korean electronics industry has a dual, or unbalanced, structure. It is comprised of large conglomerates that play a leading role both in domestic and global markets, and the technological competence of the remaining companies is weak. Considering the electronics industry in general, competition with China is fierce in such sectors as computers and home appliances where price plays a key role in competitive advantage. Competition with China is relatively low in such sectors as memory chips, particularly semiconductors, and display units where non-price factors, such as technological leadership, are more important. Of particular interests is the dramatic increase in the global market share of Chinese firms in communication equipment, rising as one of Korea's major competitors, presumably due to the role of MNEs in China.

The obstacles to further development of the electronics industry are found in the dual structure, such as the gaps between conglomerates and SMEs both between and within sectors. While leading conglomerates that have global business strategies can maintain their competitiveness through procurement of parts all over the world, the development of industries in general cannot be sustained without improving competitiveness of firms at a lower level. This conclusion implies that the government should exert greater effort to rectify the dual structure, which indicates the importance of nurturing smaller, technologically agile firms.

Automobiles

The dual structure is found also in the automobile industry, which is bifurcated into t: final auto assemblers, led by conglomerates, and component suppliers made up of SMEs at the lower level. While firms in the final assembly sector are assessed to have a competitive advantage that enables them to penetrate into overseas markets, the persistent weakness of parts suppliers is expected to be an element of vulnerability in the competitiveness of the automobile industry in general.

Whilst modularization has become important in securing competitiveness in the parts industry, it is currently being implemented as a way of reducing costs for automobile components in order to compensate for wage differentials between final auto assemblers and parts suppliers. As R&D becomes the most critical strategic element in sharpening competitive edge, first-tier companies as well as many second- and third-tier ones are expanding their R&D investment. Still, one of the biggest obstacles for parts suppliers is the shortage of high-skilled labor in the production line due to their wage differentials compared to final assemblers.

Parent companies strengthened their global sourcing as a result of business restructuring after the financial crisis and the progress of market opening and informationization. In this circumstance, conglomerates dealing with component suppliers have faced a turning point, changing from the previous vertical relationship. Parts suppliers have a low level of competence in such areas as independent technological development, purchasing and sales, and capabilities of collecting information on global market trends, in which they mostly rely on the parent companies. Whereas Chinese enterprises are more price competitive, they lag behind Korea in terms of the level of technology, which delays the rise of Chinese firms as competitive threats to Korean firms. However, building up firms' core competence requires accumulation of experience over a long time. Taking into account that Korean parts makers do not have a considerably higher capability in developing technologies compared to Chinese firms, Chinese firms can be expected to catch up to Korean firms in the near future. An upgrade in the quality of work force is needed to strengthen innovation capabilities and to expand the production capability of parts suppliers to the level where scale-economies are realized.

Machinery

The machinery industry faces a challenge to transform its current production system to one that is based on generic technologies, which enables the production of differentiated products. In general, Korea's machinery producers show dexterity in manufacturing and assembly, where company competitiveness originates. On the other hand, competitiveness is found to be low in the specialized machinery sector, which requires integration and application of new technology. This characteristic is largely due to the structure of the machinery industry, which is composed mostly of SMEs.

An ideal efficient and competitive production structure would be one where SMEs that specialized in core parts and materials strongly supported the industrial base and conglomerates performed large-scale projects as well as led the machinery industry. Ninety-eight percent of the Korean machinery industry is composed of SMEs, based on the number of enterprises. As the majority of firms are small and mostly sell a single product, they are not suitable to function as the bedrock of the machinery industry due to their poor motivation for technology development. In contrast, big companies have not in general reached the stage in which they can lead the development of the overall machinery industry, even though they rationalized their businesses through restructuring after the financial crisis.

Therefore, a pressing task is to consolidate the system-base of the industry, a system where specialized firms are closely linked through supply chains and innovation networks. It is also urgent to improve technological capability in machinery design and generic technologies, where Korea has big gaps compared to advanced countries. To accomplish this task, it is necessary to promote inward investment by foreign companies, which are leading the global industry, as well as to reinforce linkages between industry and academia.

Chemicals

The chemical industry includes such diverse industries as petrochemicals, fine chemicals, and rubber and plastic. While it is linked with a series of production chains, obvious differences are found in each sub-sector in terms of production structure, required technologies, and other aspects. While the industry's value of production, amount of exports, and share of value-added decreased slightly after the financial crisis, the chemical industry has recently experienced a recovery trend and some products meet global standards in light of production scale.

There are contrasts between such capital-intensive industries as petrochemicals and rubber and plastic and technology-intensive fine chemicals. Whereas the petrochemical sector, led by large conglomerates, has an export-to-production ratio of over 40%, with a high comparative advantage index, the fine chemical sector mostly remains oriented toward domestic demand with a lower competitiveness index in the global market. Productivity in the petrochemical industry is generally high due to its high-capital intensity, while that of the fine chemical industry is low. However, a high level of competitiveness does not necessarily relate to a higher level of productivity in petrochemicals compared to fine chemicals. Without adjustment of the excess facilities and R&D efforts for new products, its current competitiveness cannot be maintained.

In the chemical industry in general, prerequisites for sustained growth include development of new businesses and innovation of production process. Especially, the industry in general should re-orient its growth strategy to explore new markets through the development of differentiated products thus changing the current strategy of focusing on standardized products. More large companies are to be induced to enter the fine chemical sector thus playing a leading role in the development of the industry as a whole. In tandem, the government should make more efforts to rationalize the industrial structure by inducing autonomous restructuring of over-capacity in petrochemicals and enhancing cooperation between large and smaller firms.

Textiles and Garments

The share of the textile and garment industry in Korea's economy has been shrinking gradually since the 1980s. However, it still occupies a key position, with 15% of total employment in the manufacturing sector as of 2001. The industry's share of exports increased in spite of a slowdown in exports, with US$13.9 billion in the black in 2000. As the domestic textile and garment industry has tended to lose its competitive edge in general, the long-term trend of industrial decline is expected to continue.

It is difficult to expect that the textile and garment industry in general, will recover to the level of its heyday. Yet, some parts of the textile and garment industry still have potential for further development, with strategic specialization in synthetic yarn and synthetic fabrics, where Korea has a high degree of competitiveness, and strengthening design and brand marketing, which enables upgrading quality. For instance, developing super-functional textile materials and their commercialization is important for preventing a radical decline in the domestic textile industry, as well as upgrading industrial structures. Reactivating the fiber and textile sectors requires creating demand in the garment industry. It is also essential to create demand for apparel with fashion-ability and marketability. Furthermore, innovation of a distribution system in the garment industry is critical for overcoming limitations of market size and creating further demand. Additionally, an initial generation of market environment is also required for domestic textiles businesses to convert into various kinds of small lots through formulating a distribution network of low- and medium-priced fashion clothes.

CHINA AND THE EAST ASIAN ECONOMIES

China's Ascent in the World Economy

China is becoming a major player in the world economy. It has shown astonishing performances in economic and export growth. For the period from 1985 to 2002, the Chinese economy grew at an average annual rate of 8.9% and China's share of the world economy increased from 1.2% to 3.8% (Table 5). Meanwhile, China's share of world exports has rapidly increased from 1.3% in 1985 to 5.2% in 2002, which is equivalent to 15.1% average annual growth rate. China's export growth rate surpasses its two neighboring countries; during the same period, average growth rates of exports from Korea and Japan were 11.0% and 6.0%, respectively. China has also successfully diversified its export markets. In particular, China's penetration into US, Japan and EU markets, the most advanced in the world, is remarkable. In 1985, China's exports claimed only 1.1% of those three markets; but in 1999, they had 4.9% of the total.

Table 5: China in the World Economy
(US$ billions)

	1985			2002			1985-2002 avg. annual growth %	
	China	World	China / World %	China	World	China / World %	China	World
GDP	274	22,710	1.2	1,237	32,227	3.8	8.9	2.1
Exports	25	1,886	1.3	326	6,272	5.2	15.1	7.1

Note: GDP in constant terms; exports in current terms.
Source: CEPII, 2001; UNCTAD, *World Investment Report*, 2003; WTO, *International Trade Statistics*, 2003.

Several factors explain China's rapid economic growth. Following Japan and other newly industrializing economies in East Asia, China adopted export-oriented development strategies. Backed by the country's large size, export markets enable China to realize economies of scale, one of the main sources of economic growth. In addition to these factors, which are frequently jointly referred to as the success factors of Asian economic growth, China's economic development process also has a unique aspect that is not all common to other Asian countries in earlier stages of economic development: that is its strong technological base. China's shift from technological nationalism to a more pragmatic strategy of developing national capabilities in conjunction with multinational corporations has also contributed to transforming its economy.

China has transformed its economy on the foundation of a large science and technology base with technological capacities well beyond those of most developing countries (Kraemer and Dedrick, 2002). As part of its economic transition, China transformed its science and technology system to spur economic development. It did so partly by creating state-owned but market-oriented enterprises linked to commercializing the technologies developed in state-owned research institutions. For example, the four largest Chinese PC makers—Legend, Founder, Stone, and Great Wall—emerged from this background. The growth of indigenous firms with high technological competence even in earlier stages of economic development distinguishes China's economic development process from that of other Asian peers.

Conventionally, the process of economic development in developing or less developed countries is postulated on a linear model. Industrialization starts in technologically less demanding low-skilled industries; in the meantime, through experiences in low-skilled production, the economy and indigenous firms accumulate technological capabilities; and, then at the later stages of development, the economy and firms enter into technologically more demanding high-tech industries. The industrialization processes in Japan and in Asia's newly industrializing economies such as Korea and Taiwan were in most cases not exceptional to the linear stage model. But, in contrast, taking a cross-section of China's industrial composition observers would find that almost every industrial sector exists in significant scale. Leapfrogging, particularly in high-tech industries, is taking place in China's economy. China's computer industry and communications sector are good examples to show how a late-industrializing economy would take advantage of new technological opportunities through the interplay of the government and markets (Box 1).

Box 1 The Growth of China's Communications Equipment Industry

While most countries, including Taiwan, presently are deciding to postpone the actual introduction of the 3G mobile telecommunications service, Mainland China is endeavoring to developits own 3G system. The key to this daunting venture into new technology-based industry is the government's initiatives to promote the mobile Internet through a low tariff policy, to give opportunities for growth for indigenous companies, and to induce foreign investment. Three Chinese companies, DATANG Telecom, Huawei Technologies, and Chungxing, are concentrating on the development of relevant facilities such as base stations, and other mobile handset producers, including PTIC, Wavecom, Eastcom, and Chungxing, are working to upgrade their technologies in developing the 3G mobile handsets. MIC forecasts that by 2005, China will become the biggest market and production base for mobile communications, with the number of mobile telephony subscribers forecast to reach 245 million in 2005 from 117 million in 2001.

Source: http//www.ntc.no:8080/files/ntc/rapporter/taiwaninternet.doc.

Impacts of China's development on East Asian trade structure

Overall, the rapid expansion of the Chinese economy creates a new growth opportunity for the East Asian countries and the world. As is shown in Table 5, the scale of China's economy increased 4.5 times from 1985 to 2002; and China's entry into the WTO creates additional momentum for her trading partners for a bigger market with eased trade barriers. The question is, then, who will benefit relatively more from China's development. The answer is not straightforward, since the effect of increased trade depends on several factors.

The KDI study looked at trade specialization patterns and comparative advantages of China and her trading partners in Asia by calculating an index of comparative advantage in international trade for

22 sub-sectors of manufacturing. Each sub-sector was assigned to one of the four OECD categories based on R&D intensity.[5] Changes in China's trade specialization pattern are more apparent in bilateral trade with some Asian countries.

- With ASEAN:

  Among high-tech industries, China has comparative advantages in precision instruments, pharmaceuticals and it has comparative advantage in all mid-high tech industries. China has structural surplus in most mid-low tech industries except petroleum refining and rubber and plastic. In low-tech industries, China has comparative advantages in paper and textiles.

- With Korea:

  Trade between China and Korea began in full scale in 1991 when the two countries restored diplomatic relations. China has comparative advantages in high-tech industries except communications equipment including semiconductors, although the margin is narrow. In mid-high tech industries, China has comparative advantage in electrical machinery including home electronics; and, Korea shows comparative advantages in the remaining mid-high tech industries. In mid-low tech industries, Korea has strong comparative advantages in rubber and plastic and petroleum-refining; and, while China has comparative advantages In all the other sectors In low-tech industries, China has comparative advantages except in food.

- With Japan:

  China's trade with Japan shows very stable specialization patterns in high tech and mid-high tech industries, where Japan has mostly strong comparative advantages. In contrast, in mid-low tech industries China is gaining comparative advantages; and in low-tech industries, China has comparative advantages except food.

China's international trade specialization pattern shows a strong structural surplus in low-tech industries with structural deficits in the remaining manufacturing industries. But it is noteworthy that this pattern is changing rapidly. For example, it is rapidly moving from structural deficit to surplus in computers and office equipment in the high-tech sector and electrical machinery in the medium-high tech sector.

The change in China's pattern of trade specialization exemplifies how comparative advantages can be *created*. The rise of China's computer and communications equipment industries, as illustrated above, is a case in point. Coupled with the strategies of multinational corporations to capitalize on the growth potential of a country with a population of 1.2 billion, the Chinese government has introduced

5.CTB is the contribution of each sector to the trade balance (CTB) as a percentage of the manufacturing industry total. A positive CTB means structural surplus or comparative advantage; whereas a negative CTB indicates a structural deficit or comparative disadvantage. For industry classification according to R&D intensity and the method to calculate comparative advantage, see OECD, Science, Technology and Industry Scoreboard, 2001.

deliberate industrial policies to commercialize strong technological base. Indigenous firms are growing and accumulating technological capabilities that are comparable to those of foreign competitors. Technologically dynamic firms such as Huawei, (Box 2), are not prevalent in most developing countries; but, in fact, numerous Huawei's are growing in China. These factors interacting with others not mentioned here, give positive feedback in the form of high economic growth and enhanced international comparative advantage.

Box 2: Huawei (華爲) Technologies Co. Ltd.

Established in 1988 by an army wireless communications engineer, Huawei Technologies is a high-tech enterprise that specializes in research and development, production, and marketing of communications equipment. Taking 40% share in the Chinese market. Huawei's competitive strength is to produce high-tech products at low cost, which enables it to compete with foreign suppliers in both domestic and overseas markets. It has succeeded in wining the competition in supplying communication equipment projects in Vietnam, Thailand, Indonesia, South Korea, and Brazil. Sixty percent of its 16,000 workers hold masters' degrees, and more than 2,000 are Ph.D.s. Huawei spends more than 10% of its sales in research and development – US$342 million in 2001. With a headquarters in Shenzhen, Huawei has 11 R&D centers, among which are five overseas research institutes in Silicon Valley, Texas, Stockholm, Bangalore, and Moscow. It has numerous collaborative R&D projects with domestic and US universities. With its state-of-art design technologies, Huawei designs ASIC in-house and out-sources production to a US foundry company on an OEM basis.

Source: A. Kuroda, *Made in China*, tr. Park Jung Dong, 2002, p. 38 and http://www.huawei.com.

China's trade relationships with other Asian economies show where its economy is moving. Currently, China's economy has strong comparative advantages in low-tech industries; but at the same time, it is gaining comparative advantage in more technology-intensive sectors. Already, China has strong comparative advantages over ASEAN in some high-tech and most mid-high tech industries. China even shows comparative advantages over Korea in some high-tech industries, albeit with a small margin . But there exists wide gap with Japan in high-tech and mid-high tech industries. Therefore, it is to be expected that competition between China and ASEAN and Korea will intensify in the near future; but China will not be an immediate threat to Japan in world markets for high- and mid-high tech products.

Prospects for the International Division of Labor between China and other Asian Economies

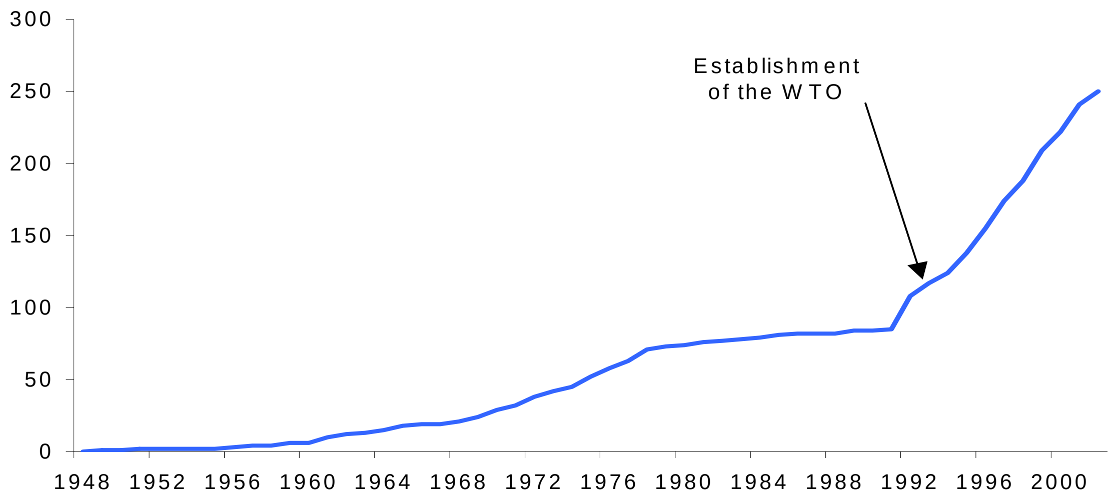
In discussing the international division of labor in Asia, the flying geese model has gained wide audiences not only in academia but also in policy circles. The model was introduced by Kaname Akamatsu in the 1930s and more rigorously developed by Kiyoshi Kojima later in the 1960s. Explaining the catching-up process of industrialization in latecomer economies, Kojima's model is based on two assumptions: (a) An economy's industrial structure is diversified and upgraded in a sequence from labor-intensive industries to capital-intensive industries and further to more capital-and knowledge-intensive industries. (b) The flying geese pattern of industrialization is transmitted through FDI from the lead country to follower countries according to industrialization stage or per capita income level.

As Kojima (2002) acknowledged, the sequential process of industrialization envisioned by the flying geese model does not fit the current status of the East Asian economies. First, Japan, as a lead country has so far been unsuccessful in establishing a big new industrial sector needed to enlarge the scope of the regional division of labor. Second, in the 1980s, the Asian NIEs and some ASEAN countries (Thailand and Malaysia) graduated from the catching-up phase, became sub-leaders in exports and FDI to other Asian economies, and went ahead of Japan in certain other activities. The regional transmission of development in a manner consistent with the model has thus developed dual or triple paths. Third, since the 1990s, China became the largest Asian recipient of FDI and this contributed to the development of many technology-intensive industries. China's economic development does not fit well to the model in that its economy has leapfrogged in some technology-intensive sectors.

Accordingly, the international division of labor in the East Asia, and particularly that between China and other Asian economies, will be more diverse and different from the past. It will not be a sequential movement or a vertical division of labor as in the past; rather, the future shape of the international division of labor in East Asia will be more complicated, with multiple relationships between economies. Several factors will affect the shape of the international division of labor; some of significant importance are briefly discussed below.

First is the trend to globalization with regionalism: The world economy is rapidly integrating in various ways. Backed by the liberalization movements where GATT and WTO had made great efforts, international trade and foreign direct investment have rapidly increased. In addition to these traditional mediators of globalization, mergers and acquisitions are also proceeding internationally on an unprecedented scale. Literally, globalization is proceeding in full scale. Along with the globalization trend, however, there are also international movements to integrate economies at the regional level, particularly since the mid-1990s. According to Boonekamp (2002), the number of regional trade agreements (RTA) notified to the WTO has increased and accelerated during the 1990s. For example, the 125 regional free trade zones agreed since the WTO system was established in 1992, is the same as the total number of cases agreed during the entire life of the GATT system since 1948 (Figure 5). Regionalism alongside globalization is indeed becoming a new trend in the world economy; and, the new trend gives a hint to the future shape of the international division of labor in the East Asian region.

Figure 5: Cumulative Number of RTAs notified to the GATT/WTO , 1948-2002



Source: Boonekamp (2002).

Second is the increasing importance of developing countries in the world economy and regional economic integration. As many developing countries adopted export-led development strategies since the 1980s, not only has the volume of world trade increased rapidly but also the share of developing countries in world manufacturing product trade has greatly expanded. For example, for the period between 1980 and 1998, those developing countries that pursued export-led growth strategies realized about 5% average annual economic growth rates, which is far higher than the 2% rates achieved by advanced countries. And the share of manufacturing products in developing countries' trade increased from less than 25% in 1980 to more than 80% in 1998. The successful industrialization of developing countries and their increased share in world trade imply that the role of developing countries in the world economy will be more important than in the past and that international trade relationships will be more diversified. As in the East Asian region, China and the first- and second-tier NIEs will play a more important role in trade and investment than before, while Japan's role as a lead country will be diminished.

Third, as economic activities of multinational corporations (MNCs) are taking a larger share in the world economy (Table 6), the global strategies of MNCs in their choice of content and location of foreign investment are becoming more crucial in the economic development of host countries. UNCTAD reports that as of 2000 there are about 60,000 MNCs with 800,000 foreign affiliates and the number of MNCs coming from developing countries is increasing. In the freer trade and investment environment of today's world, countries are competing to attract more FDI and MNCs; and they are competing in creating more favorable conditions for this.

Table 6: Multinational Corporations' Activities in the World Economy

	1982		1990		2002	
	US$ billions	**% world GDP**	**US$ billions**	**% world GDP**	**US$ billions**	**% world GDP**
MNC foreign affiliates						
Sales	2,737	25.3	5,675	26.2	17,685	54.8
Value added	640	5.9	1,458	6.7	3,437	10.6
Exports	722	6.7	1,197	5.5	2,613	8.1
World GDP	10,805	100.0	21,672	100.0	32,227	100.0

Source: UNCTAD, World Investment Report, 2003

Despite the increasing role of developing countries in the world economy, the flows of FDI are concentrated on advanced countries and on a handful of developing countries. During the period between 1990 and 2002, world FDI grew at an annual average rate of 9.5%, which is far higher than the rates of world GDP growth (3.3%) and world export growth (5.0%) (Table 7). But the destinations of FDI are mostly confined to advanced countries (Figure 6): China is the only developing country among the top ten recipient countries during the period between 1991 and 2002. According to the

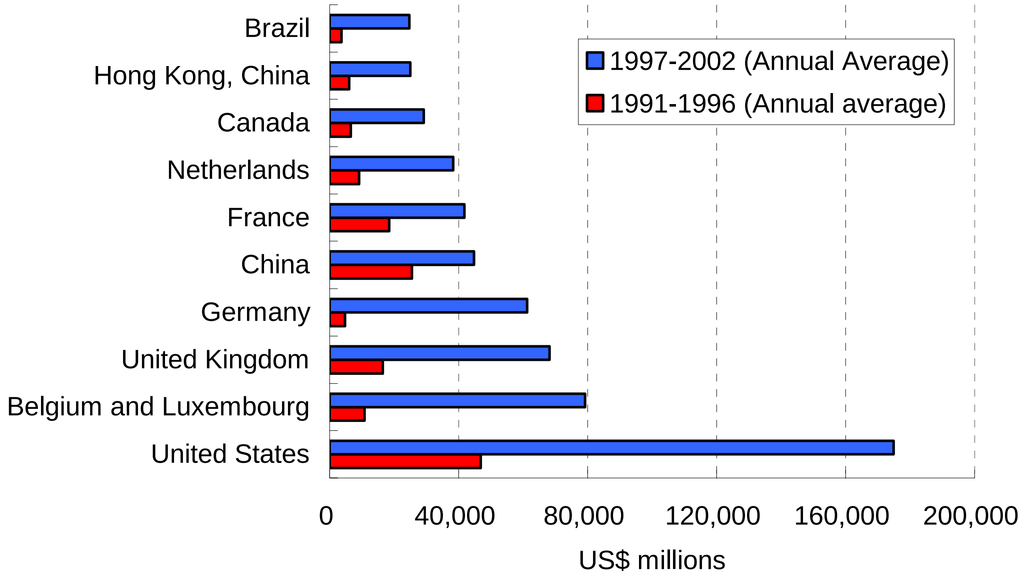
World Investment Report, 79% of US$1,271 billion world FDI flows into advanced countries and 91% of FDI comes from advanced countries.

Table 7: Trade and Investment in the World Economy

	Value (in current $US billion)		Average Annual Growth Rate (%)
	1990	2002	1990-2002
FDI inflows	209	651	9.5
FDI stock	1,954	7,123	10.8
International M&A	151	370	7.5
World GDP	21,672	32,227	3.3
World Exports	3,442	6,272	5.0

Source: UNCTAD, *World Investment Report*, 2001; 2003; WTO, I*nternational Trade Statistics, 2003.*

Figure 6: Top 10 FDI Recipient Countries



Source: UNCTAD, World Investment Report, 2003.

China is expected to become the manufacturing base of the world economy. China's industrialization will continue for the foreseeable future, and the pace of China's industrialization will be dependent upon, among other things, its success in reforming to a more market-oriented economic structure. China's rapid growth will in general mean new growth opportunities for other countries; but there will be keen competition over the Chinese and world markets. In the process, the Asian economies will experience a structural adjustment much different from the past. In the past, as the flying geese model tells, upgrading of industrial structures of the Asian economies occurred sequentially and vertically. But as China is leapfrogging in its industrialization process, the industrial restructuring in the Asian economies will proceed across almost all industrial sectors. In sum, *intra-industrial restructuring* across the Asian economies will be prevalent.

The future shape of the international division of labor in the East Asian region will be more complicated that in the past. No single country will be able to dominate in an industry; rather, many firms of different nationalities will compete in the varied segments of a product market. Over the course, many more Asian firms will go multinational following their Japanese predecessors.[6] Those MNCs will play a mediator role in promoting economic integration in the East Asian region. MNCs will relocate according to the strategic value of the host countries, so the challenge for national governments will be to create a more business-friendly, market-oriented socio-economic environment.

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6. UNCTAD (2001) reports that among the largest 50 MNCs from developing economies 33 are from the East Asia—10 from Hong Kong, 9 from Korea, 7 from Singapore, 4 from Malaysia, 2 from Taiwan, and 1 from Philippines

http://www.huawei.com

http://kotis.kita.net

http://www.ntc.no:8080/files/ntc/rapporter/taiwaninternet.doc