

何帆

hefancass@gmail.com

齐俊妍

jodyqigm@163.com

Is China Competing with Korea? Technology content and Sophistication of the China-Korea Trade

Abstract: Based on the classification of technology content, and the method of calculating the sophistication of export initiated by Kwan, Chi Hung(2002) and Lall, etc(2005), this paper investigates the structural change of the trade relationship between China and Korea. We will show that the industrial competition between China and Korea is not as severe as it looks, the technology content of Korea's product is higher than China's, and Korea has much higher sophistication of export than China.

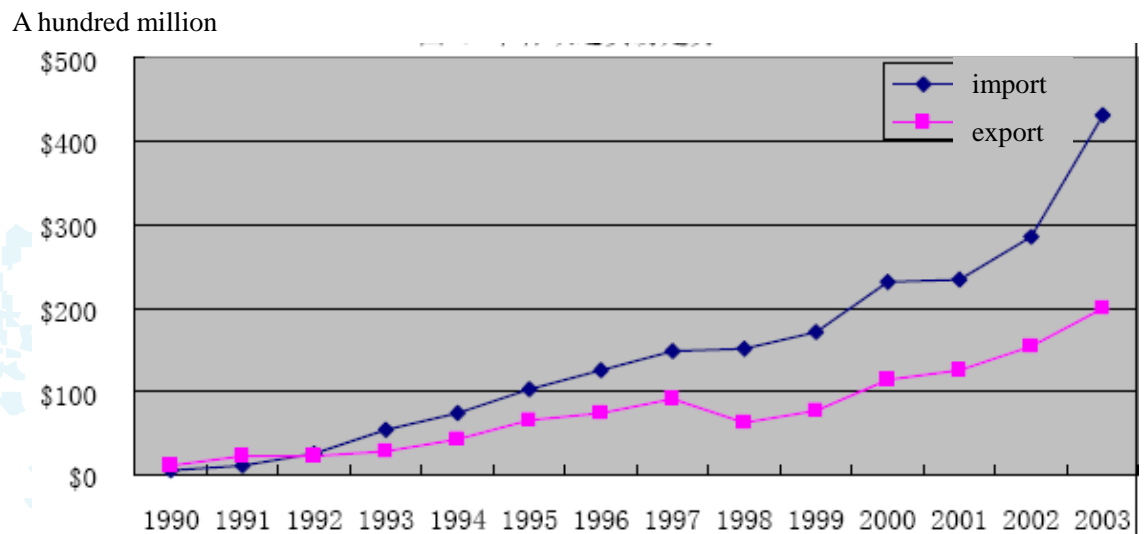
Key words: China Korea Technology content Sophistication

I Introduction

China launched on its opening-up policy in the late 1970s, and has been integrated into the world economy rapidly in the last two decades. Its robust economic growth and the rapid upgrading of its export have significant impacts on other Asian economies, including Korea. The bilateral trade between China and Korea has been growing steadily since 1990(See figure 1). China has now emerged as Korea's second largest trade partner, largest export market and the largest investment target country¹.

¹ Ministry of Commerce of the People's Republic of China: "Trade relation between China and Korea 2006",

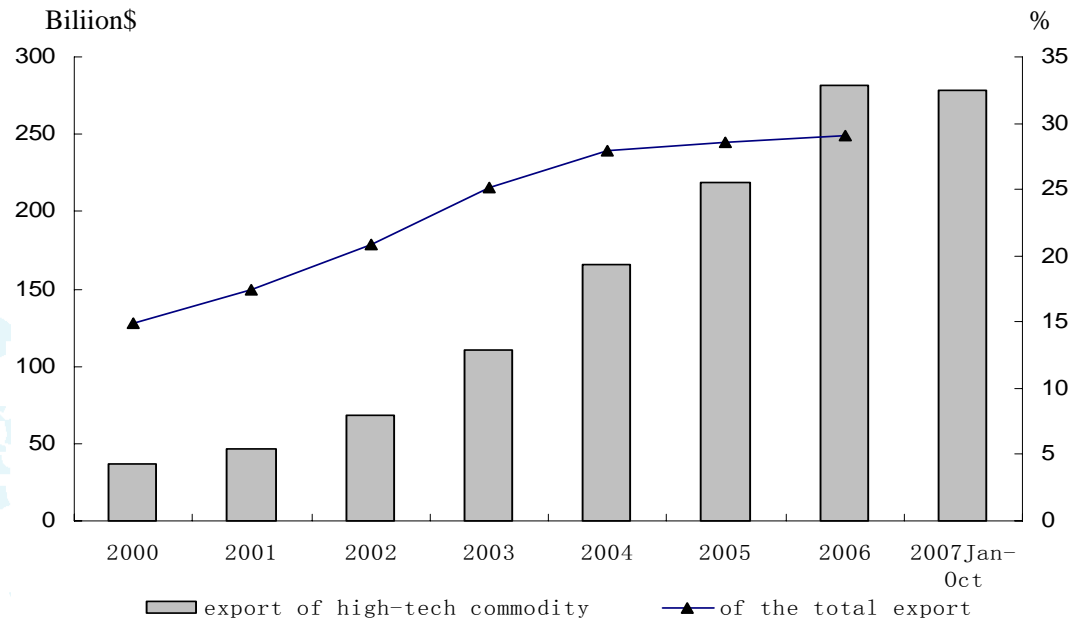
Figure 1 Trade between China and Korea



Source: Ministry of Commerce of the People's Republic of China:

But China's rapid upgrading export also caused increasing concerns from Korea. According to the latest trade statistics, China's export of high-tech products is booming in recent years(See Figure 2),Which reflects that China not only has the comparative advantage in labor-intensive industries, but also gains the comparative advantage in technologically more advanced industries. As the two major engines of export in East Asian, China and Korea may compete with each other in the third markets. Korea's government and scholars are worrying that China's upgrading export will pose potential threat to Korea, and China is becoming a competitor to Korea in the international markets.

Figure 2 China's export of high-tech products (2000-2007)



Source: Ministry of Commerce of the People's Republic of China.
<http://www.mofcom.gov.cn/>

This article argues that, this worry is not legitimate because it does not take the technology content of export into consideration and may misjudge the sophistication of China's export structure. Globalization is changing the world economy into a fully integrated market. Companies can now reallocate their investment and production in different parts around the world to take advantage of economics of scale. As a result, international trade pattern has witnessed a sea change from the traditional inter-industrial trade to a new and flourishing intra-industrial trade. The old-fashioned classification of products, such as primary product, manufacture product and high-tech product, or labor-intensive, capital-intensive and technology-intensive product fail to capture the new changes of international trade. For example, semi-conductor belongs to high-tech product, but the final assembly of semi-conductor has been moved to low income countries. Statistics indicates that developing countries export 45% of the world electronics (Lall etc, 2004), it is not the case that these countries

already have the edge on developed countries.

This article tries to do some preliminary analysis on how to evaluate the technology content and sophistication of export structure, and apply it to China-Korea trade relations. We found that both China and Korea has undergoing dramatic change of trade structure in the last two decades but Korea's achievement is more impressive. We did not find competitive relationship among China and Korea's export. The trade structure of these two countries is still complimentary at large. Cooperation among the two countries can help them to upgrade their industrial structure.

The article is structured as follows: In Section II we introduce the method of the classification based on the technology content of trade products. In section III we show how to calculate the sophistication of manufactured products and the relationship between export sophistication and technology content. Section IV investigates the technology content and sophistication of the export structure of China and Korea. And Section V is the concluding remarks.

II Technology content of traded product

In order to better analyzing the trade structure, Patitt (1984) divides trade product into five categories, i.e. resource-based, labor-intensive, scale-intensive, differentiated and science-based manufactures. The OECD (1994) suggests a more detailed classification based on technological activity within each category. Lall (2000) synthesized the product classified methodology of Patitt and OECD, taking R&D proportion, the economies of scale, entry barrier, learning effect and other factors into consideration, and identifies five different categories for trade products. Based on the 3-digital SITC level, Lall classifies over 300 SITC0-9 items into five groups, i.e. primary products(PP), resource based manufactures(RB)—the products whose competitive advantages arise

from the availability of natural resources; low technology manufactures (LT)—the products which have less advanced and well-diffused technologies, scale economies and barriers to entry are low, and labor costs tend to be a major element of competitiveness; medium technology manufactures (MT)—the products with moderately high levels of R&D, advanced skills, large scale manufacturing, and intensive interaction between firms; and high technology manufactures (HT)—the products with advanced and fast-changing technologies, high levels of specialized technical skills, high R&D investments, new international integrated production systems and sophisticated technology infrastructures, etc.

Furthermore, nine sub-group of trade products are divided: Resource based manufactures (RB) is divided into RB1, agriculture-based products and RB2, others. LT is distinguished between LT1, which includes textile, garment, footwear ('fashion' industry), and LT2, other low technology products. The difference of LT1 and LT2 lies in the fact that the brand names and design of LT1 products have high technological sophistication, leading to quality rather than price competition; MT is divided into three sub-groups. MT1 refers to automotive products, MT2 refers to processing industries, mainly chemicals and basic metals, MT3 refers to engineering products. MT3 industries produce standard and undifferentiated products, often with large-scale input and high barrier of entry, and the relocation of labor-intensive processes to low wage areas occurs but not very often, their products need advanced capabilities to reach world standards. HT is separated into HT1, electronic and electrical products, which have labor-intensive final assembly, and located by MNCs to developing countries. HT2, which includes other high-tech products, like generating equipment, aircraft, and pharmaceuticals. The classification of the product technology content can better reflects the technical depth and structural changes of the country.

III Sophistication of manufactured products

Kwan (2002) and Lall (2005) propose sophistication of export as a measure to better describe different countries' position in the ever integrating world production network. They assume that an export is more sophisticated the higher in different stages of average income of its exporters. For a given year, sophistication of product equals weighted average of exporting country's per capita GDP². Kwan (2002) and Lall, etc (2005) generate the weight by aggregating the value-share across all countries exporting the good

$$w_{ij} = \frac{x_{ij}}{\sum_{i=1}^n x_{ij}} \quad (1)$$

x_{ij} represents export j from country i , the denominator indicates commodity j in the world overall export basket. The problem with this method is that it may cause error because of different export scales in different countries. Fan, Kwan and Yao (2006) and Rodrik (2006) construct comparative advantage as the weight

$$w_{ij} = \frac{RCA_{ij}}{\sum_{i=1}^n RCA_{ij}} \quad (2)$$

RCA_{ij} represents the revealed comparative advantage(RCA) of commodity j of country i , so w_{ij} equals proportion of the RCA of country i product j to the sum of overall countries. In which RCA_{ij} equals:

² In real calculation per capita GDP can be substituted to its logarithm.

$$RCA_{ij} = \frac{X_{ij} / \sum_{i=1}^n X_{ij}}{\sum_{j=1}^m X_{ij} / \sum_{j=1}^m \sum_{i=1}^n X_{ij}} \quad (3)$$

X_{ij} is country i 's export share of product j , n represents the number of countries, and m is number of products. This approach ensures adequate weight for small low-income countries.

From the above analysis, it can be seen that, on the one hand, sophistication of product is determined by per capita income of a certain product's main exporter, on the other hand, it is determined by market-share of countries with different income level.

Usually, an export product with higher technology content is more sophisticated. But some products may have high technology content while its sophistication may be relatively low. For example, electronics product belongs to high technology product, but as a result of more and more producing networks and assembling processes are shifted to developing countries, its sophistication may not be very high. Table 1 helps to judge which matrix each county belongs to .

Table 1 Export sophistication and technology content

Technology level (R&D based)	Sophistication level	
	Low	High
Low	Technologically simple products whose export production has shifted to low wage areas, e.g. textile & clothing (LT1)	Technologically simple products whose export production remains in high wage areas because of trade distortions, resource availability, logistical needs to be near main markets, e.g resource based product (RB2)
High	Technologically advanced products with fragmental processes located in low wage areas, e.g electronics product (HT1)	Technologically advanced products without fragmental processes where high wage countries retain strong comparative advantage (HT2)

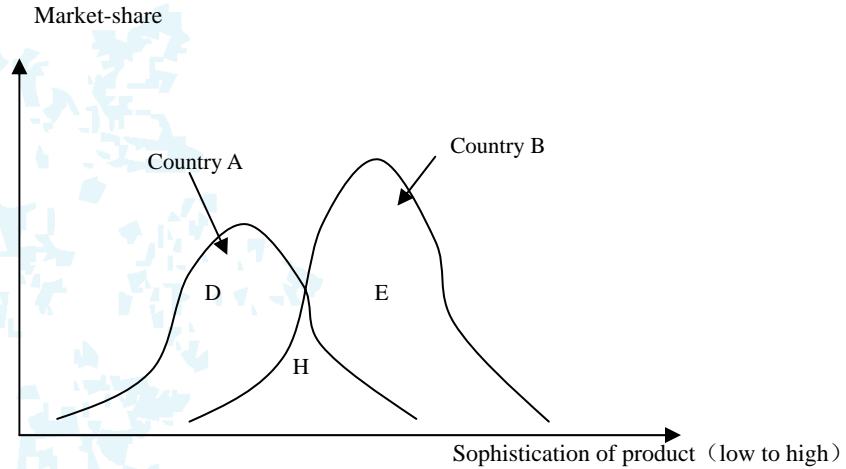
Source: Lall, etc (2005).

A certain country's export sophistication index can be calculated based on the sophistication of product for a given year. The index is the weighted average of the indices of this country's export sophistication, where sophistication of product is calculated through the above method, with the weight being proportion of each kind of exporting product to the overall export basket. As to the exporting country, the larger share of high sophisticated product, the higher this country's export sophistication is.

Figure 3 shows the sophistication distribution of different countries, in order to compare world market share of export between countries. Horizontal axis represents the sophistication of product, while the vertical axis is the world market share of the product with different sophistication. The bell shape curves indicate each country's distribution of export. The over-lapped portion H represents the competitive area in the world market, the bigger H compared with D and E, the more severe competitiveness between the two countries is.

The vertical axis of the figure 3 can also be the market share of a particular country or area, such as the market of the United States, or the market of the Asia. In that case, the over-lapped portion H represents the competitive area between two countries in the particular market or area.

Figure 3 Sophistication distributions of different countries



According to figure 3, two indices can be generated in view of judging competitive or complementary relation (Fan, Kwan, and Yao, 2006)

Competitiveness- Complementarities Index

$$CCI_{AB} = \frac{2 \times S_H}{S_D + S_E} = \frac{2 \times \sum_{j=1}^m \min(X_{Aj}, X_{Bj})}{\sum_{j=1}^m (X_{Aj} + X_{Bj})} \quad (4)$$

Where CCI_{AB} represents Competitiveness-Complementarities Index which ranges between [0,1]. S indicates the dimension of part H, D or E, min is the operator for minimization. Larger index means that overlapped area between

the two countries is correspondingly larger, thus more competitive rather than complementary relation exists.

Competitive Stress Index

If trade shares of the two countries are quite different, influence on different countries may not be symmetric even the overlapping area are the same. For example, if two countries export the same kind of product, but country B exports more than A, competitive stress from country B to A is much heavier than vice versa. As figure 2 shows, overlapped area H to D stands for competitive stress from country B to A, while H to E represents competitive stress from country A to B. competitive stress from country A to B equals:

$$CSI_{AB} = \frac{S_E}{S_H} = \frac{\sum_{j=1}^m \min(X_{Aj}, X_{Bj})}{\sum_{j=1}^m (X_{Bj})} \quad (5)$$

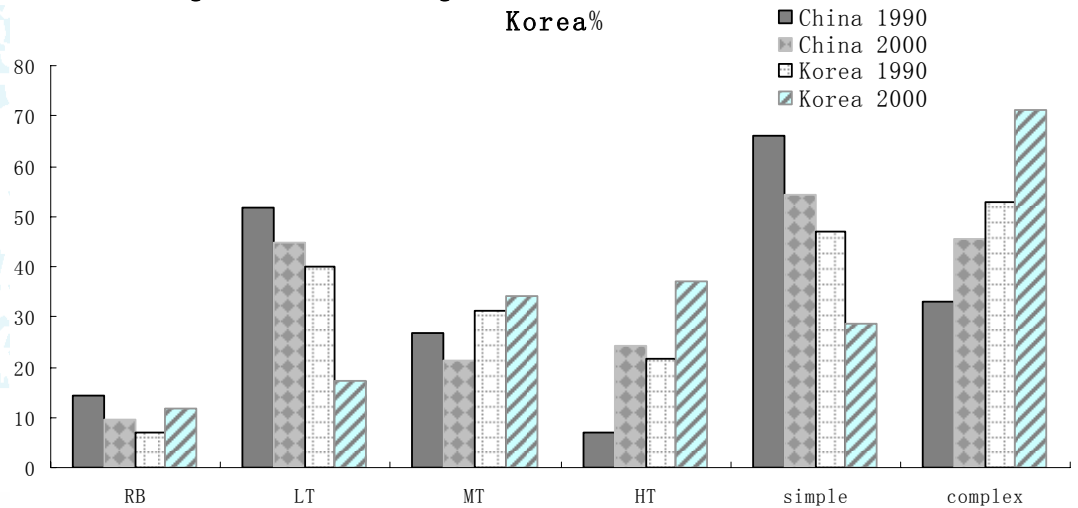
Where CSI_{AB} ranges between [0,1], the larger the index, the higher competitive stress from country A to B is.

IV Comparison of the China and Korea's trade structure

We calculated the technology content of China and Korea's export. The result is showed on Figure 4. We can see from Figure 3 that low technology manufactures still take a relatively higher proportion of China's export in 1990 and 2000, being an important momentum to China's export. While the export of high technology product increase more fast, whose percentage rises rapidly from 5.73% in 1990 to 23.99% in 2000. The upgrading of export structure is more significant in Korea's case. From 1990 to 2000, percentage

of low technology product decreases drastically, when medium technology and high technology products become its major export items. If we define (RB+LT) as ‘simple’ manufacture, and (MT+HT) as ‘complex’ manufacture, then we can see that the percentage of ‘complex’ Korean exports goes up pronouncedly from 1990 to 2000, far higher than that of China (‘complex’ Chinese export in 2000 takes up 45.6% of China’s total export, in contrast Korean percentage is 71.1%).

figure 4 :he change of trade structure:China and Korea%



Source: Calculation based on UNCOMTRADE database,SITC3.

Table 2 demonstrates the revealed comparative advantage (RCA) of China and Korea’s products classified by technology content. From 1986 to 2001, China’s comparative advantage in primary product went down and changed to comparative disadvantage, whereas low technology product especially LT1 enjoyed relatively high comparative advantage, and the high technology product HT1 gained the comparative advantage in 2001. With massive FDI flow into China since 1979, the comparative advantage of China’s labor-intensive low-tech products has been strengthened. FDI also facilitate the rapid development of several high-tech sectors (electronic computer, automatic data

processing equipment, etc.). Unfortunately, medium technology (MT1&MT2) product gained no increase of their comparative advantage.

Korea's comparative advantage in LT1 is lower than China, but RCA of MT2, MT3 and HT1 is obviously higher than China's, reflecting higher technology and skills in Korea..

Figure 5 and 6 reflect the sophistication distribution of China and Korea's exports in 1990 and 2000 respectively. Horizontal axis from left to right represents six different levels of sophistication from low to high, its calculation is based on the 3-digit SITC classification .Vertical axis indicates the world market share of the two countries.

Table 2 RCA of different kinds of product in China and Korea

	China				Korea			
	1986	1991	1996	2001	1986	1991	1996	2001
PP	3.82	1.28	0.77	0.57	0.28	0.23	0.18	0.19
RB1	0.72	0.57	0.67	0.59	0.49	0.41	0.44	0.49
RB2	0.84	0.73	0.75	0.68	0.40	0.54	0.72	1.10
LT1	3.04	4.21	4.13	3.81	4.13	3.06	1.47	1.42
LT2	0.51	1.27	1.75	1.75	1.73	1.29	0.93	0.87
MT1	0.04	0.77	0.11	0.17	0.47	0.42	1.05	1.13
MT2	0.59	0.67	0.77	0.72	1.11	1.62	1.64	1.40
MT3	0.10	0.62	0.72	0.86	0.92	1.03	1.03	1.15
HT1	0.04	0.36	0.85	1.28	1.48	1.77	1.80	1.77
HT2	0.46	0.28	0.50	0.34	0.31	0.22	0.23	0.16

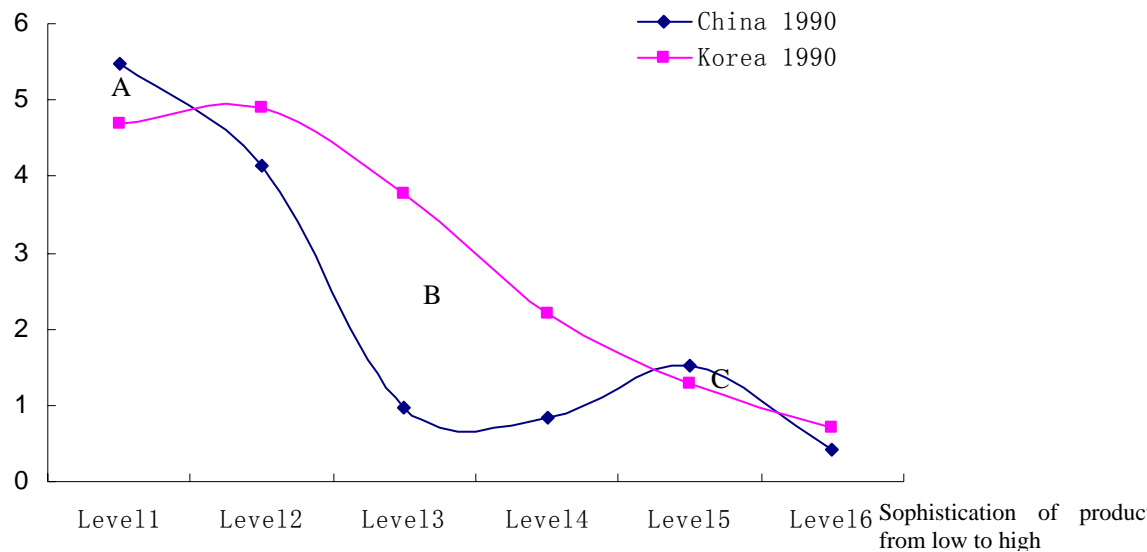
Source: calculation based on UNCOMTRADE database.

Note: herein $RCA_{ij} = (X_{ij} / X_{it}) / (W_{ij} / W_{it})$, where X_{ij} is exportation of country(region)i product j; X_{it} is the export basket of country i; W_{ij} is world exportation of product j, W_{it} is the world overall exports

In 1990 the largest market share of China is in level 1, which has the lowest sophistication, while level 2 has the largest share in Korea. From figure 4 we

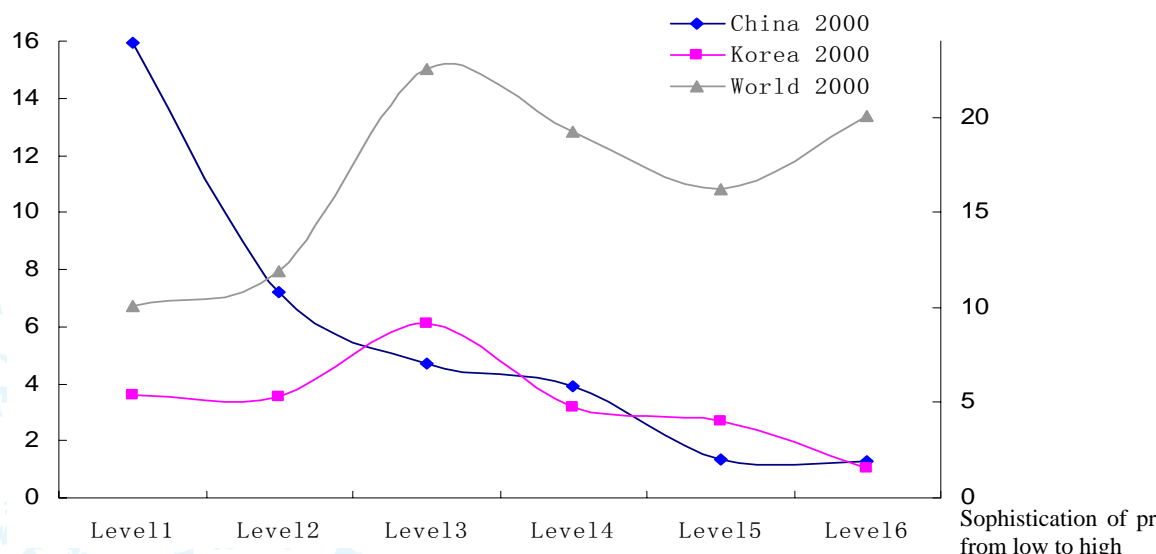
can see that, in 1990 Korea has more higher comparative advantage than China in area B, meanwhile China's comparative advantage mainly lies in area A (some products in level 1 with lower sophistication) and area C (some products in level 5 with higher sophistication). Obviously, the acreage of area B is larger than the acreage of area A plus area C, which implies that Korea has greater competitiveness compared with China in 1990s.

Figure 5 sophistication distributions of China and Korea in 1990 %



2000 witnesses the changes of trade structure in both two countries, but Korea experiences more significant transformation. The largest share of China is still in level 1, when level 3 rise as the largest share of Korea's export. This change is in accordance with the international trends (detail in figure 5).

Figure 6 sophistication distributions of China and Korea in 2000 unit: %



Note: vertical axis on the left stands for China and Korea, while one on the right represents the world

Export sophistication scores of China and Korea is 65.04 and 66.9 respectively in 1990, 56.52 and 66.52³ in 2000. Export sophistication scores of both countries fall down from 1990 to 2000, mainly because trade globalization now allows more developing countries to take part in, and as a natural result, sophistication of product as well as export sophistication scores decrease as a whole. But Korea undergoes a mild decline of 0.4, while China's decreased nearly 10.

Table 3 shows the Competitiveness-Complementarities Index and Competitive Stress Index between China and Korea, based on trade data of both countries.

³ For specific calculation, sophistication of product and then export sophistication score can be normalized to index form. The general formula we apply to derive the sophistication index is $SI(i) = 100 * (S(i) - S(\min)) / (S(\max) - S(\min))$. where SI is the normalized sophistication index of product (i), $S(\max)$ is the maximum unique sophistication score for all products, $S(\min)$ is the minimum unique sophistication score for all products. By this approach numerical range of export sophistication score is [0,100], which can be more convenient to compare.

Competitiveness-Complementarities Index	0.32
Competitive Stress Index from China to Korea	0.53
Competitive Stress Index from Korea to China	0.23
Competitive Stress Index from Korea to China in products based on technology composition	
Low technology (LT)	0.09
Medium-up technology (MT1)	0.17
Medium-down technology (MT2)	0.31
High technology (HT)	0.44

From table 3 we can see that Competitiveness-Complementarities Index between China and Korea is 0.32. Since export scale of China is larger than Korea, Competitive Stress Index from China to Korea is higher than vice versa. In products of different technology content, largest competitive Stress Index from Korea to China lies in the high technology product, which is comparatively larger than other kinds of product.

V Concluding Remarks

In the era of globalization, international trade pattern is changing from inter-industrial trade to intra-industrial trade. Thus comparative advantages among countries are related to the location of value chains among different countries. Therefore comparison of trade structure should not be limited to traditional product classification. Technology content and sophistication of export is more relevant for academic analysis and policy discussions.

We calculated the technology content as well as the sophistication index of China and Korea, and find the following conclusions:

- ✓ From the 1990s to the beginning of the 21st century, changes of China's trade structure is not prominent, low technology product (LT) with low

sophistication still takes the lion's share. In contrast, Korea witnesses more encouraging changes of industrial structure, with relatively higher sophistication and medium technology product gradually take the lead, replacing low technology products(LT). Competitive degree between China and Korea is not so great as common sense may predict. Korea's export sophistication score is more closed to developed countries and higher than China's, and the gap between the two countries tends to be widened.

- ✓ Notwithstanding export of China's information technology products take increasingly larger percentage, its export structure is not as high as what statistics show, for China undertakes mostly the assembling process with low added value.
- ✓ China and Korea may continue to make full use of its comparative advantage. Cooperation among the two countries can help them to upgrade their industrial structure. China should draw lessons from Korea, attaching greater importance to self-innovation, thereby enhance industrial competitiveness fundamentally.

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