An Analysis of Sino-EU Trade from the Vertical Specialization Perspective

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1. Introduction

Since China accessed to the World Trade Organization (WTO), Sino-EU trade has been developing constantly. According to the Ministry of Commerce (MoC), volume of Sino-EU trade reached USD 0.35615 trillion in 2007, with 27% increase over the previous year, accounting for 16.4% of China's total volume in international trade. Since 2004, EU has become China's largest trading partner for four consecutive years. Stable development of Sino-EU trade is significant for both China and EU's development, creating large amount of employment for these two economies.

Vertical specialization has been playing a very important role in Sino-EU trade development in recent years. Vertical specialization refers to specialization of a final product's internal production procedure or assembling procedure. Specifically, it is a kind of specialization between labor-intensive procedure and capital-intensive procedure, with product's R&D, design and value-added process conducted in developed countries while production of final product conducted in developing countries. Since East Asian economies like China enjoy advantage in terms of labor cost, labor-intensive industries, procedures and assembling process have been shifted to these countries gradually in recent years, helping promote East Asia's international trade development.

Therefore, to further understand benefits brought by Sino-EU trade and to help relevant governmental organizations evaluate their trade policies, it is necessary to conduct empirical study regarding Sino-EU trade's scale, structure and influencing

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factors. By combining empirical study and China's overall economic development objectives, we can plan China's future trade policies effectively.

The earliest study on vertical specialization started in the 1960s. At that time western scholars discovered intra-industry trade when studying Europeanization's impact on member states' specialization. Based on previous research, Balassa (1967) suggested a word 'vertical specialization', but he failed to attract academia's attention. Since the 1990s, amid rapid development of international vertical specialization, this field has become a hot topic in international trade. Hummels et al (1998) established vertical specialization (VS) index, by computing share of intermediate product imported in total export value to measure vertical diversification degree. By adopting a general equilibrium model, Grossman et al (2002) proved that vertical specialization could help reduce management cost effectively, providing an important theoretical foundation for vertical diversification theory. Hummel et al (2001) conducted huge amount of empirical studies on changing trend of different countries' VS indexes in the late 20th century, proving that the share of intermediate product trade increased remarkably in international trade, with significant impacts on different countries' productivities and export performance.

In recent years, some scholars also conducted empirical studies regarding China's international trade from the vertical specialization perspective. Liu et al (2006) conducted comparative analysis on Sino-US trade surplus, Sino-Japan and Sino-Korea trade deficit, suggesting that the key reason for surplus and deficit mentioned above is that China is at the end of the East Asia vertical specialization system. Qian et al (2008) studied Sino-US processing trade, discovering vertical specialization's important role in Sino-US trade. Zhang et al (2006) introduced vertical specialization into the framework of Chinese industries' international competitiveness, suggesting that in the long term, participating vertical specialization is good for promoting China's international trade competitiveness. Li et al (2007) analyzed influencing factors of Sino-US trade surplus, suggesting that FDI is the major source of Sino-US trade surplus.

More importantly, the PKU CCER research group led by Ping (2006) adopted the Hummels' method to calculate vertical specialization degree in terms of China's export to US, suggesting that the degree had been going up in recent years, with the feature that intermediate products imported from Japan and Korea accounted substantial share of China's export value to US. By taking account of the impacts of intermediate trade and processing trade, Liu et al (2007) adopted the non-competitive input-output table to calculate the influences of Sino-US trade on value added of two economies' different industry, suggesting that value added created by US's export to China per unit is higher than that of China's export to US.

However, there are still two problems in current research: firstly, most current research focus on Sino-US trade, but the scale of Sino-EU trade has surpassed that of Sino-US trade and EU has become China's largest trading partner. Although both US and EU are advanced economies, there are some difference between Sino-EU trade and Sino-US trade's industrial structures, therefore it is necessary to conduct similar research on Sino-EU trade; secondly, the method adopted to deal with processing trade when measuring VS index does not match the reality. There is huge difference between share of intermediate product in China's processing trade and that in China's normal trade, so equalizing them will lead to errors when calculating VS index.

To address problems mentioned above, by analyzing the scale, structure and influencing factors of Sino-EU trade, this report adopts the non-competitive input-output table to calculate Sino-EU trade's VS index, and measuring the impacts of Sino-EU trade and exchange rate change on employment of China's different industries.

Specially, this report has following sections:

Section two analyzes Sino-EU trade's scale, industrial structure and trading ways, identifying the role of processing trade in Sino-EU trade development in recent years.

Section three looks at Sino-EU trade's influencing factors, explaining that processing trade dominated by FDI is the major source of Sino-EU trade surplus.

Section four adopts the non-competitive input-output table to calculate the VS index of Sino-EU trade, as well as analyzing the impacts of intermediate products imported from Korea, Japan etc on Sino-EU trade's vertical diversification.

Section five adopts the non-competitive input-output table to calculate Sino-EU trade's contributions in promoting employment in China's different industries.

Section six adopts a simultaneous equation model (SEM) to analyze exchange rate change's contributions in promoting employment in China's different industries.

Section seven includes conclusions and policy suggestions.

2. Analysis of Sino-EU trade's scale and structure

Before analyzing Sino-EU trade, we need to specify what we are going to study on. In this report, Sino-EU trade refers to trade between China and 15 core EU member states (Germany, Netherland, UK, France, Italy, Spain, Belgium, Finland, Sweden, Denmark, Ireland, Austria, Greece, Luxemburg, and Portugal). There are reasons why we select this index: firstly, 15 core EU member states play dominant roles in Sino-EU trade, with total trade volume of USD 0.3273 trillion with China in 2007 (total Sino-EU trade volume was USD 0.3561 trillion in 2007); secondly, it will influence the time-series econometric model's result if we take account of new EU member states such as Czech, Slovenia; finally, there is difference between new EU member states and 15 core EU member states in terms of industrial structure, which will influence our research.

Original trade data in this report is from "China Customs Statistical Yearbook" and the Ministry of Commerce's official website. When analyzing industrial data, we adopt the product classification method used by Liu et al (2007) in editing the non-competitive input-output table.

According to our research, there are following features of Sino-EU trade:

1. EU is China's largest trading partner in terms of trade scale; there has been Sino-EU trade surplus in recent years, with a trend of rapid development.

According to MoC, total volume of Sino-EU trade reached USD 0.3561 trillion in 2007, with USD 0.11096 trillion import volume from EU to China and USD 0.24519 trillion export volume from China to EU, and with USD 0.13422 trillion Sino-EU trade surplus. As we can see in table 1, since China's WTO accession, Sino-EU trade has been developing constantly. But given that export's growth rate is higher than that of import, Sino-EU trade surplus has been increasing rapidly.

Table 1: Sino-EU trade during 2002-2007（Billion USD）

Year	2002	2003	2004	2005	2006	2007
Export to EU	48.212	72.155	107.163	134.839	169.025	245.192
Import from EU	38.543	53.062	70.124	71.742	87.337	110.960
Trade surplus	9.668	19.093	37.038	63.097	81.688	134.232

Source: Ministry of Commerce

2. Labor-intensive product, mechanical and electronic product account for the largest share of China's export to EU. According to EU, regarding 27 EU member states' import from China in 2006, textile product accounted for 12.4%, leather product and toys accounted for 6%, while mechanical and electronic product accounted for 45.5%. From the historical perspective, export volume of all China's products increased rapidly, but mechanical and electronic product enjoyed the highest growth rate. According to China's Customs, one of key mechanical and electronic products, telecommunication equipment and computer production enjoyed USD 41.46 billion export volume to 15 EU member states, with 408% increase over the year 2001, which was 2.66 times more than export volume of textile industry and 1.14 times more than that of leather industry (see table 2).

Table 2. China's export volume to 15 core EU member states in selected industries during 2001-2005（USD Billion）

Industry / Year	2001	2002	2003	2004	2005
Textile industry	23.68	30.44	40.74	51.87	86.79
Leather industry	22.49	26.88	32.39	36.22	48.11
Telecommunication equipment and computer production	81.47	106.42	201.36	307.92	414.6

Source: Data estimated according to original data from "China Customs Statistical Yearbook"

3. Major source of Sino-EU trade surplus is from labor-intensive industry. Table below is about top ten ranking of industries with the largest Sino-EU trade surplus. As we can see, top three industries are all about computer production, with higher vertical specialization degree and characteristics of processing and assembling. Others (from 4th to 10th) are labor-intensive industries that China enjoys traditional advantage, including toys, leather, textile etc.

Table 3. Top ten industries with the largest Sino-EU trade surplus

Ranking	Industry
10	Leather, Fur, and Coat Products Manufacturing
9	Household Video and Audio Equipment Manufacturing
8	Toys, games and sports requisites
7	Knit Fabric, Knitting and Product Manufacturing
6	Metal products
5	Stationery and Office Machine Manufacturing
4	Apparel, Shoes, and Hat Manufacturing
3	Computer Body Manufacturing
2	Electronic Communication Equipment and Computer Manufacturing
1	Other Computer Manufacturing

4. Processing trade plays a dominant role in Sino-EU trade, with an increasing share after China's WTO accession. According to China Customs, export by processing trade accounted for 56.6% of Sino-EU trade in 2005, with 2.1% increase over the year 2001. Accordingly, export by normal trade accounted for 42.8%, with 1.7% decrease over the year 2001 (see table 4). Processing trade also plays an important role in China's import from EU, although with a much smaller scale than that of export by processing trade. Import volume by processing trade was USD 22.5 billion in 2005, which was much smaller than that of Sino-Japan and Sino-Korea trade. Compared with normal trade, processing trade is characterized by shorter value added chain and lower value added, therefore benefits from Sino-EU trade is lower than

Sino-EU trade surplus.

Table 4. Shares of different kinds of trade between China and EU during 2001-2005

Year	Share of export by normal trade	Share of export by processing trade
2001	44.52%	54.47%
2002	44.70%	54.80%
2003	41.83%	57.79%
2004	41.55%	58.21%
2005	42.80%	56.64%

Source: data estimated according “China Customs Statistical Yearbook”

5. In terms of export volume by processing trade, share of high-tech product is obviously larger than that of labor-intensive products such as textile product. In recent years, share of high-tech product in China’s export has been increasing gradually. By referring to the OECD criteria, China regards computer and telecommunication technology, life scientific technology, electronic technology, computer assembling technology, aviation and space technology, optoelectronic technology, biological technology, material technology and other technology as high-technology. Export of computer and telecommunication product plays a major role in China’s high-tech product export. According to China Customs, export volume of computer, telecommunication and other relevant products reached USD 0.1977 trillion in 2005, while total volume of high-tech product export was only USD 0.21825 trillion in that year. Therefore, this report is going to focus on computer product which accounts for higher share of China’s high-tech product export to EU. Table 5 lists export volumes of some representative labor-intensive industries and high-tech industries during 2001 to 2005. As we can see, share of export by processing trade in computer production industry is much higher than that in labor-intensive industry. Export volume to EU by processing trade in computer production industry reached USD 10.5 billion in 2005, which was about 1000 times more than that by normal trade (only USD 10.43 million at that time). Export volume to EU by processing trade in toys industry was USD 3.1 billion in 2005, which was only 2.21 times more than that by normal trade in toys industry (USD 1.4 billion at that time). Regarding export in textile industry, volume of normal trade was obviously higher than that of processing trade.

Table 5. Scale of selected industries' export to EU during 2001-2005（USD Billion）

Year	Textile		Toys, sports and entertainment products		Pharmaceutical		Computer production		Other computer equipment production	
	ENT	EPT	ENT	EPT	ENT	EPT	ENT	EPT	ENT	EPT
2001	0.319	0.029	0.631	1.063	0.377	0.098	0.033	1.326	0.03	4.378
2002	0.555	0.16	0.743	1.773	0.479	0.15	0.018	4.008	0.001	0.353
2003	0.774	0.194	0.979	2.279	0.597	0.203	0.024	6.77	0.001	3.761
2004	0.973	0.243	1.143	1.907	0.67	0.154	0.033	9.623	0.007	6.79
2005	1.220	0.235	1.411	3.183	0.824	0.165	0.055	11.771	0.01	10.459

Note: ENT - export by normal trade; EPT - export by processing trade

Source: China Customs

6. FDI enterprise plays an important role in Sino-EU trade. FDI enterprise (including investment from Hong Kong, Macau and Taiwan) is the major source of China's international trade. Volume of international trade by FDI enterprise reached USD 1.254928 trillion, accounting for 57.73% of China's international trade. As mentioned above, FDI enterprise is also a major source of processing trade. The share of FDI enterprise is much higher in Sino-EU trade. The share of export volume by FDI enterprise increased to 63.4% from 52.93% during 2001 - 2005. In terms of export structure, share of FDI enterprise in high-tech product export is much higher than that in labor-intensive product export. The share of FDI enterprise in computer production industry reached 99.94% in 2005, which was much higher than that in textile industry (about 40%).

7. There has been a trend of decreasing nominal tariff rate of China's import commodities. According to commodity tariff rates published by WTO, table 6 calculates China's nominal tariff rates of import commodities for its most favored countries during 2002 - 2005, which applies to normal trade between China and 15 core EU member states. As we can see, there was a trend of decreasing tariff rate of China's import commodities. But since 2006, tariff rate of China's import commodities has been decreasing further, which effectively helps promote the development of China's import scale.

Table 6. China's nominal tariff rate estimated during 2002 – 2005 (%)

Industry / Year	2002	2003	2004	2005
Coal Mining and Coal Washing	4.00	4.00	4.00	4.00
Oil & Gas Mining	3.67	3.59	3.59	3.59
Ferrous Metal Ore Mining	0.50	0.50	0.50	0.50
Non-Ferrous Metal Ore Mining	1.75	1.75	1.69	1.69
Nonmetallic Mineral Mining and Quarrying	3.63	3.59	3.58	3.56
Agricultural and By-Product Processing, Food Manufacturing	19.96	18.15	16.68	16.24
Beverage Manufacturing	29.78	25.62	21.24	19.64
Tobacco Products	48.00	43.67	41.00	41.00
Textile Industry	16.84	14.33	12.02	10.72
Apparel, Shoes, and Hat Manufacturing	21.80	19.72	17.67	16.28
Leather, Fur, and Coat Products Manufacturing	13.79	13.27	12.73	12.61
Wood Processing, and Other Wood Products	5.75	4.53	3.96	4.01
Furniture Manufacturing	10.99	9.05	7.17	5.32
Paper Making & Paper Products Industry	9.47	7.83	6.54	5.67
Printing and Recording Media Reproducing	7.61	6.25	5.45	4.83
Stationery and Sporting Goods	15.06	13.93	12.80	11.78
Petroleum Processing and Coking Plant Industry	5.13	5.22	5.22	5.13
Chemical Materials & Products Manufacturing	7.99	7.65	7.37	7.18
Pharmaceutical	5.65	4.91	4.87	4.87
Chemical Fiber Manufacturing	8.40	6.50	6.50	6.50
Balata Product Industry	15.05	14.61	14.28	14.21
Plastic Product Industry	11.56	10.31	9.12	9.00
Nonmetallic Minerals Products	14.17	13.57	13.03	12.86
Ferrous Metal Smelting and Rolling Processing	5.44	5.27	5.09	5.09
Non-Ferrous Metal Rolling Processing Industry	4.64	4.50	4.45	4.39
Metal Product	10.07	9.91	9.83	9.82
General Machinery Manufacturing	10.52	9.67	9.05	8.99
Special Machinery Manufacturing	8.58	7.88	7.54	7.52
Transportation Equipment Manufacturing	17.42	15.95	14.49	13.28
Electronic Machinery and Equipment	11.90	10.88	10.27	10.15
Electronic Communication Equipment and Computer Manufacturing	10.21	9.49	8.72	8.43
Instrument, Meter, Stationery and Office Machine Manufacturing	11.26	10.34	9.90	9.73
Handicraft Article	19.91	17.99	16.19	14.86

Consequently, although the scale of Sino-EU trade keeps increasing and Sino-EU trade maintains obvious trade surplus, China's real benefits from trade surplus is not high. Characterized by low value-added and dominated by FDI enterprises, processing trade is the major source of Sino-EU trade surplus. FDI enterprises from advanced economies provide most technologies, brands, and key accessories for Sino-EU trade. China's main contributions are providing low cost but high quality labor, land resource as well as labor-intensive production procedure. Particularly, in terms of China's export of high-tech product to EU, the share of computer production industry, especially the share of processing trade is really high.

According to analysis above, it can be estimated that vertical specialization degree of China's export to EU will keep increasing. At the same time, since FDI is an important way of vertical specialization, given that despite US and EU, most FDI in China is from East Asian economies such as Japan and Korea whose investment in China developed rapidly during 2002 - 2005, therefore intermediate products imported from Japan and Korea may play an important role in Sino-EU trade.

3. Empirical analysis on Sino-EU trade's influencing factors

This section is going to analyze Sino-EU trade' influencing factors, from an overall perspective and an industry-level perspective.

According to international trade theory, following factors influence the overall scale of Sino-EU trade:

1. Trading country's market size. Apparently, market size's expansion increases demand of commodity, and then promoting foreign trade. This is one of the most important influencing factors in international trade.
2. Exchange rate. According to international trade theory, exchange rate change leads to change of comparative price level between importing country and exporting country. Theoretically, appreciation is bad for a country's export, but is good for its import.

3. FDI. In recent years, intra-industry trade and vertical specialization have been developing rapidly, since FDI is one of important platforms characterized by vertical specialization, therefore FDI's impact on the scale of foreign trade has become remarkable.

This report chooses Granger Causality test to examine impacts of factors mentioned above on Sino-EU trade. Trading countries' market size will be measured by China and EU's nominal GDP, while RMB/EU exchange rate will be selected (the reason why we do not choose RMB/USD exchange rate is that there had been little variation of RMB/USD exchange rate before China reformed its exchange rate mechanism in 2005.), FDI will be measured by real volume of FDI. Relevant data's sample space is from the 1st Quarter of 1998 to the 4th Quarter of 2006. Data is from the Ministry of Commerce, the National Bureau of Statistics, and EU Statistics Bureau's official website（http://ec.europa.eu/eurostat）.

Table 7 shows us the result of Granger Causality test:

Table 7. Result of Granger Causality test

Assumptions	Lag	Probability
EU's market size is not the Granger reason for China's export to EU	1	0.02
China's market size is not the Granger reason for China's import from EU	1	0.21
RMB/EU exchange rate is not the Granger reason for China's export to EU	1	0.59
RMB/EU exchange rate is not the Granger reason for China's import from EU	2	0.14
FDI is not the Granger reason for China's export to EU	1	0.01
FDI is not the Granger reason for China's import from EU	1	0.04

According to the result, EU's market size has significant impact on China's export to EU, but the causality between China's market size and the scale of EU's export to China is not significant; the causality between exchange rate and export / import is not significant either; FDI is the Granger reason for both China's import to EU and export from EU.

This result indirectly reflects the important role of vertical specialization in Sino-EU trade. According to analysis above, consumption goods (such as mechanical - electronic product, textile product, and PC) is China's main export to EU. Therefore, EU's economic development has significant impact on China's export to EU. But substantial parts of EU's export to China are high-tech product, raw material and component for China's export by processing trade. Since high-tech product is not a kind of direct consumption goods, the causality between EU's high-tech product export and China's market size is not significant. In terms of EU's raw material and component export, given China's export by processing trade is mainly for advanced economies, the causality is not significant either. As FDI plays an important role in vertical specialization, the causality between FDI and Sino-EU trade is very significant.

There may be two reasons explaining the insignificant causality between exchange rate and Sino-EU export / import. Firstly, the impact of exchange rate on vertical specialization characterized by processing trade is much smaller than that on normal trade. In terms of normal trade, exchange rate may have huge impact on producer's profit. But for processing trade, since its major profit is not from the process conducted in developing country, the impact of exchange rate on profit is much smaller. Secondly, China's exchange rate policy was characterized by fixed-peg to USD before 2005, while USD was the key settlement currency at the moment, which to some extent influences the statistical result.

However, vertical specialization degree varies among industries. For instance, the degree may be quite high in computer production industry, but very low in agricultural industry. According to the share of processing trade, this section classifies production industry's 26 sub-industries into two groups, setting up a Panel Data model to study the impact of FDI and other industry indexes on Sino-EU trade surplus.

1. Trade imbalance degree (EIRATE), measured by the ratio of an industry's export volume / import volume. Since the Chinese government does not release detailed data of industries' foreign trade, it is hard to conduct statistics regarding an industry's import and export volume. This report takes two steps to calculate different industries' trade scale: firstly by referring to "China Input-Output Table 2002" and the HS code

provided by China Customs, we classify industries into different groups; secondly by combining trade data provided by China Customs, we have data for different industries.

2. Share of FDI (FDIRATE), measured by the ratio of an industry FDI asset / its overall asset, which can reflect the role of FDI in an industry. Theoretically, FDI inflow can promote relevant industries' export and import simultaneously.

3. Capital intensity (KLRATE), measure by the ratio of an industry' fixed asset and its overall labor.

4. Enterprise's size (SIZE), measured by the ratio of the number of employee in an industry and the number of enterprise in an industry. Theoretically, given that other factors hold steady, the bigger the enterprise's size, the stronger its international competitiveness.

Since much sub-industries' foreign trade volume is quite small, such as electricity industry, therefore to reduce statistical errors, it is necessary to conduct industry selection. Through the selection process, by following "Industry Classification Standard of National Economy", the model's sample space is production industry's 26 sub-industries, its time space is during year 2001 – 2005. Trade data is based on "China Customs Statistical Yearbook", other data is from "China Statistical Yearbook".

By adopting the share of processing trade in overall trade during year 2001 – 2005 as a benchmark, this section classifies industries into two groups: one with higher share of processing trade, the other with lower share of processing trade, each of which includes 13 sub-industries respectively.

Industries with higher share of processing trade:

Leather, Fur, and Coat Products Manufacturing, Apparel, Shoes, and Hat Manufacturing, Stationery and Sporting Goods, Furniture Manufacturing, Wood Processing, and Other Wood Products, Textile Industry, Paper Making & Paper

Products Industry, Plastic Product Industry, Printing and Recording Media Reproducing, Nonmetallic Minerals Products, Instrument, Meter, Stationery and Office Machine Manufacturing, Agricultural and By-Product Processing, Food Manufacturing, Electronic Communication Equipment and Computer Manufacturing

Industries with lower share of processing trade:

Metal Product, Balata Product Industry, General Machinery Manufacturing, Special Machinery Manufacturing, Electronic Machinery and Equipment, Beverage Manufacturing, Chemical production, Pharmaceutical, Transportation Equipment Manufacturing, Non-Ferrous Metal Rolling Processing Industry, Chemical Fiber Manufacturing, Ferrous Metal Smelting and Rolling Processing, Petroleum Processing and Coking Plant Industry

Following Panel Data model's requirement, we conduct F-test first. Table 8 shows the test result.

Table 8. Result of F-test for the Sino-EU trade balance model

	Sino-EU	
	Processing trade	Normal trade
F2	6.63	0.11
F1	0.29	0.07
Type of model	Variable Intercept	Mixed

As we can see in the result, processing trade model belongs to variable-intercept model, while normal trade model belongs to mixed model. Table 9 shows the comparison of these two models.

Table 9. Comparison of trade balance models

Type of model	Variable	Higher share of processing trade			Higher share of normal trade		
Sino-EU	KLRATE	-2.047347	-4.36480	0	0.0834673	4.96843	0
	SIZE	1.343144	3.23455	0	---	---	---
	FDIRATE	37.38279	7.42375	0	---	---	---

Therefore, we have following conclusions.

1. In industries with higher share of processing trade, share of FDI

promotes Sino-EU trade imbalance degree remarkably.

2. In industries with lower share of processing trade, share of FDI has significant impact on Sino-EU trade imbalance degree.

3. In industries with higher processing trade, the lower capital intensity, the higher Sino-EU trade imbalance degree.

4. In industries with lower processing trade, the lower capital intensity, the lower Sino-EU trade imbalance degree.

5. In labor-intensive industry, average enterprise size has significant impact on Sino-EU trade imbalance degree.

6. In capital-intensive industry, the impact of average enterprise size on Sino-EU trade imbalance degree is not significant.

Conclusions above match the reality of Chinese economy. Industries with higher share of processing trade, such as toy, textile, computer production, mainly rely on China's comparative advantages in terms of labor cost and other resource cost, therefore FDI inflow into these industries is characterized by export-oriented, which leads to the fact that the higher share of FDI, the higher degree of trade imbalance. In these industries, export advantage manly relies on economy of scale brought by huge amount of labor input, while marginal benefits of technology and capital are relatively lower, therefore in industries with lower capital intensity, trade imbalance degree is higher.

Similarly, in these industries, technological and capital advantages brought by big enterprises can help promote export. But the fact is totally different in industries with lower share of processing trade, most of which have relatively lower degree of trade imbalance. Overall, China's capital-intensive industry does not enjoy advantage in international specialization, consequently share of market-oriented FDI is relatively higher, and dos not have significant impact on trade imbalance degree. In these industries, export advantages rely on scale of capital and technology, so the rise of capital intensity promotes trade imbalance degree. The impact of average enterprise size on trade imbalance is not significant, which means that price and quantity advantages are still key advantages for China's foreign trade, while oversea expansion by big enterprises or groups to establish effective marketing channel etc have not been implemented effectively.

Overall, the impact of FDI on Sino-EU trade surplus varies among industries, so it does not follow that FDI inflow into China certainly promotes Sino-EU trade surplus. Consequently, through adjusting industrial and FDI policies, it is possible to promote China's opening-up as well as reduce its trade imbalance when promoting FDI utilization.

Finally, given that China has been implementing higher tariff rebate rate for processing trade, next we are going to analyze nominal tariff rate change's different impacts on import by processing trade and import by normal trade.

According to international economy theory, we set up following models to measure tariff rate's impacts on processing trade and normal trade's import volume:

$$\ln(JIM_{it}) = f(TARIFF_{it}, \ln(AE_{it}))$$
$$\ln(CIM_{it}) = f(TARIFF_{it}, \ln(AE_{it}))$$

We have i=1,2,……N, t=1,2,……T. AE refers to the number of employees in different industries during different periods, which can be used to measure difference of import volumes (LN refers to natural exponent) due to scale difference of industries. Based on the method adopted to measure different industry's import and export volumes in previous section, firstly by combining industry classification standards (for data about processing trade and normal trade import / export) released by the China Customs, we have different industry's processing trade import volume (JIM) and normal trade import volume (CIM). TARIFF refers to nominal tariff rate. Model's sample space is production industry's 26 sub-industries during year 2002 – 2005 (like the previous section).

By conducting F-test for the processing trade import model and normal trade import model respectively, we have the results: processing trade model's F_2=66.8, F_1=0.36; normal trade model's F_2=227.3 , F_1=0.45. Therefore, both models are variable-intercept models. Since we mainly focus on analyzing 26 sub-industries themselves, the fixed effect model is adopted. Table 10 shows us the regression results through GLS estimation:

Table 10. GLS results for processing trade and normal trade models

Variable / model	Higher processing trade			Higher normal trade		
Tariff	-0.02	-2.82	0.01	-0.09	-6.83	0.00
AE	1.29	13.29	0.00	1.06	9.28	0.00

As we can see, it is true that the decrease of tariff rate can help promote both processing trade and normal trade's import volumes, but the effect for processing trade is much smaller than that for normal trade. Therefore, the decrease of nominal tariff rate may have larger effect in promoting the import volume of those industries with lower share of processing trade.

For the Panel data adopted in this report, since the number of cross section is much larger than the length of time series, therefore F-test for panel data may not be able to tell the difference of nominal tariff rate's impacts on different industries' import volume. Consequently, by adopting the group classification method mentioned previously, we classify 26 sub-industries into two groups (one with higher share of processing trade, the other with higher share of normal trade), each of which includes 13 sub-industries respectively, and then setting up the following model to measure the difference of nominal tariff rate's impacts on different industries' import volume.

$$LOG(IM_{it} / AE_{it}) = f(TARIFF_{it})$$

The processing trade group has F_2=35.56, F_1=0.23; the normal trade group has F_2=82.69, F_1=0.37. Consequently, by setting up a fixed effect varying coefficient model for two groups respectively, we have following GLS statistics results:

Table 11. GLS estimation results for processing trade group and normal trade group

Variable / model	Normal trade group			Processing trade group		
tariff	-0.09	-10.93	0.00	-0.01	-0.51	0.61

The model chooses the ratio of import volume / number of employee in order to eliminate the impact of economic growth on import volume. As we can see in the model, in the normal trade group, the impact of tariff rate on import volume per person is significantly negative. On the other hand, although the impact is negative as well in the processing trade group, it is not significant in terms of statistics. This is consistent with the result of the previous model.

Tariff rate rebate for processing trade helps China utilize its labor cost advantage in terms of international economy effectively, which has played a very important role in promoting China's trade development and economic growth in past decades. However, amid improvement of China's industrial structure and its continuing economic growth, this comparative advantage is expected to be weaker in the future. Compared with normal trade, processing trade dominated by FDI enterprise has lower value added, as most profits are obtained by multinational corporations from advanced economies. This fact has been proved by Chen (2007), a research fellow from the Institute of Mathematic and Systematic Science, Chinese Academy of Science, who adopted the non-competitive input-output table to measure the value added brought by Sino-US trade for both economies. However, processing trade is one of key sources of China's trade surplus. China's processing trade surplus reached USD 0.25 trillion in 2007, which basically equals to the overall scale of China's trade surplus. Therefore, as well as promoting economic growth, the tariff rate rebate policy for processing trade makes the share of processing trade too high, which to some extent reduces the effect of nominal tariff rate and contributes to China's trade imbalance.

According to empirical research above, we have following conclusions:

1. Vertical specialization has significant impact on Sino-EU trade's influencing factors. As we can see in previous analysis, influenced by vertical specialization, FDI is Sino-EU trade's Granger reason, but statistically China's market size is not a Granger reason for EU's export to China.

2. Impact of China's foreign trade varies among industries. In those industries with lower share of processing trade, the impact of FDI on industry's trade imbalance is

insignificant. But in those industries with higher share of processing trade, the impact of FDI on industry's trade imbalance is significant.

3. Processing trade dominated by FDI has certain degree of impact on tariff rate policy. Since China has been offering very high tariff rebate rate for processing trade, when processing trade dominated by FDI has too high share, tariff rate policy's effect in promoting import will be influenced.

Although to some extent, index of processing trade, index of FDI etc can reflect vertical specialization degree in China, currently the popular index is the VS index initiated by Hummels et al (1998). Next we are going to calculate each industry's VS index by adopting the non-competitive input-output table.

Section 4. Calculation of Sino-EU trade's VS index

This section will introduce the non-competitive input-occupancy-output table model for processing trade initiated by Liu et al (2007), as well as the VS index calculation method, and finally generating the calculation result.

1. Model establishment

About half of China's foreign trade is from export by processing trade[2]. For processing trade's production process, most of its raw material, components as well as equipments are imported from foreign providers, there is huge difference between export product and domestic product's production processes. In this situation, it is not appropriate to use ordinary non-competitive input-output model to study China's foreign trade, therefore we establish an extended non-competitive input-occupancy-output model for processing trade study.

To calculate the impact of import / export on national economy accurately, we classify the model's activities into three parts: production for domestic demand (D, domestic product in brief), production for export by processing trade (P, export by processing

[2] In this article, processing trade only includes processing with imported materials and processing with supplied materials.

trade in brief, including processing with imported materials and processing with supplied materials), production for export by non-processing trade (N, export by non-processing trade in brief). Specifically, production for domestic demand refers to production activity for fulfilling domestic demand; production for export by processing trade includes processing with imported materials and processing with supplied materials; production for export by non-processing trade includes export productions except processing with imported materials and processing with supplied materials. We have following specific expressions: Based on analysis above, we can establish an extended non-competitive input-occupancy-output model in table 12.

Table 12. Non-competitive input-occupancy-output model for telling the difference between export by processing trade and export by non-processing trade

<table>
<tr><th colspan="4" rowspan="3">Output
Input</th><th colspan="4">Intermediate use</th><th colspan="5">Final use</th><th rowspan="3">Overall domestic output or overall export</th></tr>
<tr><th>D</th><th>P</th><th>N</th><th rowspan="2">Total</th><th rowspan="2">C</th><th rowspan="2">CF</th><th rowspan="2">EXP</th><th rowspan="2">OT</th><th rowspan="2">Total</th></tr>
<tr><th>1,2,…, n</th><th>1,2,…, n</th><th>1,2,…, n</th></tr>
<tr><td rowspan="7">INP</td><td rowspan="3">DPI</td><td>D</td><td>1
⋮
n</td><td>X^{DD}</td><td>X^{DP}</td><td>X^{DN}</td><td></td><td>F^{DC}</td><td>F^{DI}</td><td>0</td><td></td><td>F^{D}</td><td>X^{D}</td></tr>
<tr><td>P</td><td>1
⋮
n</td><td>0</td><td>0</td><td>0</td><td></td><td>0</td><td>0</td><td>F^{PE}</td><td></td><td>F^{P}</td><td>X^{P}</td></tr>
<tr><td>N</td><td>1
⋮
n</td><td>X^{ND}</td><td>X^{NP}</td><td>X^{NN}</td><td></td><td>F^{NC}</td><td>F^{NI}</td><td>F^{NE}</td><td></td><td>F^{N}</td><td>X^{N}</td></tr>
<tr><td colspan="2">IPI</td><td>1
⋮
n</td><td>X^{MD}</td><td>X^{MP}</td><td>X^{MN}</td><td></td><td>F^{MC}</td><td>F^{MI}</td><td></td><td></td><td>F^{M}</td><td>X^{M}</td></tr>
<tr><td colspan="3">OII</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Value added</td><td>V^{D}</td><td>V^{P}</td><td>V^{N}</td><td></td></tr>
<tr><td colspan="3">Total input</td><td>$(X^{D})^{T}$</td><td>$(X^{P})^{T}$</td><td>$(X^{N})^{T}$</td><td></td></tr>
<tr><td rowspan="3">OCC</td><td colspan="3">Capital
FDI</td><td>K^{D}</td><td>K^{P}</td><td>K^{N}</td><td></td></tr>
<tr><td colspan="3">Labor</td><td>L^{D}</td><td>L^{P}</td><td>L^{N}</td><td></td></tr>
<tr><td colspan="3">Natural resources etc</td><td></td><td></td><td></td><td></td></tr>
</table>

Note:

D - Domestic production

P - Export by processing trade

N - Export by non - processing trade

C – Consumption

CF - Capital formation

EXP – Export

OT - Export

DPI - Domestic product intermediate input

IPI - Imported product intermediate input

OII - Overall intermediate input

INP – Input

OCC - Occupancy

X^D, X^P and X^N refer to column vectors of D, P and N’s overall outputs;

F^D, F^P and F^N refer to column vectors of D, P and N’s final demands;

DD refers to that domestic product is used for domestic consumption, while DP refers to that domestic product is used for export by processing trade, DN refers to that domestic product is used for export by non-processing trade;

X^{DD}, X^{DP} and X^{DN} refer to intermediate input matrixes when domestic product is used as intermediate input for D, P and N;

X^{ND}, X^{NP} and X^{NN} refer to intermediate input matrixes when product from export by non-processing trade is used as intermediate input for D, P and N;

F^{DC} and F^{DI} refer to column vectors when domestic product is used for consumption and fixed capital formation, and $F^D = F^{DC} + F^{DI}$;

F^{PE} refers to column vector when product from export by processing trade is used for export, and $F^P = F^{PE}$, all products from export by processing trade are used for export, so intermediate demand and other final demands are zero;

F^{NC}, F^{NI} and F^{NE} refer to column vectors when export by non-processing trade is sued for consumption, fixed capital formation and export, and

$F^N = F^{NC} + F^{NI} + F^{NE}$;

X^{MD}, X^{MP} and X^{MN} refer to intermediate input matrixes when imported product is used as intermediate input for D, P and N;

F^{MC} and F^{MI} refer to column vectors when imported product is used for consumption and fixed capital formation;

V^D, V^P and V^N refer to row vectors of D, P and N's value added;

L^D, L^P and L^N refer to row vectors of D, P and N's employment;

To better reflect the impact of export on domestic employment, based on the input-occupancy-output model (or extended input-output model with assets) suggested by Chen[3], we have occupancy of labor, capital and various natural resources in the third quadrant.

1.2 Data processing

1.2.1. Source of data

Reflecting processing trade, the non-competitive input-occupancy-output table is edited according to the input-output table issued by the National Bureau of Statistics, as well as data from the China Customs etc.

Specifically, the China Customs provided "China Customs Statistical Yearbook" from previous years, as well as statistical tables for processing with imported materials and processing with supplied materials etc. The National Bureau of Statistics provided "China Input-Output Table" from previous years, as well as Table for Export Commodity's Value Added, Match Table for Input-Output Units and Custom Statistics (HS 2-digit codes, with 98 categories of goods[4]), important data from the Transition

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[3] Xikang Chen, Input-Occupancy-Output Analysis and Its Application in China, in Manas Chattezji and Robert E. Kuenne, eds., *Dynamics and Conflict in Regional Structural Change*, London: Macmillan Press, 1990, pp.267-278. Xikang Chen, Input-Occupancy-Output Analysis and Its Application in the Chinese Economy, in Shri Bhagwan Dahiya(ed.), The Current State of Economic Science, Rohtak: Spellbound Publications, Pvt. Ltd., 1999, pp.501-514. Xikang Chen, Ju-e Guo, and Cuihong Yang, Extending the Input-Output Model with Assets, Economic Systems Research, vol. 17, 2005, pp. 211-226.

[4] HSHS code system is a code system for commodity classification for customs, statistics, export / import administration and international trade, drafted and released by China Customs. Its full

Matrix (from FOB to producer price), “China Economic Survey 2004”, “Industrial Statistical Yearbook (for industry)” from previous years, main indexes for FDI enterprises according to industrial unit classification, “Labor Statistical Report” and “China Statistical Yearbook” from pervious years etc. In addition, on the WTO official website, we obtain the China Customs’ nominal tariff rate table in which export / import commodity statistics is based on HS 6-digit codes.

1.2.2. Relevant assumptions

Firstly, imported product is only used for the domestic market, not for direct export[5];

Secondly, imported product for processing trade is not used in the domestics market, which means that this kind of commodity can only be used for production for export, not for domestic production and consumption;

Thirdly, distribution of imported product assumes that, given one kind of production way, imported product’s distribution structure is irrelevance with its source, while consumption of imported product by different production way is different.

1.2.3. Table

Edition of the table can be classified into four steps: firstly, confirm the controlled number, such as the volume of production for domestic demand, production for export by processing trade, production for export by non-processing trade; secondly, according to definitions of preliminary input and final use, based on relevant assumptions, design parts about value added of production for domestic demand, production for export by processing trade, production for export by non-processing trade, final use and imported product’s final use; thirdly, based on relevant assumptions, adopt the estimation method to design parts about production for domestic demand, production for export by processing trade, production for export by non-processing trade, imported product’s intermediate input; fourthly, by adopting

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name is “Commodity names and codes”. For detail explanation, please refer to “List of Commodity under China Customs’ Statistics” which was edited by China Customs, published by China Customs Press in 2006.

[5] Export without imported product means that there is no re-export.

mathematical methods to revise the original table (least square method or least cross-entropy method), make table's columns and rows balance.

According to "China Input-Output Table 1995, 2000, and 2002" issued by the National Bureau of Statistics, by referring to relevant data mentioned above, we produce the non-competitive input-occupancy-output table reflecting processing trade in 1995, 2000, and 2002.

1.3 Inference of relevant coefficients

1.3.1. Definition of direct consumption coefficient

From horizontal direction of the extended non-competitive input-occupancy-output table, D, P, N and export have following formula groups with balance relationship:

$$X^{DD}\mu + X^{DP}\mu + X^{DN}\mu + F^{D} = X^{D} \tag{1.1}$$

$$F^{P} = X^{P} \tag{1.2}$$

$$X^{ND}\mu + X^{NP}\mu + X^{NN}\mu + F^{N} = X^{N} \tag{1.3}$$

$$X^{MD}\mu + X^{MP}\mu + X^{MN}\mu + F^{M} = X^{M} \tag{1.4}$$

From vertical direction, we have following formulas:

$$\mu X^{DD} + \mu X^{ND} + \mu X^{MD} + V^{D} = (X^{D})^{T} \tag{1.5}$$

$$\mu X^{DP} + \mu X^{NP} + \mu X^{MP} + V^{P} = (X^{P})^{T} \tag{1.6}$$

$$\mu X^{DN} + \mu X^{NN} + \mu X^{MN} + V^{N} = (X^{N})^{T} \tag{1.7}$$

With $\mu = (1,1,\cdots,1)$

Taking account of direct consumption coefficient, we define that:

$$a_{ij}^{DD} = X_{ij}^{DD} / X_{j}^{D}, i, j = 1,2,\cdots,n \tag{1.8}$$

a_{ij}^{DD} refers to direct consumption of unit i's production for domestic demand when fulfilling unit j's production for domestic demand. So we have the direct consumption coefficient matrix of a product for domestic demand against a product for domestic demand:

$$A^{DD} = (a_{ij}^{DD}) = (X_{ij}^{DD} / X_j^D) \quad (1.9)$$

Similarly, we have other direct consumption coefficient matrixes:

$$\begin{aligned} A^{DP} &= (a_{ij}^{DP}) = (X_{ij}^{DP} / X_j^P), A^{DN} = (a_{ij}^{DN}) = (X_{ij}^{DN} / X_j^N) \\ A^{ND} &= (a_{ij}^{ND}) = (X_{ij}^{ND} / X_j^D), A^{NP} = (a_{ij}^{NP}) = (X_{ij}^{NP} / X_j^P) \\ A^{NN} &= (a_{ij}^{NN}) = (X_{ij}^{NN} / X_j^N), A^{MD} = (a_{ij}^{MD}) = (X_{ij}^{MD} / X_j^D) \\ A^{MP} &= (a_{ij}^{MP}) = (X_{ij}^{MP} / X_j^P), A^{MN} = (a_{ij}^{MN}) = (X_{ij}^{MN} / X_j^N) \end{aligned} \quad (1.10)$$

Putting（1.10）,（1.9）into(1.1), (1.2), (1.3) and (1.4), we have:

$$\begin{aligned} & A^{DD} X^D + A^{DP} X^P + A^{DN} X^N + F^D = X^D \\ & F^P = X^P \\ & A^{ND} X^D + A^{NP} X^P + A^{NN} X^N + F^N = X^N \\ & A^{MD} X^D + A^{MP} X^P + A^{MN} X^N + F^M = X^M \end{aligned} \quad (1.11)$$

We combine formulas above in the following table:

Table 13: Table of direct consumption coefficient matrix formulas

	D	P	N
D	A^{DD}	A^{DP}	A^{DN}
P	$A^{PD} = 0$	$A^{PP} = 0$	$A^{PN} = 0$
N	A^{ND}	A^{NP}	A^{NN}
M (imported product as intermediate input)	A^{MD}	A^{MP}	A^{MN}
V (value added)	A_V^D	A_V^P	A_V^N
L (employment)	A_L^D	A_L^P	A_L^N

1.3.2. Calculation of full demand coefficient

Formula (1.11) can be written as follow:

$$\begin{bmatrix} (I - A^{DD}) & -A^{DP} & -A^{DN} \\ 0 & I & 0 \\ -A^{ND} & -A^{NP} & (I - A^{NN}) \end{bmatrix} \begin{bmatrix} X^D \\ X^P \\ X^N \end{bmatrix} = \begin{bmatrix} F^D \\ F^P \\ F^N \end{bmatrix}$$

So we have:

$$\begin{bmatrix} X^D \\ X^P \\ X^N \end{bmatrix} = \begin{bmatrix} (I - A^{DD}) & -A^{DP} & -A^{DN} \\ 0 & I & 0 \\ -A^{ND} & -A^{NP} & (I - A^{NN}) \end{bmatrix}^{-1} \begin{bmatrix} F^D \\ F^P \\ F^N \end{bmatrix}$$

Formula above can be written as:

$$\overline{X} = (I - \overline{A})^{-1} \overline{F} \tag{1.12}$$

$$\overline{X} = \overline{B}\overline{F} \tag{1.13}$$

Here,

$$\overline{X} = \begin{bmatrix} X^D \\ X^P \\ X^N \end{bmatrix}, \ \overline{A} = \begin{bmatrix} A^{DD} & A^{DP} & A^{DN} \\ 0 & 0 & 0 \\ A^{ND} & A^{NP} & A^{NN} \end{bmatrix}, \ \overline{F} = \begin{bmatrix} F^D \\ F^P \\ F^N \end{bmatrix}$$

This is the extended input-output model, with

$\overline{B} = (I - \overline{A})^{-1} = \begin{bmatrix} (I - A^{DD}) & -A^{DP} & -A^{DN} \\ 0 & I & 0 \\ -A^{ND} & -A^{NP} & (I - A^{NN}) \end{bmatrix}^{-1}$ as the extended Leontief Inverse Matrix, or extended full demand coefficient matrix.

Make its matrix as:

$$\begin{bmatrix} (I - A^{DD}) & -A^{DP} & -A^{DN} \\ 0 & I & 0 \\ -A^{ND} & -A^{NP} & (I - A^{NN}) \end{bmatrix}^{-1} = \begin{bmatrix} B^{DD} & B^{DP} & B^{DN} \\ B^{PD} & B^{PP} & B^{PN} \\ B^{ND} & B^{NP} & B^{NN} \end{bmatrix}$$

According to matrix calculation rules, we have:

$$\begin{aligned}
B^{DD} &= (I - A^{DD})^{-1} + (I - A^{DD})^{-1} A^{DN} B^{NN} A^{ND} (I - A^{DD})^{-1} \\
B^{DP} &= (I - A^{DD})^{-1} A^{DP} + (I - A^{DD})^{-1} A^{DN} B^{NN} [A^{NP} + A^{ND} (I - A^{DD})^{-1} A^{DP}] \\
B^{DN} &= (I - A^{DD})^{-1} A^{DN} B^{NN} \\
B^{PD} &= 0, \quad B^{PP} = I \quad , \quad B^{PN} = 0 \\
B^{ND} &= B^{NN} A^{ND} (I - A^{DD})^{-1} \\
B^{NP} &= B^{NN} [A^{NP} + A^{ND} (I - A^{DD})^{-1} A^{DP}]^{-1} \\
B^{NN} &= [I - A^{NN} - A^{ND} (I - A^{DD})^{-1} A^{DN}]^{-1}
\end{aligned}$$

(1.14)

B^{DD}, B^{DP} and B^{DN} refer to full demand coefficient matrixes of D, P and N's final demand per unit against D; B^{PD}, B^{PP} and B^{PN} refer to full demand coefficient matrixes of D, P and N’s final demand per unit against P; B^{ND}, B^{NP} and B^{NN} refer to full demand coefficient matrixes of D, P and N’s final demand per unit against N.

1.3.3. Calculation of VS index

According to Hummels et al（2001）, we have following formula for calculating VS index:

$$VS_i = (\frac{X_i^M}{X_i})X_i^E = (\frac{X_i^E}{X_i})X_i^M \qquad (1.15)$$

VS_i, X_i, X_i^E and X_i^M refer to unit i’s vertical specialization value for export, overall output, export, and overall value of imported products for unit i’s production. Hummels et al (2001) assumed that there is no difference between production structures of production for export and production for domestic demand, therefore formulas above can be used to calculate vertical specialization value for export production, namely VS.

However, in terms of China’s export, Hummel’s assumption that there is no difference between production structures of different trade way does not work. There are two reasons: firstly, processing trade accounts for very large share in China’s foreign trade, with its production characteristic totally different from that of normal trade; secondly, given difference between foreign market and domestic market’s product standards, for normal trade, export product’s quality and production technology are different from that of product for domestic market. Therefore, when calculating vertical specialization value for export in China, we should refer to following formula:

$$VS_i = X_i^{MP} + X_i^{MN} = \sum_j A_{ji}^{MP} X_j^P + \sum_j A_{ji}^{MN} X_j^N \qquad (1.16)$$

X_i^{MP}, X_i^{MN} refer to overall value of imported product consumed by unit i’s production for export by processing trade and overall value of imported product consumed by unit i’s production for export by non-processing trade. Matrix refers to each unit's formula for vertical specialization:

$$VS = \mu X^{MP} + \mu X^{MN} = \mu A^{MP} X^{P} + \mu A^{MN} X^{N} \qquad (1.17)$$

By calculating the ratio of unit i's vertical specialization value for export / unit i's export value, we have unit i's vertical specialization rate for export:

$$\begin{aligned} VSSH_i &= \frac{VS_i}{X_i^E} = \frac{X_i^{MP}}{X_i^E} + \frac{X_i^{MN}}{X_i^E} \\ &= \frac{\sum_j A_{ji}^{MP} X_j^P + \sum_j A_{ji}^{MN} X_j^N}{X_i^P + X_i^N} \end{aligned} \qquad (1.18)$$

Assume $W_i^P = \frac{X_i^P}{X_i^E}$, $W_i^N = \frac{X_i^N}{X_i^E}$; So 1.18 can be written as follow:

$$VSSH_i == \frac{\sum_j (A_{ji}^{MP} W_j^P + A_{ji}^{MN} W_j^N) X_i^E}{X_i^E} = \sum_j (A_{ji}^{MP} W_j^P + A_{ji}^{MN} W_j^N) \qquad (1.19)$$

With $W_i^P + W_i^N = 1$

According to formula 1.19, each unit's vertical specialization rate for export can be written as matrix:

$$VSSH = \mu(A^{MP} W^P) + \mu(A^{MN} W^N) \qquad (1.20)$$

With $W^P = (W_1^P, W_2^P, ..., W_n^P)$ and $W^N = (W_1^N, W_2^N, ..., W_n^N)$

Calculation above is for direct vertical specialization rate. Accordingly, we have the formula for complete vertical specialization rate:

$$TVSSH = \mu(B^{MP} W^P) + \mu(B^{MN} W^N) \qquad (1.21)$$

B^{MP} and B^{MN} refer to export by processing trade (P) and export by non-processing trade (N) production's contribution in promoting imported product (M), namely the full demand coefficient matrix of P and N against M. B^{MP} and B^{MN} can be calculated as follow:

Firstly, from formula（1.13）we have:

$$\overline{B^M} = \overline{A^M}(I-\overline{A})^{-1} = \overline{A^M}\,\overline{B} \qquad (1.22)$$

With $\overline{B^M} = [B^{MD} \quad B^{MP} \quad B^{MN}], \overline{A^M} = [A^{MD} \quad A^{MP} \quad A^{MN}]$

So

$$(B^{MD}, B^{MP}, B^{MN}) = (A^{MD}, A^{MP}, A^{MN})(I-\overline{A})^{-1}$$
$$= (A^{MD}, A^{MP}, A^{MN})\begin{bmatrix} B^{DD} & B^{DP} & B^{DN} \\ 0 & I & 0 \\ B^{ND} & B^{NP} & B^{NN} \end{bmatrix}$$

From formulas above, we have:

$$\begin{aligned} B^{MP} &= A^{MD}B^{DP} + A^{MP} + A^{MN}B^{NP} \\ B^{MN} &= A^{MD}B^{DN} + A^{MN}B^{NN} \end{aligned} \qquad (1.23)$$

Through formulas 1.20 and 1.21, we can calculate different industry's vertical specialization rate for export. Since relevant coefficients for the input-output table are calculated from data of the non-competitive input-occupancy-output table which reflects processing trade from previous years, direct import coefficient and full import coefficient vary according to input-output table adopted for calculation. W^P and W^N can be calculated from each unit's values of export by processing trade and export by non-processing trade, apparently W^P and W^N vary according to year and export destination.

2. Calculation of vertical specialization rates of China's export to EU (25 countries)

According to the non-competitive input-occupancy-output table reflecting processing trade in 1995, 2000, and 2002, we adopt formulas 1.20 and 1.21 to calculate vertical specialization rate of China's export to EU.

Before conducting calculation, we have following assumptions:

Firstly, given the same trade way, export commodity's production structure is irrelevant with its destination, but is relevant with its category;

Secondly, since we cannot obtain input-output table for every year, we assume that given the same trade way, production structures of an unit's export commodity during 1996 – 1999 are consistent with that in 1995, while that in 2001 is consistent with that in 2000, that during 2003 – 2005 are consistent with that in 2002;

Thirdly, to analyze different sources of vertical specialization in China, we assume that distribution structure of an imported product in each unit is irrelevant with its source, which means that imported products from different sources are indifferent in terms of production for export. But distribution of imported product varies among production ways.

2.1 Calculation of each unit's vertical specialization rates

According to import coefficients of export by processing trade and export by non-processing trade, we have each unit's direct vertical specialization rates for its export by processing trade and export by non-processing trade:

$$
\begin{aligned}
VSSH_j^P &= \sum_{i=1}^{n} a_{ij}^{MP},\ j = 1, 2, \cdots, n \\
VSSH_j^N &= \sum_{i=1}^{n} a_{ij}^{MN},\ j = 1, 2, \cdots, n
\end{aligned} \qquad (1.24)
$$

Similarly, we have each unit's full vertical specialization rates for its export by processing trade and export by non-processing trade:

$$
\begin{aligned}
TVSSH_j^P &= \sum_{i=1}^{n} b_{ij}^{MP},\ j = 1, 2, \cdots, n \\
TVSSH_j^N &= \sum_{i=1}^{n} b_{ij}^{MN},\ j = 1, 2, \cdots, n
\end{aligned}
$$

(1.25)

By using these two formulas, we can calculate vertical specialization rates for each unit's export by processing trade (EPT) as well as export by non-processing trade (ENPT) in 1995, 2000, and 2002. Table 14 shows vertical specialization rates in 2002.

Table 14. Vertical specialization rates for each unit's export by processing trade as well as export by non-processing trade in 2002[6]

Units	VSSH		TVSSH		Units	VSSH		TVSSH	
	EPT	ENPT	EPT	ENPT		EPT	ENPT	EPT	ENPT
1	0.4389	0.0938	0.4945	0.174	22	0	0	0	0
2	0.4485	0.1525	0.5139	0.2731	23	0.3672	0.1603	0.4523	0.2619
3	0.4508	0.1289	0.4976	0.2458	24	0.3585	0.2221	0.4824	0.3727
4	0.542	0.2554	0.6099	0.4088	25	0.4309	0.208	0.52	0.3298
5	0.4891	0.2419	0.5664	0.3674	26	0.6591	0.2517	0.7188	0.4256
6	0.5075	0.1115	0.5661	0.1895	27	0.4597	0.164	0.5384	0.3336
7	0.6389	0.1991	0.6968	0.2718	28	0.4073	0.193	0.5082	0.3222
8	0.5929	0.198	0.6611	0.2821	29	0.5713	0.2622	0.6038	0.365
9	0.5831	0.1798	0.6506	0.3163	30	0.4105	0.1722	0.4841	0.2663
10	0.5399	0.2059	0.6138	0.3396	31	0.4326	0.1002	0.5007	0.1929
11	0.7302	0.684	0.7753	0.7325	32	0.2647	0.1161	0.351	0.1884
12	0.6282	0.3486	0.7101	0.5097	33	0	0.0982	0	0.1752
13	0.5512	0.2482	0.6273	0.3953	34	0.632	0.3272	0.6695	0.4353
14	0.6917	0.281	0.7369	0.4713	35	0.0545	0.0857	0.1894	0.1565
15	0.7382	0.2323	0.7758	0.4584	36	0	0.3005	0	0.4117
16	0.6944	0.3709	0.7462	0.5278	37	0	0.1471	0	0.2456
17	0.6905	0.3257	0.7547	0.536	38	0.5014	0.2005	0.569	0.3187
18	0.7239	0.3443	0.7716	0.5176	39	0.3296	0.1127	0.4176	0.2221
19	0.8221	0.5112	0.8417	0.6203	40	0	0.2577	0	0.4064
20	0.6062	0.3626	0.6403	0.5096	41	0.3851	0.1781	0.4605	0.2852
21	0.6204	0.1871	0.6777	0.3266	42	0.295	0.1101	0.3832	0.2125

Note: results above are calculated by adopting producer price as standard.

Units with higher vertical specialization rate concentrate on mechanical products (telecommunication equipment, computer and other electronic equipment production industries, electronic - mechanical equipment production industry, general or specialized equipment production industries, and transportation equipment production industry), metal production industry and oil processing industry etc. Agricultural industry and service industry have relatively lower vertical specialization rate.

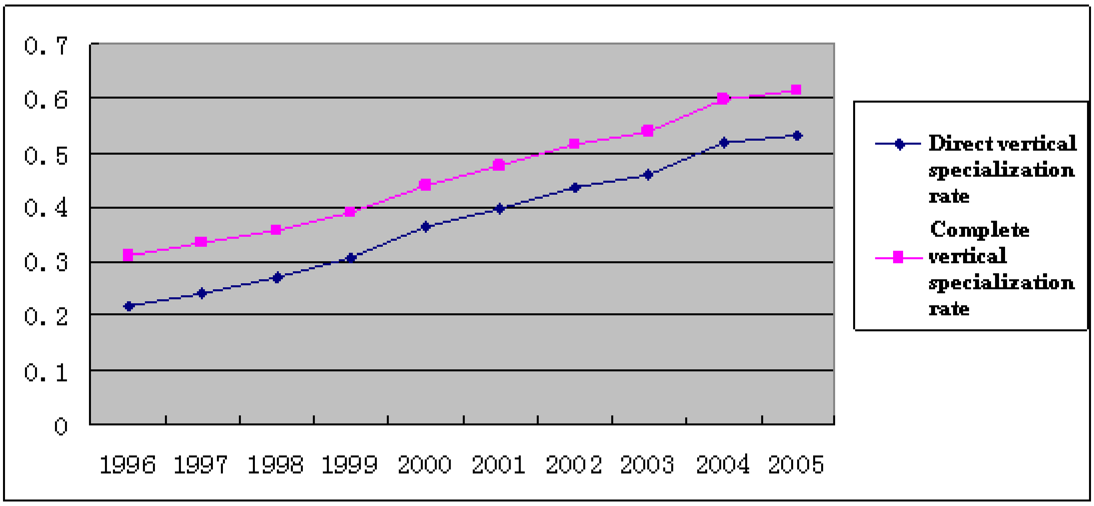
2.2 Vertical specialization rates of China's export to EU during 1996 – 2005

[6] For unit's name, please refer to annex 1.

According to values of each unit's export by processing trade (EPT) and export by non-processing trade (ENPT) during this period, as well as vertical specialization rates of each unit's EPT and ENPT, we are able to calculate vertical specialization rates of China's export to EU during 1996 – 2005. Table 15 shows the results.

Table 15. Vertical specialization rates of China's export to EU during 1996 – 2005

Year	Direct vertical specialization rate	Complete vertical specialization rate
1996	0.217625	0.311096
1997	0.242556	0.332333
1998	0.269941	0.356971
1999	0.308123	0.390736
2000	0.363999	0.439442
2001	0.395232	0.475337
2002	0.435663	0.515783
2003	0.459351	0.537837
2004	0.52	0.599036
2005	0.530659	0.612854



As we can see, vertical specialization rate of China's export to EU kept increasing during 1996 – 2005. There are three reasons: firstly, in terms of China's export to EU, the share of export by processing trade increased; secondly, the export structure changed, as the export volume of products with higher vertical specialization rate (especially mechanical equipment product) increased; thirdly, in terms of an unit's export production, international specialization became more specialized.

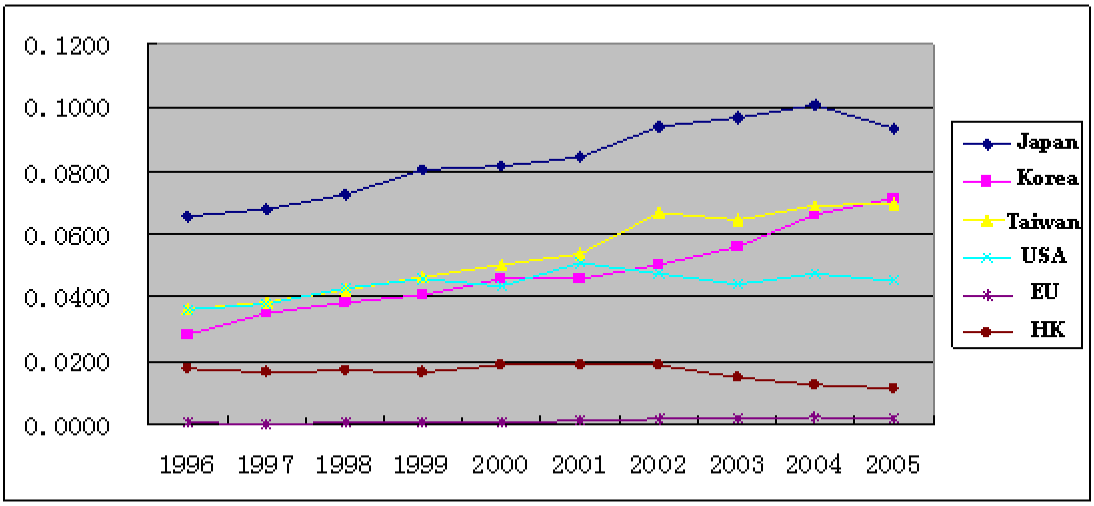
2.3 Analysis of vertical specialization rate of China's export to EU

According to assumption 2 from previous section as well as assumption 3 from this section, regarding China's production for its export to EU, consumption of imported product for processing trade and non-processing trade is irrelevant with imported product's source. Therefore, the ratio of the volume of imported products from a certain source for an unit's processing trade and non-processing trade / total volume of imported products for that unit's processing trade and non-processing trade, multiplies by vertical specialization rate of that unit's export by processing trade and export by non-processing trade in that year, we can factorize vertical specialization rate of each unit's export by processing trade and export by non-processing trade.

Based on data factorized for each year, we are able to factorize vertical specialization rate of China's export to EU.

Table 16. Factorization of vertical specialization rate of China's export to EU

Year	Complete vertical specialization rate	Japan	Korea	Japan and Korea	Taiwan	USA	EU	Hong Kong	Other economies
1996	0.3111	0.0657	0.0281	0.0938	0.0364	0.0363	0.0006	0.0175	0.1265
1997	0.3323	0.0681	0.0351	0.1032	0.0386	0.0380	0.0002	0.0163	0.1359
1998	0.3570	0.0724	0.0384	0.1108	0.0427	0.0432	0.0003	0.0169	0.1432
1999	0.3907	0.0803	0.0409	0.1212	0.0464	0.0459	0.0008	0.0162	0.1602
2000	0.4394	0.0817	0.0456	0.1273	0.0502	0.0437	0.0007	0.0184	0.1992
2001	0.4753	0.0841	0.0459	0.1301	0.0537	0.0512	0.0011	0.0184	0.2208
2002	0.5158	0.0939	0.0502	0.1440	0.0669	0.0475	0.0015	0.0188	0.2371
2003	0.5378	0.0968	0.0562	0.1530	0.0645	0.0440	0.0018	0.0145	0.2600
2004	0.5990	0.1008	0.0665	0.1673	0.0693	0.0477	0.0020	0.0125	0.3001
2005	0.6129	0.0933	0.0715	0.1648	0.0695	0.0453	0.0017	0.0112	0.3203



As we can see, regarding China's export to EU, main raw materials and semi-finished products are from Japan, Korea, Taiwan and USA, with about 20% from Japan, 10% from Korean, Taiwan, and USA respectively. Therefore, about half of export commodities' values are from imported products from these countries. While import of raw materials and semi-finished products from EU is very limited, accounting for less than 0.5% of export commodities' values.

Section 5. Calculation of Sino-EU trade's impact on China's employment

In this section, we are going to adopt the extended non-competitive input-occupancy-output model to analyze Sino-EU trade's impact on China's employment. As we all know, there are 1.3 billion people in China, which makes full employment a critical problem for Chinese economy. Since China's WTO accession in 2001, China's export has been developing rapidly, creating huge employment opportunities and reducing serious employment pressure caused by China's SOEs reform before.

1 Theoretical foundation

First of all, based on the structure of non-competitive input-occupancy-output table, we define the direct employment coefficient:

$$A_L^D = (A_{Lj}^D) \equiv (L_j^D / X_j^D) \quad (3.1)$$

$$A_L^P = (A_{Lj}^P) \equiv (L_j^P / X_j^D) \quad (3.2)$$

$$A_L^N = (A_{Lj}^N) \equiv (L_j^N / X_j^D) \quad (3.3)$$

L_j^D, L_j^P, L_j^N refer to the number of employment when unit j satisfies D (production for domestic demand), P (production for export by processing trade), N (production for export by non-processing trade etc) respectively, X_j^D, X_j^P, X_j^N refer to total output of unit j from D, P, N respectively, $A_{Lj}^D, A_{Lj}^P, A_{Lj}^N$ refer to the number of employment per production of unit j from D, P, N respectively (namely direct employment coefficient). Based on A_{Lj}^D, A_{Lj}^P, and A_{Lj}^N, we have A_L^D, A_L^P, A_L^N as vectors for direct employment coefficient.

Based on input-output theory, if taking account of export's promotion effect on L (employment) through its demand per unit for D, P and N, we can adopt previous section's method (calculating total import or complete vertical specialization rate) to calculate complete employment coefficient as follow:

$$\begin{aligned} B_L^D &= A_L^D B^{DD} + A_L^N B^{ND} \\ B_L^P &= A_L^D B^{DP} + A_L^P + A_L^N B^{NP} \\ B_L^N &= A_L^D B^{DN} + A_L^N B^{NN} \end{aligned} \quad (3.4)$$

Therefore, according to formula 3.4, we can calculate each unit's number of full employment brought by its export by processing trade and export by non-processing trade per person per year.

2 Sino-EU trade's impact on each industry's employment

By adopting formula 3.2-3.4, we can calculate employment coefficient of each unit's export by processing trade and export by non-processing trade per person per year. Table 17 shows the coefficients for year 2002.

Table 17. Employment effect of each unit's export by processing trade and export by non-processing trade per person per year

Per person per year / 10 thousand RMB

Unit	Direct employment effect		Full employment effect		Unit	Direct employment effect		Full employment effect	
	P	N	P	N		P	N	P	N
1	0.1473	0.3275	0.3262	0.8214	22	0.0000	0.0000	0.0000	0.0000
2	0.1164	0.2587	0.2207	0.4230	23	0.0328	0.0730	0.1836	0.2407
3	0.0430	0.0955	0.1087	0.2109	24	0.0350	0.0777	0.2618	0.3079
4	0.0699	0.1555	0.1608	0.2957	25	0.0850	0.1890	0.1973	0.3214
5	0.1138	0.2530	0.2126	0.3968	26	0.0669	0.1486	0.1679	0.4405
6	0.0432	0.0960	0.3166	0.8467	27	0.1080	0.2400	0.2223	0.3961
7	0.0572	0.1270	0.1958	0.5900	28	0.2243	0.4985	0.3794	0.6955
8	0.0577	0.1283	0.2084	0.5039	29	0.0441	0.0980	0.0935	0.2170
9	0.0479	0.1065	0.1946	0.5007	30	0.2022	0.4494	0.3358	0.6385
10	0.0585	0.1300	0.1786	0.3665	31	0.0933	0.2074	0.3535	0.7611
11	0.0244	0.0543	0.1005	0.1121	32	0.0616	0.1370	0.2095	0.2932
12	0.0380	0.0845	0.1265	0.2719	33	0.0000	0.1212	0.0000	0.2622
13	0.0853	0.1895	0.1965	0.3682	34	0.0696	0.1546	0.1382	0.3022
14	0.0284	0.0631	0.0940	0.1998	35	0.1052	0.2337	0.4219	0.4895
15	0.0382	0.0850	0.0908	0.2474	36	0.0000	0.2168	0.0000	0.3625
16	0.0436	0.0970	0.1001	0.2224	37	0.0000	0.2696	0.0000	0.4634
17	0.0360	0.0800	0.0929	0.2115	38	0.1486	0.3303	0.2651	0.5471
18	0.0361	0.0803	0.0911	0.2214	39	0.2097	0.4660	0.3627	0.6732
19	0.0210	0.0467	0.0471	0.1427	40	0.0000	0.3048	0.0000	0.4515
20	0.0487	0.1083	0.0891	0.3030	41	0.1152	0.2561	0.2842	0.4983
21	0.0677	0.1504	0.1906	0.5098	42	0.1640	0.3646	0.3482	0.5899

As indicated in table 17, we compare and analyze 10,000 RMB export's employment effect under different kind of trade way. Both direct employment effect and full employment effect are higher in export by non-processing trade than in export by processing trade, which means that the former one plays a very important role in addressing domestic employment problem.

Based on each unit's employment effect, as well as Sino-EU trade data during 1996 – 2005, we can calculate each unit's employment effect in terms of goods trade. Table 18 shows that in year 2002.

Table 18. Sino-EU goods trade’s employment effects in each unit

Per person per year / 10 thousand RMB

Unit	Direct employment effect	Full employment effect	Unit	Direct employment effect	Full employment effect
1	0.3275	0.8213	13	0.1844	0.3598
2	0.2587	0.4230	14	0.0603	0.1911
3	0.0955	0.2109	15	0.0747	0.2129
4	0.1555	0.2957	16	0.0843	0.1933
5	0.2529	0.3968	17	0.0438	0.1141
6	0.0797	0.6832	18	0.0536	0.1425
7	0.1237	0.5711	19	0.0221	0.0513
8	0.1237	0.4847	20	0.0527	0.1033
9	0.0964	0.4482	21	0.1415	0.4756
10	0.1058	0.3029	28	0.4985	0.6955
11	0.0543	0.1121	41	0.2502	0.4893
12	0.0801	0.2581	Total export	0.08371	0.3103

According to units, both finished product’s direct employment effect and full employment effect are lower than that of primary product and service, since international specialization of finished product is more specialized and needs less labor.

3 Sino-EU trade (goods)’s impact on employment during 1996-2005

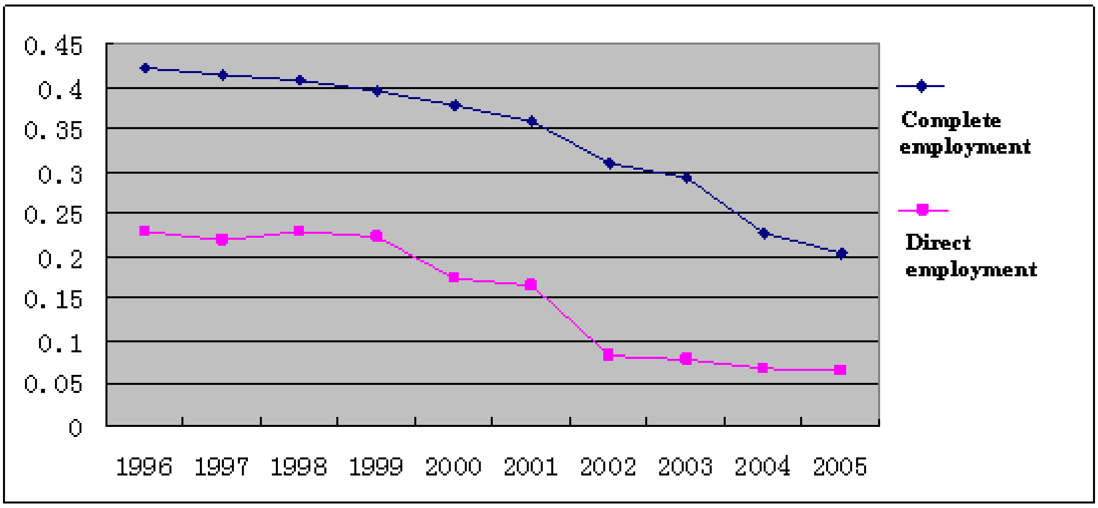
According to each unit’s employment effect data per person per year, as well as each unit’s structural coefficients, we can calculate Sino-EU trade’s employment effect per person per year as follow:

Table 19. Employment effect of China’s export to EU during1996-2005

Per person per year / 10 thousand RMB

	Full employment	Direct employment
1996	0.42175	0.22979
1997	0.41377	0.2194
1998	0.40667	0.23029
1999	0.39411	0.22222
2000	0.37844	0.17392

2001	0.35826	0.16593
2002	0.3103	0.08371
2003	0.29357	0.07923
2004	0.22814	0.06734
2005	0.20357	0.06479

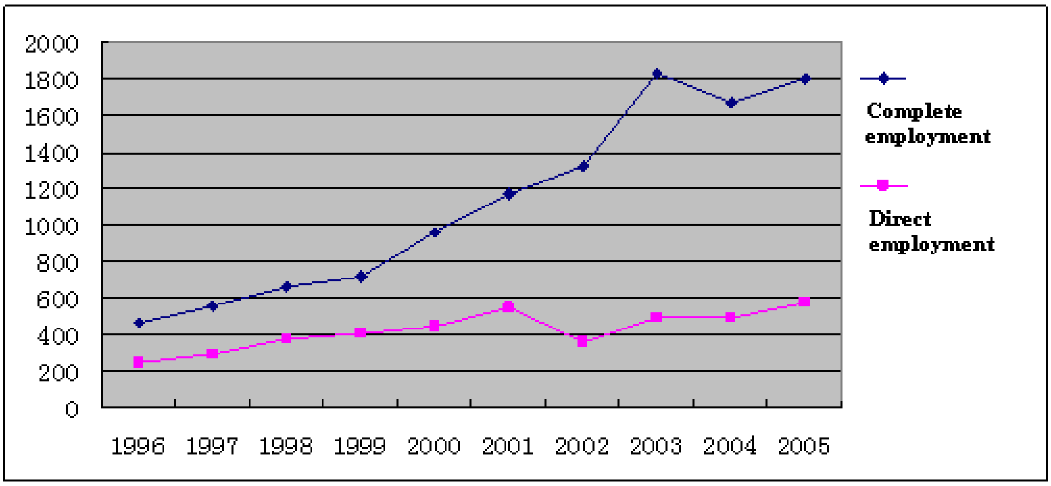


As we can see, employment effect per person per year declined constantly during 1996 – 2005, but given the rapid increase of total export volume at the same time, overall employment effect of China's export to EU increased constantly. Therefore, Sino-EU trade plays a very important role in promoting each unit's employment.

Table 20. Overall employment effect of Sino-EU trade during 1996-2005

10 thousand persons per year

Year	Full employment	Direct employment
1996	458.235	249.664
1997	559.379	296.611
1998	661.485	374.579
1999	714.935	403.125
2000	966.044	443.949
2001	1173.19	543.368
2002	1319.28	355.888
2003	1832.02	494.426
2004	1671.24	493.306
2005	1806.27	574.834



Section 6. Calculation of exchange rate's impacts on each industry's employment in China

By adopting open economy macroeconomic theory, as well as referring to China's reality, this section sets up a macro-simultaneous model to analyze the impacts of China's exchange rate policy reform on its employment in 1994.

1. Theoretical analysis of the impacts of exchange rate change on employment

Here exchange rate refers to RMB/USD nominal exchange rate. The impacts of its change on employment are as follow:

(1) Exchange rate change influences real effective exchange rate directly, while change of real effective exchange rate influences export directly, therefore when not taking price factor into account, depreciation of nominal exchange rate will lead to increase of employment;

(2) Depreciation of nominal exchange rate will lead to increase of money supply, and then influencing the price level. If the rise of price level surpasses the depreciation level, then there will be appreciation of real effective exchange rate and negative impact on export, which may further lead to decline of employment;

(3) Depreciation of exchange rate leads to increase of import, which may influence domestic employment;

(4) Under current export-oriented economic policy, depreciation of exchange rate will promote FDI and have positive impact on employment;

(5) Exchange rate change will influence balance of international payment, as well as macro economy stability, and output;

(6) For export-dependent industry and domestic-demand-dependent industry, impact of exchange rate change is different. Different exchange rate level influences employment structure of different industry, especially that of production industry and service industry.

Therefore, impact of exchange rate change on employment is very complicated. It is hard to explain this impact through only one formula. So we set up a macro-simultaneous model to analyze this impact.

2．Model structure

By taking account of changing characteristics of China's economic structure since its reform and opening-up in 1978, as well as by referring to the consistent dynamic process of national economy's three stages – production, distribution and consumption, based on the unity between national economy's goods-service flow and capital flow, we set up a macro-econometric model reflecting characteristics of current China, in terms of production and total output, allocation of labor resource, price level and wage, national income and distribution, expenditure and aggregate demand, finance and money as well as national payment etc.

In this model, equilibrium between aggregate supply and aggregate demand determines the accumulation of floating asset. Given huge amount of implicit unemployment in rural areas, the number of rural employment is decided by the equation of social labor allocation. In an open economy, net export not only influences economic growth rate, but also influences macro-economy stability through international payment reflected by import and export etc. Specifically, model structure includes:

（1）Production and real total output

The formula of production mainly includes output of agricultural industry, production industry as well as service industry. Each industry's number of employee and capital stock determine each industry's output. The output formula is as follow:

$$\ln(y_i) = f(k_i, n_i)$$

y_i refers to industry i's output, k_i and n_i refer to that industry's capital stock and number of employee.

Real total output has the following equation:

XGDP=XAP+XIP+XSP，XAP,XIP and XSP refer to real output of agricultural industry, production industry as well as service industry respectively.

（2）Labor resource allocation

Each industry's employment is decided by that industry's output and productivity. The higher the output, the more the employment. However, the higher the productivity, the less the employment. Total employment is decided by employment of agricultural, production and service industries, which can be expressed as follow:

Table 21. Each industry's production formula（within the parentheses is t-value）

	Agricultural employment（nf）	Production employment（ni）	Service employment（ns）
Constant	9.87 (6.78)	0.75 (1.58)	0.54 (1.41)
Lag for that industry	0.05 (6.78)	0.77 (3.87)	0.86 (3.85)
Output		0.15 (0.87)	0.08 (0.37)
Ratio of output / labor	-0.61 (-5.69)	-0.13 (-0.83)	-0.04 (-0.18)
AR(1)	0.96		
R^2	0.94	0.99	0.99
F statistical value	120.84	578.49	1768.74
DW statistical value	1.99	1.87	2.00

（3）Price level and wage

Formulas for price level and wage include formulas of GDP deflator index, CPI, agricultural production price index, production price index, service price index, wage index. Price index is mainly influenced by money supply, wage level, while wage index is influenced by the ratio of output / labor, non-agricultural output, money supply etc.

（4）Expenditure and aggregate demand

This part mainly includes formulas of resident consumption, governmental consumption, fixed-capital-formation (export / import will be explained in another part). Resident consumption is mainly influenced by disposable income, while governmental consumption is mainly influenced by governmental expenditure and GDP, fixed-capital-formation is decided by governmental expenditure, money supply as well as FDI.

（5）International economy

This part mainly includes formulas of export, import, FDI, real effective exchange rate, current account balance, capital account balance, balance of international payment etc. Formulas influenced directly by exchange rate (including real effective exchange rate and nominal exchange rate) are export, FDI, real effective exchange rate etc. Exchange rate also indirectly influences import, current account balance, as well as balance of international payment. We have formulas of export, FDI and real effective exchange as follow:

$$Ln(E) = -2.92 - 1.21 * \ln(REER) + 1.61 * \ln(YGDP)$$

（-4.87）（-8.57）（-55.17）

R^2=0.99, DW=2.14

$$FDI = -835.58 + 0.50 * FDI(-1) + 0.07 * BKFCN + 0.009 * YGDP + 219.80 * RATE$$

（-2.85）（3.43）（2.21）（2.25）（3.58）

R^2=0.99, DW=1.58

$$Ln(REER) = 1.18 + 0.84 * \ln(REER(-1)) - 0.04 * \ln(RATE) + 0.25 * \ln(XNI) - 0.13 * \ln(WR)$$

（0.84）（6.12）（-0.25）（0.57）（-0.41）

R^2=0.94，DW=1.27

Explanations:

E：Value of goods and service (calculated in RMB);

REER：Real effective exchange rate from IMF;

YGDP：Nominal domestic output;

FDI：Foreign direct investment;

RATE：RMB/USD exchange rate;

XNI：Ratio of labor / output;

WR：Average wage index.

（6）Finance and money

There are two key formulas: formula for financial income and expenditure, and formula for money supply determination. Since balance of international payment influences money supply under the fixed exchange rate mechanism, we add balance of international payment as a variable into the formula for money supply determination.

D（M）=-0.008+2.39*D(XGDP)+0.001*BPCN

(-0.15) (4.18) (0.94)

R^2=0.5, DW=1.58

D（M）refers to growth rate of money supply, D(XGDP) refers to growth rate of real output, D（BPCN）refers to changing rate of balance of international payment.

3. Empirical analysis

In this simultaneous model, we regard exchange rate change as an exogenous variable to analyze its impacts on different industry's employment.

Simulation 1

Scenario 1: Exchange rate policy reform did not conducted in 1994, RMB / USD exchange rate maintained at 5.76:1 level. Employment at this stage is compared with simulated employment situation after exchange rate policy reform.

Scenario 2: Exchange rate changes according to reality.

Table 22. Employment in production and service industries

10 thousand persons

Year	Change of employment in production industry	Change of employment in service industry	Change of employment in non-agricultural industry
1994	17.52	1.2	18.72
1995	49.82	4.06	53.88
1996	88.38	8.59	96.97
1997	126.5	14.63	141.13
1998	160.58	22	182.58
1999	189.3	30.55	219.85
2000	212.56	40.16	252.72
2001	230.83	50.72	281.55
2002	244.74	62.14	306.88
2003	254.94	74.39	329.33
2004	262.02	87.38	349.4
2005	266.28	101.06	367.34
2006	267.75	115.34	383.09
Total	2371.22	612.22	2983.44

According to table above, exchange rate policy reform in 1994 accelerated China's industrialization process, promoting the shift of labor from agricultural industry to production and service industries, so the number of employee increased significantly in both production and service industries. Past 13 years from 1994 to 2006, witnessed employment increase by about 30 million jobs in production and service industries, which was promoted by the exchange rate policy reform. But reform's impacts on production and service industries' employment are not consistent, with 23.71 million people employed in production industry but only 6.12 million people employed in service industry (1/4 of that in production industry). According to change during this period, impact of exchange rate change on employment increased gradually, as in 1994 (the first year after the reform), employment increased by 187.2 thousand jobs in production and service industries, while in 2006, employment increased by 3.83 million jobs. This indicates that reform in 1994 not only helped promote export in the short-term, but also influenced the overall economic structure through various ways. After slow adjustment of industrial structure, with development of China's openness, impact of exchange rate on employment became more and more remarkable.

Simulation 2

Scenario 1: RMB/USD exchange rate holds steady since 2004.

Scenario 2: Since 2005, RMB has been appreciating gradually, with RMB/USD exchange rate reaching 6:1 in 2010.

Table 23. Impact of RMB's slow appreciation on employment

10 thousand persons

Year	Agriculture	Production	Service	Overall employment
2005	0.36	-0.18	-0.02	0.17
2006	1.91	-0.95	-0.1	0.85
2007	5.83	-2.96	-0.33	2.54
2008	13.33	-6.89	-0.85	5.59
2009	25.09	-13.2	-1.83	10.05
2010	40.82	-21.93	-3.42	15.48
Total	87.34	-46.11	-6.55	34.68

Given China's current demographic structure, even though that RMB is experiencing slow appreciation, overall number of employment keeps increasing, but mainly in terms of agriculture. This means that RMB appreciation to some extent will slow the industrialization process. In terms of employment variation in production and service industries, RMB maintains its slow appreciation trend, which will reduce employment by 520 thousand jobs from 2005 to 2010 (reduce employment by 460 thousand jobs in production industry, 60 thousand jobs in service industry).

Section 7. Conclusions and policy suggestions

According to analysis above, we have following conclusions:

1. There is a strong relationship between rapid growth of Sino-EU trade scale (trade surplus) and rapid development of vertical specialization in China. Data analysis shows that in recent years, processing trade and FDI indexes which can effectively reflect vertical specialization, as well as VS index which directly reflect vertical specialization all have been developing rapidly.

2. Vertical specialization mainly concentrates on labor-intensive industries such as computer assembling industry, because China has been offering higher tariff rebate rate for processing trade, and China's comparative advantages include relatively cheap cost of labor and production factors. Therefore profits for domestic industries are very limited. Econometric model also indicates that FDI plays a more important role in promoting foreign trade of those industries with higher share of processing trade.

3. Japan and Korea play important roles in Sino-EU trade. Factorization of VS indexes shows that key raw materials and semi-finished products as intermediate input for China's export to EU, are imported from Japan, Korea, Taiwan, and USA, with about 20% of value from Japan, about 10% from Korea, Taiwan and USA respectively. Therefore, about half of value of China's export to EU is from these countries.

4. Sino-EU trade effectively promotes China's employment development. According to the non-competitive input-occupancy-output table, Sino-EU trade's positive impact on China's employment is very significant, with a full employment effect of 18 million jobs in 2005.

5. In those industries with higher vertical specialization degree, effect of tariff rate policy is not obvious. Vertical specialization mainly concentrates on processing

trade. Since China has been offering very high tariff rebate rate to processing trade, econometric results show that effect of nominal tariff rate on promoting export will be influenced if the share of processing trade dominated by FDI is too high in the industry.

6. Exchange rate change has significant impact on employment, especially in terms of long-term structural impact. Exchange rate policy reform in 1994 accelerated China's industrialization process, promoting employment by 30 million jobs. Given close trade and investment relationship between China and EU, substantial parts are closely related to EU.

To address the trade imbalance problem which has become increasingly serious, to help change China's economic growth pattern and trade growth pattern, we have following policy suggestions:

1. In terms of industry-level, we should focus on developing service industry, promoting the share of service industry in national economy. Currently, China's service industry develops slowly, even slower than that in some developing countries such as India. There is obviously trade deficit in this area. Therefore, developing service industry is significant for promoting domestic demand, reducing domestic economy imbalance, and providing employment opportunities. It is also an important way to change China's economic growth pattern. Specifically, we should cancel restrictions preventing private enterprises entering some service industries as soon as possible, improving market competition mechanism, offering tax prioritizations for service industry, accelerating financial mechanism reform, providing financing support for helping SMEs get access into service industry, and accelerating some public service units' privatization.

2. Industrial policy preferences should be given to capital-intensive and technology-intensive industries. It is true that labor-intensive industry will still play an important role in promoting economic growth in the near future. Its existence mainly depends on using scale and price advantages to win oversea market, but its technology

level is low, it cannot play a dominant role in international specialization and cannot form a big multinational corporation. Therefore, as well as ensuring stable development of labor-intensive industry, we should give more industry policy preferences to capital-intensive industry. At the same time, through policy tools such as tax and finance, we can promote cluster effect in labor-intensive industry to help them form stronger big enterprises.

3. In capital-intensive and technology-intensive industries, more policy preferences should be given to emerging high-tech industry, namely “sunrise industry”. Capital-intensive industry is just a rough category, industries characterized by high pollution, high energy consumption, and resource-dependent such as electrolytic aluminum, cement production also belong to this category. These industries are foundation industries for national economy, but they have led to serious environmental damage and energy consumption, and their over production capacity is one of important reasons for rapid development of trade surplus in recent years. Therefore, industrial policies should emphasize on sunrise industry characterized by low pollution, low energy consumption, higher domestic demand, such as pharmaceutical, sophisticated instruments etc. Specific implementations are setting higher standards regarding energy consumption and pollution, administrating industries characterized by high pollution, high energy consumption, and resource-dependent as well as projects with over production capacity seriously, conducting relevant research to promote technology level of foundation industries of national economy, offering incentives such as subsidy and tax preference etc to industry by referring to indexes in terms of energy consumption and pollution, giving more policy preferences to sunrise industry.

4. We should guide FDI inflow into those labor-intensive and technology-intensive industries with lower vertical specialization degree. Most FDI in China’s labor-intensive industry is export-oriented, with obvious effect in promoting trade imbalance. For those industries with higher degree of vertical specialization such as telecommunication, computer and other electronic equipment production industries,

most FDI inflow just use China's cheap labor cost to conduct production at the end of value chain (mainly through processing trade), so most profits go back to multinational corporations. Consequently, "Guidance list for FDI enterprise" should be adjusted; we should also have relevant policy tools such as slight variation of income-tax etc to guide FDI inflow into industries with lower degree of vertical specialization such as pharmaceutical, advanced chemical materials production, aviation equipment production, etc, to promote China's FDI quality as well as improve trade imbalance.

5. We should adjust policy preferences in terms of tariff rate appropriately. Since China's labor cost will keep rising in the future, normal trade's role in China's foreign trade will be stronger. Currently, complete rebate of tariff rate may not match the requirements for realizing change of China's trade growth pattern and economic growth pattern. Relevant administrative departments should conduct further research to adjust this policy gradually. As well as ensuring stable development of foreign trade scale, we should improve structure of China's foreign trade and increase export value added.

6. Given RMB slow appreciation's limited impact on employment, we can promote employment through positive monetary and financial polices. Therefore, when conducting exchange rate policy reform, adjustment of exchange rate policy should match requirements for realizing other macro-economic objectives, to contribute to changing China's economic growth pattern and trade pattern.

With change of China's economic structure and gradual adjustment of trade policy, as well as keeping its scale developing constantly, Sino-EU trade will have its structure further improved. China's key contributions to East Asia economic structure will be changed by providing advance technologies and brands rather than providing cheap labor cost, high quality labor, and land resource. In the future, overall volume of Sino-EU trade will keep increasing constantly, with that growth rate of import from EU to China will be higher than that of China's export to EU. China's trade structure will be further improved, as the role of labor-intensive industry with higher vertical specialization degree will decline in China’s foreign trade. Scale of Sino-EU mutual investment will keep increasing, with that growth rate of China’s investment in EU will be higher than that of EU’s investment in China.

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Attachment:

Annex 1: China's Input-Output Table for 42 Units in 2002

Code	Units	Code	Units
01	Agricultural Industry	22	Garage Industry
02	Coal Mining and Coal Washing	23	Electric Power and Heating Power Generation
03	Oil & Gas Mining	24	Natural Gas Production and Distribution
04	Metal Ore Mining	25	Tap Water Production and Supply
05	Nonmetallic Mineral Mining and Quarrying	26	Construction
06	Food Manufacturing and Tobacco Processing	27	Transportation and Warehousing Industry
07	Textile Industry	28	Postal Industry
08	Apparel, Leather, Fur, and Coat Products Manufacturing	29	Information Transmission, Computer Service, and Software Industries
09	Wood Processing and Furniture Manufacturing	30	Wholesale and Retail Service
10	Paper Making, Printing, Stationery and Sporting Goods	31	Accommodation and Catering
11	Petroleum Processing and Coking Plant Industry	32	Finance and Insurance
12	Chemical Industry	33	Real Estate
13	Nonmetallic Minerals Products	34	Leasing and Commercial Service
14	Metal Smelting and Rolling Processing	35	Travel
15	Metal Product	36	Scientific Research
16	General、Special Machinery Manufacturing	37	Comprehensive Technology Service
17	Transportation Equipment Manufacturing	38	Other Social Service
18	Electronic Machinery and Equipment	39	Education
19	Electronic Communication Equipment and Computer Manufacturing	40	Health, Social Protection, and Social Welfare
20	Instrument, Meter, Stationery and Office Machine Manufacturing	41	Culture, Sports and Entertainment
21	Other Production	42	Public Management and Social Organizations