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Decomposition of Global Value Chains for Equipment Exports of China

*Wei **Zhang*** and Chen-Chen **Yong*****
Faculty of Economics and Administration
University of Malaya

Abstract

Traditional trade statistics on gross trade is clouded by double counting of trade in intermediates across national borders. The value-added statistical method provides clarity to such situations which decomposes the global value chains (GVC) of exports. We have examined China's equipment manufacturing products trade by adopting value-added statistical method based on Wang, Wei and Zhu (2013). The decomposition results show a dominant share of domestic value-added (DVA), a small share of foreign value-added (FVA), a tiny share of returned domestic value-added (RDV), and pure double counting (PDC). This indicates that the exports of China's equipment products are mainly final products. Moreover, the results of participation and position indices show a stable participation trend and an upward trend in GVC respectively. Comparing with five selected countries, China's equipment industry participation in GVC is moderate and belongs to downstream industries.

Keywords: *global value chains, value added, decomposition, China, equipment industry*

1. Introduction

Since the nineties, international vertical specialization has spearheaded economic globalization. Final products comprise a large number of intermediate product that lead to the growth of world trade growth. Lamy and Shiraishi (2011) pointed out that the current production of many products is fast carrying the label of "Made in the World" with participation from many countries in various sectors yielding product division to form the global value chain (GVC) model.

Since joining the World Trade Organization (WTO) in 2001, China's exports had increased to US$1.2 trillion in 2009, surpassing that of Germany.

The total trade of commodities of China was US$4.16 trillion in 2013, which exceeded that of the United States as the largest trading country in the world. Simultaneously, the share of Chinese global exports accounted for 11.8 per cent of the world's gross trade. China's trade imbalance has become prominent and significant with trade deficit of US$1.14 billion in 1978 turning to a trade surplus of US$382.5 billion in 2014. China-US trade surplus was US$242.9 billion.

The conventional representation of trade numbers may not be an accurate definition of the inter country trade. Trade in intermediate goods far exceeded that for the final product when the production of exported products require imports of large quantities of intermediate products. Statistical measurements will overestimate the true value of the country's ability to create, making it easy to trigger trade disputes and other critical issues. According to a commonly cited study of the Apple iPod (Dedrick, Kraemer, & Linden, 2010), an iPod assembled in China cost US$144 at factory gate price, had only US$4 of value added from China. Intermediate products through global manufacturing chains mandates that the value of the final product is drawn from source countries of the final assembly country. Multiple transactions across national boundaries causes "double counting" problem clouding the accuracy of trade numbers.

After nearly thirty years of rapid development, China is now the world's largest manufacturing country. China being the final assembly location of many final products is part of the GVC. This is especially poignant for the equipment manufacturing industry, which represents an important portion of the manufacturing industry. This study explores the position of equipment manufacturing industry in the GVC and provide the empirical support for planners and policy makers in monitoring, evaluating and formulating relevant policies. Despite the importance of the equipment manufacturing industry, the decomposition of this value-added exports has yet to be fully researched. This study aims to analyse the decomposition of equipment's value-added exports of China. Total value-added exports can be decomposed into: 1) domestic value-added, 2) domestic value-added that returned home, 3) foreign value-added, and 4) pure double counting of value-added exports.

2. Statistical Reporting Issues for Global Value Chains in International Trade

2.1. Main Drawbacks of Conventional Trade Statistics

Conventional statistical calculation is characterized by the total amount from the final product technology and price. Schott (2008) in using the exports similarity index (ESI), stated that China's export products complexity was

similar to OECD countries, but of lower quality and did not appear to be catching up in most manufacturing industries. Gaulier, Lemoine, and Ünal-Kesenci (2007), Bensidoun, Gaulier, Lemoine, and Ünal (2009) and other scholars also proved this using different methods. Rodrik (2006) believed that China and India's exports have complexity, within its own economic capacity, and are dissimilar. Yi (2003), Hale and Long (2006), Wang and Wei (2008), Guo and Yang (2010) produced different interpretations on the causes of export complexity. Qiu, Ye, and Sun (2012) found that there is an overall upward trend by calculating the exports of manufacturing complexity for 24 industries in China. However, the economic freedom and the research and development of China's manufacturing value chain with positive effect is not found to be significant. Some of the drawbacks include the fact that the technical complexity of the method does not distinguish between technological content and source. Therefore, it cannot accurately distinguish whether the two sides are complementary or competitive. Moreover, the deciding factor of a competitive advantage of a country is not only on its technology, but also include factors such as infrastructure, natural resources and capital.

2.2. Rules of Origin of the Final Product Statistics

Under the global value chain, the international division of labour reported a new change from the labour division within the industry to that for intra-industry, gradually evolving into labour based division of intra-product international division of the labour system. In this division of the labour system, the final product goes through two or more links. These production links are distributed in two or several countries, and produce value-added in various production processes (Milberg, Jiang, & Gereffi, 2014). The intermediate inputs cross national borders. Traditional international trade statistics is based on the rules of origin of the final product statistics. However, with the rapid development of trade in intermediates, their proportion has exceeded the trade in final product. This new trade regime had dynamically altered international trade patterns. Traditional statistical methods look more and more obsolete in tandem with these changes. Specifically, there is a large number of repeated trade data for intermediate goods in multiple production links. If trade statistics are counted based on the gross value instead of the value-added method, it will result in large amounts of double counting. Another consideration is that a country's trade in goods contains the value of inputs from other countries, that is, the rule of origin does not reflect the product in the value chain of different production processes. A country's trade statistics will therefore include other countries' intermediate products (Koopman, Wang, & Wei, 2014). Thus, the total value of the statistical final

product does not truly reflect the real situation of a country's trade. There is a need for the existing international trade statistical methods to be improved so that it is more reflective of the true scale of international trade and national trade incomes.

2.3. Double-counting Value-added in Trade Statistics

The trade in value added accounting method is gaining more traction. This method forms the base of the global value chain to calculate the contribution of countries to the product value, which deducts the intermediate products each time through customs' statistics of the double-counting value-added. It represents the status of the countries in global trade. The trade gains of countries can also be determined by the ratio of each country's exports of domestic value-added and foreign value added (Koopman, Wang, & Wei, 2012). In 2010, WTO proposes "World Manufacturing" to measure the added value of each link in the value chain to solve the double counting problem and restore the true face of international trade in order to promote the reform of international trade statistical methods under the global value chain. The former WTO Director General Pascal Lamy, pointed out that the statistical trade data based on trade value of total imports and exports resulted in misunderstandings on the imbalance between many countries in 2011. The statistical method with an altered domestic value-added measurement in total trade flows is better able to detect the global trade situation and reflect trade imbalance.

2.4. Global Value Chains Framework

Koopman, Powers, Wang, and Wei (2010) proposed a new measurement framework for value-added and participation in global value chains in the process of international trade, known as the KPWW method. Koopman et al. (2012) reported the advantages of value added method which is further detailed by Daudin, Rifflart and Schweisguth (2011). They expanded the total exports into five parts, and for the first time, provided a set of measurement formula for the "double counting" in trade value. Koopman et al. (2012) also proposed a method to measure the position of a country's international division of labour called "GVC_Position". They believed that if a country is located in an industrial high-end global value chain (upstream industry), it means that it is more inclined to participate as an intermediate product provider of the international division of labour, and vice versa. This method contributes towards a complete unified framework for added value theory. Lately, Wang, et al. (2013) expanded the KPWW method to thoroughly decompose a country's exports into 16 terms. This method is more comprehensive compared to the KPWW method.

3. Methodology

Based on literature on global value chain theory presented earlier, we will utilize the latest method of decomposition of value-added proposed by Wang, et al. (2013) to decompose the share of foreign value-added and the domestic value-added for the exports of equipment manufacturing industry products of China from year 2000 to 2014. Based on the world input output tables (WIOT), the equipment manufacturing industry includes manufacture of basic metal, manufacture of fabricated metal products, except machinery and equipment; manufacture of computer, electronic and optical products; manufacture of electrical equipment; manufacture of machinery and equipment n.e.c. (not elsewhere classified); manufacture of motor vehicles, trailers and semi-trailers and manufacture of other transport equipment.

Based on Wang et al. (2013), the total exports of a country were decomposed into four major categories: 1) domestic value-added absorbed by countries abroad (DVA), including the DVA in the final goods exports, DVA in intermediate exports, and DVA in re-exported intermediates to third countries, 2) returned domestic value-added (RDV), which includes intermediates that return as final imports, and intermediates that return as intermediate imports, 3) foreign value-added (FVA) which include foreign value-added used in final goods export, and foreign value added used in intermediate exports, and 4) pure double counting (PDC), which is made up of pure double counting from foreign source and domestic source.

4. Results

4.1. The Share of Equipment Industry Products in China's Manufacturing Industry Exports

Since China's equipment manufacturing industry reported a trade surplus in 2004, its industrial scale and imports and exports trade volume experienced rapid growth. In 2007, China's imports and exports of equipment manufacturing products accounted for 49.3 per cent and 49.7 per cent of total import and export respectively (Chen & Liu, 2011). China became the largest trading country in the equipment manufacturing industry in 2009. In 2012, the trade volume of Chinese equipment industry exceeded US$1.8 trillion, which is 1.1 times larger than that of the United States, 1.6 times that of Germany, and 2.5 times that of Japan. Imports and exports in 2013 were US$820 billion and US$113 billion, respectively, accounting for 42 per cent of total imports and 51 per cent of total exports (Lin & He, 2015).

Table 1 shows the exports share of Chinese equipment industry products in the whole manufacturing industry products exports from 2000-2014. According to this table, the proportion of equipment industry exports

Table 1 Share of Equipment Industry Exports in Manufacturing Industry Exports, 2000-2014 (USD billion)

Year	*Manufacturing*	*Equipment*	*Proportion of Manufacturing (%)*		
			Total	*Final*	*Intermediate*
2000	199.2	95.6	48.0	27.7	20.3
2001	210.5	101.1	48.0	27.8	20.2
2002	259.3	131.6	50.7	29.5	21.2
2003	366.2	200.4	54.7	32.3	22.5
2004	518.0	306.3	59.1	34.7	24.5
2005	671.4	396.9	59.1	35.1	24.0
2006	862.7	523.1	60.6	35.0	25.6
2007	1087.8	670.6	61.7	35.7	26.0
2008	1259.0	799.5	63.5	36.0	27.5
2009	1036.3	649.2	62.6	37.4	25.2
2010	1375.9	891.0	64.8	37.6	27.2
2011	1639.1	1044.7	63.7	36.2	27.6
2012	1727.8	1099.4	63.6	36.4	27.2
2013	1876.1	1178.4	62.8	34.0	28.8
2014	1994.7	1257.8	63.1	33.3	29.8

Note: The equipment manufacturing industry includes manufacture of basic metal; manufacture of fabricated metal products, except machinery and equipment; manufacture of computer, electronic and optical products; manufacture of electrical equipment; manufacture of machinery and equipment n.e.c.; manufacture of motor vehicles, trailers and semi-trailers; manufacture of other transport equipment.

Source: World Input-Output Table.

accounted for 48.0 per cent of total manufacturing industry exports in 2000. Until the end of 2014, the proportion has increased to 63.1 per cent of the total exports of manufacturing exports, which reported a 15 per cent growth and captured more than half of the share of gross exports. This indicates that the exports of equipment products have become the primary enzyme of China's manufacturing exports growth. Based on types of exported products, the final products share has increased from 27.7 per cent in 2000, to 33.3 per cent in 2014, of the percentage of gross exports in manufacturing, while the intermediates exports show a rapid growth from 20.3 per cent in 2000, to 29.8 per cent in 2014. The share of final products exports is consistently higher than the intermediate products during the reporting period, which means that the exports of Chinese equipment product are mainly final products.

4.2. Value-added Decomposition of China's Equipment Industry Exports

The decomposition results of value-added for China's equipment exports are shown in Tables 2 and 3. The total DVA of China's equipment manufacturing exports increased from US$72.5 billion in 2000 to US$945.4 billion in 2014, with an average annual growth rate of 20.2 per cent. The proportion of domestic added-value in total exports shows a smile curve, which decreases from 75.9 per cent in 2000 to 67.1 per cent in 2008, and then gradually increases to 75.2 per cent in 2014. This explains the fact that China's equipment manufacturing industry is increasingly participating in GVC. The domestic value added in final exports (DVA_Fin) also shows a significant downward trend, the value declines from 44.0 per cent in 2000 to 41.6 per cent in 2014, which is a decrease of 2.4 per cent.

The domestic value added in intermediate exports (DVA_Int) shows a weak upward trend. The value increases from 18.7 per cent in 2000 to 21.5 per cent in 2014. The domestic value added in re-exported intermediates to third countries (DVA_Intrex) also shows a slight downward trend. The value decreases from 13.2 per cent in 2000 to 12.1 per cent in 2014, a decrease of only one percentage point.

Although China's equipment exports have a high relative proportion of DVA, it does not mean that the exports are high in technological content and in the upstream position of GVC. This is because the exports of domestic value-added is mainly dominated by final exports rather than intermediate exports. This indicates that China's equipment exports in GVC is not significant and is in downstream position. However, the decreasing share of DVA_Fin, as well as the increasing share of domestic exports of intermediate goods (including DVA_Int and DVA_Intrex) shows that the Chinese equipment manufacturing industry has a tendency of moving upwards in GVC.

The returned domestic value added (RDV) of the Chinese equipment manufacturing industry shows a steady upward trend, rising from US$1 billion in 2000 to US$33.7 billion, while its share of total exports increases from 1.1 per cent in 2000 to 2.7 per cent in 2014 per cent, an increase of 1.6 percentage points. However, it still occupies a small portion of total exports of equipment. The returned domestic value added as final imports (RDV_Fin) volume increases from US$0.4 billion in 2000 to US$13.3 billion in 2014, while the share of total exports increases slowly from 0.5% to 1.1%. The returned domestic value added as intermediate imports (RDV_Int) rises sharply from US$0.6 billion in 2000 to US$13.3 billion in 2014, with the proportion of total exports rising from 0.6 per cent in 2000 to 1.6 per cent in 2014.

The relatively small increase in RDV of China's equipment exports is mainly due to the fact that China's equipment industry belongs to downstream industry within the GVC, which mainly follows the design of the core

Table 2 Decomposition of GVC Exports of Chinese Equipment Products (USD billion)

Year	*Total exports*	*DVA*				*RDV*			*FVA*			*PDC*		
		DVA_ Fin	*DVA_ Int*	*DVA_ Intrex*	*Total*	*RDV_ Fin*	*RDV_ Int*	*Total*	*FVA_ Fin*	*FVA_ Int*	*Total*	*DDC*	*FDC*	*Total*
2000	95.6	42.0	17.8	12.7	72.5	0.4	0.6	1.0	13.2	4.3	17.6	0.3	4.1	4.5
2001	101.1	45.1	19.0	13.2	77.4	0.6	0.7	1.3	13.4	4.3	17.8	0.4	4.3	4.6
2002	131.6	57.2	23.8	16.3	97.4	0.9	1.1	2.0	19.4	6.0	25.3	0.7	6.1	6.8
2003	200.4	83.5	33.3	23.0	139.8	1.6	1.7	3.3	34.6	10.4	45.0	1.4	10.9	12.3
2004	306.3	122.8	49.3	34.6	206.6	2.6	2.6	5.2	56.7	17.0	73.7	2.6	18.0	20.7
2005	396.9	160.8	62.7	43.0	266.5	3.2	3.3	6.4	74.8	22.1	97.0	3.9	23.0	27.0
2006	523.1	206.6	84.1	60.5	351.2	4.5	4.3	8.8	95.6	29.3	124.8	6.0	32.2	38.3
2007	670.6	264.3	110.5	75.0	449.8	3.6	6.1	9.7	123.7	39.3	163.0	7.8	40.3	48.1
2008	799.5	320.7	140.5	94.4	555.6	4.5	7.7	12.1	1319.0	46.3	178.2	8.8	44.8	53.5
2009	649.2	292.2	114.1	69.8	476.1	5.2	6.6	11.7	95.5	31.3	126.8	6.1	28.4	34.5
2010	891.0	383.0	153.2	98.5	634.7	8.2	10.2	18.4	134.4	47.9	182.2	10.5	45.2	55.6
2011	1044.7	442.3	184.1	120.7	747.1	10.7	13.4	24.1	150.5	56.8	207.3	12.4	53.8	66.2
2012	1099.4	477.4	198.7	121.8	797.9	11.5	15.7	27.2	1519.0	56.8	208.7	13.7	51.9	65.6
2013	1178.4	487.5	232.8	135.8	856.0	12.1	19.4	31.5	150.5	67.3	217.8	15.6	57.4	73.0
2014	1257.8	522.9	270.5	151.9	945.4	13.3	20.4	33.7	140.9	67.4	208.2	15.8	54.6	70.4

Notes: Please refer to Appendix 1 for definitions of the variables.

Table 3 Decomposition of GVC Exports of Chinese Equipment Products (percentage)

Year	*DVA*				*RDV*			*FVA*			*PDC*		
	DVA_ Fin	*DVA_ Int*	*DVA_ Intrex*	*Total*	*RDV_ Fin*	*RDV_ Int*	*Total*	*FVA_ Fin*	*FVA_ Int*	*Total*	*DDC*	*FDC*	*Total*
2000	44.0	18.7	13.2	75.9	0.5	0.6	1.1	13.8	4.5	18.4	0.3	4.3	4.7
2001	44.6	18.9	13.1	76.5	0.6	0.7	1.3	13.3	4.3	17.6	0.4	4.2	4.6
2002	43.5	18.1	12.4	74.0	0.7	0.8	1.5	14.7	4.6	19.3	0.5	4.7	5.2
2003	41.6	16.6	11.5	69.7	0.8	0.8	1.6	17.3	5.2	22.5	0.7	5.4	6.1
2004	40.1	16.1	11.3	67.5	0.9	0.9	1.7	18.5	5.6	24.1	0.9	5.9	6.7
2005	40.5	15.8	10.8	67.2	0.8	0.8	1.6	18.8	5.6	24.4	1.0	5.8	6.8
2006	39.5	16.1	11.6	67.1	0.9	0.8	1.7	18.3	5.6	23.9	1.2	6.2	7.3
2007	39.4	16.5	11.2	67.1	0.5	0.9	1.4	18.4	5.9	24.3	1.2	6.0	7.2
2008	40.1	17.6	11.8	69.5	0.6	1.0	1.5	16.5	5.8	22.3	1.1	5.6	6.7
2009	45.0	17.6	10.8	73.3	0.8	1.0	1.8	14.7	4.8	19.5	0.9	4.4	5.3
2010	43.0	17.2	11.1	71.2	0.9	1.1	2.1	15.1	5.4	20.5	1.2	5.1	6.2
2011	42.3	17.6	11.6	71.5	1.0	1.3	2.3	14.4	5.4	19.8	1.2	5.2	6.3
2012	43.4	18.1	11.1	72.6	1.1	1.4	2.5	13.8	5.2	19.0	1.2	4.7	6.0
2013	41.4	19.8	11.5	72.6	1.0	1.6	2.7	12.8	5.7	18.5	1.3	4.9	6.2
2014	41.6	21.5	12.1	75.2	1.1	1.6	2.7	11.2	5.4	16.6	1.3	4.3	5.6

Notes: Figures are in percentage of total exports and percentage of distribution for the respective category. Please refer to Appendix 1 for definitions of the variables.

components product, research and development, and branding from developed countries that participate in the processing and assembly-based low-end production processes. However, the share of RDV in China's equipment exports shows an upward trend. Although the share of RDV is small, the value-added of Chinese exports would be rarely returned to the domestic market, from the subdivision level aspects, the proportion of intermediate products exports (RDV_Int) is higher than the final products (RDV_Fin) in China's equipment industry. This indicates that the returned goods are mainly intermediate, may be mainly primary intermediate products, processed into advanced intermediate products, then exported to foreign countries.

The foreign value added (FVA) in the exports of Chinese equipment manufacturing industry increases significantly from US$17.6 billion in 2000 to US$208.3 billion in 2014, with an average annual growth rate of 19.3 per cent. As of 2011, the foreign value-added in final goods (FVA_Fin) amounted to US$140.9 billion. While, the foreign value-added in intermediate goods (FVA_Int) constitutes US$67.4 billion. The FVA_Fin is more than twice that of the FVA_Int. From the perspective of the proportion of total equipment products exports, the FVA also shows a significant downward trend where the value of 18.4 per cent in 2000 has decreased to 16.6 per cent in 2014, a drop of 1.8 percentage points. It indicates that the foreign value added in China's equipment exports is slowly decreasing. FVA_Fin is significantly higher than that of FVA_Int, decreasing by 2.6 points, from 13.8 per cent in 2000 to 11.2 per cent in 2014. The FVA is mainly accounted for by the final product during the reporting period. This shows that China's equipment industry products are mainly engaged in the final process of production, such as processing and assembly-based activities, which participated in cross-country production sharing on the low end of GVC. However, FVA_Int is increasing during this period, which implies that China is upgrading its equipment industries to begin producing intermediate products for foreign countries to produce the final products.

The proportion of pure double counting (PDC) shows a tendency to increase. A percentage of 4.7 per cent in 2000 increases to 5.6 per cent in 2014. Simultaneously, the exports from US$4.6 billion in 2000 increases to US$70.4 billion in 2011. These data indicate that the intermediate goods of the equipment industry have been going through few domestic and foreign customs before it has been utilized in the final production. Moreover, the pure double counting from domestic country (DDC) is significantly lower than that of the pure double-counting from foreign countries (FDC), which respectively increases from 0.3 per cent and 4.3 per cent in 2000, to 1.3 per cent and 4.3 per cent in 2011, and separately increased by 1 and zero percentage points, respectively. It implies that PDC is mainly due to the fact that their imports of intermediate products frequently cross national borders, but it does not explain

how Chinese equipment industry participates in the international division of labour or whether it is deepening in GVC. Moreover, since intermediate trade crosses national borders, it is similar to domestic inter-industry transactions that produces intermediate inputs where the values of these intermediate trade values do not constitute the gross domestic production (GDP).

According to Table 4, the participation rate of China's equipment industry shows a slight downward trend, decreasing from 31.6 in 2000 to 28.6 in 2014. The participation reported the highest index of 35.5 in 2007, and the lowest rate of 28.6 in 2014. Furthermore, the position index of China's equipment manufacturing industry is always negative during the reporting period, but has a slight uptrend, where the value of index has risen from -0.0443 in 2000 gradually to -0.0392 in 2014. It implies that the equipment industry of China

Table 4 Index of Participation and Position of GVC for Chinese Equipment Industry

Year	*GVC Participation Index*	*GVC Position Index*
2000	31.6	-0.0443
2001	30.7	-0.0390
2002	31.7	-0.0594
2003	33.9	-0.0942
2004	35.4	-0.1088
2005	35.3	-0.1157
2006	35.4	-0.1046
2007	35.5	-0.1115
2008	34.1	-0.0896
2009	30.3	-0.0763
2010	31.5	-0.0812
2011	31.4	-0.0716
2012	30.1	-0.0687
2013	30.0	-0.0606
2014	28.6	-0.0392

Note: GVC participation index is calculated based on Koopman et al. (2010) where GVC participation index = (DVA_Intrex / total exports) + (FVA / total exports), GVC position index = ln ((1 + (DVA_Intrex / total exports)) – ln ((1 + (FVA / total exports)). Larger GVC participation index indicates higher degree of participation in GVC. For position index, if a country's DVA_Intrex share is higher than its FVA share, it probably lies upstream of the GVC. Conversely, it means that it lies in downstream of the GVC indicating that country uses a large share of intermediates inputs from other countries to produce its own exports products.

remains in the lower position and participation in global value chains, but has a tendency to move up, which is in tandem with the results reported by Wang (2014) on China's manufacturing industry.

During this period, the GVC position index shows an unstable trend, going down in 2005, then up in 2014. The reason for the decrease in position index is highly resulted from the decrease in FVA which slightly dropped from 58.1 per cent in 2000 to 57.8 per cent in 2014. In addition to the greater share of FVA as compared to DVA_Intrex, it implies that the contribution of foreign imports to China's equipment manufacturing exports is significantly greater than the contribution of the exports of China's equipment industries to foreign supply chains.

5. Discussion

It can be seen that the result for DVA exhibited a "smile curve" during the entire study period. The decrease began in year 2000 and reached the bottom in 2006. However, FVA showed an opposite trend where it reached the highest value in year 2007 and decreases thereafter. This illustrates that after joining the WTO, the degree of participation in international trade division becomes deeper, especially in the rapid development of processing trade. During this period, China used a large number of foreign materials and intermediate products to produce industrial equipment. Therefore, the proportion of DVA decreased while FVA increased. On the other hand, the global economic crisis in 2008 has reduced the demand from foreign markets. In the short term, the exports fell sharply due to the increase of protectionism in some countries, which encourages the adoption of domestic intermediate products.

The increasing trend of the small share of PDC from 4.6 per cent in 2001 to 7.2 per cent in 2007 shows that after China joined the WTO, the trade tariffs and barriers has largely decreased, which leads to increased demand for intermediate goods in the manufacturing sector. Therefore, the frequent trade between China and other countries in intermediate goods leads to the increase of double counting. RDV which constitutes the smallest share in total equipment exports shows that China choose to outsource some products to other countries for production and processing, then re-export it to the homeland (Liou, Lin, Chang, and Hsu, 2016).

Table 5 shows the top five importers of equipment manufacturing products from China during 2000 to 2014. Based on the results, the top two importers of Chinese equipment manufacturing exports, the US and Japan remained unchanged from 2000-2014. The bilateral trade between China and the US increased from US$22.9 billion in 2000 to US$208.1 billion in 2014. Since joining the WTO in 2001, China's trade with Germany, South Korea, UK, and Taiwan had surpassed US$10 billion. This implies that joining

Table 5 The Top Five Importers of Equipment Products from China during 2000-2014 (USD billion)

Country	Ranking	2000		2005		2010		2014	
China	1	USA	22.9	USA	88.8	USA	152.6	USA	208.1
	2	Japan	12.4	Japan	42.3	Japan	67.2	Japan	102.2
	3	Germany	5.1	Germany	21.2	Germany	43.8	S. Korea	62.6
	4	S. Korea	4.2	S. Korea	18.0	S. Korea	42.2	Germany	48.6
	5	UK	3.5	Taiwan	11.5	UK	23.3	Taiwan	30.3

Source: Author's calculation based on World Input-Output Table from 2000 to 2014.

the WTO has successfully promoted and developed China's equipment manufacturing exports. This coincides with the development trend of China's overall equipment manufacturing trade.

As shown in Table 6, the US is the only country that shows positive GVC index between 2000 and 2014. In the same period, Germany, as a highly developed industrialized country, showed a downward trend in its position index. The number was from -0.05 in 2001 to -0.07 in 2007, from the high position, decreasing in its GVC position. The GVC position index for Japan, although positive in the early period, shows a slight downward trend that achieves a negative value after 2011. This indicates that Japan's equipment industry is changing from upstream to downstream industry. This is also consistent with the result of Suder, Liesch, Inomata, Mihailova, and Meng (2015, p. 409) that the high gain potential in Japan has decreased during the period of 2000 to 2007. The reason cited by them is that some of production activity has moved out of Japan to other countries through foreign direct investment (FDI).

Compared with the aforementioned countries, China ranked in the middle level position in GVC. By the end of 2014, China has caught up with Japan. The position index line of China shows a sharp wave during that period. From 2000 to 2007, the position index shows a downward trend which can be explained by China joining the WTO in 2001. Foreign direct investment (FDI) continues into the equipment manufacturing industry, mainly engaged in low-end assembly and processing stage of production, leading to China's decreasing position index in GVC. This is consistent with Lin and He (2015), who posited that China is still in the low-end position in GVC, lower than the USA and Japan.

6. Conclusion

This paper uses the GVC method proposed by Wang et al. (2013) to decompose the gross exports of China's equipment industry products based on the World Input-Output Tables from 2000 to 2014. The first aspect is the

Table 6 Participation and Position Indices for Six Countries

Year	*Participation (%)*						*Position*					
	China	*Korea*	*Japan*	*Germany*	*UK*	*USA*	*China*	*Korea*	*Japan*	*Germany*	*UK*	*USA*
2000	31.6	35.8	24.2	32.6	36.1	22.0	-0.0443	-0.0896	0.0806	-0.0501	-0.0075	0.0352
2005	35.3	35.1	26.8	33.4	37.1	23.1	-0.1157	-0.0843	0.0515	-0.0530	-0.0007	0.0300
2010	31.5	37.9	30.2	35.5	41.5	24.9	-0.0812	-0.1272	0.0313	-0.0771	-0.0839	0.0339
2014	28.6	37.5	33.6	35.6	40.2	25.7	-0.0392	-0.1160	-0.0373	-0.0756	-0.0715	0.0015

Source: Authors' calculation.

result of gross exports decomposition of China's equipment industry. (1) the exports of domestic value-added is mainly dominated by DVA_Fin, while both DVA_Int and DVA_Intrex are relatively small, which to some extent indicates that China's equipment manufacturing industry in the GVC is not significant. (2) the share of FVA_Fin is greater than FVA_Int which shows that the China's equipment products are mainly engaged in the final process of production, such as processing, assembly-based activities. (3) China's exports would be rarely returned to the domestic market shown by the smallest share of RDV.

It demonstrates an upward trend for intermediate products exports of China's equipment manufacturing industry from 2000 to 2014, while the final products show a downward trend. The domestic value-added in China's equipment industry exports is significantly less than its gross exports trade, and the gap between them is growing. This indicates that the value-added accounting method for international trade objectively restore the real situation of China's equipment manufacturing trade. During the reporting period, the share of domestic value-added in the exports of equipment manufacturing industry of China shows a downward trend, and dominated by the exports of final product. However, the proportion of the domestic added value of the intermediate product exports is increasing. It illustrates that although China's equipment industry is still in a relatively downstream position in the global value chain, it is gradually rising to the upper position of the value chain. The exports of China's equipment product is made up of more and more foreign value-added, which means that it improves the degree of its participation in the global value chain, but mainly in the low-end production process, such as assembly or final product processing. Simultaneously, the proportion of value-added in intermediate products in the China's manufacturing industry keeps increasing, which indicates that China's equipment industry has the tendency in upgrading from downstream position of the GVC to middle stream.

Moreover, the value of foreign value added in final products (FVA_FIN) is higher than the sum of foreign value added in intermediate products (FVA_INT) and purely double-counting from foreign accounts (FDC), indicating that it lies in the lower position in GVC. An increase in the share of FDC and FVA_INT in China's equipment industry shows that participation in the GVC for the equipment industry belongs to a downstream industry. The value-added exports of intermediate goods to third countries (DVA_REX) is significantly higher than the returned domestic value-added (RDV), indicating that China's equipment industry is mainly involved in a few global value chain production links.

Appendix 1 Definition of Variables

Variable	*Definition*
DVA_Fin	Domestic value added in final exports
DVA_Int	Domestic value added in intermediate exports
DVA_Intrex	Domestic value added in re-exported intermediate exports to third countries
FVA_Fin	Foreign value added in final goods
FVA_Int	Foreign value added in intermediate goods
RDA_Fin	Returned domestic value added as final imports
RDA_Int	Returned domestic value added in intermediate imports
DDC	Double counting from domestic country
FDC	Double counting from foreign countries

Notes

* Wei Zhang is a graduate from the University of Malaya, Malaysia. He obtained his Master Degree in Economics. His research area is on international trade. He can be reached at <alex7933@live.cn>.

** Chen-Chen Yong is currently Senior Lecturer at Faculty of Economics and Administration, University of Malaya. Her research interests include international trade and human capital. She can be reached at <ccyong@um.edu.my>.

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