The change of Domestic Value-added in China's Exports: A Structural Decomposition Analysis Approach

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Abstract: China's exports can be divided into three different kinds of trade: processing trade, normal trade of goods and normal trade of services. Based on China's non-competitive input-output table captures processing trade, we calculate domestic value-added in exports in 2002, 2007 and 2010. We then use the structural decomposition analysis to discuss six factors which could be the driving forces of the change of domestic value-added in exports under the three kinds of trade in period 2002-2007 and 2007-2010. The results show that six driving forces have different effects on the DVA of exports. Normal trade is the dominated contributor of the increasing the DVA in China's exports. The increase of DVA generated by exports is mainly due to the expansion of export volume. In the long run, the effective way to increase DVA of exports is to expand the fabrication effects.

Keywords: non-competitive input -output table captures processing trade; Domestic value-added in exports; Structural decomposition analysis

1. INTRODUCTION

After China joined the WTO in the end of 2001, China's foreign trade has been expanding rapidly. Foreign trade has become one of the most important driving forces for China's rapid economic growth. According to the data released by the National Bureau of Statistics, China's gross exports (including goods and services) is $365.0 billion, accounts for 25.1% of China's GDP in 2002. By the year of 2012, China's gross exports reached $2.2 trillion, accounts for 27.2% of GDP, five times larger than that of 2002, with an average annual growth rate of 20 percent in ten years. This growth rate is much higher than that of GDP.

Joining the WTO not only expanded the import and export volume of China, it also changed the characteristics of China's trade. The expansion of global trade in the past decades is characterized by increasing international fragmentation of production, where production processes are sliced into many different tasks that can be done in different countries. As a result, the value-added are shared by many countries and regions instead of the final exporters. With these changes on trade characteristics, the standard trade statistics on gross exports no longer gives the accurate measures on the true value that a country gained from foreign trade. Economists and economic policymakers are more concerned with accurate measurement of value-added generated by trade. OECD and WTO even cooperated and built OCED-WTO TiVA (Trade in Value Added) database. In China, processing trade persistently constitutes about 50 percent of China's exports since the late 1990s. Because most of the raw materials and components in processing trade are imported from other countries, large proportion of gains from exports does not belong to China. So it is very important to study the value-added generated by China's exports.

With the prevalence of processing trade, any measurement based on aggregate results combining processing exports and other production could have highly overstated China's economic benefits. Therefore, it is critical to develop a framework separating productions of processing exports and general exports for China so that the total domestic value-added (short as DVA) from exports can be measured more accurately. Lau, Chen *et al.* (2006) developed a non-competitive input-output table capturing processing trade for China (known as DPN table), where the input structures are differentiated for the productions of domestic use, processing exports and normal exports, to study China's DVA of exports. This methodology was subsequently adopted, directly or indirectly, and with variations, by other researchers working on similar and related topics (Koopman et al. 2008; Dean et al., 2011; Chen et al., 2012).

Despite the crucial role of the DVA of exports in aiding our understanding of key issues and trends in foreign trade, little attention has been devoted to the driving forces behind it. But this is essential to understand how China's valued added in trade would change in the long run. In this paper, we not only estimate the DVA of China's exports by DPN model, but also try to figure out and quantify the factors that caused the DVA of exports changes. Such changes may be driven by a variety of factors, such as the expansion of export scale, export structure changes, changes in the structure of export products, changes in technology and

other factors. Study the relationship between these factors and the changes in DVA of exports, gives us better understanding of what truly influenced the value added in China's exports.

Structural decomposition analysis (SDA) is a widely accepted method developed from the input–output model. It is a useful approach to quantify the contributions of all kinds of driving forces to the DVA of exports overtime. Structural decomposition study has been used for many problems, such as environmental pollution, consumption growth, and so on (De Haan, 2001; Koller & Stehrer 2010; Bin Su & B. W. Ang, 2012). To the best of our knowledge, there are few decomposition studies of China's DVA in exports. By examining the effects of the processing trade, normal trade of goods and normal trade of service separately, we find out which kind of trade contributes most to the improving the DVA of exports. Using SDA we figured out which factor mostly affects the DVA of gross exports, as well as the exports of three different kinds of trade separately. Additionally, this is the first study to look at the 2002-2007, and 2007-2010 period, which are two very important but different periods in the development of China's exports.

The remaining content is organized as follows. In Section 2, we first introduce the measurement for estimate the DVA of exports by China's DPN table, then present the SDA methodological framework of DVA of exports decomposition and provide the data source. Section 3 presents the results of an empirical study using the data of China. Section 4 concludes.

2. METHODS AND DATA

2.1. Methodology of measuring DVA in China's exports with the DPN table

Lau, Chen *et al.* (2006) developed a modified input-output framework (the non-competitive input-output table capturing processing trade, also called the DPN table) for China, where the input structures are differentiated for the productions of domestic use, processing trade and normal trade, to study China's DVA of exports. The framework of the DPN table is shown in Table 1:

Table 1. Non-competitive Input-occupancy Output Table Capturing Processing Trade

(DPN Table)

			Intermediate use			Final use					Total output or import
			D	P	N	Consumption	Gross capital formation	Export	Other capital	Total of final use	
Input	Intermediate input of domestic products	D	Z^{DD}	Z^{DP}	Z^{DN}	F^{DC}	F^{DI}	0		F^{D}	X^{D}
		P	0	0	0	0	0	F^{PE}		F^{P}	X^{P}
		N	Z^{ND}	Z^{NP}	Z^{NN}	F^{NC}	F^{NI}	F^{NE}		F^{N}	X^{N}
	Imported products intermediate input		Z^{MD}	Z^{MP}	Z^{MN}	F^{MC}	F^{MI}	0		F^{M}	X^{M}
	Value-added		V^{D}	V^{P}	V^{N}						
	Total input		X^{D}	X^{P}	X^{N}						

Note: The superscripts D, P, and N denote the production for domestic use, production for the exports of processing trade and normal trade, respectively.

In the table, X^{D}, X^{P} and X^{N} represent the column vectors of total output of D, P, and N; Z^{DD}, Z^{DP},and Z^{DN} represent products in the production for D as intermediate input by D, P, and N, respectively; Z^{ND}, Z^{NP},and Z^{NN} represent the products of N used as intermediate input by D, P, and N, respectively; Z^{MD}, Z^{MP},and Z^{MN} represent the imported products used as intermediate input by D, P, and N, respectively; F^{D}, F^{P} and F^{N} represent the column vectors of final demand of D, P, and N, respectively; V^{D}, V^{P}, and V^{N} represent the column vectors of value-added for production of D, P, and N, respectively.

If we suppose $X=\begin{bmatrix} X^{D} \\ X^{P} \\ X^{N} \end{bmatrix}$, $Z=\begin{bmatrix} Z^{DD} & Z^{DP} & Z^{DN} \\ 0 & 0 & 0 \\ Z^{ND} & Z^{NP} & Z^{NN} \end{bmatrix}$, $F=\begin{bmatrix} F^{D} \\ F^{P} \\ F^{N} \end{bmatrix}$, $V=\begin{bmatrix} V^{D} \\ V^{P} \\ V^{N} \end{bmatrix}$,

$M=\begin{bmatrix} Z^{MD} & Z^{MP} & Z^{MN} \end{bmatrix}$, then there are two accounting equations:

$$X=\mu Z+F \tag{1}$$

$$X'=\mu' Z+\mu' M+V' \tag{2}$$

where $\mu'=(1,\ldots,1)$ denotes the summation row vector, a prime is used to indicate transposition.

Define $A=\left[A_{ij}\right]=\left[\frac{Z_{ij}}{X_j}\right]=\begin{bmatrix} A^{DD} & A^{DP} & A^{DN} \\ 0 & 0 & 0 \\ A^{ND} & A^{NP} & A^{NN} \end{bmatrix}$ as the matrix of input coefficients, the equation (1) can be written as $X=AX+F$. As same as the standard Leontief model, its solution is given by $X=(I-A)^{-1}F=LF$, where $L\equiv(I-A)^{-1}$ denotes the extended Leontief inverse.

If we define the column vector of value-added coefficients of D, P, and N as A_v, $A_v^{'}=V^{'}(\hat{X})^{-1}$, then we can measure the domestic value-added generated by gross exports (i.e., the DVA of exports) as follows:

$$\mathbf{v}=A_v(I-A)^{-1}E=A_vLE \tag{3}$$

where $E=\begin{bmatrix} 0 \\ F^{PE} \\ F^{NE} \end{bmatrix}$ is the column vector of gross exports.

2.2. The Decomposition of the DVA of Exports

In structural decomposition analysis (SDA) the number of possible decomposition formulas is given as n!, where n denotes the number of variables. Dietzenbacher and Los (1998) recommend that studies should report the mean of all n! decompositions. In analyzing the changes in the DVA generated by gross exports, we apply the principle of polar decompositions (see for example De Haan, 2001) and hierarchical decompositions (see for example Koller & Stehrer, 2010) to reduce the number of decompositions.

If we writing $B_v=A_vL$, the equation (3) can be rewrite as

$$\mathbf{v}=B_vE \tag{4}$$

In the first step, the decomposition forms of $\mathbf{v}$ yields

$$\Delta \mathrm{v}=\frac{1}{2}(\Delta B_v)(E_0+E_1)+\frac{1}{2}(B_{v0}+B_{v1})(\Delta E) \tag{5}$$

where the subscripts 0 and 1 denote time indexes. The first term on the right-hand side of equation (5) is interpreted as to reflect the fabrication effects, and the second term is interpreted as to reflect the final demand effects.

If we define A_d as the column vector of non-competitive import coefficients of D, P,

and N with $A_d' = (\mu' M)(\hat{X})^{-1}$, denote A_s as the column sums of matrix A with $A_s' = \mu' A$ then equation (2) can changes into

$$\mu' = A_s' + A_d' + A_v' \tag{6}$$

Obviously, A_s, A_d and A_v are fully dependent.

In structural decomposition techniques, the determinants are assumed to be independent. Dietzenbacher & Los (2000) pointed out dependencies may cause a bias in the results of decomposition analyses. They had given some alternative decomposition forms to overcome this problem in general non-competitive input-output model. There are three decomposition forms of ΔB_v:

$$\Delta B_v^{\,1} = (A_{v1}L_1 - A_{v0}\tilde{L}_1) + (A_{v0}\tilde{L}_1 - A_{v0}\breve{L}_1) + (A_{v0}\breve{L}_1 - A_{v0}L_0) \tag{7a}$$

with $\tilde{L}_1 = (I - \tilde{A}_1)^{-1}$, $\breve{L}_1 = (I - \breve{A}_1)^{-1}$,

where $\tilde{A}_1 = A_1(\hat{A}_{s1} + \hat{A}_{d1})^{-1}(\hat{A}_{s0} + \hat{A}_{d0})$, $\breve{A}_1 = A_1\hat{A}_{s1}^{-1}\hat{A}_{s0}$,

$$\Delta B_v^{\,2} = (A_{v1}L_1 - A_{v0}\tilde{L}_1) + (A_{v0}\breve{L}_0 - A_{v0}L_0) + (A_{v0}\tilde{L}_1 - A_{v0}\breve{L}_0) \tag{7b}$$

with $\breve{A}_0 = A_0\hat{A}_{s0}^{-1}\hat{A}_{s1}(\hat{A}_{s1} + \hat{A}_{d1})^{-1}(\hat{A}_{s0} + \hat{A}_{d0})$

$$\Delta B_v^{\,3} = (A_{v1}\tilde{L}_0 - A_{v0}\breve{L}_0) + (A_{v0}\breve{L}_0 - A_{v0}L_0) + (A_{v1}L_1 - A_{v0}\tilde{L}_0) \tag{7c}$$

With $\tilde{A}_0 = A_0\hat{A}_{s0}^{-1}\hat{A}_{s1}$

The right-hand sides of equations (7a)-(7c) are structured in the same way. The three terms reflect the fabrication effects due to changes of the value added coefficients, the non-competitive import coefficients, and the input mix.

We report the averages over these decompositions as ΔB_v, that is :

$$\Delta B_v = \frac{1}{3}(\Delta B_v^{\,1} + \Delta B_v^{\,2} + \Delta B_v^{\,3}) \tag{8}$$

In order to analyze the effect of different trade in the value-added by exports, we suppose

$\bar{E} = \begin{bmatrix} 0 & 0 & 0 \\ E_P & 0 & 0 \\ 0 & E_N & E_S \end{bmatrix}$ as an extend matrix of gross export, where E_P, E_N, E_S represent the column vectors of the export of processing trade, normal trade of goods, and normal trade of services, respectively. Although in the Manual on Statistics of International Trade in Services 2010, the processing trade is divided into a kind of manufacturing services on physical inputs owned by others, the processing trade is all belongs to the goods trade in the DPN model. Thus, we have $E_P = F^{PE}$, and $E_N + E_S = F^{NE}$.

Let e denoted as the sum of gross exports, i.e. $e = \mu' \bar{E} \mu$. Let $a' = \mu' \bar{E}$, then the structure matrix of gross exports is defined as $S = \bar{E}(\hat{a})^{-1}$. The row vector $r = \frac{1}{e} \cdot a$ denoted as the ratio of three different export (processing trade, normal trade of goods, and normal trade of services) in gross exports. We have:

$$\bar{E} = e \cdot \bar{E}(\hat{a})^{-1} \cdot \frac{1}{e} \cdot a = e \cdot S \cdot r \tag{9}$$

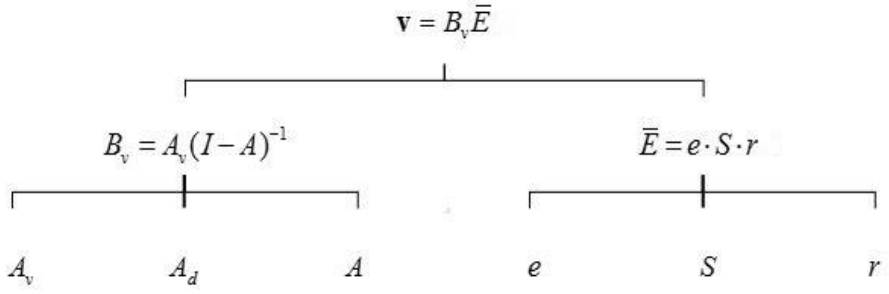
$\Delta \bar{E}$ can be decomposed as follow:

$$\Delta \bar{E} = \frac{1}{2}(\Delta e)(S_0 r_0 + S_1 r_1) + \frac{1}{2}[e_0(\Delta S) r_1 + e_1(\Delta S) r_0] + \frac{1}{2}(e_0 S_0 + e_1 S_1)(\Delta r) \tag{10}$$

The first term on the right-hand side of equation (9) expresses the change in $\bar{E}$ caused by the export scale. The second term indicates the effects due to change in export structure. The third term shows how the changes in the proportion of three different trade would have affected $\bar{E}$.

We sketch mainly the model by equation (4), (8), and (10), and its hierarchical structure in Figure 1, which forms the basis for the decomposition of the DVA of exports.

FIGURE 1. Hierarchical decomposition of the DVA of exports



2.3. Data

For this study, we will use 2002, 2007 and 2010 China-DPN tables to estimate the value added embedded in China's total exports. Because sectors has been changed and are not consistent in all three tables, we rearranged the sectors on these tables, so that there are 41 industries in all of the three parts: domestic use (D), processing trade (P) and normal trade (N).

Theoretically, we can use the DPN table directly to compute the value added in China's export. But in order to analyze the impact of processing trade, normal trade of goods and normal trade of services on DVA export of China thoroughly, we choose to use exports of goods data released by the General Administration of Customs of China and services data published by the State Administration of Foreign Exchange, combined with the export structure of the DPN table, to determine the export structure vector of processing trade (E_P), normal trade of goods (E_N) and service (E_s), respectively. There are two main reasons: First, in DPN table, processing trade is composed of trade in goods only, and therefore exports are listed separately. But for normal trade, export includes both trade in goods, and trade in services. In other words, trade in goods and trade in services are combined in the same export column in the DPN table. Secondly, DPN table does not update the data in a timely manner. However, there are official data adjustments. For these two reasons, China's exports data (including goods processing trade, normal trade in goods and in services) were sourced from the China Statistical Yearbook.

Using the SDA formula given by the section 2, we analyze the driving forces behind the DVA of exports changes in period 2002-2007 and 2007-2010. During 2002-2007, China joined the WTO, and experienced a rapid economic development in the pre-crisis period; during 2007-2010, China's export structure has changed dramatically because of the financial crisis. Because the factors that driven changes of value added are mainly structure variables, which affected little by price factors, so we use these DPN tables in current price directly without considering the effects of inflation.

3. RESULTS

3.1. Analysis of changes in China's DVA generated by exports

Based on the 2002, 2007 and 2010 China's 41 sectors DPN tables, we estimated the DVA embedded in total trade, in processing trade , in normal trade in goods and normal trade in services, respectively. (See table 2).

Table 2. The gross and DVA of China's exports in 2002, 2007 and 2010

		Volume (billion US$)				Shares (%)		
		Total	Processing trade	Normal trade in goods	Normal trade in service	Processing trade	Normal trade in goods	Normal trade in service
Gross Exports*	2002	365.0	179.9	145.7	39.4	49.3%	39.9%	10.8%
	2007	1342.1	618.9	601.6	121.7	46.1%	44.8%	9.1%
	2010	1748.0	740.3	837.5	170.2	42.4%	47.9%	9.7%
DVA of Exports	2002	200.2	54.9	113.7	31.6	27.4%	56.8%	15.8%
	2007	798.2	226.9	469.3	102.1	28.4%	58.8%	12.8%
	2010	1102.4	285.1	673.1	144.2	25.9%	61.1%	13.1%

Data source:* China Statistical Yearbook

From the perspective of the composition of the gross trade volume, we can find that the proportion of goods exports is much higher than that of services exports. And, the proportion of processing exports decreased, the proportion of normal exports in goods increased gradually, and the proportion of normal trade in services exports drops at first and then raised. The proportion of the processing trade exports decreased 6.9 percentage points during the period of 2002-2010, with a decrease of 3.8 percentage points during the period of 2007-2010. There are two reasons for this decline. First, due to the impact of the international financial crisis in 2008, the demand for processing exports especially to Europe and to other developed economies dropped dramatically. Second, China's labor cost is rising after 2007, so the comparative advantage in processing trade continued to shrink. In this situation, some multinational companies have transferred their production to other Southeast Asian countries, where labor cost is cheaper than in China. This promoted the China's industries transform from the processing trade to the normal trade. And normal trade has developed rapidly as well. Normal trade in goods accounts for gross exports grew from 39.9% in 2002 to 47.9% in 2010, increased about 8 percentage point. The service trade of China mainly depends on the traditional items, such as transportation, tourism and so on. In 2002-2007, trade in goods grew really fast, and trade in services was left behind. But in recent years, China has been gradually opening up in its services market and improving the quality of services, especially in financial and other types of new services. China's service exports increased significantly, and its proportion in gross exports has also increased.

Processing trade has a much lower share in the perspective of the DVA of exports than in the perspective of gross exports. Specifically, the share of processing trade in the DVA of gross exports is 27.4%, 28.4% and 26.0%, in 2002, 2007 and 2010 respectively. Meanwhile, normal trade in goods is the biggest contributor of the DVA of gross exports with a share of 56.8%, 58.8% and 61.1% in 2002, 2007 and 2010 respectively. The production of processing exports refers to an activity which raw materials, parts and components are imported and be processed or assembled finished products and finally be re-exports. Therefore, the production for processing exports requires more imports and thus has a much weaker linkage with domestic sectors and a much lower valued-added than the normal trade. According to the data in table 2, we can see that each $1000 of processing trade exports contains only $385 of

domestic value-added in 2010, while in normal trade of goods exports and trade of services exports, that figure is $804 and $847, respectively. From this point, in the same amount of exports, domestic value-added in processing trade exports is much lower than that of the normal exports. Relatively, the higher the proportion of processing trade exports, the lower the value-added of China's exports is.

The DVA share of China's processing exports is lower than of normal exports, both goods and services, but it is growing fast in the period 2002-2010. In the year 2002, $1000 export processing trade exports contains only $305 domestic value-added, the normal trade in goods and in services contained $780 and $803, respectively. The DVA in each $1000 of China's processing trade increased $80 in 2002-2010, higher than that of normal trade in goods ($23) and services ($44). This is indicating that China's processing trade industry upgrade significantly. In the long run, the DVA share of processing trade exports will increase.

3.2. Disentangling the drivers of the changes in China's DVA generated by exports

Using the data showed in Table 2, we calculated the change of the DVA of exports of 2002-2007 and 2007-2010 (See table 3). In 2002-2007, China's DVA of exports has increased by $598.0 billion; in 2007-2010, China's DVA of exports has an increase of $304.2 billion.

We find that exports in normal trade of goods is the major contributor to these DVA increase. Specifically, it has contributed 59.5%, 67.0% in periods of 2002-2007, 2007-2010 respectively. As the proportion of processing exports decrease, the contribution of processing exports to the DVA of gross exports dropped by 9 percentage point, from 28.8% to 19.1%. Similarly, the proportion of the normal trade of services increased, and the contribution of normal trade in services to DVA also increased in these two time periods.

Table 3. The change of DVA in China exports in period 2002-2007, 2007-2010

	The change of DVA in exports (billion US$)				Contribution ratios (%)		
	total	Processing trade	Normal trade in goods	Normal trade in service	Processing trade	Normal trade in goods	Normal trade in service
2002-2007	598.0	172.0	355.6	70.4	28.8%	59.5%	11.8%
2007-2010	304.2	58.2	203.8	42.1	19.1%	67.0%	13.8%

According to the SDA formula given in Section 2, we considered the following factors as driving forces that has caused the change of DVA in exports. There are: the change in the value-added coefficients (ΔA_v), the change in the import coefficient (ΔA_d), the change in the intermediate inputs (ΔA), the change in the volume of exports or exports scale (Δe), the change in exports structure (ΔS) and change in the ratio of three different export (processing trade, normal trade of goods, and normal trade of services) (Δr). We get the following result:

Table 4. Decomposition of the change of DVA in exports: 2002-2007, 2002-2010

	Period	ΔA_v	ΔA_d	ΔA	Δe	ΔS	Δr
Change caused by each factors (billion US$)	2002-2007	2.2	57.5	-8.7	556.5	-21.2	11.7
	2007-2010	-11.1	40.3	5.7	248.1	-3.8	24.9
Contribution ratios (%)	2002-2007	0.4%	9.6%	-1.5%	93.1%	-3.5%	2.0%
	2007-2010	-3.6%	13.3%	1.9%	81.5%	-1.2%	8.2%

The expansion of trade volume is the main driving force of DVA growth of China. In 2002-2007, the increase of exports volume can explain 93.1% of DVA increase. China's trade expended rapidly during this period, with an average annual growth rate of 29.7%. In 2007-2010, although its influence decreased, exports volume still contribute 81.5% of the change of DVA in exports. Because of the 2008 financial crisis, China's exports have been affected, with an average annual growth rate of export of around 9%.

The gross exports structure change has negative effect on China's DVA of exports. Although Chinese companies are trying to transform their role in the global value chain to a relative higher place with changing their export structure, they still have a long way to go. According to our analysis, the changes in the export structure actually lower the percentage of DVA embedded China's exports. Export structure is an important issue needed to be solved, if one wants to improve the DVA ratio in China's foreign trade.

The change in the ratio of three kinds of trade in the gross exports increased the DVA in China's export. The changes in the export proportion of three kinds of trade are: the proportion of processing trade gets lower; the proportion of normal trade of goods has increased; the proportion of normal trade of service decreased in the first period, and then increased in the second period. Due to the extensive use of imported parts and components of processing trade, the DVA contained in the processing trade are relatively low compared to other kinds of trade. So the drop in the relative share of processing trade actually increased the proportion of DVA in the total export. Therefore, as the proportion of processing trade in the total export reduces, the effect of change in the ratio of three different exports has increased from 2% in 2002-2007 to 8.2 % in 2007 -2010.

Overall, the fabrication effects, including change in value added coefficient, import coefficient and intermediate input structure, has a minor effect on the DVA of exports. (i) In 2002-2007, as the upgrading of industrial structure and the increase of labor cost, the value added coefficient of industries increased, so the effect of value added ratio on the DVA of exports is positive, while in 2007-2010, this effect is negative. (ii) As the transformation of Chinese industries, the imports used in production decreased. More domestic products are used as substitutions, therefore import coefficient decreased. This is reflected by the positive impact on exports of value added. (iii) In period 2007-2010, more and more domestic raw materials and manufacture-related services were employed in export production, which can be viewed as one of the indications of an increasing competitiveness of domestically produced goods. This has a positive effect on the DVA of exports. Thus, the intermediate input structure change has a positive effect on the DVA of exports with contributed 1.9%.

The above analysis shows that the contribution of fabrication effects on DVA of exports are relatively limited. The increasing of DVA in exports dependents mainly on the rapid expansion of exports volume. However, it is difficult for the exports volume to keep expand at a high speed, so the effective way to increase DVA of exports is to expand the fabrication effects. Using more domestic product and less imported components during the production process, trying to increase the mount of domestic value-added in output, we can positively affect the DVA of exports.

We also analyze the effects of different kinds of trade form of the DVA in exports (See results in table 5).

Table 5. Decomposition of the change of DVA in exports: by three kinds of trade, in 2002-2007, 2002-2010

		Contribution ratios (%)					
		ΔA_v	ΔA_d	ΔA	Δe	ΔS	Δr
2002-2007	Processing trade	0.7	21.5	0.9	89.2	-7.2	-5.1
	Normal trade of goods	0.04	4.4	-2.3	91.0	-2.3	9.1
	Normal trade of services	1.1	6.6	-2.8	113.0	-0.8	-17.1
2007-2010	Processing trade	-2.1	36.3	-1.3	114.9	-10.7	-37.1
	Normal trade of goods	-4.2	8.6	2.3	73.1	1.7	18.5
	Normal trade of services	-3.0	4.1	4.2	76.3	-2.5	20.8

It can be seen from the Table 5 that under different kinds of export, the driving forces has different effects on the DVA of exports.

In processing trade, the main driving force is the trade volume, and the import coefficient also has a relatively large effect on the DVA of exports. In fact, the main feature of the processing trade is the use of imported parts and components for assemble. Lower import coefficient means an increase in value-added coefficient in this sector, which means a consumption of more domestic labor and capital. In periods of 2002-2007 and 2007-2010, the effects of import coefficient contributed 21.5% and 36.3% in the change of the DVA of processing exports.

In normal trade of goods and services, beside the largest driving force of export volume, the ratio of normal trade in China's gross exports is also an essential factor. In 2002-2010, the proportion of normal trade of goods in China's gross trade has increased from 39.9% to 47.9%. The contribution of that on DVA of normal exports of goods is 9.1% and 18.5%, in the periods of 2002-2007, 2007-2010 respectively. In 2002-2007, because of the relative fast growth of goods trade, the proportion of services trade has decreased form 10.8% to 9.1%. Therefore, the contribution of that to the DVA of services exports is -17.1%. In 2007-2010, proportion of services trade has increased to 9.7%, with a contribution of 20.8% to the change of DVA in services exports.

Overall, the change of value added coefficient has positive correlation with the change of DVA of each kind of exports. Using the data from China's 41 sector DPN table, we can find

that in 2002-2007, 22 processing trade industries has an increase in its value added coefficient; 37 normal trade industries' value added coefficient has also increased. In 2007-2010, 16 out of the 41 processing trade industries has a decrease in its value added coefficient; in 39 non-processing trade sector, its value added coefficient has decreased. Therefore, in 2002-2007, this factor has a positive effect on the DVA of exports while in 2007-2010, it has a negative effect.

In the post-crisis era, the slowdown of world economic growth (especially in the developed economies) decreased demand for Chinese exports, in particular for processing exports, as can be seen from the gradually declining proportion of processing exports in total exports after 2007. Even worse, given the rising unemployment rates in the U.S. and Europe, trade disputes against Chinese exports may become frequent, which means that it is hard for China's exports to continuously maintain rapid growth as what happed in last ten years when China just joined WTO. In other words, the growth rate of China's export volume will slow down in the coming years, implying that it is not sustainable to stimulate economic growth via unlimited expansion of export scale. Instead, more efforts are required to find ways to raise DVA ratio of exports in the near future.

4. CONCLUSION

In this study, we used the non-competitive input-output table capturing processing trade to estimate the domestic value-added generated by China's gross exports. We have tried to analyze the effects of three different trade in China's exports, which is processing trade, normal trade in goods and normal trade in services. In order to figure out what causes the change of the DVA of China's exports, we used the structural decomposition analysis and discussed six main factors: the value-added coefficients, the import coefficient, the intermediate inputs, the volume of exports or exports scale, the exports structure and the ratio of three different export (processing trade, normal trade of goods, and normal trade of services).

It is clear that the rise of gross exports' contribution to China's GDP growth was largely ascribed to the increase in the DVA generated by normal exports, because the DVA generated by processing exports is much lower than that of normal exports. However, we find that increases in the DVA ratio for processing exports exceeds that for normal exports in period 2002-2010, indicating that China's processing trade involve some kind of industry upgrade.

We find that the increase of DVA generated by exports is mainly due to the expansion of export volume, whereas the possible upgrading of export structure has no clear positive effect. The effective way to increase DVA of exports in the long run is to expand the fabrication effects, such as use more domestic product and less imported components during the production process, try to increase the amount of domestic value-added in output.

The six driving forces have different effects on the DVA of exports. In processing trade, the main driving force is the trade volume, and the import coefficient also has a relatively large effect. The decrease of import coefficient means an increase in the DVA of processing exports. In normal trade of goods and services, besides the largest driving force of export

volume, the ratio of normal trade in China's gross exports is also an essential factor. For each kind of trade, the change of value added coefficient has a positive correlation with the change of DVA of exports.

In order to increase the DVA of China's exports while maintaining steady growth in trade volume, the focus of China's foreign trade policy should be on export upgrading, trade structure optimizing, and to increasing DVA ratio of export. There are several possible ways: promoting the growth of normal exports; encouraging the exports of industries with relatively high value-added coefficients, especially the exports in services; promoting the processing industrial upgrading by gradually increase the wages and the share of labor compensation in value added.

References

Su, B. and Ang, B. W. (2012) Structural Decomposition Analysis Applied to Energy and Emissions: Aggregation Issues, *Economic Systems Research*, 24:3, 299-317

Dean, J.M., Fung, K.C. and Wang, Z. (2011) Measuring vertical specialization: The case of China, *Review of International Economics*, 19, 609-625

De Haan, M. (2001) A Structural Decomposition Analysis of Pollution in the Netherlands. *Economic Systems Research*, 13, 181-196

Dietzanbacher, E. and Los, B. (1998) Structural Decomposition Techniques: Sense and Sensitivity. *Economic Systems Research*, 10, 307-323

Dietzanbacher, E. and Los, B. (2000) Structural Decomposition Analyses with Dependent Determinants. *Economic Systems Research*, 12, 497-514

Koopman, R., Wang, Z. and Wei, S.-J. (2008) How much of Chinese exports is really made in China? Assessing domestic value-added when processing trade is pervasive, NBER Working Paper 14109, http://www.nber.org/papers/w14109

Koller, W. and Stehrer, R. (2010). Trade Integration, Outsourcing and Employment in Austria: a Decompostion Approach. *Economic Systems Research*, 22, 237-261

Lawrence J. Lau, Xikang Chen, Leonard K. Cheng, K. C. Fung, J. Pei, Yun-Wing Sung, Z. Tang, Y. Xiong, C. Yang and K. Zhu. (2006) Estimates of U. S.-China Trade Balances in Terms of Domestic Value-Added, Stanford Center for International Development, Working Paper No. 295. Available online at: http://siepr.stanford.edu/publicationsprofile/1059

Koller, W. and Stehrer, R. (2010) Trade Integration, Outsourcing And Employment in Austria: a Decomposition Approach, *Economic Systems Research*, 22, 237-261

Chen, X., Cheng, Leonard K., Fung, K.C., Lau, Lawrence J., Sung, Yun-Wing., Zhu, K., Yang, C., Pei, J., and Duan. Y., (2012) Domestic value added and employment generated by Chinese exports: A quantitative estimation, *China Economic Review*, 23, 850–864