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# How did China Raise its Manufacturing Domestic Value added in Exports through GVC Moving up?

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***Abstract:*** Despite its high implication into global value chains (GVCs), the Chinese real domestic value added in exports increased at an annual average growth rate of 14% over the 2000-2016 period and its ratio from 65% to 83%. To understand this evolution, a GVC augmented function of domestic value added in exports is proposed and estimated using panel data of 16 Chinese manufacturing sectors over the 2005-2014 period from OCDE TiVA and WIOD databases. Besides the traditional positive effects of labor productivity, capital intensity and employment on domestic value added in exports, we find that China's GVC positon improvement through withdrawing backward links and increasing forward links exerted positive effects. The negative elasticity of backward links multiplied by the decreasing share of foreign value added and by its indirect productivity effect contributed to increase Chinese domestic value added in exports. This contribution is 3.5 times higher than that of GVC forward links, measured as the product of the positive elasticity of forward links multiplied by the increasings hare of exports of intermediate goods embodied to exports of third countries. This successful moving up from low cost labor-intensive processing and assembly to relatively higher value-added intermediated goods decreased the risk of being stuck in low-value-added tasks, while the future one should be much more complicated in the context of increasing trade protectionism.

## 1. Introduction

During the last three decades, globalization was a dominant feature of the world trade in which maximization of profit and efficiency have pushed multinational firms to fragment their "product" chains into "task" ones across countries in function of comparative advantages (Grossman and Rossi-Hansberg, 2008). This global production fragmentation allowed countries relying less on domestic inputs for producing exported goods, leading the decline in the share of domestic value added content in exports observed in most countries (Johnson and Noguera, 2017). It facilitated accessing to world market and to higher quality and sophisticated imported inputs, and benefiting new ideas, technology transfer, management know-how and spillover, etc. from multinationals, thus exerted

positive effects on scale of their exports and productivity growth (Pietrobelli and Rabellotti, 2011; Kawakami and Sturgeon, 2011; Pahl & Timmer, 2019; Ndubuisi and Owusu, 2021 etc.). These positive effects may mitigate or even reverse the decline in domestic value added in exports, depending on the capacity of countries' moving up to high value added exports. The total effect of global value chains (GVCs) participation necessities thus an empirical investigation.

China's strong implication into GVCs provides an excellent case study to asset this impact. The Chinese real domestic value added in exports increased at an annual average rate of 14% over the 2000-2016 period with its ratio increased from 65% in 2000 to 83% in 2016, after a first period of decline over the 1980s and 1990s period (Johnson and Noguera, 2017). This rise was coincided with the decrease of imported intermediate inputs for processing and assembly which are gradually substituted by domestically produced ones to supply Chinese processing exporters (Kee and Tang, 2016; Duan *et al.*, 2018), or to be embodied in exports of third countries.Using panel data over the 2005-2014 period for 26 Chinese manufacturing sectors, a simple statistical analysis shows that the Chinese real domestic value added in exports has negative relationship with the share of foreign value added relative to gross exports known as GVC backward links, which decreased at an annual average growth rate of 3.78% over the 2005-2014 period[12]. It also shows a positive one with the share of domestic value added embodied in intermediate exports relative to gross exports named GVC forward links, which increased at annual average growth rate of 0.95%. The obtained negative statistical relationship between real domestic value added in exports and GVC participation (i.e. the sum of GVC backward and forward links, which decreased at an annual average growth rate of 0.73%) suggests that the impact of GVC on domestic value added mainly passed through the decreasing share of foreign value added. While the positive correlation with GVC position (i.e. log difference between forward links and backward links, which increased at an annual average growth rate of 9.42%), shows the moving up strongly contributed to increase domestic value added. These intuitive results suggest that GVC integration may exert different effects, and support the argument that "linking into global value chains is not enough for taking gains" (Banga, 2014). They suggest that China's GVC moving up from processing and assembling imported intermediate goods at final stages to produce higher value added intermediate inputs increased its domestic value added, and thus reduced the risk of being stuck in low-value-added tasks for China[3].

To verify if these intuitive results still stay when are added other control variables, we proposed a GVC augmented manufacturing value added function of employment, capital intensity and labor productivity, and applied it to panel data for 16 manufacturing sectors over the period of 2005 to 2014 from OECD TiVA and WIOD databases. The obtained results confirm the above initiative results. The rise in domestic value added in exports is due to the capacity of domestic firms to imitate and produce intermediate goods to substitute imported ones for assembly and processing, or to be embodied in exports of third countries; and thus due to moving up from low cost labor-intensive processing and assembly to relatively higher value-added capital- and techno-intensive goods. However, the moving up was mainly due to the substitution of imported intermediate inputs which are easy to be imitated, while the ITC and electronic sector still depends strongly sophisticated imported intermediate goods difficult to be imitated as suggested its negative GVC position.

This study contributes to the emerging literature on the determinants of domestic value added in exports thanks to the recent data availability on value added in trade (WIOD, the OECD-WTO TiVA or the EORA etc.). Using customs transaction-level data and firm survey data over 2000-2007 period, Kee and Tang (2016) and Duan *et al.* (2018) argued that the rise in the ratio of domestic value added in exports is due to the substitution for imported materials which caused the decrease of the vertical specialization share and an upgrading of China's position in global value chains. Yu and Luo (2018) estimated the impact of labor productivity, capital formation, and vertical specialization and its interaction with R&D on domestic value added in exports for the Chinese manufacturing industries over the 1995-2011 period. As our results, they found a negative coefficient of vertical specialization and positive effects of labor productivity and capital. Our study goes beyond the study of Yu and Luo (2018) by utilizing four GVCs participation indices, while they used only one. Assche and Biesebroeck (2018) argued that moving up and labor improvement contributed to processed exports in China. Lianling and Cuihong (2017) and Chen *et al.* (2018) found that the increase in China's domestic value-added in exports comes from an expansion of exports volume. Zhu (2019) found that labor productivity and the substitution of domestically produced intermediate inputs for imported intermediate inputs raised the DVA of China's exports.

The originality of our paper comes from several points. We have estimated real domestic value added in exports in real terms and the share of domestic value added relative to gross exports, which allow us to compare the previous

studies which used one of the two variables. We have used four GVC indices while the other papers used one or two GVC measurements, which allowed us to test the potential different effects of GVC integration. Third, we have found that GVC backward links increased domestic value added through productivity and volume channels, while the previous studies studied only the volume effect. We have found that demand-side variables such as foreign demand and real exchange rate exerted significant positive effects together with supply-side variables on real domestic value added as found in Ceglowski (2019) for US, while no studies have analyzed this impact in the case of China.

The rest of this study is the following. The next section presents a manufacturing model of domestic value added in exports. The third section presents the definitions and the sources of variables and analyses their evolutions. The fourth section gives econometric tests and estimation over panel data for 16 manufacturing sectors in China over the 2005-2014 period. The political and economic applications are given in the conclusion.

## 2. The Determinants of Real Domestic Value Added in Exports

Global value chains suggest that instead of competing with final products on world consumer market, countries compete over providing domestic value added at different production stages on world production market according to comparative advantages (Bems and Johnson, 2017). Labor productivity differences among different countries are a source of comparative advantages because technological change affects the position located at different stages of the same supply chain due to the sequential nature of international production (Costinot *et al.*, 2013). To take into account these supply-side factors, consider the following Cobb-Douglas manufacturing production function as in Constantinescu *et al.* (2017), Yu and Lou (2018), Gal and Witheridge (2019), Montalbano and Nenci (2020) among others as following: $DVA = PK^{\alpha}L^{(1-\alpha)}$

Where DVA represents real domestic manufacturing value added in exports, P is productivity driven by standard process of economic innovation and traded-related effects, K real capital stock and L employment in manufacturing sector.

As explained in introduction, it is well known that the Chinese manufacturing is driven by capital-intensity production mode (Hua, 2020), we rewrite the above function as

$$DVA = P\left(\frac{K}{L}\right)^{\alpha} L$$

We obtain thus a manufacturing model of real domestic value added in exports in function of productivity, capital intensity and employment such as:

$$\ln DVA_{it} = a_0 + a_1 \ln P_{it} + a_2 \ln\left(\frac{K}{L}\right)_{it} + a_3 \ln L_{it} + +\mu_i + \pi_t + \varepsilon_{it} \qquad (1)$$

To compare to the study of Kee and Tang (2016) etc., we also estimate a function of ratio of domestic value added relative to gross exports such as

$$\ln(DVA/X)_{it} = b_0 + b_1 \ln P_{it} + b_2 \ln\left(\frac{K}{L}\right)_{it} + b_3 \ln L_{it} + +\mu_i + \pi_t + \varepsilon_{it} \qquad (2)$$

Where i represents manufacturing sectors, t years. $\mu_i$ captures fixed sector effect, $\pi_t$ captures year-fixed effects, $\varepsilon_{it}$ is error terms. All variables are taken in natural logarithm so that their coefficients are interpreted as elasticities. The waited signs of all the variables are positives.

The Chinese manufacturing industry has been facing two challenges: rise of labor cost and labor shortages. Chinese manufacturing labor costs have been rising steadily and very quickly. The annual average salaries increased at 8.89% on average over 2005-2014 period. It is however not enough to cover the expensive living cost because of high house price, damaging manufacturing competitiveness. Moreover, the aging population sensibly decreases labor supply. The young people of "unique child" generation are not anymore motivated to work in manufacturing firms because of difficult work conditions. The annual average growth rate of manufacturing employment is 4.33% over the 2005-2015 period.

These challenges have put Chinese manufacturing firms under strong pressure to upgrade their production mode towards capital- and technology-intensity. The manufacturing capital intensity increased at 10% per year on average over the 2005-2014 period. Ce phenomena is particularly important in Chinese textile and clothing societies, which have no choice either to close down or to upgrade product lines via robotic and automated technology (Sharif and Huang, 2019). These challenges exert positive "X-efficiency", push management effort near to its optimum and exacerbate competition via Schumpeterian "creative destruction" benefiting to the most performing manufacturing enterprises. Chinese manufacturing labor productivity increased from 4902 $/employee in 2005 to 22752 $/employee in 2016, at an annual growth rate of 10.98%. Assche and Biesebroeck (2018), Yu and Lou (2018)

and Zhu (2019) found that labor productivity exerted a positive effect on China's domestic value added in exports.

To capture the impact of China's GVC participation on domestic value added in exports, we add a GVC participation index into the above functions as following:

$$\ln DVA_{it} = a_0 + a_1 \ln P_{it} + a_2 \ln\left(\frac{K}{L}\right)_{it} + a_3 \ln L_{it} + a_4 \ln GVC_{it} + \mu_i + \pi_t + \varepsilon_{it} \quad (3)$$

$$\ln(DVA/X)_{it} = b_0 + b_1 \ln P_{it} + b_2 \ln\left(\frac{K}{L}\right)_{it} + b_3 \ln L_{it} + b_4 \ln GVC_{it} + \mu_i + \pi_t + \varepsilon_{it} \quad (4)$$

As explained in the introduction, GVC integration may lead the decline of domestic value added in exports, which may be mitigated or even reversed by its positive impact on access to world market and productivity improvement via technological change moving up firms' position along global supply chains, increasing thus domestic value added in exports (Costinot *et al.*, 2013). Frederick and Gereffi (2011) argued that by GVCs allowed market diversification of apparel exporters in China and Asia. Zheng and Sheng (2006) showed that GVCs provided external channels of knowledge and learning opportunities for the Yunhe wood toy cluster in Zhejiang, China. Rasiah *et al.* (2011) showed joining GVCs moved up button manufacturing in Qiaotou-city cluster in China. Kee and Tang (2016) argued that FDI and trade are the main channels through which the GVC participation of the Chinese firms succeed to rise their domestic value added in exports. We argue in this study that the impact of GVC participation on real domestic value added may pass through its direct impact on export volumes and its indirect productivity effect. The coefficients of GVC indices ($a_4$ and $b_4$) capture volume effects. To check if GVC exerts an effect on productivity, we make regression such as $lnP_{it} = c_1 GVC_{it}$, which checks if productivity is effectively a channel through which GVC exerts domestic value added. Total effect of GVC on real domestic value added in exports is thus the sum of $a_1c_1+a_4$, and $b_1c_1+b_4$ for share of GVC relative to gross exports.

## 3. Definitions and Sources of Variables

The above functions are estimated for 16 manufacturing industries over the period from 2005 to 2014. The analysis period and the sample size are determined by data availability from the OECD Trade in Value Added (TiVA) and World

Input-Output Database (WIOD) databases. The OECD TiVA publishes data over the period from 2005 to 2015 for 16 manufacturing sectors (2018 edition). The WIOD published Socio Economic Accounts Release 2016 available February 2018 over the period from 2000 to 2014 for 18 manufacturing sector (Timmer *et al.*, 2015). Both databases use an industry list based on the International Standard Industrial Classification (ISIC) Revision 4 and used 2008 System of National Accounts (SNA) concepts allowing for data compatibility. The definitions the sources of data are the following and resumed in table Annex 1.

Domestic value added content of exports corresponds to exported value added that has been generated in the domestic economy. Its volume is calculated as its domestic value-added in exports obtained from OECD TiVA database deflated by value-added price (2010=100) from World Input-Output Database. During the studied period of 2005 to 2014, the real manufacturing domestic value-added in exports increased very quickly for all industries at an annual average growth rate, which varied from 10% for basic metal sector to 25% for ICT & electronics sector. The textile & apparel sector was the biggest industry in 2005. Its domestic value added increased from $74 billion in 2005 to $277 billion (became the second biggest) in 2014 at an average growth rate of 15%. It has the second highest domestic value added share in gross exports after food products sector, which increased from 82.5% in 2005 to 88.5% in 2014, probably due to the substitution of Chinese intermediate goods for imported materials, which are easily to be imitated and produced locally. The domestic value added of ICT & electronics sector increased even much more quickly, at an average growth rate of 24.7% from US$ 43 billion in 2005 (the second biggest sector) to US$ 336 billion in 2014, becoming the most important industry in 2014. Contrary to textile & apparel sector, the domestic value added share of ICT & electronics sector is low, but increased quickly, passed from 56.9% in 2005 (last one) to 67.7% (before last) in 2014, due to its final assembly position and to its relying on complex imported inputs from more advanced counties difficile to be imitated. Chinese domestic value added part was only 1.8% in the iPhone's price used to pay the salaries of Chinese final assembly workers (Linden *et al.*, 2011) and only 38.1% for Huawei P30 Pro (Japan Economic News, June 27, 2019). The ratio of Chinese domestic value added in exports continually increased over the period 2005 to 2016 except for the two years after the 2008-2009 financial crisis. Its ratio increased from 72% in 2005 to 79% in 2009 and to 82.5% in 2016.

Employment of manufacturing sectors comes from WIOD. The employment in all sectors increased except for the "other manufacturing" sector. Labor-intensive textile & apparel sector created the most employment, which increased from 27.6 million persons in 2005 to 32.7 million persons in 2014, but only at an annual average growth rate of 2.2%: which is the lowest rate except for coke & petroleum sector (0.8%) and "other manufacturing" sector (0.4%). The employment in textile & apparel sector accounted for 23% of total manufacturing employment in 2005, decreased to 19% in 2014. All labor-intensive sectors created more than a half employments in 2005 (53%), decreased to 48% in 2014. It suggests that labor-intensive sectors become more capital intensive because of the quick rise of labor costs. The employment in the machinery sector increased from $ 7.8 million to 15.2 million, thus created 7.3 million employment, the highest level of employment during 2005-2014 period. The employment in ICT & electronic and electronic equipment sectors also created 3.4 million and 4.9 million employments respectively. The employment share in medium and high technology sectors increased from 30% in 2005 to 36% in 2014, while in medium sectors passed from 16% to 17% respectively.

Capital intensity is the ratio of nominal capital stocks deflated by the price of intermediate goods and divided by number of employees. Capital stocks and number of employees of manufacturing sectors comes from WIOD. The capital intensity of all manufacturing sectors increased quickly in 2014 relative to 2005. Only two sectors increased at annual average growth rates less than 10% (8.3% and 9.5% respectively for the coke & petroleum sector and for food sector). Others increased from 11% per year at average for chemicals to 17% for fabricated metal sector (17.6%). The capital intensity increased 17% per year at average for ICT & electronic and 15% for textiles & apparel sector and 17.3% for other manufacturing sector.

Productivity is measured as real output divided by numbers of employees reported in WIOD. Real output is nominal output deflated by its price index (100=2010) which is reported in WIOD. The ICT & electronic sector has highest annual average growth rate of 22.39%, increased from 3056 $/person in 2005 to 20119 $/person in 2014, followed by motor vehicles and other transport sectors (18%). The textile & apparel sector has the lowest labor productivity from 2020 $/person in 2005 to 7620 $/person in 2014, i.e. at an annual growth rate of 11.5% on average. The labor productivity in other manufacturing sector increased only at an annual average rate of 4.9%.

We have adopted four GVC indices according to Koopman *et al.* (2014)whose data come from OECD TiVA. GVC backward linkage is measured as share of foreign value added embodied in sector relative to gross exports of industry. It captures the value of imported intermediate goods embodied in a domestic industry's exports from foreign industry upstream in the production chain. A large share indicates that the industry mainly engage in final assembly of imported inputs from other countries and thus strongly depend on the rest of the world. The share of foreign content relative to exports decreased by 9.6 percentage points from 26.3% in 2005 to 16.6% in 2016. It decreased for all sectors except coke and petroleum sector. The ICT & electronics sector has the highest share of foreign value added either relative to its exports, which decreased from 43% in 2005 to 32% in 2014. The share decreased 8 percentage points for four sectors (electrical equipment, other transport, rubber & plastics, paper & printing), followed by the machinery sector. The textiles and apparel sector's share decreased from 17% in 2005 to 11% in 2014.

GVC forward linkage is calculated as domestic value added embodied in intermediate exports that are further re-exported to third countries relative to gross exports of China's sector. It measures exports of intermediate goods that are used as inputs for the production of exports of other countries. An increasing ratio suggests that the country is moving up in the GVCs to start producing intermediate goods for other countries. It reflects the dependence of the rest of the world on the country. The highest share of intermediate goods exported to third country is motor vehicles whose shares increased from 67% in 2005 to 71% in 2014, followed by transport equipment from 31% to 35%. The share is slightly increased for textile & apparel sectors, while that of ICT & electronic decreased slightly.

GVC participation is the sum of forward and backward linkages. It measures the extent to which a sector is involved in the global production chain. The larger the ratio, the greater the intensity of involvement of a sector in a country in GVCs. GVC position is the log ratio of a country's supply of intermediates used in other countries' exports to the use of imported intermediates in its own production. This index characterizes the relative upstreamness of an industry position in a particular sector. A positive one means that sector is relatively upstream by producing inputs for others, thus contributing more value added to other countries' exports than other countries produce and contribute to sector. A negative one suggests that sectors are relatively downstream by

importing a large portion of intermediates from other countries to produce its final goods. It allows knowing if there is an effect of moving up.

All industries had positive position indices except for other transport, other manufacturing and ICT & electronic sectors in 2005. The sector position improved for all sectors in 2014 relative to 2005, except for motor vehicles and coke, petroleum sectors. The position of ICT & electronic sector improved, but still lightly negative in 2014, meaning that this sector imported more intermediate goods to produce final goods.

Fig. 2 shows the simple statistical relationship between real domestic value-added in exports and each of explanatory variables with the control for sector-fixed effects and year-fiexed effects for 16 manufacturing sectors over 2005-2014 period. The results show that real domestic value-added in exports is positively correlated with all explanatory variables, except for GVC backward links and its participation. However, these simple statistical relationships do not take the other determinants of manufacturing value added into account. The results may be biased. We thus propose in next section to estimate the model of domestic manufacturing value added determinants presented in section 2.

## 4. Econometric Tests and Results

Before econometric regressions, we need to know if the variables are stationary at an absolute level to avoid spurious results. We apply Levin-Lin-Chu panel data unit-root tests in which time trend and panel-specific means (fixed effects) options were used; the variables are lagged by one period. We subtract the mean of the series across panels from the series to mitigate the impact of cross-sectional dependence (Levin *et al.* 2002). The results, reported in Table A1, allow us to reject the null hypothesis that panels contain unit roots, so we can accept the hypothesis that the variables are stationary at an absolute level. We apply Hausman specification test and its results show that fixed effect estimations are preferred to random effect ones.

The estimations are made for domestic value added in exports in real terms and its share relative to gross exports over the 2005-2014 period for 26 manufacturing industries with time-fixed and sector-fixed effects. Table 1 reports the baseline results for domestic value added in exports in real terms (part a) and ratio of DVCs relative to gross exports (part b).

The results show that labor productivity improvement, capital intensity and employment exert positive effects with estimated elasticities of 0.97%, 0.60%

and 0.43% respectively for real domestic value added in exports (column 1a table 1), of 0.10%, 0.08% and 0.04% for the shares of domestic value added in exports relative to gross exports (column 1b, table 1). Thus, an increase of labor productivity, capital intensity and employment of 10% led an increase of 9.7%, 6.0% and 4.3% in real domestic value added in exports respectively; and an increase of 1.0%, 0.8% and 0.4% in the shares of domestic value added in exports. Labor productivity is the most important factor relative to factors of production.

GVC exerts direct effects on real domestic value added in exports and its share. The obtained results show that GVC backward linkages exerted a negative effect with estimated coefficient of -1.58 for real domestic value added in exports (column 2a table 1) and of -0.27 for the share of DVA relative to gross exports (column 2b table 1), while 1.78 and 0.32 for GVC forward links (column 3a and 3b table 1). They show that the coefficient of GVC participation is estimated to -1.21 for real domestic value added in exports (column 4a table 1) and -0.27 for the ratio of DVA relative to gross exports (columns 4b table 1); while 1.18 and 0.20 for GVC position links (column 5a and 5b table 1).

To check the potential indirect effects of GVC integration on labor productivity as suggested in the literature (Constantinescu *et al.* 2019; Gal and Witheridge, 2019), productivity is respectively regressed on four GVC indices. It appears that GVC backward links and participations exert statistically significant negative effects on productivity growth with estimated coefficients of -1.54 and -3.84 respectively (columns 1c and 2c Table 1), while GVC forward links and position exert positive effects but only statistically significant for GVC position with estimated coefficient of 0.92 (columns 3c and 4c, Table 1).

We calculate now annual average contribution of explanatory variables to domestic value added in exports as the product of the estimated coefficients of explanatory variables multiplied by their annual average growth rates. During the 2005-2014 period, labor productivity, capital intensity and employment increased at an annual average growth rate of 10.98%, 10.35% and 4.33% respectively (column 1, Table 2). They contributed to rise 10.65% (10.98%*0.97), 6.21% (10.35%*0.6) and 1.86% (4.33%*0.43) of real domestic value added in exports on average per year respectively, and 1.1% (10.98%*0.10), 0.83% (10.35%*0.08) and 0.17% (4.33%*0.04) of the share of domestic value added relative to gross exports (columns 4 and 5, Table 2).

Concerning GVC contribution, the share of foreign value added content in total exports decreased at an annual average growth rate of -3.78% over the

2005-2014 period (1, table 2). As the coefficients of the impact of GVC backward link on real DVAs and share of GVAs are negative (-1.58 and -0.27 respectively), it led an increase of 5.97% (-1.58*(-3.78%)) of real domestic value added in exports and 1.02% (-0.27*(-3.78%)) of its ratio on average per year respectively (columns 4 and 5, Table 2). The coefficient of GVC backward link on productivity is estimated to -1.54 (column 1c, Table 2). Its indirect impact via productivity on real domestic value added in exports is thus -1.02% (-1.54*0.66), and -0.06% (-1.54*0.04). The contribution of GVC backward links to real DVAs and its share via its indirect impact on productivity is 3.86% ((-1.02)*(-3.78)) and 0.23% ((-0.06*(-3.78)). Thus the total effect of backward links is 9.83% for real DVAs and 1.25% for its share (columns 4 and 5, table 2).

The domestic value added in exports of intermediate products as a share of total exports increased at an annual average growth rate of 0.95% during the 2005-2014 period. The estimated coefficient of the GVC forward links is 1.78 and 0.32. This led an increase of 1.69% (0.95*1.78 %) for real domestic value added content and 0.30% (0.32%*0.95) per year at average of its share (columns 4 and 5, Table 3). The effect of forward links on productivity is positive but statistically insignificant (column 2c, Table 1).

The GVC participation decreased at 0.73% per year on average. Its coefficient on real GVCs and its share are -1.21 and -0.27 respectively. Thus GVC participation led an increase of 0.88% (-1.21*(-0.73%)) of real domestic value added in exports, and 0.20 (-0.27*(-0.73)) of its share (columns 4 and 5, Table 3). The coefficient of GVC participation on labor productivity is estimated to -3.84 (column 3c, Table 1). The contribution of GVC backward links to real DVAs and its share via its impact on productivity is -3.43 (0.89*(-3.84)) and -0.31 (0.89*(-1.54)), leading an increase of 2.5% in real domestic value added in exports and of 0.22% in its share (Columns 4 and 5, Table 3). Thus the total effect of GVC participation is 3.38% for real DVAs and 0.42% for its share.

As it increased from 0.3 to 0.8, i.e. at an annual average growth rate of 9.42%, GVA position improvement increased real domestic value added of 11.12% (1.18*9.42%) per year on average and 1.88% (0.20*9.42%) in share of domestic value added (columns 4 and 5, Table 2). The coefficient of GVC position on labor productivity is 0.92 (column 4c, Table 1). The contribution of GVC position to real DVAs and its share via its impact on productivity is 6.12% (9.42*0.92*0.71) and 0.47% (9.42*0.92*0.05) (Columns 4 and 5, Table 2). Thus the total effect of GVC position improvement is 17.24% for real DVAs and 2.36% for its share.

In the baseline estimation, we have used supply-side factors to explain Chinese manufacturing domestic value-added in exports for 26 manufacturing industries over the 2005-2014 period. The conventional macroeconomic analysis emphasizes on demand-side expenditure switching and relative price effect when estimating exports. The absence of these factors (foreign demand and real exchange rate) may bias the obtained empirical results. These two demand factors are important to explain China's domestic value added in exports, because Chinese manufactured products are since the beginning of 1990s in surplus, strongly depends world market (Hua, 2020). Thus, we add these two variables into the baseline equations to estimate income and relative price elasticities of domestic value added to capture international competitiveness and thus its impact on domestic production. The obtained results show that all variables stay statistically significant as before as well as two demand side variables, except for the impact of foreign demand and real exchange rate on share of DVAs[4].

The obtained results in this paper are similar to the positive effects of labor productivity and capital on domestic value added and negative coefficients of GVC backward link obtained in Yu and Lou (2018) who estimated for Chinese industries over 2000-2011 period and Assche and Biesebroeck (2018). They support the results found by Kee and Tang (2016), and Duan *et al.* (2018), who argued that the domestic substitution for imported intermediate goods in processing exports decreased the share of foreign value added and thus increase the share of domestic value added in exports. They support finally the results of Chen *et al.* (2018) and Lianing and Cuihong (2017) who found the rise of domestic value added in exports is mainly due to the scale of exports. Our study finds moreover productivity effect of GVCs in this rise.

## 5. Conclusion

Despite its high implication into global value chains, the Chinese real domestic value added in exports increased at an annual average rate of 14% over the 2000-2016 period against 8% for foreign value added, leading its domestic value added ratio relative to gross exports increased from 65% to 83%. This study analyzed the determinants of domestic value added in exports over the 2005-2014 period in real terms and its share relative to gross exports, using OECDTiVA and WIOD databases. We find positive effects on domestic value added in exports of labor productivity, capital intensity, employment and China's GVC moving up,which passed directly through the volume effect of backward links and forward links with a higher effect for the first ones, and indirectly

through the impact of backward links on labor productivity. China's GVC integration rose domestic value added in exports either through withdrawing backward links (product of the estimated negative effectsmultiplied by the decreasing share of foreign value added and productivity effect)or through increasing forward links (product of the positive coefficient multiplied by increasing share of domestically produced intermediate goods embodied in the exports of third countries). These double virtuous effects of GVC linkages are possible because Chinese firms are able to produce more and more intermediate goods to substitute imported intermediate goods in processing and assembly and to export them to third countries.

First, over the 2005-2014 period, the annual average growth rate of labor productivity increased at 10.98%, which is higher than for wage growth rate per year on average (8.89%) in manufacturing sector. This has allowed keeping the Chinese manufacturing competitiveness. Continue to keep labor productivity improvement is essential to set off the rise of labor cost and shortage. China should emphasize education training qualified labor force corresponding to the need of manufacturing production and provide them social and economic incentives to would work in firms for long term. The actual high mobility of manufacturing industry is an obstacle to improve labor efficiency. Moreover, firms producing domestic intermediate goods should make more efforts to improve their productivity.

Second, during the studied period, the Chinese manufacturing industry is marked by decreasing the share of foreign value added in exports thanks to the substitution for imported intermediate goods by domestic suppliers and the increasing share of exports of intermediate goods embodied to exports of third countries.This virtuous cycle helped Chinese manufacturing moving up its GVC position from backward links up to forward links at an annual average growth rate of 9.42%, which mostly contributes to rise domestic value added in exports (17.24% per year on average). This moving up from low cost labor-intensive goods to relatively higher value-added capital-intensive and techno-intensive goods decreased the risk of being stuck in low-value-added for China. The risk is however not zero. The future moving up will bemuch more difficult than the 2005-2014 period marked by the substitution of imported intermediate goods to processing and assembly production chains, which were relatively easy to be imitated and to produced locally. We observe that the GVC position of the ICT and electronic sector as the biggest sector was still negative in 2014, suggesting that its production depended imported sophisticated intermediate

**Table 1: Determinants of real domestic value added in exports of China's 16 manufacturing sectors over 2005-2014 period**

**a. real domestic value added in exports**

| | *1a* | *2a* | *3a* | *4a* | *5a* |
|---|---|---|---|---|---|
| Labor productivity | 0.97*** | 0.66*** | 0.92*** | 0.89*** | 0.71*** |
| | (14.0) | (9.60) | (14.7) | (11.02) | (11.5) |
| Capital intensity | 0.60*** | 0.35*** | 0.54*** | 0.51*** | 0.38*** |
| | (4.78) | (3.26) | (4.78) | (3.84) | (3.70) |
| Employment | 0.43*** | 0.41*** | 0.58*** | 0.33*** | 0.51*** |
| | (2.73) | (3.17) | (4.07) | (1.98) | (4.03) |
| GVC Backward links | | -1.58*** | | | |
| | | (-7.98) | | | |
| GVC Forward links | | | 1.78*** | | |
| | | | (5.92) | | |
| GVC participation | | | | -1.21*** | |
| | | | | (-1.88) | |
| GVC position | | | | | 1.18*** |
| | | | | | (8.76) |

**b. share of real domestic value added relative to gross exports**

| | *1b* | *2b* | *3b* | *4b* | *5b* |
|---|---|---|---|---|---|
| Labor productivity | 0.10*** | 0.04*** | 0.09*** | 0.08*** | 0.05*** |
| | (11.01) | (6.50) | (13.0) | (7.95) | (9.56) |
| Capital intensity | 0.08*** | 0.04*** | 0.07*** | 0.06*** | 0.04*** |
| | (5.14) | (3.72) | (5.80) | (3.79) | (4.84) |
| Employment | 0.04* | 0.04** | 0.07*** | 0.02 | 0.05*** |
| | (1.93) | (2.74) | (4.25) | (0.78) | (4.71) |
| GVC backward links | | -0.27*** | | | |
| | | (-13.6) | | | |
| GVC forward links | | | 0.32*** | | |
| | | | (9.76) | | |
| GVC participation | | | | -0.27*** | |
| | | | | (-3.41) | |
| GVC position | | | | | 0.20*** |
| | | | | | (17.4) |
| Sector-fixed effect | Yes | Yes | yes | Yes | Yes |
| Year-fixed effect | Yes | Yes | yes | Yes | Yes |
| Number of observation | 160 | 160 | 160 | 160 | 160 |
| Number of sectors | 16 | 16 | 16 | 16 | 16 |

**c. impact of GVC on productivity**

| | *1c* | *2c* | *3c* | *4c* |
|---|---|---|---|---|
| GVC backward links | -1.54***<br>(-6.93) | | | |
| GVC forward links | | 0.35<br>(0.82) | | |
| GVC participation | | | -3.84***<br>(-6.50) | |
| GVC position | | | | 0.92***<br>(5.14) |
| Sector fixed effect | Yes | yes | Yes | yes |
| Year fixed effect | Yes | yes | Yes | yes |
| Number of observation | 160 | 160 | 160 | 160 |
| Number of sectors | 16 | 16 | 16 | 16 |

*Notes:* t-statistics are reported in brackets. *, ** and *** indicate significance at the 10%, 5% and 1% levels of confidence, respectively.

**Table 2: Annual average contributions of production factors and GVC participation to domestic value added in exports in China over the 2005 to 2014 period**

| | *Annual average growth rate* | *Estimated coefficients* | | *Estimated effects* | |
|---|---|---|---|---|---|
| | | *Real DVA* | *DVA share in exports* | *Real DVA* | *DVA share in exports* |
| | *a* | *b* | *c* | *a*b* | *a*c* |
| Productivity | 10.98 | 0.97 | 0.10 | 10.65 | 1.10 |
| Capital intensity | 10.35 | 0.60 | 0.08 | 6.21 | 0.83 |
| Employment | 4.33 | 0.43 | 0.04 | 1.86 | 0.17 |
| Productivity | 10.98 | 0.66 | 0.04 | 7.25 | 0.44 |
| Capital intensity | 10.35 | 0.35 | 0.04 | 3.62 | 0.42 |
| Employment | 4.33 | 0.41 | 0.04 | 1.78 | 0.17 |
| Backward links | -3.78 | -1.58 | -0.27 | 5.97 | 1.02 |
| Backward links via productivity | -3.78 | -1.02<br>(-1.54*0.66) | -0.06<br>(-1.54*0.04) | 3.86 | 0.23 |
| Total effect of Backward links | -3.78 | -2.60 | -0.33 | 9.83 | 1.25 |
| Productivity | 10.98 | 0.92 | 0.09 | 10.10 | 0.99 |
| Capital intensity | 10.35 | 0.54 | 0.07 | 5.59 | 0.72 |
| Employment | 4.33 | 0.58 | 0.07 | 2.51 | 0.30 |
| Forward links | 0.95 | 1.78 | 0.32 | 1.69 | 0.30 |

*contd. table 2*

| | *a* | *b* | *c* | *a*b* | *a*c* |
|---|---|---|---|---|---|
| Forward links via productivity | 0.95 | ns | ns | ns | ns |
| Total effect of Forward links | 0.95 | 1.78 | 0.32 | 1.69 | 0.30 |
| Productivity | 10.98 | 0.89 | 0.08 | 9.77 | 0.88 |
| Capital intensity | 10.35 | 0.51 | 0.06 | 5.28 | 0.62 |
| Employment | 4.33 | 0.33 | 0.02 | 1.43 | 0.09 |
| GVC participation | -0.73 | -1.21 | -0.27 | 0.88 | 0.20 |
| GVC participation via productivity | -0.73 | -3.42 (-3.84*0.89) | -0.31 (-3.84*0.08) | 2.50 | 0.22 |
| Total effect of GVC participation | -0.73 | -4.63 | -0.58 | 3.38 | 0.42 |
| Productivity | 10.98 | 0.71 | 0.05 | 7.80 | 0.55 |
| Capital intensity | 10.35 | 0.38 | 0.04 | 3.93 | 0.41 |
| Employment | 4.33 | 0.51 | 0.05 | 2.21 | 0.22 |
| GVC position | 9.42 | 1.18 | 0.20 | 11.12 | 1.88 |
| GVC position via productivity | 9.42 | 0.65 (0.92*0.71) | 0.05 (0.92*0.05) | 6.12 | 0.47 |
| Total effect of GVC position | 9.42 | 1.83 | 0.25 | 17.24 | 2.36 |

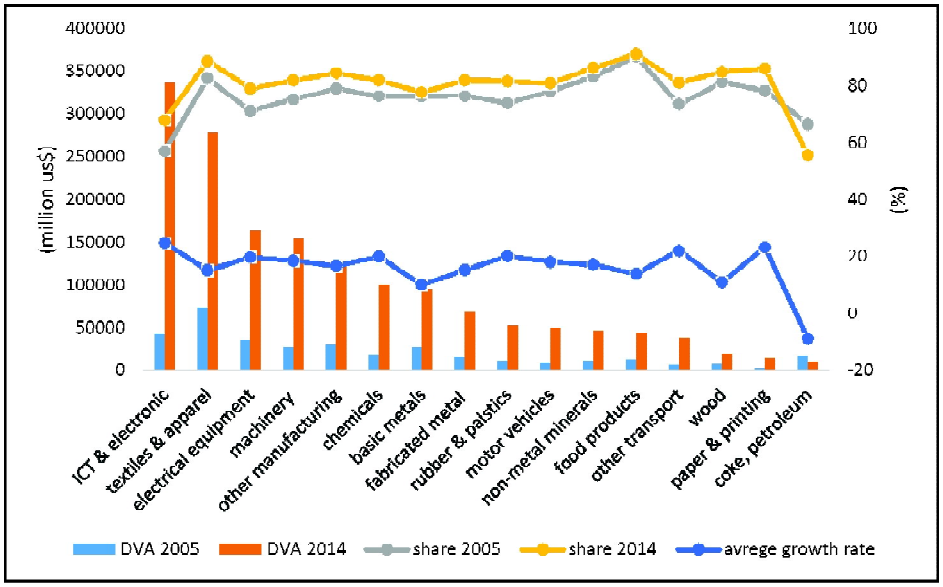


**Figure 1: Evolution of domestic value added in exports and its shares for 16 manufacturing sectors**

*Source:* OECD-WTO's TiVA datebase, 2018 version.

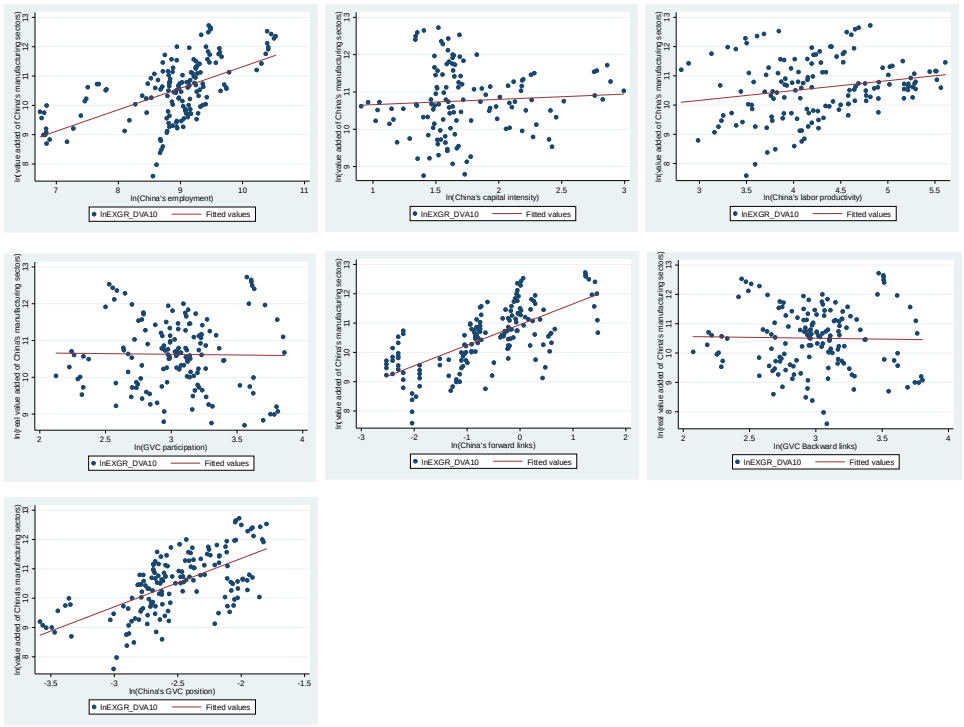


**Figure 2: Statistical relationship between real domestic value added and explanatory variables**

goods difficult to be imitated. This difficulty is intensified by the rising trade protectionism from developed countries, especially from the United-States and from the effects of Covid-19. China should emphasize research and development, and innovation to develop its own core technologies able to compete in world market.

This study is limited to the Chinese manufacturing sectors. The future research may extend to service sector, which contributes more and more the domestic value added in China and to include other countries to compare them with China. It may extend to study other economic, social and environmental effects of China's GVC integration.

## *Notes*

1. We use four GVC indices such as backward links, forward links, participation and position (Koopman *et al.*, 2014).
2. The estimations are made with time and sector fixed effects using OECD TiVA database.

3. Moving up passes through product upgrading into more sophisticated products, functional upgrading into more sophisticated tasks, or inter-sectoral upgrading into new higher value added supply chains (Humphrey and Schmitz 2002 and Humphrey 2004).
4. The results are not reported here because of limited spaces, but available if requested.

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**Table Annex 1: Definitions and sources of variables**

| *Names of variables* | *Calculation methods* | *sources* | *Levin-Lin-Chu unit-root test** |
|---|---|---|---|
| real domestic value added in exports | Nominal domestic value added in exports deflated by value-added price (2010=100) | OECD TiVA; World Input-Output Database | -9.7155 |
| Share of domestic value added in gross exports | Rapport between domestic value added and gross exports | OECD TiVA | -6.4972 |
| Employment | Employment of manufacturing | WIOD | -7.8438 |
| Capital intensity | ratio of nominal capital stocks deflated by the price of intermediate goods and divided by number of employees. | WIOD | -5.8730 |
| Labor productivity | nominal output deflated by its price index (100= 2010) and divided by numbers of employees | WIOD | -6.2494 |
| GVC backward links | share of foreign value added relative to gross exports | OECD TiVA | -6.7616 |
| GVC forward links | Share of domestic value added embodied in intermediate inputs re-exported to third countries relative to gross exports | OECD TiVA | -7.5628 |
| GVC participation | sum of forward and backward linkages | OECD TiVA | -5.7529 |
| GVC position | log ratio of supply of intermediates used in other countries' exports to the use of imported intermediates in its own production | OECD TiVA | -7.0606 |
| Foreign demand | | OECD TiVA | -13.0342 |
| Real exchange rate | nominal exchange rate multiplied by ratio of sectoral producer price between US and China | International Financial Statistics, IMF, WIOD | -5.4007 |

*Note:* * Levin-Lin-Chu unit-root test (Ho: Panels contain unit roots) is made with time trend and panel-specific means (fixed effects) and subtracted cross sectional means options. The variables are lagged by one period. The results of adjusted t are reported in table corresponding p-value=0.0000 for all variables.