Domestic Value Added in Chinese Exports*

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Preliminary and Incomplete. Comments are welcome.

Abstract

In this paper, we use transaction-level trade data and firm-level production data to assess the domestic value added (DVA) in Chinese processing exports. Using export and import data for processing firms over 2000-2006, we compute the DVA ratio (DVAR) to gross exports for each firm and industry. Despite a substantial heterogeneity across industries, the average DVA ratio in Chinese processing exports has risen from 35 percent in 2000 to 49 percent in 2006. Firm-level regression results suggest that the rising DVAR is mainly driven by firms substituting imported materials with domestic materials. We also find that the substitution is in part due to the large influx of foreign direct investments that induce the production of domestic intermediates. Changes in wages and exchange rates do not seem to affect firms' DAVR. In sum, our results show that Chinese exporters have been expanding along the global supply chain and are no longer only responsible for the final stages of production.

Key Words domestic value added, value added trade, China

JEL Classification Numbers: F2

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1 Introduction

In 2010, the total value of US imports from China is \$383 billion, while the total value of US exports to China is \$284 billion. This results in an almost \$100 billion trade deficit against China. In 1995, the values of US bilateral imports, exports and deficit with China were \$48.5 billion, \$24.7 billion and \$23.8 billion, respectively. The dramatic increase in Chinese exports and its resulting trade deficits have attracted much attention from the academics, policy makers, and the mass media. The most heated issue is probably about the impact of Chinese imports on the US labor market. In a recent study, Autor, Dorn, and Hanson (2011) find that Chinese imports significantly lower job creation, wages, and labor market participation in the US. Scott (2011) further exclaims that the "*growing US trade deficit with China costs 2.8 million jobs between 2001 and 2010*."

However, with China being dubbed the "factory of the world," a large part is due to its participation in the global supply chain particularly at the final stage. While many products are "made in China", they embody inputs from around the world. The most referred to example is that of Apple's iPod, where only US\$4 out of its value of US\$150 can be attributable to producers located in China, with the rest being created mostly in the US, Japan, and Korea (Dedrick, Kraemer and Linden, 2009). In fact, the iPod example is far from exceptional. As Figure 1 shows, processing exports, which involve firms importing materials for assembling and pure exporting, persistently contributed over 50 percent of Chinese exports from 2000-2006. With this prevalence of processing trade, any policy analysis based on aggregate statistics of gross trade flows could be highly misleading.

In this paper, we provide evidence based on micro-level data on the time-series trend, the cross-sectional pattern, and the determinants of the domestic value added (DVA) in Chinese exports. Different from most existing studies on value-added trade that rely on aggregate data on trade and input-output tables, we take a ground-up approach by using transaction-level (firm-country-product-year) import and export data of all exporters in China over 2000-2006. There are several advantages of using the micro-level approach. We measure DVA in trade directly rather than indirectly using aggregate data that require strong assumptions when sector-to-sector trade data are usually unavailable. By using firm-level data, we can examine the variation in DVA across firms in addition to that across industries or countries, which have been the focus of the existing literature. Thus, we can also assess the determinants and the consequences of the changing DVA

in exports at the firm level.

Despite these advantages, there are drawbacks of our approach. First, we choose to focus on processing exporters that operate in only one industry section (groups of HS 2-digit categories) to better assure that imports are being used for production of exported goods. Second, our measure can be subject to measurement biases due to domestic transactions between firms. In particular, if a processing firm imports more materials than its need and sells some of the imports to other processing plants locally, its computed DVA ratio ($DVAR$), which equals the ratio of net exports to gross exports, is biased downward and in the extreme case can be negative. On the other hand, if a processing firm buys imported materials from other processing firms, the computed $DVAR$ can be biased upward towards 1. To correct for the measurement biases due to indirect importing, we use two rules to identify those firms that generate "leakage". To limit the upward bias in our industry measures, we use a firm's material-to-sales ratio recorded in the manufacturing firm censuses as an upper bound of the firm's import-to-export ratio. By definition, a processing firm that exports all its output should have its material-to-sales ratio above its import-to-export ratio. On the other hand, to limit the downward bias, we use the 25th percentile of the foreign content share (i.e., $1 - DVAR$) in non-processing exports in the same industry as the lower bound of the processing firms' foreign content share. The rationale of using this rule is based on the fact that processing firms in China are exempted from import tariffs, while non-processing firms have to pay tariffs for all imports and thus have higher incentives to purchase intermediate inputs locally. These incentives would imply a higher average $DVAR$ among non-processing firms.

After addressing the "leakage" issue, we then use the cleaned sample to compute a firm's $DVAR$ in each sample year. To measure the DVA of Chinese exports at the industry level, we first sum up all firms' import and export values to the industries in which they operate, and then calculate the industry DVA by simply subtracting total exports by total imports of the industry. For firms that operate in multiple industries, we use the weighted average of $DVAR$, with weights equal to the firm's export share in the respective industry. We use the same approach to calculate $DVAR$ for each export destination country.

Overall, we find that the average $DVAR$ in Chinese processing exports gradually rose from about 35 percent in 2000 to 49 percent in 2006. Such increase is widespread across industries as well as across destination countries. There is notable variation in $DVAR$ across industries and countries.

For instance, $DVAR$ for the textiles industry (HS2 = 50-63) increased from 0.37 in 2000 to 0.53 in 2006, while it increased from 0.32 to 0.48 for machinery, mechanical, and electrical equipment (HS2 = 84-85). Destination-level $DVAR$ is positively correlated with destination countries' capital endowment, skill endowment, and income per capita. These patterns reflect China's comparative advantage in labor-intensive production.

Firm-level regression results further confirm that Chinese processing firms' $DVAR$ is increasing within firms over the sample period. We verify that the within-firm increase is not driven by rising production costs, but a gradual substitution of imported inputs with domestic inputs. We also find that the domestic content in processing firms' exports is increasing at both the intensive and the extensive (in terms of the number of varieties) margins, despite the fact that firms' export volume and variety have been increasing over time. In sum, our evidence suggests that Chinese exports now capture a larger part of the global production network and are no longer only responsible for the final stages of production.

After documenting the aggregate and firm-level trends, we use micro-level data to examine the main determinants of the rising $DVAR$ in Chinese processing exports. Preliminary firm-level regression results show that the observed substitution of imported inputs with domestic inputs is in part due to the large influx of FDI after China's accession to the WTO. An increased presence of foreign firms in the downstream sectors has generated a significant increase in the demand for locally produced intermediate inputs in the upstream sectors, inducing improvement in domestic input quality and variety. As a result, both the share of imports in total materials and import variety decrease within firms over time, even when firms' export variety is rising. As predicted by our model, rising wages cannot explain the increase in firms' $DVAR$. Contrary to our model and the conventional view, we find no evidence that the weakening yuan during our sample period contributes to the rising firms' $DVAR$.

This paper relates to the growing literature on domestic value-added trade (e.g., Hummels, Ishii and Yi, 2001; Koopman, Powers, Wang, and Wei, 2010; and Johnson and Noguera, 2012a, 2012b; among others). In particular, it is closely related to Chen, Chang, Fung, and Lau (2001) and Koopman, Wang, and Wei (2012) who gauge and examine the trend of the domestic content in Chinese exports. Using data on trade and input-output tables at the industry level, Koopman, Wang, and Wei (2012) introduce a novel method to estimate DVA separately for processing exports and non-processing exports of China. They show that while DVA rose tremendously from 1997 to 2004 for both types of exports, DVA for processing exports is significantly lower than that of non-processing exports. Importantly, they show that failing to account for the pervasive processing trade in some developing countries can result in an upward bias in estimating DVA using the traditional method.[1] Our paper complements Koopman, Wang, and Wei (2012) by providing direct measures of DVA for processing exports using transaction-level data. Consistent with their findings, we also find that DVA for Chinese processing exports was rising significantly over the same period.

The rest of this paper is organized as follows. Section 2 describes the data source and presents the basic data pattern. Section 3 discusses our methodology. Section 4 presents our results and Section 5 concludes.

2 Data

The main data set we use covers the universe of Chinese import and export transactions in each month between 2000 and 2006.[2] It reports values (in US dollars) of a firm's exports (and imports) at the HS 8-digit level (over 7000 products)[3] to each destination (from each source) country. This level of disaggregation is the finest for empirical studies in international trade – i.e., transactions at the firm-product-country-month level.

Processing trade has been playing a significant role in driving China's export growth. Figure 1 shows the share of processing exports in aggregate exports in China over 2000-2006. While both processing and ordinary exports have been increasing, the share of processing exports has been consistently around 55 percent of total exports. Table 1 breaks down processing trade by China's major export market, including the US, the EU, Japan, and other East Asian countries. While processing trade increased by over four folds from 100 billions USD to 450 billions, the US consistently ranked as the top destination, accounting for about 25% of Chinese total processing exports. Following the US is Hong Kong, which accounted for slightly over 20% of the total. Japan has been the third largest market for Chinese processing exports, but its prominence has declined from 18% in 2000 to 10% in 2006. Figure 3 shows the share of processing exports in each top-10

[1] Johnson and Noguera (2012a) adopt the same approach proposed by Koopman, Wang, and Wei (2012) and find that after taking processing trade into account, estimated DVA for both China and Mexico decline significantly.

[2] The same data set has been used by Manova and Zhang (2010) and Ahn, Khandelwal and Wei (2010).

[3] Example of a product: 611241 - Women's or girls'swimwear of synthetic fibres, knitted or crocheted.

destinations for 2000 and 2006. The share of processing exports accounted for 63% of Chinese exports to the US in 2006. It was 74% for Hong Kong, the highest among the top 10 destinations, and was 28% for Italy, the lowest among the top 10 (See Table 2 for details). In sum, processing exports is a major part of China's overall exports, as well as of its exports to destinations such as the US. Given the high foreign content and the prevalence of processing trade, any analysis based on gross trade flows can therefore be highly misleading.

We present in Figure 2 the share of processing exports in 2006 by industry section. There exists a substantial heterogeneity in the prevalence of processing exports across industries. The share is close to zero for the "Vegetables" section (HS2 = 6 -14) and as high as 80 percent for the "Machinery, mechanical, and electrical equipment" section (HS2 = 84-85).

The advantage of focusing on processing exporters is that we do not need to worry about imports for final consumption. By definition, all imports in processing trade have to be used as intermediate inputs. However, not all processing exporters import for their own production. Some of them import for other processing firms, which also implies that some processing firms export more than what their imported materials can support. As is discussed in the introduction, we develop systematic rules to identify potential processing firms that import and export for other firms. To this end, we use data from the *Annual Surveys of Industrial Firms* conducted by China's National Bureau of Statistics (NBS hereafter). The surveys cover all state-owned enterprises (SOEs) and non-state-owned firms that have sales above 5 million yuan in a given year.[4] The NBS data contain detailed information for most of the common balanced-sheet information, such as firm ownership, output, value added, industry code (480 categories), exports, employment, original value of fixed asset, and intermediate inputs. Table A3 presents the industry's median materials-to-sales ratio, the variable that we use to set an upper bound for the import-to-export ratio for processing firms. By definition, these ratios are always larger than the firms' $DVAR$.

[4] The industry section in the official statistical yearbooks of China is constructed based on the same data source. The unit of analysis is a firm, and not the plant, but other information in the survey suggests that more than 95% of all observations in our sample are single-plant firms.

3 Methodology

We now define the main variable of interest – domestic value added ratio ($DVAR$), starting from the accounting identity of a firm's total revenue. A firm's total revenue (PY) consists of the following components: profits, (π), wages (wL), cost of capital (rK), cost of domestic material $\left(P^D M^D\right)$, and cost of imported material $\left(P^I M^I\right)$.

$$PY = \pi + wL + rK + P^D M^D + P^I M^I$$

In theory, processing exporters sell all their output abroad and have revenue equal exports (EXP), and all their processing imports (IMP) equal exactly their cost of imported material $\left(P^I M^I\right)$:

$$EXP = wL + rK + P^D M^D + IMP + \pi.$$

Hence, exports minus imports is the domestic value added (DVA) for processing firms:

$$DVA = EXP - IMP = wL + rK + P^D M^D + \pi, \tag{1}$$

which includes wages, cost of capital, cost of domestic materials, and profits. In the analysis below, we focus on the ratio of DVA to a firm's gross exports, which we will refer to as $DVAR$:

$$DVAR = \frac{DVA}{EXP} = 1 - \frac{P^I M^I}{PY}. \tag{2}$$

Notice that the ratio of domestic value added to total exports depends only on the share of imported materials in total revenue. This is an accounting identity that is not specific to the functional form of the underlying production, and it highlights that to understand the $DVAR$ of a firm, we should focus on the determinants of the share of imported materials in total sales. To properly study the share of imported materials in total revenue, we will need to introduce more structure in the analysis by assuming a specific production function, which will be discussed in the following section.

3.1 Determinants of Domestic Value Added

For each year t, consider firm i with productivity, ϕ_{it}, who uses both domestic $\left(M_{it}^{D}\right)$ and imported materials $\left(M_{it}^{I}\right)$, alongside capital (K_{it}) and labor (L_{it}) to produce output Y_i, according to the following production production:

$$
\begin{aligned}
Y_{it} &= \phi_{it} K_{it}^{\alpha_K} L_{it}^{\alpha_L} M_{it}^{\alpha_M}, &(3)\\
M_{it} &= \left(M_{it}^{D\frac{\sigma-1}{\sigma}} + M_{it}^{I\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, &(4)\\
\alpha_K + \alpha_L + \alpha_M &= 1 \text{ and } \sigma > 1. &(5)
\end{aligned}
$$

Each firm faces input prices $\left(r_t, w_t, P_t^D, P_t^I\right)$ for capital, labor, domestic materials, and imported materials. Given (4) it can be shown that the price index of materials is a constant-elasticity-of-substitution (CES) function of P_t^D and P_t^I :

$$P_t^M = \left(\left(P_t^D\right)^{1-\sigma} + \left(P_t^I\right)^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$$

Firms' cost minimization implies the following the total cost to produce Y_{it} units of output:

$$
\begin{aligned}
C_{it}\left(r_t, w_t, P_t^D, P_t^I, Y_{it}\right) &= \frac{Y_{it}}{\phi_{it}} \left(\frac{r_t}{\alpha_K}\right)^{\alpha_K} \left(\frac{w_t}{\alpha_L}\right)^{\alpha_L} \left(\frac{P_t^M}{\alpha_M}\right)^{\alpha_M}, \text{ with} &(6)\\
\frac{P_t^M M_{it}}{C_{it}} &= \alpha_M. &(7)
\end{aligned}
$$

Thus, it is straightforward to show that the marginal cost to produce Y_{it} is

$$\frac{\partial C_{it}}{\partial Y_{it}} = \frac{1}{\phi_{it}} \left(\frac{r_t}{\alpha_K}\right)^{\alpha_K} \left(\frac{w_t}{\alpha_L}\right)^{\alpha_L} \left(\frac{P_t^M}{\alpha_M}\right)^{\alpha_M}. \tag{8}$$

A profit-maximizing firm will set the price of output as a constant markup, $\mu > 1$, over its marginal cost:

$$P_{it} = \frac{\mu}{\phi_{it}} \left(\frac{r_t}{\alpha_K}\right)^{\alpha_K} \left(\frac{w_t}{\alpha_L}\right)^{\alpha_L} \left(\frac{P_t^M}{\alpha_M}\right)^{\alpha_M},$$

hence the total revenue and the share of imported materials in total revenue are

$$
\begin{aligned}
P_{it}Y_{it} &= \mu\frac{Y_{it}}{\phi_{it}}\left(\frac{r_t}{\alpha_K}\right)^{\alpha_K}\left(\frac{w_t}{\alpha_L}\right)^{\alpha_L}\left(\frac{P_t^M}{\alpha_M}\right)^{\alpha_M} = \mu C_{it}, \text{ and} \\
\frac{P_t^I M_{it}^I}{P_{it}Y_{it}} &= \mu\frac{P_t^I M_{it}^I}{C_{it}} = \mu\frac{P_t^M M_{it}}{C_{it}}\frac{P_t^I M_{it}^I}{P_t^M M_{it}} = \mu\alpha_M\frac{P_t^I M_{it}^I}{P_t^M M_{it}}.
\end{aligned}
$$

Finally, the share of imported materials in total materials can be obtained by the following minimization problem:

$$
\begin{aligned}
&\min P_t^I M_{it}^I + P_t^D M_{it}^D \\
s.t. M_{it} &= \left(M_{it}^{D\frac{\sigma-1}{\sigma}} + M_{it}^{I\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}},
\end{aligned}
$$

which will give us the following expression:

$$
\frac{P_t^I M_{it}^I}{P_t^M M_{it}} = \frac{1}{1+\left(\frac{P_t^I}{P_t^D}\right)^{\sigma-1}}.
$$

Thus, according to (2), $DVAR$ of firm i in period t is

$$
DVAR_{it} = 1 - \frac{\mu\alpha_M}{1+\left(\frac{P_{it}^I}{P_{it}^D}\right)^{\sigma-1}}. \tag{9}
$$

Equation (9) shows that, given μ and α_M, which are predetermined by the demand and production functions, factors that affect the relative price of imported materials relative to that of the domestic materials will have a direct impact on the domestic value added of processing firms. It is also clear that factors that do not affect the relative material prices, such as wages (w_t) or productivity (ϕ_{it}), will not affect $DVAR_{it}$.

What are the factors that may influence the relative material price? One obvious factor is exchange rate, E_t. Specifically, let the price of imported materials in Chinese Yuan equals to the world price of the materials $\left(P_t^{I*}\right)$, divided by the yuan's exchange rate (E_t):

$$
P_t^I = \frac{P_t^{I*}}{E_t}.
$$

A depreciation of Chinese yuan (a lower E_{it}) causes the price of imported materials in yuan to be higher. That will cause $DVAR$ to be higher according to (9) .

Another factor that will affect the relative price of materials could be the presence of foreign direct investment (FDI) in the output industry, when we allow imported and domestic materials to consist of different varieties. For simplicity, consider M_{it}^D and M_{it}^I as CES aggregates of different varieties of domestic and imported materials,

$$M_{it}^D = \left[\sum_{v=1}^{V_t^D} m_v^{D\frac{\lambda-1}{\lambda}} \right]^{\frac{\lambda}{\lambda-1}}, \; M_{it}^I = \left[\sum_{v_i=1}^{V_t^I} m_{v_i}^{I\frac{\lambda-1}{\lambda}} \right]^{\frac{\lambda}{\lambda-1}}, \lambda > 1.$$

We assume that the elasticity of substitution between any two varieties of imported materials, as well as any two varieties of domestic materials is λ. Thus, the average price of imported and domestic materials will be

$$\begin{aligned} P_t^D &= \left[\sum_{v=1}^{V_t^D} \left(P_{vt}^D\right)^{1-\lambda} \right]^{\frac{1}{1-\lambda}}, \; P_t^I = \left[\sum_{v=1}^{V_t^I} \left(P_{vt}^I\right)^{1-\lambda} \right]^{\frac{1}{1-\lambda}}, \text{ with} \\ \frac{\partial P_t^D}{\partial V_t^D} &< 0. \end{aligned}$$

Rodriguez-Clare (1996) and Kee (∞) show that the presence of FDI in a downstream industry may increase demand for domestic materials, which lead to more entries in the domestic material industry and increase the variety of domestic materials, V_t^D,

$$V^{D'}\left(FDI_t\right) > 0.$$

This will lower the price of domestic materials, given $\lambda > 1$. Thus, an increase in FDI in the output industry will raise the available domestic varieties of materials, V_t^D, which will increase the demand for domestic materials and thus increase firms' $DVAR$.

3.2 Caveats

The accounting identity (2) relies on two important assumptions. First, we assume zero imported content in domestic materials. In other words, we assume that $P^D M^D$ embodies purely domestic content. Second, we assume that imported materials have no Chinese content, such that IMP is completely foreign-made. If the first assumption is violated (i.e., the $P^D M^D$ embodies foreign content), DVA will be over-estimated based on (1). On the other hand, if the second assumption is violated (i.e., IMP embodies domestic content), DVA will be under-estimated. The net bias will depend on the extent each assumption is violated, but there is little information for us to assess the direction of the bias at this stage. However, the existing estimates by Hummels, Ishii, and Yi (2001) and Koopman, Wang, and Wei (2012) show that for Chinese processing trade, the foreign content in domestic materials is around 5 to 10 percent. We will take the conservative estimate of 10 percent and discount all our $DVAR$ measures by 10 percent for all firms in all industries.

There is another caveat regarding using (2) to estimate $DVAR$. This is specific to the Chinese context as processing firms are legally permitted to sell their imported materials domestically and benefited from tariff exemption, as long as the buyer is also a registered processing firm. The buying and selling of unused imported materials between two processing firms are widespread in the Chinese customs data and it introduces a lot of noise in the calculation of $DVAR$. In the extreme cases, some of the $DVAR$ are negative when processing import is larger than processing export. One way to get around this is to rely on industry input-output tables. However, by construction, input-output tables assume proportionality in the construction that all firms within the same industry are assumed to be completely homogeneous in terms of products and technology. This is not the case from what we observe in the Chinese customs data. Even within a very narrowly defined industry, the products and technology of firms vary widely. Moreover, some processing firms may consider the purchases of imported materials from other processing firms as domestic purchases, while others may consider this kind of materials imported materials. On top of that there will be domestic transaction costs such as markups and transportation or distribution fees involved in the trade of imported materials among processing firms. All these issues are completely sidestepped in the use of an industry input-output table. Here we adopt a completely ground-up approach by only relying on firm-level information and focus on those firms that can give us reliable $DVAR$ estimates. We will discuss how we filter out those processing firms that engage in indirect importing and exporting in the following section.

3.3 Dealing with Indirect Importing

Under the current customs regulations in China, processing firms can legally sell imported materials to other processing firms for export processing. Such transactions are not confined within the same industries or geographic locations.[5] For example, a shoes processing exporter may import leather and sells it to a handbag processing exporter. While it is not clear how common the practice of indirect importing is, it impacts the way we construct firm-level $DVAR$ based on (1). In particular, for firms that import more than their needs (the *excessive importers*), using (1) may underestimate their $DVAR$, and in the extreme scenario may cause $DVAR$ to be negative (issue (i)).[6] On the other hand, for firms that buy imported materials from other processing firms (the *excessive exporters*), using (1) may overestimate their $DVAR$, and in the extreme scenario, may cause $DVAR$ to be very close to 1 (issue (ii)).

To address the complication due to indirect importing, we need to first identify the excessive importers and exporters. To this end, we use data from the *Annual Surveys of Industrial Firms* conducted by China's National Bureau of Statistics (NBS) for 2000-2006, which we refer to as NBS data from now on. In particular, we use a firm's material-to-sales ratio to set an upper bound of the firm's import-to-export ratio. To this end, we first merge the transaction-level trade data with the NBS data.[7] Not all the firms from the two data sets can be merged. Table 3 and 4 presents the size of the merged sample relative to the full sample. In terms of the number of firms, about 16% of the single-section processing exporters from the customs were merged with the NBS data and survive our filters that weed out excessive importers. In terms of the export value, our final sample covers about 32% of the original customs sample. Importantly, all manufacturing industry sections were covered in almost all years.

Total material costs presumably consist of costs of domestic and imported materials. For these export processing firms, the value of total sales is very close to that of total exports reported in the customs data. Hence, we can use the ratio of total material costs to total sales to set an upper

[5] See *Regulations Concerning Customs Supervision and Control over the Inward Processing and Assembling Operation* by the Ministry of Commerce of China:
http://english.mofcom.gov.cn/aarticle/lawsdata/chineselaw/200211/20021100053665.html

[6] In the raw data about 10 percent of the single-section firms have negative net exports.

[7] Since there is no common firm identifier that exists in both data sets, we use firm names to do the merge. For rare cases that have duplicate firm names, we use the firm's address to improve the merge. Depending on the year, 37-48% of export value in the trade data set is successfully merged to the NBS firm data set. On average, 70% of export value reported in NBS is covered. See Ma, Tang, and Zhang (2012) for details.

bound for the import-to-export ratio for these firms as follows:

$$\frac{P^D M^D + P^I M^I}{PY} \geqslant \frac{P^I M^I}{PY} = \frac{IMP}{EXP}.$$

Hence, we only focus on the single-section export-processing firms that have their import-to-export ratio no greater than the material-to-output ratio. This helps us weed out the excessive importers.

On the other side of the same token, there are processing firms that appear to import too little as they purchase intermediate inputs from other processing firms locally. To identify these "excessive exporters" (issue (ii) above), we use the 25th percentile of $DVAR$ of the single-section *non-processing* firms that export within the same industry section.[8] We first identify all registered ordinary exporters that only export in one industry section. Unlike processing firms, these exporters are not obliged to export all products that use imported materials. They need to pay tariffs on imports and can use the imported materials for both domestic and foreign sales. Their incentives to use imported materials are thus lower than processing traders. In addition, they are not restricted by customs regulations whom to sell in the domestic economy. Thus, the $DVAR$ of ordinary exporters should be higher than processing firms in the same industry section. Figure 4 plots the median $DVAR$ of processing exporters against the 25th percentile of $DVAR$ of ordinary exporters across industry sections. As is shown, the former are always higher than the latter. In sum, we focus on single-section processing exporters that have their import-to-export ratio bounded between the two cutoffs as follows:

$$\frac{P^D M^D + P^I M^I}{PY} \geqslant \frac{IMP}{EXP} \geqslant \left(\frac{IMP}{EXP}\right)^{OT}_{(25)}, \text{ where} \tag{10}$$

$DVAR^{OT}_{(25)} = 1 - \left(\frac{IMP}{EXP}\right)^{OT}_{(25)}$ is the 25 percentile of the $DVAR$ of ordinary exporters within the same industry section.[9] Using this filtered set of firms with excessive importers and exporters removed,

[8] All empirical results are quantitatively similar if we use the 50th percentile of ordindary traders' DVAR.

[9] Sometimes, particularly for those industries that use a lot of commodities based materials such as iron, copper and crude oil, firms have incentive to stock up imported materials when the international prices of such commodities are low in order to hedge again rising prices in the future. Thus, for this reason, the contemporary imports may not be fully used by the contemporary exports within a firm. For these firms, the calculation of DVA based on (1) may not be accurate.

There is no easy way to get around the issue of inventory management. As it will be shown in the next section, almost all the negative DVA HS 2 observations are no longer negative once we use (10) to select firms to construct industry DVA. This suggests that while inventory management could be important, it may not affect our results, except for those industries that heavily rely on commodities with volatile international prices.

we obtain the DVA in exports in each industry section by subtracting total imports from total exports.

3.4 Dealing with Multi-industry firms

We can infer DVA based on (1) for all firms, regardless of how many products they produce. However, if our goal is to calculate DVA of Chinese exports at the product or industry level, information from multi-industry firms is not too useful. The reason is that how a multi-industry firm assigns the imported materials to the production of products in different industries is generally not observable in the data. Thus, we focus on the subset of export-processing firms that only operate within a single industry section (20 of them), according to the United Nations industry classification.[10] Examples of an industry section include Chemical Products (HS2 = 28-38), Textiles (HS2 = 50-63), Footwear and Headgear, etc. (HS2 = 64-67), and Machinery, Mechanical, Electrical Equipment (HS2 = 84-85). For these sets of single-industry processing firms, while we do not know the breakdown of its imports into each HS-2 or HS-6 categories, we know that all imports into an industry section are used in production of exported products within that section (subject to the potential "leakage" problem as discussed above). Using the sample of single-section exporters, we are able to estimate the average DVA for each section.

Let us reiterate the procedures of constructing the firm-level data set. We keep export-processing firms in the transaction-level data set who export in a single industry section.[11] We then merge the customs data to the production data from the NBS manufacturing surveys, and apply the material-sales bound to remove the "excessive importers" in the sample, as specified in (10). Then we use the 25th percentile of the ordinary exporters' $DVAR$ from each section to remove the "excessive exporters." We use the final cleaned sample to conduct sector-level, country-level, and firm-level analyses below.

[10] See http://unstats.un.org/unsd/tradekb/Knowledgebase/HS-Classification-by-Section.

[11] In the customs data, there are records showing imports from China. Goods are first exported from China and re-imported possibly due to VAT avoidance or transport cost saving. See Liu (2012).

4 Results

4.1 Cross-sectional Pattern

The cleaned data set contains unique single-section 5641 processing exporters in 7 years (2000-2006), It covers over 34% of total processing export value as reported in the transaction-level data (see 4). We also repeat our firm-level regression analysis using a balanced sample of firms to make sure that all our results are not driven by entry/exit of firms. The results remain quantitatively similar.

Our sample over all 20 industry sections throughout the sample period. Figure 7 presents the overall results. The (weighted) average $DVAR$ across all industry sections in Chinese processing exports ($DVAR$) has been rising. It was 35 percent in 2000, and by 2006, it reached 49 percent. Figure 8 shows the average firm $DVAR$ by industry section for the year 2006. Figure 9 shows the distributions of the $DVAR$ across industry sections for 2000, 2003 and 2006. It is clear that across the board, the share of domestic content in Chinese processing exports is increasing over time. As is shown in Table A2, the industry sections that have the highest $DVAR$ are Vehicles and Aircrafts (HS2 = 86-89; $DVAR = 0.690$), Vegetables (HS2 = 6-14; 0.679), and Live Animals (HS = 1-5; 0.633). In 2000, the top 3 industry sections with the highest $DVAR$ are Wood and Articles (HS2 = 44-46; $DVAR = 0.568$), Stone, Plaster, and Cement (HS2 = 68-70; $DVAR = 0.531$), and Beverages and Spirits (HS2 = 16-24; $DVAR = 0.473$). In 2006, the industries with lowest $DVAR$ are Precious Metals (HS = 71; 0.315), Plastics and Rubber (HS = 39-40; 0.325), and Animal and Vegetable Oil (HS2 = 15; 0.399). The full list of $DVAR$ for all industries and the corresponding $DVAR$ can be found in Table A2.

Across export destinations, $DVAR$ tends to be positively correlated with destination countries' capital abundance, skill abundance, and income per capita (see Figure 10, Figure 11, and Figure 12). Regardless, there is an across-the-board rise in the $DVAR$ in Chinese processing exports to most destination countries.

What cause $DVAR$ to increase over time? One possibility is the rising costs of production in China. From (2) it is clear that higher wages or prices of domestic materials will push $DVAR$ up, unless it is offset by a reduction in the profit margins of the firms. Alternatively, the rise in $DVAR$ could be a result of processing firms substituting imported materials with domestic materials. Such substitution may be caused by the fact that a larger fraction of the global production chains is moving to China. If the second reason is the main culprit behind the rising $DVAR$ in Chinese exports, then the threat that Chinese workers are replacing workers in other countries, such as the US, is larger.

4.2 Firm-level Analysis

To examine the firm-level determinants of the rise in $DVAR$, we estimate the following regression using the merged customs-NBS data:

$$DVAR_{it} = \alpha_i + \alpha_t + \alpha_1 \left(\frac{wL}{PY}\right)_{it} + \alpha_2 \left(\frac{P^D M^D + P^I M^I}{PY}\right)_{it} + \epsilon_{it}, \tag{11}$$

where i stands for firm, t represents year, and ϵ_{it} is the regression residual. The rising $DVAR$ within firms over time will be captured by the year fixed effects as follows,

$$\alpha_t > \alpha_{t-1}.$$

We include the material-to-sales ratio, $\frac{P^D M^D + P^I M^I}{PY}$, in (11) and the share of wages in total sales as controls, based on equation (1). If α_1 and α_2 are both positive and significant, while the year fixed effects are either not rising or insignificant, then the increasing domestic production costs is the primary reason for the rise in $DVAR$. Conversely, if α_1 and α_2 are not positive and significant, while the year fixed effects are rising and significant, then it suggests that some imported materials are being substituted with domestic materials, leaving the share of material costs in total sales unchanged. While we have data for seven years (2000 to 2006), we omit the dummy for year 2000 in the regressions. That way, the coefficients on the year dummies for 2001 to 2006 can be interpreted as the within-firm increase in $DVAR$ in each year relative to 2000.

Table 5 presents our baseline results. Firm and year fixed effects are always included. Column (1) shows that all year fixed effects are positive and significant, suggesting that a firm's $DVAR$ is on average rising during the sample period. In particular, firm $DVAR$ increases on average by 18 percentage points from 2000 to 2006, which is similar in magnitude to the aggregate trend (see Figure 7). Note that the aggregate trend can be driven by different firms entering and exiting the market in a systematic way. However, given that we control for firm fixed effects in the regression, the within-firm increase in $DVAR$ is independent of the reallocation of firms within the sector. In other words, the regression results provide stronger support for the rising $DVAR$ in Chinese exports than what the aggregate trend depicts.

In Columns (2) to (5), we include wage rates, the share of the wage bill in total sales, as well as the share of material costs in total revenue as regressors separately, in addition to firm and year fixed effects. The idea of including these regressors is to examine whether the rising $DVAR$ is driven by either rising labor costs or the changing cost share of materials. According to our model, wages should not matter for $DVAR$. In all specifications year fixed effects remain positive, rising, and significant, while none of the control variables are positive and significant. This suggests that the within-firm increase in $DVAR$ is not driven by rising domestic costs of production, as is defined in our accounting identity (1).[12] We also repeat the same analysis for different samples by ownership type (private, domestic private, foreign-owned). The results are presented in Columns (6) to (8). Across all specifications, the year fixed effects are always positive, rising and significant, suggesting that the within-firm increase in $DVAR$ is broad based and wide reaching and it is not driven by certain firms or industries.

Next, we examine whether the rising $DVAR$ within firms arises from Chinese processing exporters substituting more imported materials with domestic materials over time. To this end, we estimate the following specification:

$$\left(\frac{IMP}{Material}\right)_{it} = \delta_i + \delta_t + \delta_1 \left(\frac{wL}{PY}\right)_{it} + \delta_2 \ln \left(\frac{K}{L}\right)_{it} + \nu_{it},$$

where $\left(\frac{IMP}{Material}\right)_{it}$ is the share of imported materials in total material cost for firm i in year t, δ_i and δ_t are firm and year fixed effect, respectively. Firm-level controls, including the wage-sales ratio and the (log) capital-labor ratio, are included. If firms are using more domestic materials in place of imported materials, the year fixed effects are expected to be declining, negative and significant:

$$\delta_t < \delta_{t_{-1}}.$$

[12] We have also tried to include the profit-to-sales ratio as a regressor. While the coefficient on the profit-to-sales is positive and significant, as is specified in(1), the year dummies remain quantitatively similar. We choose not to report the specification with profit-to-sales included as a regressor as the measurement error of profits can be large in developing countries' data sets. Results are available upon request.

Table 6 presents the results. Similar to Table 5, we omit the year fixed effect for 2000 in the specification. The coefficient on a year dummy is thus interpreted as the within-firm change in $\left(\frac{IMP}{Material}\right)_{it}$ in that year relative to 2000. In Column (1) we only include firm fixed effects and year fixed effects. All the year fixed effects are negative and significant, suggesting that $\left(\frac{IMP}{Material}\right)_{it}$ is declining during the sample period. In particular, the result suggests that a firm's $\left(\frac{IMP}{Material}\right)_{it}$ dropped by about 16 percentage points in 2006 compared to 2000. This decisively indicates that Chinese processing exporters are using more domestic materials relative to imported materials, providing a reason for our findings that $DVAR$ is increasing within firms over time. When we include other firm controls and split the sample by ownership type of firms, we continue to obtain consistent and significant results (columns (6)-(8)).

In Table 7, we further verify whether the decline in the share of imported materials in total material cost is in part driven by the decline in the variety of imported materials. We measure import variety by the count of imported HS6-country pairs at the firm level. To empirically examine the trend in import variety, we regress the log of a firm's number of import variety on firm fixed effect, γ_i, year fixed effects, γ_t, and the firm-level controls as follows:

$$\ln(import\_variety_{it}) = \gamma_i + \gamma_t + \gamma_1 \left(\frac{wL}{PY}\right)_{it} + \gamma_2 \left(\frac{P^D M^D + P^I M^I}{PY}\right)_{it} + \omega_{it}.$$

Similar to Table 6, all the year fixed effects are negative, suggesting that on average, processing firms' import variety is declining over time. At the sample mean, the number of import varieties decreased by 0.36 log points in 2006 relative to 2000. These findings are consistent with the hypothesis that processing firms are substituting imported inputs with domestic inputs at the extensive margin.

One can argue that the decline in import variety can possibly be due to Chinese exporters specializing in their core competence, and thus exporting and importing fewer varieties. To verify this claim, we estimate the following specification:

$$\ln(Export\_variety_{it}) = \beta_i + \beta_t + \beta_1 \left(\frac{wL}{PY}\right)_{it} + \beta_2 \left(\frac{P^D M^D + P^I M^I}{PY}\right)_{it} + u_{it},$$

where $Export\_variety_{it}$ is firm i's count of exported HS6-country pairs. Firm fixed effects (β_i), year fixed effects (β_t), and other firm-level control variables are included as before.

As is shown in Table 8, despite the decline in the share of imported materials in total material cost and the decline in import variety, the number of varieties exported by a processing firm is rising over time, particularly after China's accession to the WTO by the end of 2001. These results show that while Chinese processing firms are expanding their product scopes, they are reducing their reliance on foreign imported inputs.

In sum, our empirical results suggest that the domestic content in Chinese processing exports is rising over time. The rise is mainly driven by firms actively substituting imported materials with domestic materials, but not rising production costs. Nevertheless, in the last sample year (2006), Chinese processing exports still embody substantial foreign content (40-50 percent), as many anecdotes have described.

5 Possible reasons for the rising DVAR

What cause the Chinese processing firms to substitute imported materials with domestic materials? There are at least two main reasons behind the rising $DVAR$ at the firm level. As we argue in section 3.1, one reason is related to the weakening Chinese currency during our sample period. Another reason is about the huge foreign direct investment (FDI) inflow after China's WTO accession at the end of 2001.

From 2000 to 2006, the Chinese yuan has depreciated with respect to the currencies of most China's trade partners. A weaker yuan implied higher cost of imported materials (in yuans), inducing firms to turn to substitutes in the domestic market in order to minimize production cost. Thus, we would expect a rising firms' $DVAR$ when the yuan is depreciating. To examine this relation, we first construct a firm-specific time-varying exchange rate (exposure to a yuan appreciation). For each firm i, let I_{it} be the set of *common* countries firm i imports from in two consecutive years, t and $t-1$. Denote country j's exchange rate with respect to the yuan for year t and $t-1$ by E_{jt} and E_{jt-1}; and its shares in firm $i's$ imports in year t and $t-1$ by s_{jt} and s_{jt-1}. The firm-specific rate of yuan appreciation with respect to source countries in year t is defined as

$$d\ln E_{it} = \sum_{j\in I_{it}} \frac{1}{2}\left(s_{jt} + s_{jt-1}\right)\left(\ln E_{jt} - \ln E_{jt-1}\right).$$

Then the firm-specific Tornqvist exchange rate for imports is

$$E_{it} = E_{i_{t-1}} \exp\left(d \ln E_{it}\right),$$

with the base year (2000 or any starting year) exchange rate set to 1 for all firms, i.e., $E_{i0} = 1, \forall i$. Likewise, we also construct a firm-specific time-varying exchange rate that is relevant for the exports of each firm. Given that exchange fluctuation with regard to export market may affect firm markups, it is not clear apriori how the exchange rate with respect to the destination countries' currencies may affect firm $DVAR$ (Chatterjee, Dix-Carneiro and Vichyanond, 2012).

Let us now explore the reason related to FDI. As part of the conditions for China's accession to the WTO, the country has to relax restrictions substantially on foreign participation in its economy in early 2000s. This regime change resulted in a large inflow of FDI into China. In addition to raising the demand for labor, an increased presence of foreign firms also generated huge demand for high-quality locally produced intermediate inputs. The entry of foreign firms in the downstream industry therefore causes quality upgrading and variety expansion in the upstream industries (Rodriguez-Clare, 1996; Kee, ∞). As such, all firms have access to better and more domestic materials, indirectly raising exporters' $DVAR$. We measure FDI both at the industry and industry-province level, using information of foreign capital stock from the NBS data.

We test the hypothesis related to the influx of FDI (hypothesis 1) and the yuan depreciation (hypothesis 2) in Table 9. Overall, our empirical results show that a higher level of foreign capital stock in the sector or in the sector-province increases firms' $DVAR$ in the same industry, supporting our hypothesis 1. However, the yuan depreciation against either China's import-source or destination countries do not appear to affect firms' $DVAR$.

6 Conclusions

In this paper, we use a ground-up approach to assess the domestic value added (DVA) in Chinese exports based on transaction-level trade data and firm-level production data. We find that the DVA ratio ($DVAR$) used to be around 35 percent in 2000, it has since risen to 49 percent in 2006. Such changes affect most industries in our sample, and most export destinations of Chinese exports. Our finding of rising DVA resonates with the existing findings in the literature, such as

Koopman, Wang and Wei (2012), who use information from the input-output tables for China to measure $DVAR$ in Chinese exports.

Firm-level regression results show that firm $DVAR$ is increasing gradually over the sample period, and that the increase is not driven by rising domestic capital or labor costs, but a gradual substitution of foreign imported inputs with domestic inputs. We also find that foreign content in processing exports is decreasing over time at both the intensive and the extensive (number of varieties) margins. Preliminary evidence suggests that the substitution is in part due to the huge influx of FDI after the country's accession to the WTO, which increased the supply of locally produced intermediates. Changes in the Chinese yuan exchange rate, either against import-source or destination countries, do not appear to affect firms' $DVAR$ during our sample period. Regardless of the reasons, our findings point to the fact that Chinese exports have been expanding along the global production network and are no longer only responsible for the final stages of production.

Given that processing exporters do not need to pay tariffs or VAT on such imported inputs, they have more incentives to use imported materials compared to non-processing exporters. Thus, the domestic content in processing exports is likely to be lower than that of non-processing exports. In other words, our $DVAR$ estimates provide a reasonable lower bound for the $DVAR$ of overall Chinese exports. Nevertheless, if we apply our $DVAR$ estimates to all Chinese exports, a back-of-the-envelope calculation shows that only about half of Chinese exports to the US are originated from China. Any policy analysis based on gross exports will most likely overestimate the impact of Chinese exports on the US labor market.

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Figure 1: Share of Chinese Processing Exports, 2000-2006

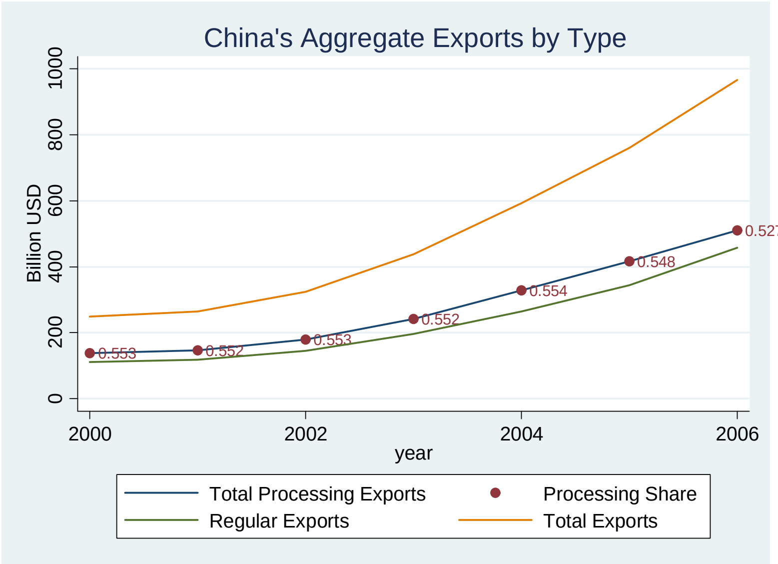

Figure 2: Shares of Processing Exports by Industry Group (2006)

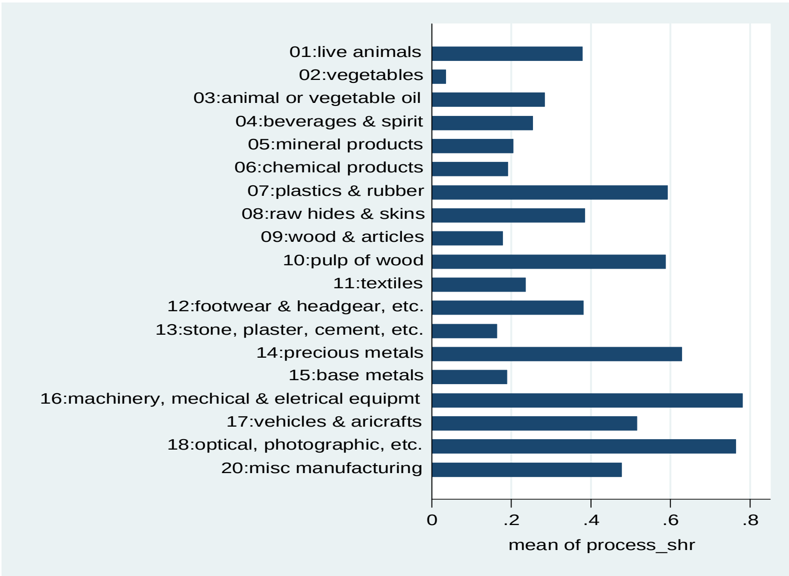

Figure 3: Shares of Processing Exports in Top Destinations (2000, 2006)

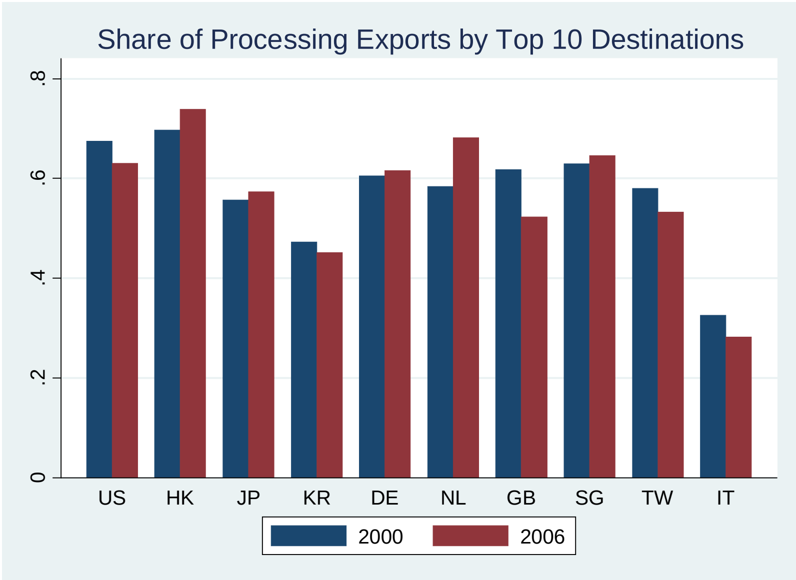

Figure 4: Median DVAR of Processing Exporters against 25 percentile of DVAR of Ordinary Exporters (2006)

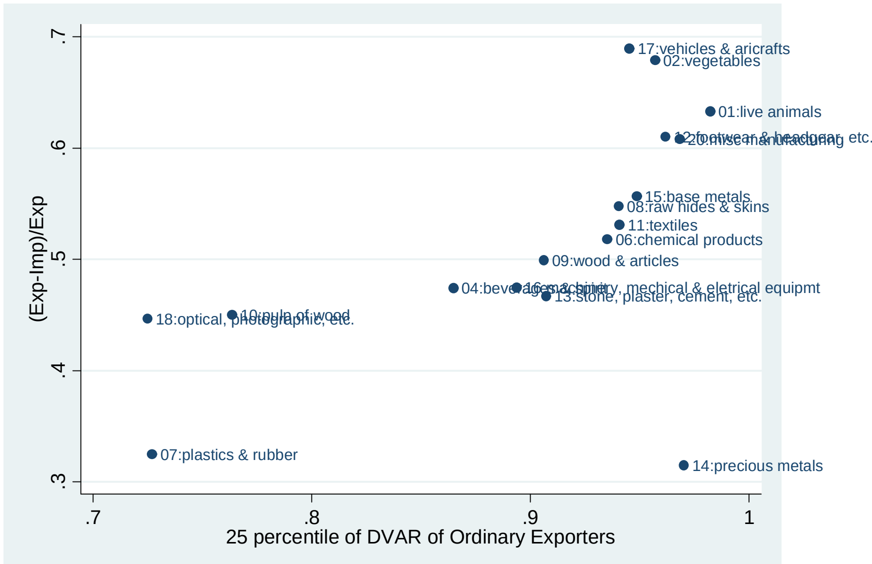

Figure 5: Unadjusted DVAR versus adjusted DVAR (with Leakage)

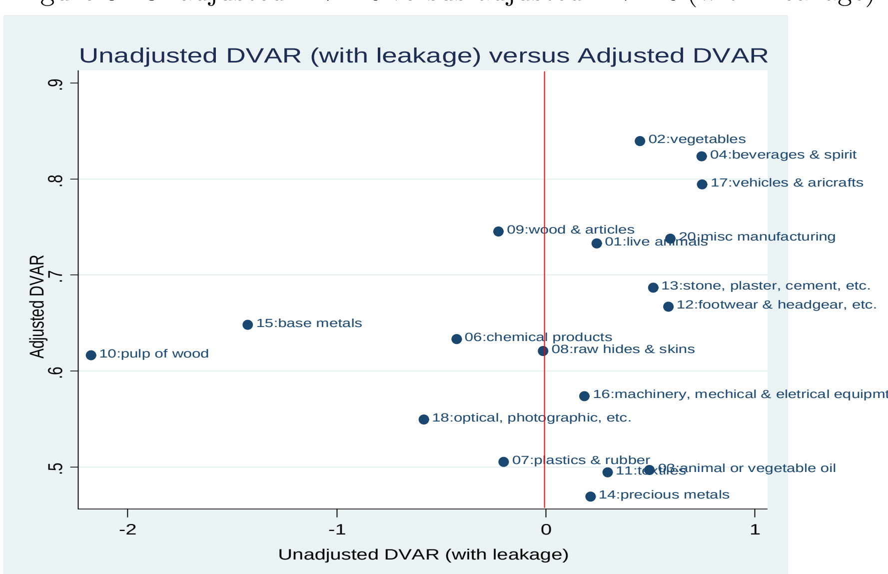

Figure 6:

Figure 7: Domestic Value Added (DVA) Ratios in Processing Exports (2000-2006)

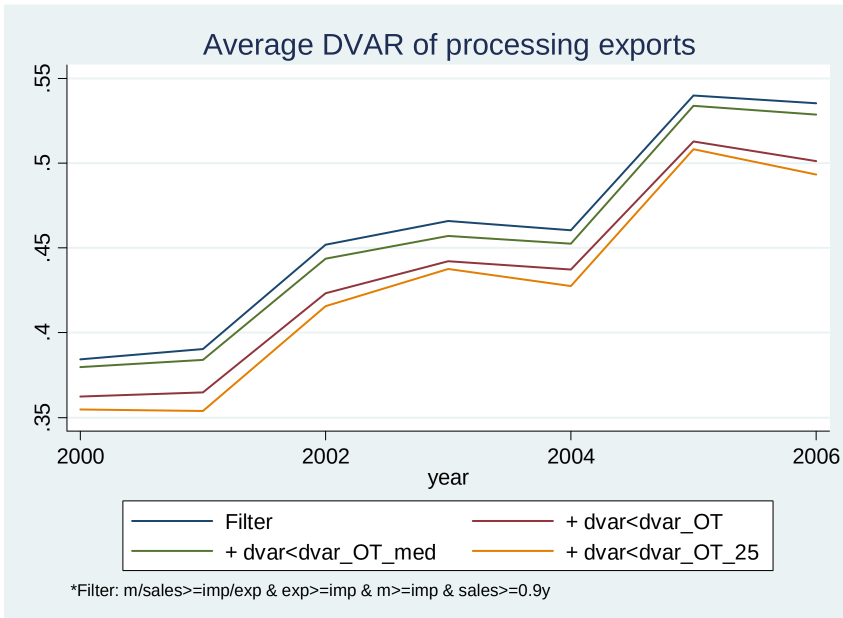

Figure 8: DVAR by Industry Section in 2006

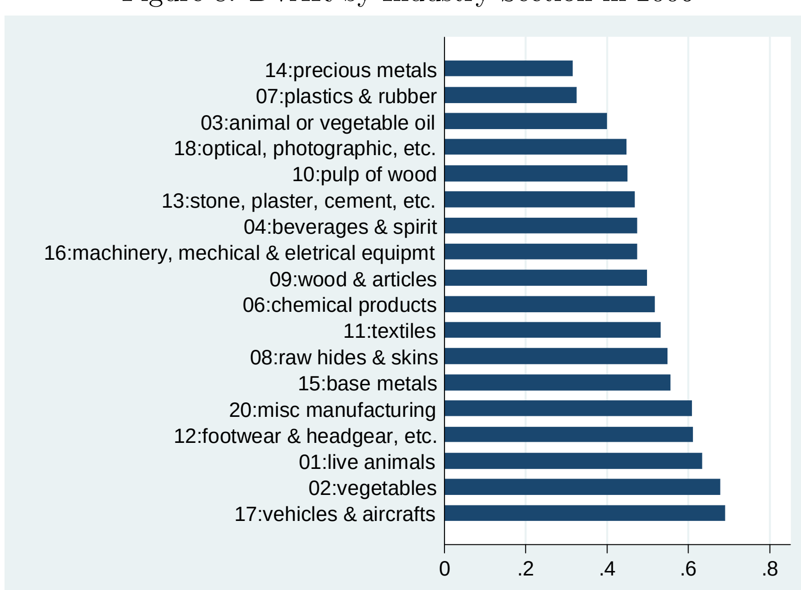

Figure 9: Distributions of DVA Ratios (2000-2006)

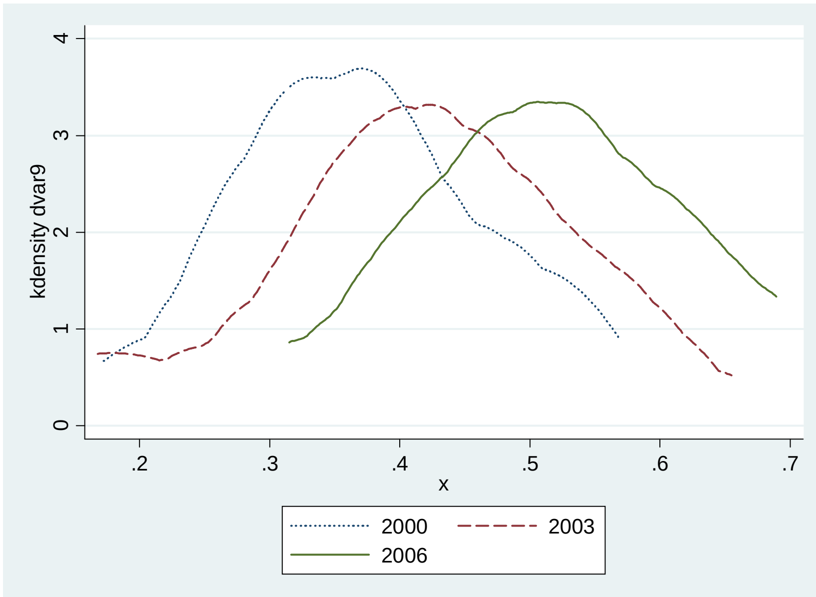

Figure 10: DVAR vs. Capital Endowment across Destinations (2006)

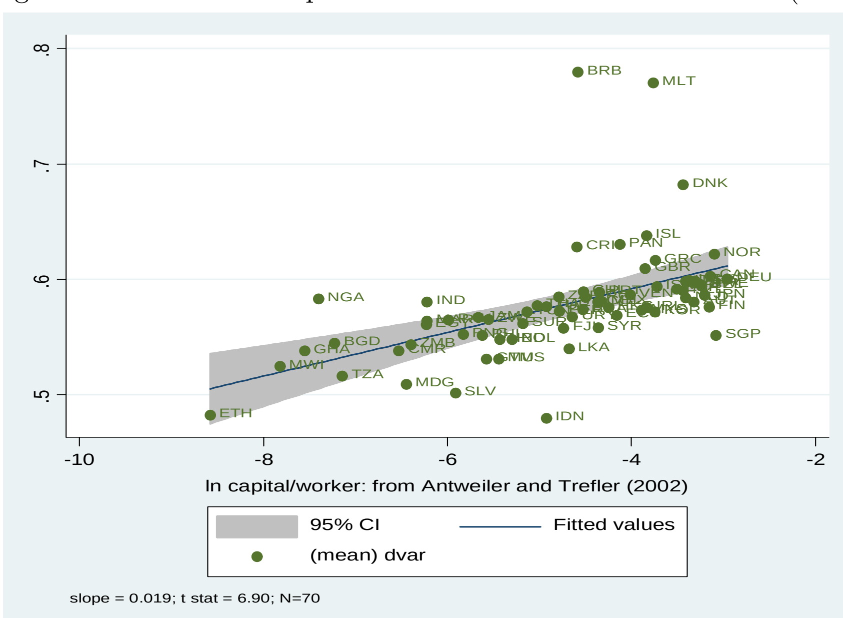

Figure 11: DVAR vs. Human Capital Endowment across Destinations (2006)

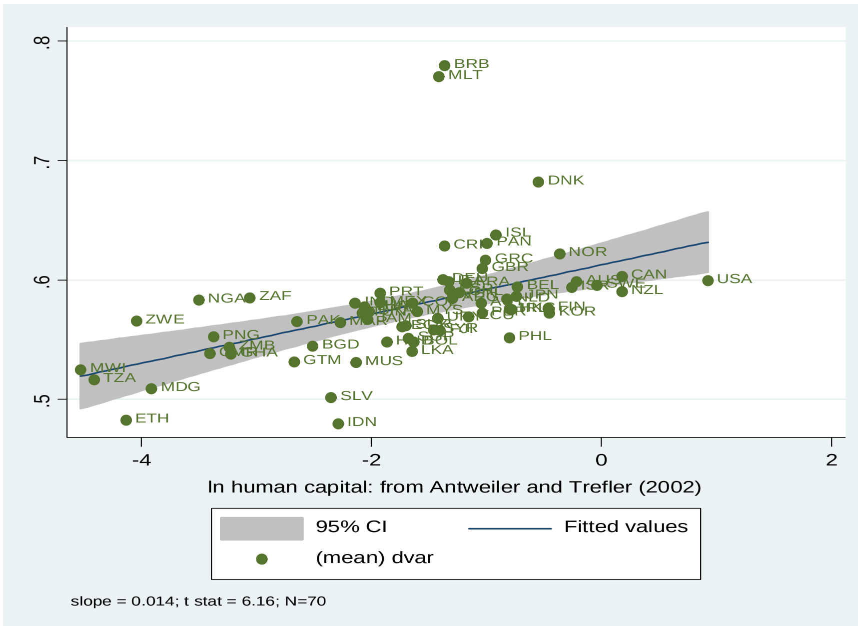

Figure 12: DVAR vs. per capita Income across Destinations (2006)

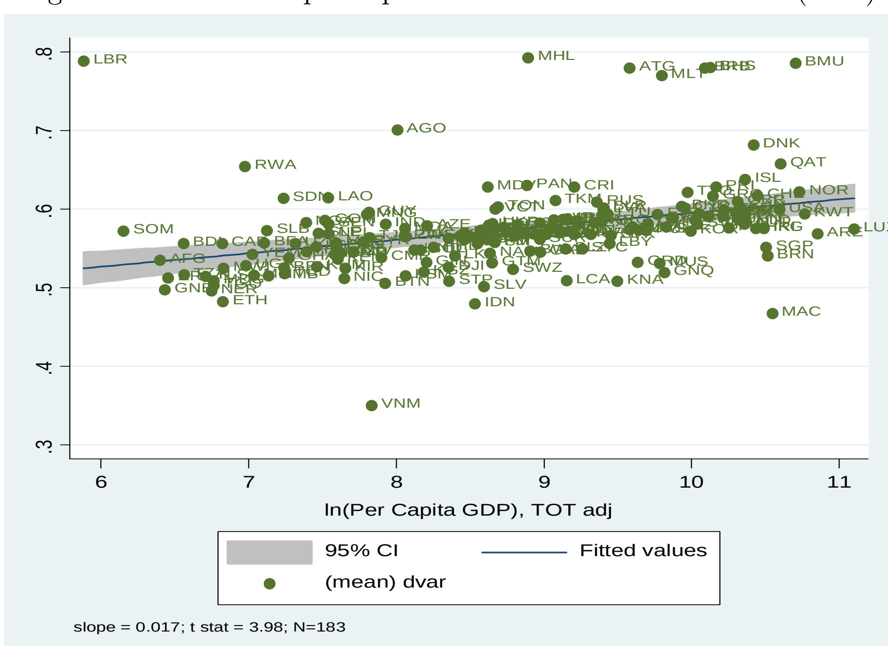

Table 1: Top 10 Destinations for China's Processing Exports

	2000			2003			2006		
Rank		Share	USD (Bil)		Share	USD (Bil)		Share	USD (Bil)
1	United States	0.25	25	United States	0.25	50.1	United States	0.25	113
2	Hong Kong	0.22	22.2	Hong Kong	0.23	44.6	Hong Kong	0.23	105
3	Japan	0.18	18.2	Japan	0.15	30.1	Japan	0.1	47.1
4	Korea, Republic of	0.04	4.17	Germany	0.04	8.65	Germany	0.05	21.3
5	Germany	0.04	3.8	Netherlands	0.04	7.85	Netherlands	0.04	18.9
6	Singapore	0.03	3.17	Korea, Republic of	0.04	7.81	Korea, Republic of	0.04	18.2
7	Netherlands	0.03	3.07	Singapore	0.02	4.92	Singapore	0.03	12.8
8	United Kingdom	0.03	2.77	United Kingdom	0.02	4.81	United Kingdom	0.02	11.1
9	Taiwan	0.02	2.06	Taiwan	0.02	4.45	Taiwan	0.02	9.89
10	France	0.02	1.59	France	0.02	3.94	Malaysia	0.02	7.17
Total			101			198			449

Table 2: Share of Processing Exports in Top Chinese Processing Exporrt Destinations

Rank		2000		2003		2006
1	US	0.675	US	0.675	US	0.630
2	HK	0.697	HK	0.716	HK	0.738
3	JP	0.557	JP	0.591	JP	0.574
4	KR	0.473	KR	0.460	KR	0.451
5	DE	0.606	DE	0.632	DE	0.616
6	NL	0.584	NL	0.676	NL	0.682
7	GB	0.618	GB	0.562	GB	0.523
8	SG	0.630	TW	0.587	SG	0.646
9	TW	0.580	SG	0.615	TW	0.533
10	IT	0.326	FR	0.626	IT	0.283

Table 3: Representativeness of Subsamples in the Original Customs Sample (in terms of number of exporters)

Group	number				
	customs	merged	% of customs	filtered	% of customs
01:live animals (1-5)	400	101	25.25%	22	5.50%
02:vegetables (6-14)	175	46	26.29%	16	9.14%
03:animal or vegetable oil (15)	21	14	66.67%	10	47.62%
04:beverages & spirit (16-24)	676	284	42.01%	117	17.31%
05:mineral products (25-27)	69	44	63.77%	8	11.59%
06:chemical products (28-38)	1822	717	39.35%	259	14.22%
07:plastics & rubber (39-40)	5284	1842	34.86%	636	12.04%
08:raw hides & skins (41-43)	2575	916	35.57%	386	14.99%
09:wood & articles (44-46)	457	123	26.91%	44	9.63%
10:pulp of wood (47-49)	2052	921	44.88%	150	7.31%
11:textiles (50-63)	16527	6038	36.53%	2922	17.68%
12:footwear & headgear, etc. (64-67)	3784	1625	42.94%	958	25.32%
13:stone, plaster, cement, etc. (68-70)	814	304	37.35%	150	18.43%
14:precious metals (71)	1309	326	24.90%	99	7.56%
15:base metals (72-83)	3321	1295	38.99%	495	14.91%
16:machinery, mechical eletrical & equipmt (84-85)	16401	6349	38.71%	2692	16.41%
17:vehicles & aricrafts (86-89)	900	424	47.11%	221	24.56%
18:optical, photographic, etc. (90-92)	2474	753	30.44%	374	15.12%
20:misc manufacturing (94-96)	3625	1195	32.97%	735	20.28%
Total	62716	23319	37.18%	10294	16.41%

Table 4: Representativeness of Subsamples relative to the Original Customs Sample (in terms of export value)

Group	sales (million usd)				
	customs (mil usd)	merged	% of customs	filtered	% of customs
01:live animals (1-5)	695.0	348.0	50.07%	50.2	7.22%
02:vegetables (6-14)	135.0	54.6	40.44%	23.9	17.70%
03:animal or vegetable oil (15)	78.6	68.6	87.28%	60.6	77.10%
04:beverages & spirit (16-24)	1090.0	784.0	71.93%	331.0	30.37%
05:mineral products (25-27)	6740.0	6640.0	98.52%	81.6	1.21%
06:chemical products (28-38)	3110.0	1700.0	54.66%	731.0	23.50%
07:plastics & rubber (39-40)	9230.0	5960.0	64.57%	2940.0	31.85%
08:raw hides & skins (41-43)	5120.0	3240.0	63.28%	1070.0	20.90%
09:wood & articles (44-46)	441.0	256.0	58.05%	117.0	26.53%
10:pulp of wood (47-49)	1410.0	870.0	61.70%	315.0	22.34%
11:textiles (50-63)	29400.0	19600.0	66.67%	9590.0	32.62%
12:footwear & headgear, etc. (64-67)	13100.0	9160.0	69.92%	6680.0	50.99%
13:stone, plaster, cement, etc. (68-70)	1140.0	835.0	73.25%	459.0	40.26%
14:precious metals (71)	9680.0	7400.0	76.45%	630.0	6.51%
15:base metals (72-83)	8990.0	4760.0	52.95%	2610.0	29.03%
16:machinery, mechical eletrical & equipmt (84-85)	122000.0	74000.0	60.66%	39900.0	32.70%
17:vehicles & aricrafts (86-89)	15900.0	12000.0	75.47%	8650.0	54.40%
18:optical, photographic, etc. (90-92)	5460.0	4070.0	74.54%	1060.0	19.41%
20:misc manufacturing (94-96)	6810.0	3960.0	58.15%	2360.0	34.65%
Total	240539.4	155709.8	64.79%	77659.3	32.29%

Table 5: Dependent variable: Firms' DVAR in processing exports

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	all	all	all	all	all	private	dom private	foreign
$\alpha_{2001}-\alpha_{2000}$	0.0273***	0.0263***	0.0274***	0.0264***	0.0264***	0.0269***	0.0776	0.0285***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.080)	(0.007)
$\alpha_{2002}-\alpha_{2000}$	0.0572***	0.0555***	0.0573***	0.0547***	0.0548***	0.0546***	0.0955	0.0546***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.083)	(0.007)
$\alpha_{2003}-\alpha_{2000}$	0.0901***	0.0893***	0.0901***	0.0875***	0.0876***	0.0880***	0.217**	0.0865***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.089)	(0.008)
$\alpha_{2004}-\alpha_{2000}$	0.0992***	0.0978***	0.0993***	0.0983***	0.0984***	0.0989***	0.175**	0.0982***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.086)	(0.008)
$\alpha_{2005}-\alpha_{2000}$	0.141***	0.138***	0.141***	0.137***	0.137***	0.138***	0.216**	0.138***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.088)	(0.008)
$\alpha_{2006}-\alpha_{2000}$	0.178***	0.175***	0.178***	0.174***	0.174***	0.175***	0.277***	0.174***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.099)	(0.009)
ln(wage rate)		0.00545						
		(0.005)						
$\frac{wL}{PY}$			-0.00260		-0.00269	-0.00278	0.160	-0.00306
			(0.004)		(0.004)	(0.004)	(0.240)	(0.004)
$\frac{P^D M^D + P^I M^I}{PY}$				-0.0798***	-0.0798***	-0.0784***	-0.199	-0.0776***
				(0.020)	(0.020)	(0.020)	(0.245)	(0.020)
N	10285	10170	10285	10285	10285	10200	506	9562
r2	.122	.122	.122	.13	.13	.131	.115	.133

Note: Firm and year fixed effects are always included. Data set: merged NBS and customs data. standard error in parentheses. * p<0.10; ** p<0.05; *** p<0.01

Table 6: Dependent variable: Share of imports in total materials

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	all	all	all	all	all	private	dom private	foreign
$\delta_{2001} - \delta_{2000}$	-0.0245***	-0.0243***	-0.0246***	-0.0245***	-0.0246***	-0.0249***	-0.0964*	-0.0235***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.056)	(0.008)
$\delta_{2002} - \delta_{2000}$	-0.0335***	-0.0331***	-0.0340***	-0.0335***	-0.0339***	-0.0344***	-0.0621	-0.0353***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.069)	(0.008)
$\delta_{2003} - \delta_{2000}$	-0.0756***	-0.0761***	-0.0758***	-0.0765***	-0.0767***	-0.0776***	-0.109	-0.0794***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.068)	(0.009)
$\delta_{2004} - \delta_{2000}$	-0.0839***	-0.0838***	-0.0843***	-0.0846***	-0.0850***	-0.0857***	-0.113	-0.0879***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.078)	(0.010)
$\delta_{2005} - \delta_{2000}$	-0.117***	-0.116***	-0.117***	-0.117***	-0.118***	-0.119***	-0.181**	-0.120***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.081)	(0.010)
$\delta_{2006} - \delta_{2000}$	-0.159***	-0.160***	-0.160***	-0.160***	-0.161***	-0.162***	-0.192**	-0.164***
	(0.010)	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)	(0.086)	(0.010)
ln(wage rate)		-0.00100						
		(0.006)						
$\frac{wL}{PY}$			0.0128		0.0127	0.0127	0.0621	0.0129
			(0.013)		(0.012)	(0.012)	(0.215)	(0.012)
$\ln(K/L)$				-0.00444	-0.00439	-0.00450	0.00884	-0.00595
				(0.005)	(0.005)	(0.005)	(0.038)	(0.005)
N	10285	10170	10285	10260	10260	10175	505	9540
r2	.0866	.0869	.0871	.0873	.0878	.0885	.113	.0913

Note: Firm and year fixed effects are always included. Data set: merged NBS and customs data.
standard error in parentheses. * p<0.10; ** p<0.05; *** p<0.01

Table 7: Dependent variable: ln(import variety)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	all	all	all	all	all	private	dom private	foreign
$\gamma_{2001}-\gamma_{2000}$	-0.146***	-0.149***	-0.145***	-0.146***	-0.146***	-0.142***	-0.429**	-0.137***
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.206)	(0.020)
$\gamma_{2002}-\gamma_{2000}$	-0.174***	-0.176***	-0.174***	-0.175***	-0.175***	-0.173***	-0.0199	-0.169***
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.248)	(0.022)
$\gamma_{2003}-\gamma_{2000}$	-0.332***	-0.336***	-0.331***	-0.332***	-0.332***	-0.331***	-0.424	-0.327***
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.278)	(0.024)
$\gamma_{2004}-\gamma_{2000}$	-0.398***	-0.404***	-0.398***	-0.399***	-0.398***	-0.398***	-0.000772	-0.401***
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.263)	(0.028)
$\gamma_{2005}-\gamma_{2000}$	-0.490***	-0.498***	-0.490***	-0.491***	-0.491***	-0.492***	-0.180	-0.493***
	(0.028)	(0.029)	(0.028)	(0.029)	(0.029)	(0.029)	(0.252)	(0.029)
$\gamma_{2006}-\gamma_{2000}$	-0.359***	-0.371***	-0.359***	-0.360***	-0.360***	-0.358***	-0.123	-0.355***
	(0.030)	(0.031)	(0.030)	(0.030)	(0.030)	(0.030)	(0.275)	(0.031)
ln(wage rate)		0.0167						
		(0.016)						
$\frac{wL}{PY}$			-0.00840		-0.00843	-0.00858	-0.395	-0.00661
			(0.012)		(0.012)	(0.012)	(0.780)	(0.010)
$\frac{P^D M^D + P^I M^I}{PY}$				-0.0200	-0.0201	-0.0122	0.799	-0.0142
				(0.053)	(0.053)	(0.054)	(0.796)	(0.055)
N	10285	10170	10285	10285	10285	10200	506	9562
r2	.102	.103	.102	.102	.102	.103	.157	.107

Note: Firm and year fixed effects are always included. Data set: merged NBS and customs data.
standard error in parentheses. * p<0.10; ** p<0.05; *** p<0.01

Table 8: Dependent variable: export variety in processing exports

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	all	all	all	all	all	private	dom private	foreign
$\beta_{2001} - \beta_{2000}$	-0.0608***	-0.0662***	-0.0603***	-0.0617***	-0.0612***	-0.0614***	0.339**	-0.0526**
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.165)	(0.023)
$\beta_{2002} - \beta_{2000}$	0.0321	0.0352	0.0334	0.0298	0.0310	0.0307	0.503**	0.0490*
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.197)	(0.026)
$\beta_{2003} - \beta_{2000}$	0.0845***	0.0814***	0.0852***	0.0821***	0.0828***	0.0819***	0.756***	0.0897***
	(0.027)	(0.028)	(0.027)	(0.027)	(0.027)	(0.027)	(0.254)	(0.028)
$\beta_{2004} - \beta_{2000}$	0.119***	0.115***	0.120***	0.118***	0.119***	0.118***	0.956***	0.119***
	(0.030)	(0.031)	(0.030)	(0.030)	(0.030)	(0.030)	(0.221)	(0.031)
$\beta_{2005} - \beta_{2000}$	0.193***	0.187***	0.194***	0.189***	0.190***	0.189***	1.074***	0.190***
	(0.032)	(0.033)	(0.032)	(0.032)	(0.032)	(0.032)	(0.235)	(0.032)
$\beta_{2006} - \beta_{2000}$	0.283***	0.276***	0.284***	0.280***	0.281***	0.280***	1.162***	0.280***
	(0.034)	(0.035)	(0.034)	(0.034)	(0.034)	(0.034)	(0.263)	(0.034)
ln(wage rate)		0.0115						
		(0.018)						
$\frac{wL}{PY}$			-0.0346***		-0.0347***	-0.0347***	-0.150	-0.0350***
			(0.009)		(0.009)	(0.009)	(0.638)	(0.008)
$\frac{P^D M^D + P^I M^I}{PY}$				-0.0742	-0.0743	-0.0744	-0.205	-0.0745
				(0.060)	(0.060)	(0.060)	(0.603)	(0.060)
N	10285	10170	10285	10285	10285	10200	506	9562
r2	.0446	.0448	.045	.0453	.0457	.0454	.168	.0444

Note: Firm and year fixed effects are always included. Data set: merged NBS and customs data. standard error in parentheses. * $p<0.10$; ** $p<0.05$; *** $p<0.01$

Table 9: Firm (1-DVAR), Import and Export Exchange Rates, and FDI

	(1)	(2)	(3)	(4)
foreign capital in	sector	sector-province	sector	sector-province
ln(foreign capital)	-0.0762***	-0.0454***	-0.0763***	-0.0454***
	(0.012)	(0.010)	(0.012)	(0.010)
imp-weighted E	-0.0058	0.0338	-0.0060	0.0337
	(0.065)	(0.054)	(0.065)	(0.054)
exp-weighted E	-0.0022	0.0542	-0.0030	0.0536
	(0.084)	(0.052)	(0.085)	(0.052)
$\frac{P^D M^D + P^I M^I}{PY}$; (α_m)	0.0337**	0.0380**	0.0339**	0.0381**
	(0.015)	(0.015)	(0.015)	(0.015)
$\frac{wL}{PY}$			-0.00354	-0.00272
			(0.004)	(0.004)
N	7544	7536	7544	7536
r2	.0525	.0331	.0525	.0331

Standard error in parentheses. * p<0.10; ** p<0.05; *** p<0.01. A higher import-weighted or export-weighted exchange rate means a stronger Chinese yuan with respect to the trade partners' currency.

Table A1: Weighted Average of DVAR

year	DVAR (filter 1)	DVAR (filter 2)	DVAR (filter 3)	DVAR (filter 4)
2000	0.384	0.362	0.380	0.355
2001	0.390	0.365	0.382	0.354
2002	0.452	0.423	0.444	0.416
2003	0.466	0.442	0.458	0.438
2004	0.460	0.437	0.452	0.428
2005	0.540	0.513	0.534	0.508
2006	0.535	0.501	0.528	0.493

Filter 1: Include exporters that have m/sales>=imp/exp & exp>=imp & m>=imp & sales>=0.9y

Filter 2: Include exporters that satisfy Filter 1 and dvar<dvar_OT

Filter 3: Include exporters that satisfy Filter 1 and dvar<dvar_OT_med

Filter 4: Include exporters that satisfy Filter 1 and dvar<dvar_OT_25

Table A2: DVAR by Industry Section and Year

Industry Section	Year						
	2000	2001	2002	2003	2004	2005	2006
01:live animals (1-5)	-	0.409	0.397	0.369	0.428	0.680	0.633
02:vegetables (6-14)	-	0.637	0.236	0.364	0.446	0.480	0.679
03:animal or vegetable oil (15)	0.173	0.245	0.281	-	0.319	0.465	0.399
04:beverages & spirit (16-24)	0.473	0.575	0.366	0.655	0.577	0.452	0.474
05:mineral products (25-27)	0.318	-	0.163	-	0.345	0.114	-
06:chemical products (28-38)	0.234	0.434	0.445	0.478	0.370	0.412	0.518
07:plastics & rubber (39-40)	0.318	0.353	0.315	0.337	0.370	0.465	0.325
08:raw hides & skins (41-43)	0.395	0.171	0.293	0.332	0.425	0.423	0.548
09:wood & articles (44-46)	0.568	0.508	0.313	0.190	0.508	0.583	0.499
10:pulp of wood (47-49)	0.286	0.255	0.367	0.374	0.259	0.342	0.450
11:textiles (50-63)	0.365	0.351	0.444	0.449	0.453	0.500	0.531
12:footwear & headgear, etc. (64-67)	0.464	0.488	0.534	0.563	0.589	0.588	0.610
13:stone, plaster, cement, etc. (68-70)	0.531	0.557	0.562	0.529	0.598	0.568	0.467
14:precious metals (71)	0.346	0.372	0.109	0.168	0.218	0.238	0.315
15:base metals (72-83)	0.395	0.455	0.476	0.403	0.520	0.385	0.557
16:machinery, mechical eletrical & equipmt (84-85)	0.319	0.301	0.402	0.432	0.404	0.530	0.475
17:vehicles & aircrafts (86-89)	0.339	0.529	0.484	0.529	0.481	0.563	0.690
18:optical, photographic, etc. (90-92)	0.345	0.378	0.456	0.407	0.420	0.419	0.447
20:misc manufacturing (94-96)	0.453	0.434	0.490	0.501	0.562	0.556	0.608

Source: China's Customs Trade Data and National Bureau of Statistics Manufacturing Survey

Table A3: Median of Materials to Sales Ratio by Industry Section and Year

Industry Section	Year						
	2000	2001	2002	2003	2004	2005	2006
01:live animals (1-5)	0.782	0.844	0.732	0.667	0.716	0.675	0.746
02:vegetables (6-14)	0.774	0.789	0.754	0.730	0.845	0.747	0.750
03:animal or vegetable oil (15)	0.880	0.988	0.731	0.730	0.668	0.762	0.595
04:beverages & spirit (16-24)	0.832	0.770	0.783	0.728	0.820	0.762	0.764
05:mineral products (25-27)	0.805	0.994	0.765	0.865	0.710	0.854	0.827
06:chemical products (28-38)	0.811	0.822	0.787	0.750	0.797	0.768	0.761
07:plastics & rubber (39-40)	0.805	0.800	0.822	0.791	0.816	0.813	0.790
08:raw hides & skins (41-43)	0.807	0.810	0.784	0.785	0.767	0.791	0.750
09:wood & articles (44-46)	0.801	0.810	0.796	0.840	0.779	0.769	0.770
10:pulp of wood (47-49)	0.805	0.800	0.789	0.796	0.810	0.796	0.750
11:textiles (50-63)	0.798	0.778	0.771	0.771	0.767	0.755	0.743
12:footwear & headgear, etc. (64-67)	0.798	0.774	0.757	0.761	0.759	0.750	0.737
13:stone, plaster, cement, etc. (68-70)	0.805	0.802	0.728	0.759	0.750	0.758	0.716
14:precious metals (71)	0.751	0.752	0.714	0.726	0.706	0.682	0.720
15:base metals (72-83)	0.838	0.819	0.806	0.788	0.806	0.777	0.781
16:machinery, mechical eletrical & equipmt (84-85)	0.808	0.805	0.785	0.774	0.799	0.793	0.769
17:vehicles & aircrafts (86-89)	0.815	0.836	0.851	0.823	0.829	0.819	0.799
18:optical, photographic, etc. (90-92)	0.817	0.771	0.763	0.739	0.760	0.752	0.722
20:misc manufacturing (94-96)	0.796	0.788	0.769	0.786	0.782	0.752	0.749

Source: China's National Bureau of Statistics Industrial Firm Survey

Table A4: 25th-percentile of Ordinary Exporters' DVAR by Industry Section and Year

Industry Section	Year						
	2000	2001	2002	2003	2004	2005	2006
01:live animals (1-5)	0.845	0.983	0.986	0.940	0.938	0.943	0.982
02:vegetables (6-14)		0.858	0.920	0.935	0.948	0.957	0.957
03:animal or vegetable oil (15)							
04:beverages & spirit (16-24)	0.754	0.826	0.737	0.843	0.843	0.859	0.865
05:mineral products (25-27)	0.832		0.833		0.502	0.914	
06:chemical products (28-38)	0.820	0.839	0.899	0.927	0.899	0.897	0.932
07:plastics & rubber (39-40)	0.773	0.906	0.854	0.635	0.826	0.805	0.727
08:raw hides & skins (41-43)	0.908	0.945	0.961	0.978	0.907	0.875	0.950
09:wood & articles (44-46)	0.907	0.778	0.890	0.857	0.928	0.892	0.907
10:pulp of wood (47-49)	0.982	0.600	0.967	0.878	0.566	0.624	0.764
11:textiles (50-63)	0.904	0.893	0.933	0.936	0.924	0.954	0.942
12:footwear & headgear, etc. (64-67)	0.785	0.959	0.985	0.987	0.961	0.957	0.972
13:stone, plaster, cement, etc. (68-70)	0.947	0.936	0.883	0.914	0.890	0.931	0.913
14:precious metals (71)	1.000	0.998	0.942	0.991	0.946	0.993	0.970
15:base metals (72-83)	0.819	0.914	0.886	0.934	0.947	0.929	0.947
16:machinery, mechical eletrical & equipmt (84-85)	0.908	0.831	0.830	0.871	0.851	0.896	0.894
17:vehicles & aircrafts (86-89)	0.854	0.855	0.888	0.861	0.847	0.958	0.945
18:optical, photographic, etc. (90-92)	0.834	0.912	0.925	0.787	0.876	0.848	0.724
20:misc manufacturing (94-96)	0.862	0.917	0.944	0.971	0.963	0.960	0.971

Source: China's Customs Trade Data and National Bureau of Statistics Manufacturing Survey