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Abstract

Processing trade and foreign-invested enterprises (wholly foreign-owned firms and Sino-foreign joint ventures, FIEs) played significant roles in China's economic growth in recent decades; FIEs currently account for about 20% of China's total economic output and about 60% of its exports. However, because of their ownership, FIEs complicate the measurement of domestic value-added generated from exports and the distribution of gains from trade. In this paper, we extend the method developed by Koopman, Wang and Wei (2012) to further separate Chinese exports into those by FIEs and by Chinese owned domestic enterprises (COEs), in addition to processing and normal exports. We propose an accounting framework and a detailed estimation procedure that accounts for the production and trade activities of FIEs and COEs separately. We first estimate the value-added contributions from each type of firms and decompose gross exports into domestic and foreign content by firm types; then we estimate factor ownerships by firm types based on enterprises survey data and compute the distribution of domestic value-added by factor ownership thus the distribution of gains from trade to related parties. Empirical estimation is based on China's 2007 benchmark input-output tables with detailed trade and Balance of payment statistics. Firm heterogeneities within each IO industry are identified by linking the NBS enterprises surveys and the Customs' firm transaction level data. Preliminary results indicate that in 2007 FIEs operating in China created nearly 45% Chinese value-added in Chinese exports, while Chinese processing firms only contributed less than 5%. About 52% of the value of Chinese exports was captured by foreign factor owners (including factors owned by Taiwan, and Hong Kong).

Keywords: Firm heterogeneity, processing trade, foreign-invested enterprises, input-output table, gross national income in exports.

JEL Classification: F1, C67, C81

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I Introduction

Globalization has been characterized by two unprecedented trends in recent decades. Production has been increasingly fragmented across countries, and roughly two-thirds of international trade are trade in intermediate inputs (Johnson and Noguera, 2012). In the meantime, large developing countries that were previously closed, notably China and India, became much more engaged in globalization. In particular, outsourcing and FDI to developing countries accelerate the "slicing up" of the global value chain across national borders, exerting substantial impacts on world trade flows (Hummels, Ishii, and Yi, 2001, hereafter HIY) and income distribution between and within countries.

These trends have posted challenges to the measurement of international trade flow and of the National Income Account. Exports and GDP are measured by different accounting standards. GDP is measured in value-added --- a net concept, while export is measured in gross term containing intermediate inputs, which may cross country borders many times before they become final products. [1,2] Therefore, when global supply chain is fragmented across borders, the commonly used export to GDP ratio is a misleading indicator of a country's dependence on trade.

This is illustrated in Figure 1, which shows the importance of export, measured by gross export over GDP, for a selection of large countries. Two interesting patterns emerge. First, China and Mexico have extraordinarily high export/GDP ratios, in contrast to other large economies.[3]. Second, dramatic increases in exports/GDP ratio for Mexico and China happened when major trade liberalization packages were implemented: NAFTA in 1994 for Mexico, and China's WTO accession at the end of 2001.

[Insert Figure 1 Here]

Do the patterns imply that China and Mexico are more open to trade than other countries? Not necessarily so. Accompanied with the rising fragmentation of global production, both China and Mexico have experienced rapid expansion of processing trade. Many processing exporters are also fully or partially owned by foreign investors. For example, around 50 percent of China's

[1] For example, contribution of auto industry to a country's GDP is counted as value-added, exclusive of the value of intermediate inputs such as steel and plastics that are either imported or made by other domestic industries, while the exports of auto industry includes the value of all intermediate inputs.

[2] The dramatic increase of trade in intermediate products is the most important factor to explain why world trade growth is much faster than global GDP growth in the last three decades (Yi, 2003).

[3] In 2006, China's and Mexico's export to GDP ratios are respectively 36.7% and 29.8%, much higher than the U.S., EU, Japan, Brazil and India (respectively at 7.9%, 12.1%, 14.9%, 12.9%, and 13.2%).

exports are processing exports. Among them, a majority share has been done by foreign invested enterprises (FIEs). Figure 2 shows the annual share of processing export and FIEs export – both stayed at around 50% for most years from 1995 to 2010.

[Insert Figure 2 Here]

Furthermore, processing trade is characterized as "importing for export"-- firms import parts and materials, and then re-export the processed or assembled final products. Under processing regime, imported inputs enjoy duty exemption and preferential tax treatments, therefore processing exporters tend to use imported inputs more intensively than normal producers do. Ignoring such a difference in production technology will overestimate the domestic value-added share in gross exports, in particular for economies that are integrated into the global supply chain and heavily involved in processing trade, such as China and Mexico.

To illustrate the idea, consider an iPad for example, which is designed and owned by Apple, assembled in China, and exported to the US and other countries. In trade statistics, each iPad sold in the US adds $275 to America's trade deficit with China. However, most parts of iPad are produced outside China, and therefore the value-added contributed by China is merely $10.[4] As a result, although iPads accounted for around $4 billion of America's reported trade deficit with China in 2011, the *Chinese content* in the deficit was estimated to be only $150 million. Similar difference between trade statistics and actual domestic content of trade has been reported by case studies by Linden, Kraemer, and Dedrick (2007) for iPod, and by Xing and Detert (2011) and the New York Times (2010) for iPhone. Finally, Branstetter and Lardy (2006) estimate that Chinese domestic value-added accounts for only 15% of the value of exported electronic and information technology products. All above cases imply that relying on the conventional trade statistics measure a country's engagement in global trade could be very misleading --- Johnson and Noguera (2012), for example, estimate that after accounting for foreign content in Chinese export, the controversial US-China imbalance is in fact around 40% smaller than what reported in official trade statistics.[5]

Thus, a precise measure of the domestic content of Chinese exports is essential in understanding China's growing role in global trade. As illustrated by the above cases, such

[4] Those numbers are based on a study by the Personal Computing Industry Center at University of California-Irvine, and cited by the economist (2012).

[5] In a more general sense, because roughly two thirds of world trade is trade in intermediate inputs, correctly accounting for domestic contents in trade is essential for a precise understanding of world trade and global imbalance, as well as the distribution of gains across nations.

measure must recognize the pervasiveness of processing trade and FIEs in China. Therefore this paper proposes a new estimation strategy to estimate the domestic value-added content in China's exports by firm types, following several pioneering works. Two major contributions are made. First, departure from current literature that relies on industry-level input-output table, we turn to firm level trade and production data to improve the measurement of domestic value-added in Chinese exports. Moreover, we decompose gross exports into domestic and foreign content by four types of firms: domestic- and foreign- owned enterprises that are doing processing exports and that are doing normal exports and domestic sales. Second, we measure the distribution of domestic value-added (i.e. net income) by factor ownership and attribute gains from trade to domestic and foreign factor owners. Domestic value-added is defined as value-added generated by domestic producers. It includes value-added generated by all types of enterprises operating in China, a concept that is consistent with the GDP. While foreign value-added is value-added generated/produced outside China and brought into China via imports. This production side concept, however, is different from how the value-added is distributed to different type of factor owners, including labor compensation and capital owners' profits. Through income distribution, the value-added generated from production is converted to net income of various factor owners which contribute to a country's Gross National Income (GNI). Our preliminary results indicate that in 2007 FIEs operating in China created nearly 45% China's domestic value-added in Chinese exports, while Chinese processing firms only contributed less than 5%. Furthermore, our findings show that about 52% of the value of Chinese exports was captured by foreign factor owners (including factors owned by Taiwan, and Hong Kong and foreign producers provide intermediate inputs).

Our study is built on a growing literature that has emphasized the vertical structure of global supply chain and therefore has revised the conventional measure of global trade flow. Notably, Koopman, Wang, and Wei (2012, KWW hereafter) propose a formula to compute domestic and foreign contents when processing trade is pervasive. Their method drops the proportionality assumption adopted by HIY (2001), i.e., imported inputs are *no longer* assumed to be used in the same intensity for processing exports and domestic sales. This is particularly important to account for the high proportion of foreign content in China's processing exports. Their study shows that the share of domestic content in Chinese manufacturing exports was about 50%

before China's WTO membership, and has risen to over 60% since then. Interestingly, more sophisticated products are found to have relatively low domestic content.

However, the KWW approach relies on industry-level data, which is still subject to measurement bias as long as different firms and products within an industry have different imported input use intensities. Recent firm-level studies have shown that exporters differ in many dimensions from non-exporters (Melitz, 2003; Bernard, Redding and Schott, 2007; Lu, 2012), including their choice of inputs. There is also large heterogeneity across firms in their import use intensity. Exporters are more likely to use imported inputs intensively than firms that produce only for the domestic market. Firms that are engaged in processing exports are more likely to rely on imported inputs than normal exporters. One solution is to get direct measures of the input-output coefficients for processing exports. Such information is indeed available in the case of Mexico, and De La Cruz et al (2012) apply the KWW approach to analyze Mexico's exports and show that on average domestic value added only accounts for 34% in Mexico's manufacturing exports.

Alternatively, one may turn to firm-level information to mitigate the measurement bias. That was first attempted by Feenstra and Jensen (2012), using firm level data on imports and production to allocate imported inputs across industries for the U.S. Using transaction level trade data over 2000-2006, Kee and Tang (2012) study Chinese processing exporters. By merging firms' export, import, and production information, they are able to study firms' heterogeneous input choices, without resorting to the standard input-output data. However, to get inference for the aggregate pattern, one would still need to aggregate the detailed micro information into certain level. For processing trade, by its nature, one may expect that the imported inputs are primarily used by the firm to produce for exports and therefore contain little Chinese value added, while domestically sourced inputs contain no imported value added. Thus one can compute the share of domestic value added in exports for this group of firms by simply looking at the ratio of (exports-imports)/exports. With a carefully-cleaned sample of processing firms, they find that the average share of domestic value added in China's processing exports has risen from 35% in 2000 to 49% in 2006. The trend over time is very similar to what reported by KWW which focus on total exports but use industry level data. Another study by Upward et al. (2012) also works with a merged sample of Chinese firms, with trade and production information from 2003-2006. They examine the proportion of exports which comes from imported intermediate inputs and find that

the foreign content of Chinese export is high but is falling over the sample period. Furthermore, they also provide evidence that more skill- and technology-intensive sectors export a large fraction of their output. Complementary to studies on China, Ahmad et al. (2012) focus on Turkish exports in 2005. Using firm-level data, the authors could separate input-output coefficients for firms that sell primarily to the domestic market versus those that sell primarily to the world market. They find that the share of foreign content in Turkey's exports in 2005 is about 27%, which is 6 percentage points higher than the share estimates from official I-O table based on aggregated data at the industry level.

Estimations based on IO tables and estimations based on firm-level data are complementary in enhancing our understanding of global trade. National statistical agencies in most countries usually compile IO tables at the industry level, without separating exporters and non-exporters. Thus it assumes within-industry homogeneity in production technology across firms. In reality, different firms, even those that produce the same products, often use different production technology, and thus have different IO coefficients as well as imported intermediate use intensity. To reduce the aggregation bias caused by firm heterogeneity in the existing IO tables, we have to use micro data that combine detailed production and trade information at the firm level. However, even with the most detailed plant level data, the "aggregation bias" cannot be completely eliminated. Thus choosing the right way to group firms and therefore minimize the aggregation bias is one important task that we aim to tackle in this paper. By comparing the means and percentiles of imported input intensity and value added share across different groups, we group firms by their ownership (i.e., FIEs versus Chinese domestic owned enterprises - COEs) and trade types (i.e., processing exporter versus normal exporter and non-exporter).

In summary, we developed a framework and a detailed estimation procedure that accounts the production and trade activities of FIEs and COEs separately. Though our empirical investigation is based on the Chinese data, our method is also applicable to other emerging economies that are involved in massive processing trade or have significant FDI inflows, such as Mexico and Vietnam.

The rest of the paper is organized as follows. Section II presents a conceptual framework for estimating shares of domestic value added in a country's exports. Section III describes the data and details our estimation strategy. Section IV presents the estimation results for Chinese exports. Finally, Section V concludes.

II. Theoretical Framework

To estimate the domestic and foreign value added of a country's exports, it is common to use a *non-competitive* I/O model. Given its structure, each intermediate or final use is divided into two sources, domestically-produced and imported. This captures the fact that even within the same sector classification, domestic and imported goods may not be close substitutes for each other. The non-competitive I/O accounting framework has been widely used in international trade literature. HIY (2001), for example, use a non-competitive I/O model to estimate vertical specialization in trade for a group of 14 countries.

Given a typical non-competitive I/O table such as the one in the Appendix,[6] we can express the output vector X, the total domestic value-added share (DVs) in final demand, and the total foreign value-added share (FVs) in final demand (i.e., total vertical specialization share as in HIY) as follows,

$$X = (I - A^D)^{-1} Y^D$$

$$DVs = A_V (I - A^D)^{-1}$$

$$FVs = uA^M (I - A^D)^{-1}$$

Where A^D is a n by n matrix of direct input coefficients of domestic products; A^M is a n by n matrix of direct input coefficients of imported goods; Y^D is an n by 1 vector of final demands for domestically produced products, including usage in gross capital formation, private and public consumption, and gross exports; A_v is a 1 by n vector of value-added to gross output ratio; u is a 1 by n vector of ones.

Assuming that exports and domestic sales use the same technology, DVs and FVs are also the shares of domestic and foreign content in exports. So total exports (*te*) is,

$$te = uE = u(I - A^D)(I - A^D)^{-1} E = (A_V + uA^M)(I - A^D)^{-1} E = DVsE + FVsE$$

In China and Mexico, as we discussed earlier, processing exports account for a significant proportion of total exports. With tariff and tax exemptions, processing exports usually have higher imported input use intensity than normal exports and domestic sales. In this case, the non-competitive I/O model is not suitable. KWW proposed an expanded non-Competitive I/O model that tracks separately the I/O coefficients for processing exports, and those for domestic sales and normal exports. Using superscript P and N to denote processing exports and domestic sales

[6] We provide a non-competitive I/O table in the appendix Table A1.

and normal exports respectively, then in KWW's expanded I/O table, the direct input coefficients can be written as[7]:

$$A^{NN} = [a_{ij}^{nn}] = [\frac{z_{ij}^{nn}}{x_j - e_j^p}], \quad A^{MN} = [a_{ij}^{mn}] = [\frac{z_{ij}^{mn}}{x_j - e_j^p}], \quad A_v^N = [a_j^{vn}] = [\frac{v_j^n}{x_j - e_j^p}]$$

$$A^{NP} = [a_{ij}^{np}] = [\frac{z_{ij}^{np}}{e_j^p}], A^{MP} = [a_{ij}^{mp}] = [\frac{z_{ij}^{mp}}{e_j^p}], A_v^P = [a_j^{vp}] = [\frac{v_j^p}{e_j^p}]$$

The total domestic value-added share, for normal export & domestic sales and processing export respectively, can be computed as

$$[B_V^N \quad B_V^P] = [A_V^N \quad A_V^P] \begin{bmatrix} I - A^{NN} & -A^{NP} \\ 0 & I \end{bmatrix}^{-1} = \left[A_V^N (I - A^{NN})^{-1} \quad A_V^N (I - A^{NN})^{-1} A^{NP} + A_V^P\right]$$

The total domestic value-added share and total foreign value-added share *of total exports* can be computed as

$$TDVs = A_V^N (I - A^{NN})^{-1} \frac{E^N}{te} + (A_V^N (1 - A^{NN})^{-1} A^{NP} + A_V^P) \frac{E^P}{te}$$

$$TFVs = \mu A^{MN} (I - A^{NN})^{-1} \frac{E^N}{te} + \mu (A^{MN} (1 - A^{NN})^{-1} A^{NP} + A^{MP}) \frac{E^P}{te}$$

The expanded I/O model proposed in KWW accounts for the different production technologies of processing exports and normal exports and domestic sales. However, it does not distinguish the I/O coefficients among firms with different ownership. FIEs (both wholly foreign-owned firms and Sino-foreign joint ventures) have been playing a significant role in China's economic growth, accounting for about 20% of China's total economic output. The role played by FIEs in China's exporting industries is greater than their role in most other large countries. This is not surprising since most processing trade is carried out by FIEs. Even so, while the share of processing exports keeps steady at more than 50% during the last decade, FIE's share in China's total exports increases steadily from 31% in 1995 to 58% in 2006. Table 1 shows the different pattern of FIEs and COEs in using imported products (intermediates, capital goods, or final consumption goods), for processing exports or normal use. It is clear that compared with COEs, FIEs have a much higher share in the use of imported intermediate inputs for processing exports, and much lower share in the use of imported intermediate inputs for

[7] The model is given in the Appendix Table A2.

normal use. Furthermore, processing exports account for more than two thirds of their exports, also much higher than COEs. Therefore, domestic value-added generated from FIEs is lower, and their contributions to China's GDP may be significantly lower than COEs. To correctly estimate domestic value-added embodied in FIE's production and exports, we have to account their production and exports separately.

[Insert Table 1 Here]

Based on the above observation, we split firms into 4 groups according to their export type and ownership(i.e., processing trade by COEs: CP; processing trade by FIEs: FP; normal trade & domestic sales by COEs: CN; normal trade & domestic sales by FIEs: FN).[8] A detailed discussion of the split and the comparison of key variables between the four groups is provided in next section. The structure for such a further-split I/O table is specified in Table 2.

[Insert Table 2 Here]

To be more concrete, for the input use matrix in Table 2, the first two letters in superscript denote the ownership of the supplier and the user of the intermediate inputs, where C denotes COE, F denotes FIE, while M denotes imports. The last letter in superscript denotes the trade type: P denotes processing while N denotes domestic sales & normal exports. We still hold the assumption that normal exports use inputs in the same proportion as production for domestic sales similar to KWW (2012) for both COEs and FIEs.

From Table 2, the additive condition for IO coefficients holds for all type firms' production.[9]

$$uA^{Clk} + uA^{Flk} + uA^{Mlk} + A_v^{lk} = u \qquad l = C, F; k = N, P \tag{1}$$

In block matrix notation, the extended IO model can be written in the following compact form:

$$\begin{bmatrix} I - A^{CCN} & -A^{CCP} & -A^{CFN} & -A^{CFP} \\ 0 & I & 0 & 0 \\ -A^{FCN} & -A^{FCP} & I - A^{FFN} & -A^{FFP} \\ 0 & 0 & 0 & I \end{bmatrix} \begin{bmatrix} X^C - E^{CP} \\ E^{CP} \\ X^F - E^{FP} \\ E^{FP} \end{bmatrix} = \begin{bmatrix} Y^C + E^{CN} \\ E^{CP} \\ Y^F + E^{FN} \\ E^{FP} \end{bmatrix} \tag{2}$$

[8] We are conducting further statistical tests based on detailed firm level data in order to determine the best split of firm types in a particular industry to minimize aggregation errors caused by firm heterogeneity in traditional I/O tables.

[9] The expressions for the direct input coefficients are listed in the note below Table 2.

$$M - Y^M = A^{MCN}(X^C - E^{CP}) + A^{MCP}E^{CP} + A^{MFN}(X^F - E^{FP}) + A^{MFP}E^{FP} \quad (3)$$

The analytical solution of the system is

$$\begin{bmatrix} X^C - E^{CP} \\ E^{CP} \\ X^F - E^{FP} \\ E^{FP} \end{bmatrix} = \mathrm{B} \begin{bmatrix} Y^C + E^{CN} \\ E^{CP} \\ Y^F + E^{FN} \\ E^{FP} \end{bmatrix} \quad (4)$$

Where B is the Leontief inverse and can be expressed as[10],

$$B = \begin{bmatrix} I - A^{CCN} & -A^{CCP} & -A^{CFN} & -A^{CFP} \\ 0 & I & 0 & 0 \\ -A^{FCN} & -A^{FCP} & I - A^{FFN} & -A^{FFP} \\ 0 & 0 & 0 & I \end{bmatrix}^{-1} = \begin{bmatrix} B^{CCN} & B^{CCP} & B^{CFN} & B^{CFP} \\ 0 & I & 0 & 0 \\ B^{FCN} & B^{FCP} & B^{FFN} & B^{FFP} \\ 0 & 0 & 0 & I \end{bmatrix}, \quad (5)$$

We can compute vertical specialization (FVs) or foreign content share in processing and normal exports for FIEs and COEs in each industry separately:

$$\begin{bmatrix} FVs^{CN} \\ FVs^{CP} \\ FVs^{FN} \\ FVs^{FP} \end{bmatrix}^T = \begin{pmatrix} uA^{MCN} & uA^{MCP} & uA^{MFN} & uA^{MFP} \end{pmatrix} B = \begin{bmatrix} uA^{MCN}B^{CCN} + uA^{MFN}B^{FCN} \\ uA^{MCN}B^{CCP} + uA^{MCP} + uA^{MFN}B^{FCP} \\ uA^{MCN}B^{CFN} + uA^{MFN}B^{FFN} \\ uA^{MCN}B^{CFP} + uA^{MFN}B^{FFP} + uA^{MFP} \end{bmatrix}^T, \quad (6)$$

where each *FVs* is an 1 by *n* vector. And the total foreign content share in a particular industry is the sum of the weighted sum:

$$\overline{FVs} = FVs^{CN}\hat{s}^{CN} + FVs^{CP}\hat{s}^{CP} + FVs^{FN}\hat{s}^{FN} + FVs^{FP}\hat{s}^{FP}, \quad (7)$$

where each $\hat{s}$ is a *n* by *n* diagonal matrix, the share of each type in China's total exports in each IO industry. Obviously, the sum of $s^{CN}, s^{CP}, s^{FN}, s^{FP}$ equals a diagonal matrix of ones.

Similarly, the share of domestic content in gross exports for processing and normal exports for FIEs and COEs at the industry level can also be computed separately:

[10] Detailed expressions for each element in B are provided in the Appendix B.

$$\begin{bmatrix} DVs^{CN} \\ DVs^{CP} \\ DVs^{FN} \\ DVs^{FP} \end{bmatrix}^T = \begin{pmatrix} A_v^{CN} & A_v^{CP} & A_v^{FN} & A_v^{FP} \end{pmatrix} B = \begin{bmatrix} A_v^{CN} B^{CCN} + A_v^{FN} B^{FCN} \\ A_v^{CN} B^{CCP} + A_v^{CP} + A_v^{FN} B^{FCP} \\ A_v^{CN} B^{CFN} + A_v^{FN} B^{FFN} \\ A_v^{CN} B^{CFP} + A_v^{FN} B^{FFP} + A_v^{FP} \end{bmatrix}^T, \quad (8)$$

where each *DVs* is an 1 by *n* vector. And,

$$\overline{DVs} = DVs^{CN} \hat{s}^{CN} + DVs^{CP} \hat{s}^{CP} + DVs^{FN} \hat{s}^{FN} + DVs^{FP} \hat{s}^{FP} \quad (9)$$

The total foreign income share (*FIs*) of domestic value added can be computed as

$$\begin{bmatrix} FIs^{CN} \\ FIs^{CP} \\ FI^{FN} \\ FIs^{FP} \end{bmatrix}^T = \begin{pmatrix} A^{GCN} & A^{GCP} & A^{GFN} & A^{GFP} \end{pmatrix} B = \begin{bmatrix} A^{GCN} B^{CCN} + A^{GFN} B^{FCN} \\ A^{GCN} B^{CCP} + A^{GCP} + A^{GFN} B^{FCP} \\ A^{GCN} B^{CFN} + A^{GFN} B^{FFN} \\ A^{GCN} B^{CFP} + A^{GFN} B^{FFP} + A^{GFP} \end{bmatrix}^T \quad (10)$$

where each FIs is an 1 by n vector, we use an additional G in superscript to denote direct foreign factor income.

The total domestic national income share (*DNIs*) of exports can be estimated as

$$\overline{DNIs} = \overline{DVs} - (FIs^{CN} \hat{s}^{CN} + FIs^{CP} \hat{s}^{CP} + FIs^{FN} \hat{s}^{FN} + FIs^{FP} \hat{s}^{FP}) \quad (11)$$

The foreign income share of gross exports can be estimated as

$$\overline{FNIs} = \overline{FVs} + (FIs^{CN} \hat{s}^{CN} + FIs^{CP} \hat{s}^{CP} + FIs^{FN} \hat{s}^{FN} + FIs^{FP} \hat{s}^{FP}) \quad (12)$$

where *DNIs* and *FNIs* are 1 by *n* vectors.

III. Data and Estimation Strategy

In this section, we describe our data and estimation strategy. Our data come from several sources. First, the official I/O tables for the benchmark year 2007 published by the National Bureau of Statistics of China (NBSC), with 42 sectors (including 16 manufacturing sectors). As robustness, we also utilize the most disaggregate I/O table with 135 sectors (including 80 manufacturing sectors). Second, firm level production data provided by the NBSC from 1998-2007, which is often named as "the Annual Surveys of Industrial Production" (ASIP) in the literature.[11] Third, export and import data at transaction level are from the China's General Administration of Customs (CGAC), for 2007. To get a sense of how different types firms use imported intermediate input in their production, we merge the ASIP data with the firm-level

[11] See Brandt et al (2012) for more details on this dataset.

trade data. In addition, this merged sample also provides useful information on foreign share in total paid-in capital, value added share in total output and detail income (such as labor compensation, operation surplus and depreciation) in value added for all four types of firms. Lastly, since the merged sample only covers industrial firms, we obtain information on imported service use at sector level from the sector level imported services use and income table in China's Balance of Payment (BOP) statistics provided by the People's Bank of China (PBC). We merge the imported services use data from PBC and imported goods use data from NBS to estimate a complete imported use matrix for the 2007 China I/O table. The BOP table also provides information on foreign factor income, including investment income and employee compensation. These data provide useful information to estimate the sector level foreign factors income shares in domestic value added. A detailed data description of the datasets, as well as the matching procedure, is provided in the data Appendix C.

3.1. Comparison across four types of firms

Correctly accounting for imported intermediate inputs is essential for us to estimate the domestic value added share in China's exports. Different types of firms, however, have different production technology and consequently different pattern in using imported inputs. Firms dwelling on processing trade will import large amount of inputs, but export almost all those imports in their final form. Thus processing exporters differ quite a lot from other exporters in their domestic value added share. This has been emphasized in KWW. Similarly, FIEs may also differ systematically from COEs. Therefore, we need to justify whether we can reduce firm heterogeneity within each I/O industry by separating firms into different groups by their input usage pattern based on detailed firm level data.

We turn to the merged sample of ASIP firm survey data and customs transaction level trade data. After dropping firms with obviously unreasonable values for key variables (for example, negative gross output, or negative input value, zero employment) and outliers (we drop top and bottom 0.5 percentiles for output, total sales, etc.), we are left with 301,774 firms in the ASIP data in 2007. Out of them, 92,628 are exporters. Not surprisingly, most exporters are also importing --- 38,025 firms are exporting and importing at the same time. Furthermore, processing exporters are major contributors to Chinese exports --- altogether 26,611 exporters

are doing processing trade. By ownership, nearly 70% of firms are private or limited liability firms. Foreign firms and joint ventures take nearly 21.5%. The rest are SOEs and collective firms.

As we have mentioned above, because of the important roles played by FIEs and processing exporters in Chinese exports, we divide firms into four groups by their ownership and export types. They are processing exports by COEs (CP), processing exports by FIEs (FP), normal exports or domestic sales by COEs (CN); normal exports or domestic sales by FIEs (FN). Most non-exporters are COEs, while most processing exporters are FIEs. Due to lack of information on imported input use intensity for non-exporters, we compare imported input use intensity among exporters.[12] Table 3A summarizes the mean, the variance and different percentiles for imported input intensity, over total input or output, for each of the 4 types of exporters. On average, FP firms (foreign owned processing exporters) have the highest imported input intensity, while CN firms (Chinese owned normal exporters) have the lowest. Within processing exporters, for all percentiles, FP firms have higher imported input intensity than CP firms. This can also be seen from the kernel density plot in Figure 4. And CP firms have higher imported input intensity than CN firms and FN firms.

In Table 3B, we further perform cross-table mean comparison for the imported input use intensity across different groups, using the Scheffe multiple-comparison tests. It can be seen that all group means are significantly different from each other. In particular, note that (1) Within processing exports, FP firms on average use significantly more imported input over total input or output compared with CP firms; (2) Within FIEs, FN firms on average use significantly less proportion of imported input than FP firms; (3) Within COEs, CN firms on average use significantly less proportion of imported input than CP firms. Firms in different groups do have distinct patterns of input usage. Similar patterns are found for most of the 16 manufacturing sectors and are presented in the appendix Table A4.

In Table 3C, we compare the mean and variance of import use intensity across four types of firms, for 16 manufacturing sectors.[13] Starting from column (3) to column (5), each column gives the number of firms, the number of exporters, the number of processing exporters. Then columns (6) give the mean squares for between-group variability of imported input use intensity.

[12] Normal exporters, as well as non-exporters, however, may be more likely to use imported inputs indirectly by sourcing the inputs from direct importers or intermediaries. So our estimate of import intensity for normal exporters may be understated.

[13] As robustness check, we compare the mean and variance across 80 manufacturing sectors (using 135-sector I/O table) and find similar results.

In addition, between-group sum of squares variance in general takes around 10-20% of total variance, except for the petroleum sector, in which between-group variance could explain about 40% of total variation. The last four columns (7)-(10) report the within-group mean and variances for all four types for 16 manufacturing sectors. The mean and variance of FP group is mostly larger than those of other groups.

[Insert Table 3A\B\C Here]

Realizing the large difference between exporters and non-exporters as emphasized in recent literature, a further division may divide normal firms into normal exporters versus non-exporters (i.e., firms that sell only at domestic market). Though this may further reduce the aggregate bias, it has the following disadvantages: (1) our firm level data lack enough information on imported input use intensity for non-exporters. While there are a large number of non-exporting producers in the ASIP data, there is no information on where their intermediate inputs are sourced from. This precludes us from conducting similar statistical test as we did for the four type firms separated in our paper; (2) more importantly, firms engaging in processing trade in China are not required to locate in a special export processing zone, unlike in Korea and Taiwan (Naughton, 2006; Ma and Van Assche, 2010).[14] Under processing regime, firms can get imported intermediate inputs not only free of Custom tariffs, but also without paying value-added taxes (VAT), which range from 13 to 17 percent. In addition, being recognized as "processing importer" also reduces the procedures for tax "collection" and then "rebate", since value-added tax is not collected for imported intermediate goods used to produce exports. Therefore, if a firm needs to import inputs to fulfill its export contracts, it tends to import input under processing regime. In contrast, normal exporters cannot enjoy such benefits. This is the most important fact to fully understand the incentive mechanism behind China's processing exports.[15] Given such huge incentive, it is hard to rationalize it if a producer imports intermediate inputs for exporting purpose under normal regime. Based on this observation, it is very likely that the difference between normal exporters and firms that sell only to domestic

[14] There are two types of processing trade in China: (1). type I (pure assembly), producers do processing and assembly, without ownership of the imported inputs. (2). Type II (processing with imported intermediate goods), producers own imported inputs (see Feenstra and Hanson, 2005).

[15] VAT revenue is the major tax revenue source for the Chinese government. In 2012, for example, the total VAT and consumption tax revenue that China Customs collected from imports amounts to around 1.5 trillion RMB, 14.7 percent of China's total tax revenue, while tariff revenue for the same year only amount 0.23 trillion RMB, 2.8% of China's total tax revenue. See reports by the Ministry of Commerce at http://szs.mof.gov.cn/zhengwuxinxi/gongzuodongtai/201301/t20130123_729605.html (last visited March.25, 2013).

market in terms of imported input use intensity are not so significant to justify further separation comparing to most other countries that without such value-added tax incentives.[16] Based on these two reasons, we decide not to separate normal exporters and domestic non-exporters in our current study, but putting it to our agenda for future research.

3.2. Estimation Strategy

Based on equations (6)–(9) in section II, we could compute the shares of domestic content in processing and normal exports for both FIEs and COEs in each industry. However, the NBSC only publishes traditional intermediate input matrices (*Z*), the value added vector (*V*), the output vector (*X*), the exports vector (*E*), the imports vector (*M*), and a final demand (excluding exports) vector (*Y*). We have to estimate the IO coefficients for each type firms according to the I/O structure specified in Table 2, and the traditional IO statistics published by NBSC will be used as constants in our estimation model.

To clarify, the key variables in our estimation model are listed as follows,

Variables	**Definition**
z_{ij}^{llk} and z_{ij}^{mlk} (l=c,f, k = n,p)	intermediate good *i* produced by type *l* firms and used by type *l* firms and trade mode *k* in sector *j*
z_{ij}^{mlk}	imported intermediate good *i* used by firms of type *l* in sector j for trade mode *k*
x_j^{lk}	output by *l type* firms in sector j for trade mode *k*, which are known from industrial enterprises surveys from NBSC and processing exports statistics from China customs
v_j^{lk}	value added by *l type* firms in sector j for trade mode *k*
y_j^l	final goods used domestically produced by *l* type firms in sector j
y_j^m	imported final goods of sector j, which are known from detailed CGAC trade statistics (8 digit HS) and UN BEC
e_j^{cn}, e_j^{fn}, e_j^{cp}, e_j^{fp}	normal and processing exports of sector *j* by FIEs and COEs respectively, which are known from detailed CGAC trade statistics

Equipped with data from detailed trade statistics, the industrial enterprises surveys and the conventional I/O tables, our estimation procedure is conducted by a quadratic programming model. It involves the estimation of 8 inter-industry-between-firm-type domestic input transaction matrix Z^{llk}, 4 inter-industry-between-firm-type imported input transaction matrix Z^{mlk}, 4 sector-level value added vector V^{lk} for *l=C,F, k=N,P and 2 domestic final demand vector* y_j^l,

[16] Concern remains if there is quality difference for goods sold in domestic market or exported. If exports are better quality goods (particularly to US, EU and Japan markets), due to higher quality standards in those countries, exporters may have to use more imported materials.

l=C,F. Assume there are K sectors, this means our estimation involves $12K^2$ unknowns for intermediate inputs, 4K unknowns for value added, and 2K unknowns for final demand. We can make initial conjectures about their values based on trade statistics and coefficients from the official benchmark I/O table. These conjectured values are referred to as "initial values". Specifically, we combine information from a standard I/O table and trade statistics to determine the values for sector-level imported inputs for each type of production, imports for final demand, and sector-level exports by each firm type. This helps us get initial values for $z0_{ij}^{mlk}$ and $z0_{ij}^{clk}$ for *l=c,f, k=n,p,* and also y_i^m.

To be precise, we use information from an I/O table to determine sector-level total imports/exports, and information from trade statistics to determine the relative proportion of processing and normal exports produced by different firm types within a sector. Using I/O table to determine sector-level total imports/exports helps to ensure that the balance conditions in official I/O account are always satisfied. It will also ensure that the I/O table with separate firm types always sum to the published official table. In mathematical terms, the initial value of intermediate imports are generated by allocating sector imported intermediates m_i^{lk} (*l=c,f, k = n,p*) in proportion to input *i*'s usage in sector *j*:

$$z0_{ij}^{mlk} = \frac{z_{ij}}{\sum_j^K z_{ij}} m_i^{lk}, \tag{13}$$

where m_i^{lk} can be estimated from detailed CGAC trade statistics.

The initial values for domestically produced intermediates are generated in two steps. In the first step, we estimate total domestic product *i* used as intermediate inputs in sector *j* as a residual of total intermediate inputs and imported intermediate inputs:

$$z_{ij}^d = z_{ij} - \sum_l \sum_k z0_{ij}^{mlk} \tag{14}$$

In the second step, we assume a proportional usage of z_{ij}^d:

$$z0_{ij}^{c\ln} = z_{ij}^d \frac{(x_j^l - e_j^{lp})}{x_j} \frac{x_i^c - e_i^{cp}}{x_i - e_i}, \quad z0_{ij}^{f\ln} = z_{ij}^d \frac{(x_j^l - e_j^{lp})}{x_j} \frac{x_i^f - e_i^f}{x_i - e_i} \tag{15}$$

$$z0_{ij}^{clp} = z_{ij}^{d} \frac{e_j^{lp}}{x_j} \frac{x_i^c - e_i^{cp}}{x_i - e_i} \quad , \quad z0_{ij}^{flp} = z_{ij}^{d} \frac{e_j^{lp}}{x_j} \frac{x_i^f - e_i^f}{x_i - e_i} \tag{16}$$

Sector level gross output and direct value-added by each firm types are obtained from the ASIP data and Statistical Yearbooks. x_i can be separated into total output of COEs (x_i^c) and FIEs (x_i^f). x_i^{cp} denotes processing exports of COEs. It is the same as e_i^{cp}. x_i^{fp} denotes processing exports of FIEs. It is the same as e_i^{fp}. The output of COEs for normal exports & domestic use, x_i^{cn}, is the difference between output and processing exports ($x_i^c - e_i^{cp}$). Similarly, the output of FIEs for normal exports and domestic use x_i^{fn} is $x_i^f - e_i^{fp}$. Following the same approach, we could also separate v_j into v_i^c, v_i^f.[17] By combining the industrial survey data and the trade data, we can separate v_i^c, v_i^f into the initial values $v0_i^{cp}$ and $v0_i^{cd}$, $v0_i^{fp}$ and $v0_i^{fn}$.

The initial value of domestic final demand $y0_i^l$ is generally derived as residual:

$$y0_i^l = (y_i - y_i^m) \frac{x_i^l - e_i^{l\mathrm{n}} - e_i^{lp}}{x_i - e_i} \tag{17}$$

However, these initial conjectures are not guaranteed to satisfy various economic and statistical restrictions on the data. Therefore, we cast the estimation problem as a constraint optimization problem. Using the previously-defined notations, the programming model is specified by the following objective function and seven sets of constraints:

$$\begin{aligned} \text{Min } S = & \sum_{i=1}^{K}\sum_{j=1}^{K}\sum_{l}\sum_{k} \frac{(z_{ij}^{clk} - z0_{ij}^{clk})^2}{z0_{ij}^{clk}} + \sum_{i=1}^{K}\sum_{j=1}^{K}\sum_{l}\sum_{k} \frac{(z_{ij}^{flk} - z0_{ij}^{flk})^2}{z0_{ij}^{flk}} \\ & + \sum_{i=1}^{K}\sum_{i=1}^{K}\sum_{l}\sum_{k} \frac{(z_{ij}^{mlk} - z0_{ij}^{mlk})^2}{z0_{ij}^{mlk}} + \sum_{j=1}^{K}\sum_{l}\sum_{k} \frac{(v_j^{lk} - v0_j^{lk})^2}{v0_j^{lk}} + \sum_{i}^{K}\sum_{l} \frac{(y_i^l - y0_i^l)^2}{y0_i^l} \end{aligned} \tag{18}$$

where *z*'s, *v*'s and y's are variables to be estimated, $z0$, $v0$, $y0$ denote initial values**.**

Constraint set 1: row sum constraints based on the I/O table

$$\sum_{j=1}^{K}\sum_{l}\sum_{k} z_{ij}^{clk} + y_i^c + e_i^{cn} = x_i^c - e_i^{cp} \tag{19}$$

[17] ASIP dataset only includes industrial firms. For other industries such as construction, transportation, etc., we can only get sector-level value-added data from the Statistical Yearbooks. Share of FIEs are estimated based on total sales of FIEs or total registered capital by FIEs.

$$\sum_{j=1}^{K}\sum_{l}\sum_{k} z_{ij}^{flk} + y_i^f + e_i^{fn} = x_i^f - e_i^{fp} \tag{20}$$

$$\sum_{j=1}^{K}\sum_{l}\sum_{k} z_{ij}^{mlk} + y_i^m = m_i \tag{21}$$

Constraint set 2: column sum constraints based on the I/O table

$$\sum_{j=1}^{K}(z_{ij}^{ccn} + z_{ij}^{fcn} + z_{ij}^{mcn}) + v_j^{cn} = x_j^c - e_j^{cp} \tag{22}$$

$$\sum_{i=1}^{K}(z_{ij}^{ccp} + z_{ij}^{ccp} + z_{ij}^{mcp}) + v_j^{cp} = e_j^{cp} \tag{23}$$

$$\sum_{j=1}^{K}(z_{ij}^{cfn} + z_{ij}^{ffn} + z_{ij}^{mfn}) + v_j^{fn} = x_j^f - e_j^{fp} \tag{24}$$

$$\sum_{i=1}^{K}(z_{ij}^{cfp} + z_{ij}^{ffp} + z_{ij}^{mfp}) + v_j^{fp} = e_j^{fp} \tag{25}$$

Constraint set 3: intermediate inputs adding up condition for each column

$$\sum_{j=1}^{K}(z_{ij}^{ccn} + z_{ij}^{fcn} + z_{ij}^{mcn}) + \sum_{j=1}^{K}(z_{ij}^{ccp} + z_{ij}^{fcp} + z_{ij}^{mcp}) = x_j^c - v_j^c \tag{26}$$

$$\sum_{j=1}^{K}(z_{ij}^{cfn} + z_{ij}^{ffn} + z_{ij}^{mfn}) + \sum_{j=1}^{K}(z_{ij}^{cfp} + z_{ij}^{ffp} + z_{ij}^{mfp}) = x_j^f - v_j^f \tag{27}$$

Constraint set 4: intermediate inputs adding up condition for each inter industry transaction

$$\sum_{l}\sum_{k} z_{ij}^{clk} + \sum_{l}\sum_{k} z_{ij}^{flk} + \sum_{l}\sum_{k} z_{ij}^{mlk} = z_{ij} \tag{28}$$

Constraint set 5: import intermediate inputs adding up condition

$$\sum_{j=1}^{K} z_{ij}^{mlk} = m_i^{lk} \qquad \text{for } l = c, f \quad k = n, p \tag{29}$$

Constraint 6: value-added and final use constraints

$$\sum_{k} v_j^{lk} = v_j^l, \qquad l = c, f \tag{30}$$

$$y_i^c + y_i^f = y_i - y_i^m \tag{31}$$

Constraint 7: Non-negativity constraints

$$z_{ij}^{llk}, \quad z_{ij}^{mlk}, \quad v_j^{lk}, \quad y^m \geq 0 \qquad for\ l = c, f \quad k = n, p \tag{32}$$

The economic meanings of the 7 sets of constraints are straightforward. Equations (19)-(21) are row sum constraints for the expanded I/O account. They state that total gross output of sector *i* has to be equal to the sum of domestic intermediaries, final demand and exports (both processing and normal exports from different type of enterprises) in that sector. Similarly, total imports have to equal imported intermediate inputs plus imports delivered to final users. Equations (22)-(25) are column sum constraints for the expanded I/O account. They define the value of processing exports and normal production for the four type firms in sector *j* as the sum of domestic and imported intermediate inputs as well as primary factors inputs. These seven constraints are corresponding equations to the three rows and four columns in the extended I/O account presented by Table 2. Equations (26) and (27) are column sum identities of intermediate inputs used by COEs and FIEs. They state that total intermediate inputs of COEs and FIEs have to equal to total outputs minus value added (both gross output and value-added by sectors are obtained from NBS ASIP by aggregation). Equations (28) to (31) are a set of adding-up constraints to ensure that the solution from the model is consistent with official statistics on sector-level trade and within-industry transactions. Equation (32) is the non-negativity condition for elements in the extended I/O table.[18]

IV. Results

Using the estimation method described in the previous section, we estimated an extended non-competitive IO table with separate production account by the four type firms. In Appendix table A3, we give all trade share parameters that we use in estimation. Base on the table and the set parameters, the results of domestic and foreign value added share of 4 type exports are estimated.

4.1. Share of domestic and foreign value added

[18] The partition among the five parts of imports(m_i^{cp}, m_i^{cd}, m_i^{fp}, m_i^{fd} and y_i^m) based on Custom import statistics and UN BEC classification is allow to adjust (which we are less confident) slightly only to the extent that a feasible solution from model could be obtained. This reconciliation procedure is implemented in GAMS (Brooke et al, 2005), related computer programs and data files will be available at the USITC website for downloading sometime in the future.

Table 4 presents our estimation results for the share of domestic (DVs) and foreign value added (FVs, or vertical specialization) in China's processing and normal exports by COEs and FIEs in 2007, which are calculated by using equation (6)-(9). We start with the benchmark I/O table with 42 sectors, in the top panel.[19] As it shows, though the direct domestic value-added share for processing COEs is very close to that for non-processing COEs (i.e., at 20.86% and 22.04 respectively), the total domestic value-added share of the former, at 36.95%, is much lower than the latter, at 84.9%. Similarly for FIEs, the total domestic value-added share of processing exporters is 36.81 while that of non-processing exporters is 78.95%. This is consistent with the findings in KWW and Chen et al. (2012). However, we find that the domestic value added share of COEs and FIEs are very similar in the same trade mode. So we conclude that the difference of value added share between COEs and FIEs can be mainly attributed to the ratio of processing exports to non-processing exports. In the bottom panel of Table 4, we further utilize the most disaggregate I/O table with 135 sectors. The patterns are quite similar to the 42 sector I/O table. Summing across all types of firms, nearly 60% of Chinese exports are domestic value-added, while 40% are foreign value-added.

[Insert Table 4 Here]

4.2. Comparison with previous studies

In Table 5, we compare our decomposition results with those of existing literature, namely share of value-added estimated by HIY (2001), KWW (2012), and Chen et al. (2012). In general, our results are very close to those of KWW and Chen et al. Compared with HIY (2001) that impose proportionality assumption, all other three studies show lower domestic value added share and higher foreign value added share in China's exports. This indicates that ignoring the difference between processing export and normal exports, as HIY do, will overestimate domestic value added share and underestimate foreign value added share. The domestic value-added share estimates of Chen et al. for manufacturing sector is 2 percent lower than our estimation results, but in general these 3 methods give very close estimates.

[Insert Table 5 Here]

4.3. Decomposition of domestic value added

[19] A concordance between the 42 sectors and the 135 sectors is provided in the Appendix D.

In 2007, the gross value of Chinese exports is 1.22 trillion US dollars, and the share of domestic value added in Chinese gross exports is estimated to be 59%, so the gross domestic value added in export is 720 billion US dollars. Figure 3 shows the contribution of COEs and FIEs in processing exports and normal exports. Nearly 45% of domestic value added can be attributed to the FIEs. The income that goes to COEs is a bit larger than a half of the total exports. This distribution of value-added across four firm types, as well as the value-added to gross export ratio (VAX) for each firm type, is also shown in Table 6.

[Insert Figure 3 Here]

[Insert Table 6 Here]

4.4. Domestic and foreign value added share by sectors

In Table 7, we show the decomposition of value added by manufacturing sectors. Again, in the top panel we start with the 42-sector I/O table, and follow it with the 135-sector I/O table in the bottom panel for more disaggregate patterns. First, out of the 42 sectors, 16 belong to manufacturing. Sorting by domestic value-added share in a descending order, 3 sectors have domestic value-added share over 75 percent. They are textile and apparel industry, leather, fur and feather, and finally timber production. They are all labor-intensive and export mostly in normal regime. Only one industry –communication equipment and computer – falls below 50 percent. This is a typical industry that is deeply integrated with the global supply chain and has a large proportion of processing exports.

Similarly but to a more disaggregate level, the bottom panel shows that out of the 80 manufacturing sectors, 20 sectors have domestic value-added share over 80 percent. Those with relatively high share of domestic value-added are in food and beverage sectors, such as Tobacco, Slaughtering and Processing of Meat, Alcohol and Wine, etc. This high domestic share category also includes textile, cement, medicines, etc. Those sectors have relatively lower share of processing exports. In contrast, most high-tech industries have relatively low share of domestic value-added. 12 industries have domestic value-added share less than 50 percent, most of which can be labeled as relatively high-tech and sophisticated. They also tend to have high share of processing exports. For example, processing exports account for nearly 98 percent of exports in Computer sector, and processing exports by FIEs is as high as 90 percent. This observation is consistent with KWW using a sample of 57 manufacturing industries. In the past decades,

especially after China joining the WTO, China accelerated its integration into global supply chain, its exports in those high-tech industries have been growing quickly. However, due to their low share of domestic content, their role in driving GDP growth is less impressive. In between are 48 sectors with domestic value added share above 50% but below 80%. Many sectors in this range are also labor intensive, including such as furniture, apparel, headgear, and footwear, etc.

[Insert Table 7 Here]

4.5. The distribution of value added in exports to factor owners

In order to capture the foreign factor inputs in each sector, we add a row of foreign factor income in the bottom of the expanded IO table (Table 2). There are two types of foreign factor inputs in domestic production: labor and capital. As we discussed in the data section, to infer foreign labor and capital income share, we utilize the merged sample of ASIP balance sheet data and the CGAC trade data to get value added and foreign share in total paid-in capital for all four types of firms. Multiplying those shares with operation surplus gives the foreign capital income in domestic value-added. In addition, we collect sector level investment income data from Balance of Payment (BOP) table compiled by the People's Bank of China (PBOC). In each sector, we apply the labor and capital income share based on the BOP to compute the share of foreign factor in the value-added of export by four types of firms.[20]

Table 8 presents our estimates on foreign income shares in processing and normal exports by either COEs or FIEs, based on equations (10)-(12). Obviously there is a small share of foreign income in exports generated by COEs. In 2007, for each 100 US dollars processing exports by COEs, 37 dollars are domestic value-added, only 0.5 dollars can be attributed to foreign factor income. Similarly, for each 100 US dollars normal exports by COEs, 85 dollars are domestic value-added, only 0.76 dollars is attributed to foreign factor income. While the foreign factor income share in FIEs is much higher. For example, for each 100 US dollars processing exports by FIEs, 37 dollars are domestic value added, while 16.3 dollars can be attributed to foreign factor income. Similarly, for each 100 US dollars normal exports by FIEs, 79 dollars are domestic value added, a striking 33 dollars is attributed to foreign factor income.

Based on equations (11) and (12), we can use domestic value added in exports minus the part that goes to foreign factors income to estimate the domestic GNI of exports. Then using

[20] Detailed procedure is provided in Appendix C.4.

foreign value added in exports[21] plus the foreign income from domestic value added, we can get the foreign GNI of Chinese exports. The results are shown in the last two rows of Table 8. In China, the majority of processing exports contributes to foreign GNI, regardless of the ownership type of exporters. For example, for 100 US dollar processing exports by COEs, on average 63.5 dollars go to foreign GNI. The number is even higher for processing exports by FIEs. About half of normal exports by FIEs can be attributed to foreign GNI, while the foreign GNI share in normal exports by COEs is much lower, at around 16 percent. Overall, there are 47.5 US dollars in domestic GNI and 52.5 US dollars in foreign GNI for each 100 USD Chinese gross exports.

[Insert Table 8 Here]

4.6. Robustness check

In our benchmark estimation, we set the initial values for inter-industry, inter-firm type transaction, final demand, and value-added, $z0_j^{lk}$, $y0_j^{lk}$, $v0_j^{lk}$, based on the available official I/O table and other available statistics. However, different sets of initial values may affect our estimated I/O table by firm types. Besides the above-mentioned initial values, we perform three alternative ways of setting the initial values as sensitivity tests.

First, we initialize the value-added, $v0_j^{lk}$, as the residual of total gross output minus total intermediate input. That is:

$$v0_j^{lk} = x0_j^{llk} - \sum_{i=1}^{K} z0_{ij}^{clk} - \sum_{i=1}^{K} z0_{ij}^{flk} - \sum_{i=1}^{K} z0_{ij}^{mlk} \quad l = c, f \quad k = n, p$$

Second, by combining the industrial firm survey data and the trade data, we can separate v_i^c, v_i^f into the initial values $v0_i^{cp}$ and $v0_i^{cn}$, $v0_i^{fp}$ and $v0_i^{fn}$.

The initial value of domestic final demand $y0_i^l$ is generally derived as residuals implied by equations (17) and (26). Any negative values are replaced by zero or

$$y0_i^l = (y_i - y_i^m)\frac{x_i^l - e_i^{\ln} - e_i^{lp}}{x_i - e_i}$$

while the intermediate input matrix is set as follows：

[21] We assume there is no Chinese owned factor income in these imported foreign value-added, it may not 100% true as China's outgoing FDI grow at dramatic pace in recent years.,

$$z0_{ij}^{clk} = \frac{z_{ij}}{\sum_{i}^{K} z_{ij}} \frac{x0_j^{lk} - v0_j^{lk}}{x0_j - v0_j} \frac{x0_i^{cn} - e0_i^{cn} - y0_i^{cn}}{x0_i - e0_i - y0_i}$$

$$z0_{ij}^{flk} = \frac{z_{ij}}{\sum_{i}^{K} z_{ij}} \frac{x0_j^{lk} - v0_j^{lk}}{x0_j - v0_j} \frac{x0_i^{fn} - e0_i^{fn} - y0_i^{fn}}{x0_i - e0_i - y0_i}$$

$$z0_{ij}^{mlk} = \frac{z_{ij}}{\sum_{i}^{K} z_{ij}} \frac{x0_j^{lk} - v0_j^{lk}}{x0_j - v0_j} \frac{m0_i - y0_i^{m}}{x0_i - e0_i - y0_i}$$

Finally, similar to the second method, we first initialize the value of domestic final demand, $y0_i^l$, as residuals implied by equations (13) to (17) and the intermediate transaction matrix is set as follows：

$$z0_{ij}^{clk} = \frac{z_{ij}}{\sum_{i}^{K} z_{ij}} \frac{x0_j^{lk}}{x0_j} \frac{x0_i^{cn} - e0_i^{cn} - y0_i^{cn}}{x0_i - e0_i - y0_i}$$

$$z0_{ij}^{flk} = \frac{z_{ij}}{\sum_{i}^{K} z_{ij}} \frac{x0_j^{lk}}{x0_j} \frac{x0_i^{fn} - e0_i^{fn} - y0_i^{fn}}{x0_i - e0_i - y0_i}$$

$$z0_{ij}^{mlk} = \frac{z_{ij}}{\sum_{i}^{K} z_{ij}} \frac{x0_j^{lk}}{x0_j} \frac{m0_i - y0_i^{m}}{x0_i - e0_i - y0_i}$$

Value-added is initialized similar to the first method as the residual of total gross output minus total intermediate input.

Table 9 reports the results of direct domestic value-added and total domestic value-added share using different initial values. All alternative ways of initialization give qualitatively and quantitatively similar pattern and magnitude. We thus conclude that our benchmark estimation is robust, as long as we control gross output and value-added for each industry by COEs and FIEs from industrial survey data and intermediate imports use for each type firms from trade statistics, both of them are aggregated from more detailed micro data. Sector level results of these sensitivity tests are listed in the Appendix Table A5. Except for a few cases, most sectors are still in the same range of total domestic value-added share as indicated the benchmark results. The correlation between benchmark and alternative method 1, for example, is 95%.

[Insert Table 9 Here]

V. Conclusion

For most countries that we know of, national statistical agencies usually compile an I/O table at the industry level for the whole economy. I/O tables are not separately available for exporters and non-exporters. It assumes that there exists only one single homogenous production technology for all of the firms (and all of the products) in the same industry classification. In other words, a single average production technology is deemed to produce the entire output of the industry. We know that the truth is that different firms, even those producing the same products, often use different production technology, and thus have different IO coefficients and import intermediate use intensity. This paper provides an estimation method to reduce the aggregation bias caused by firm heterogeneity in existing IO tables by combine firm level and industry-level data, thus make an important contribution to current vertical specialization and trade in value-added literature and have the potential applying to other developed and developing countries.

More specifically, complementary to the existing literature, we propose an extension to the approach of KWW (2012) by considering export by both FIEs and Chinese domestic owned firms, for processing exports and normal exports separately. Processing trade and FIEs play major role in the fast growth of Chinese exports. But they also use imported intermediate inputs much more intensively than normal exports by COEs. Thus it is important to separate domestic production by trade mode and ownership to capture processing and FIEs exports. By extending the theoretical framework of KWW (2012) and apply it to China's firm level trade and production data, we are able to obtain more detailed estimates on domestic and foreign value-added share in Chinese exports. Our empirical results show that processing exports and exports by FIEs have much lower domestic value added share. However, within processing export regime, the value-added structures between FIEs and COEs are similar, indicating the major source of difference in domestic value added share between FIEs and COEs is their different fraction of processing trade.

We further study the distribution of gross national income (GNI) by factor ownership. In the total Chinese export value, about 52% is obtained by foreign factors owners. This implies the

Chinese local gain from exports in value-added term may not be as large as what official trade statistics indicate.

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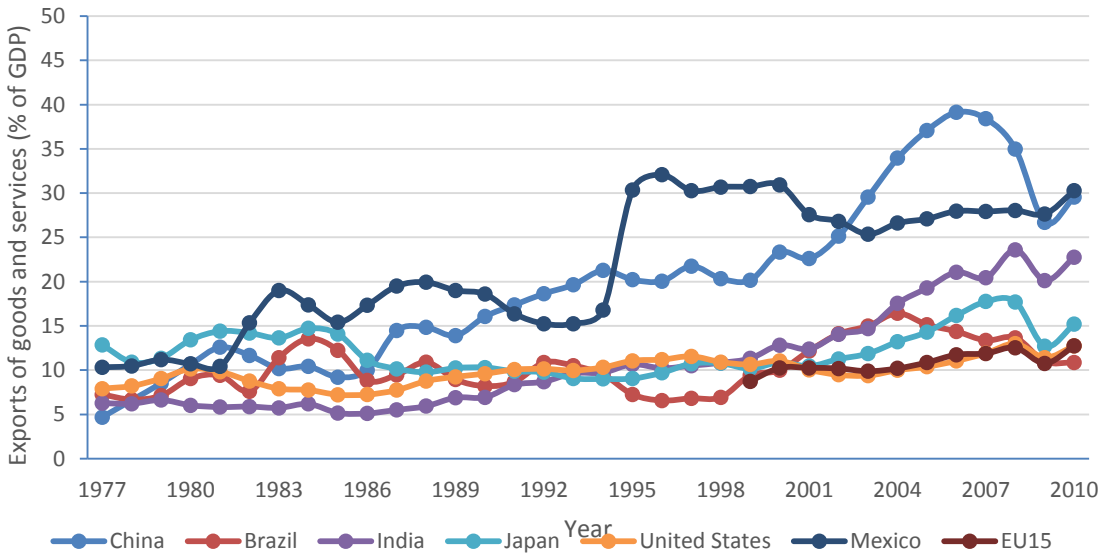
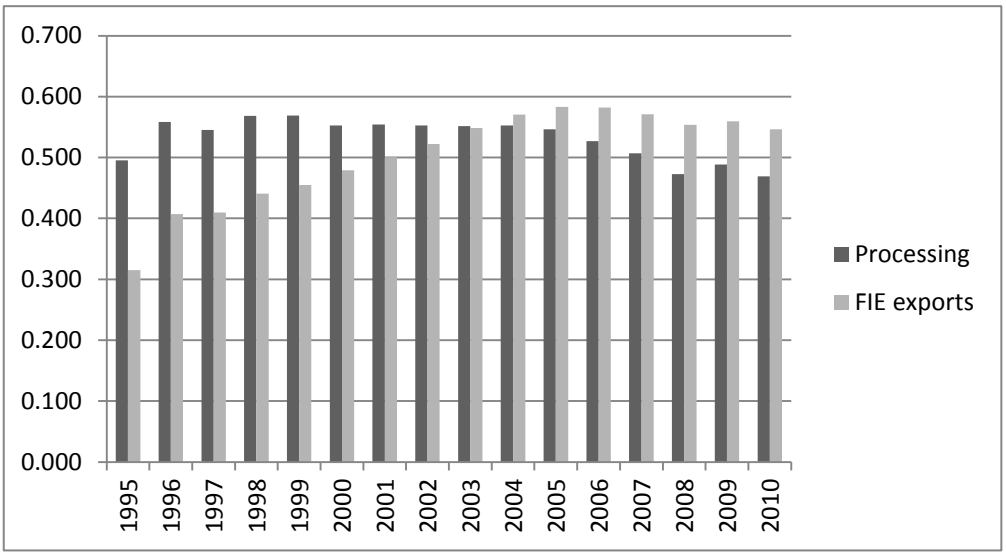
Figure 1 Export/ GDP for large economies in the world, 1977-2010



DATA source: UN comtrade and the World Development Indicators. EU-15's export excludes trade within EU-15 countries.

Figure 2 Processing exports and FIEs exports in China (1995-2010)



Data Source: China Customs

Figure 3 Distribution of Domestic Value Added Across Four Types of Exporters, 2007

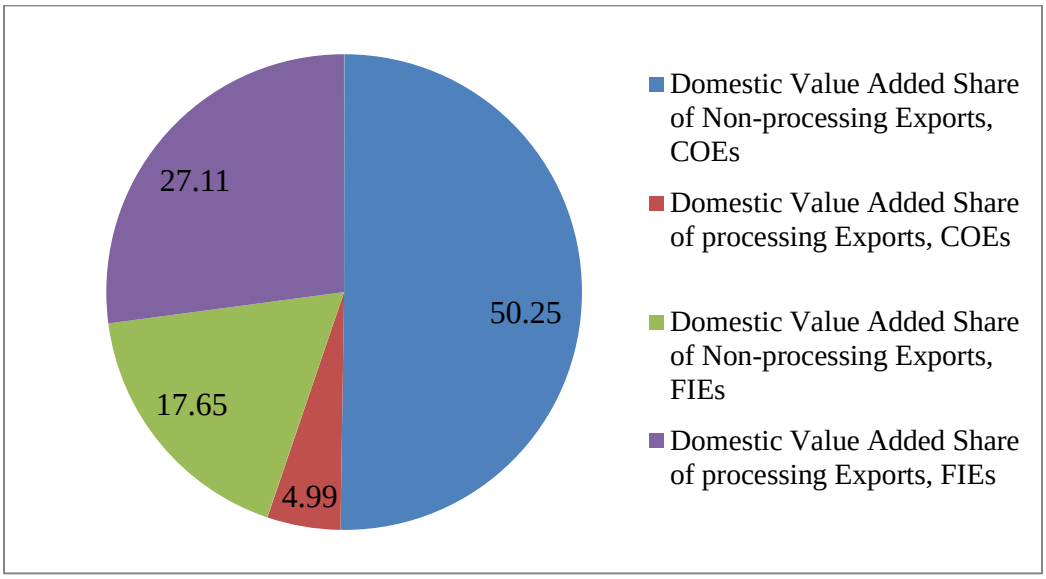


Figure 4: Kernel density for CP and FP Firms.

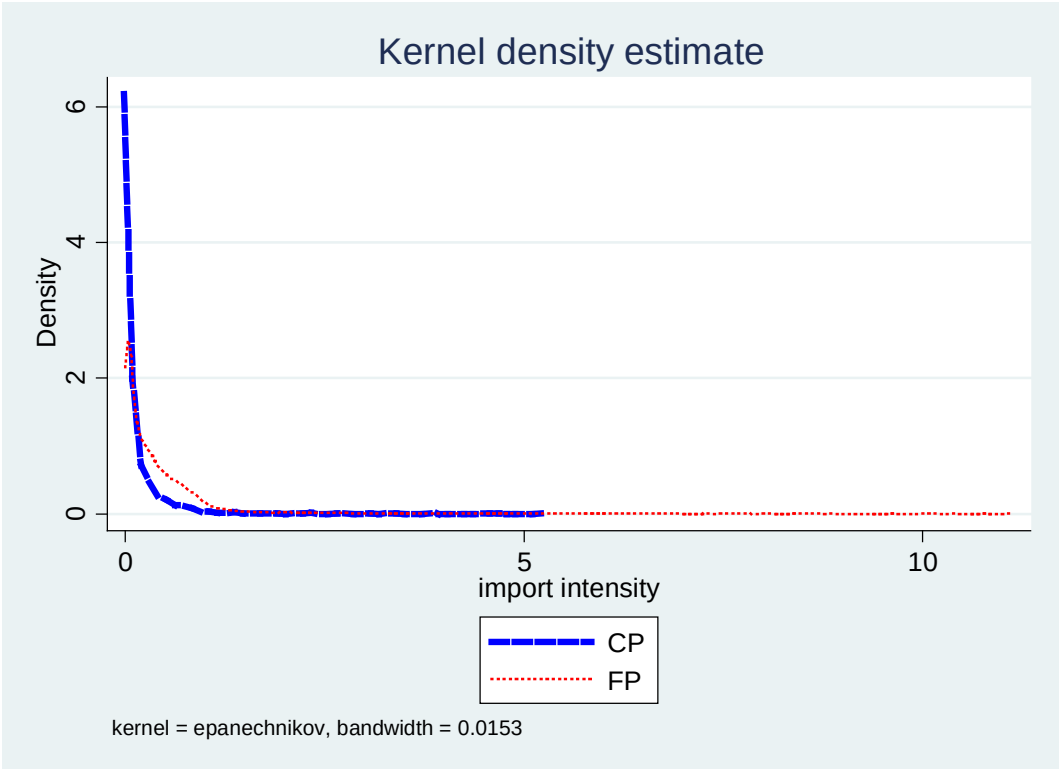


Table 1: Structure of import uses and share of processing exports, 2002-2007

Year	Firm type	imported intermediates for		imported capital goods for		imported goods for final consumption	share of	
		processing exports	normal use	processing exports	normal use		Normal exports	processing exports
2007	State Owned Firms	10.72	73.53	2.06	11.32	2.37	73.00	27.00
2007	Joint Venture Firms	34.10	46.35	9.34	7.83	2.38	39.10	60.90
2007	Whole Foreign Owned	58.10	18.07	17.60	2.69	3.55	16.09	83.91
2007	Collective Firms	18.03	72.38	1.69	6.43	1.48	75.83	24.17
2007	Private Firms	12.18	65.88	1.45	13.28	7.20	90.04	9.96
2007	All Firms	32.78	47.30	9.03	7.59	3.31	48.34	51.66
2008	State Owned Firms	7.64	79.87	1.56	8.79	2.13	76.17	23.83
2008	Joint Venture Firms	31.03	49.09	9.56	7.94	2.38	42.68	57.32
2008	Whole Foreign Owned	52.82	22.05	16.87	3.45	4.81	18.36	81.64
2008	Collective Firms	13.81	77.09	1.24	6.40	1.47	78.51	21.49
2008	Private Firms	11.23	66.75	1.79	12.35	7.88	90.45	9.55
2008	All Firms	27.54	53.44	8.14	7.18	3.70	51.87	48.13
2009	State Owned Firms	8.00	76.10	1.58	11.75	2.58	71.38	28.62
2009	Joint Venture Firms	28.90	52.47	7.27	9.11	2.25	41.34	58.66
2009	Whole Foreign Owned	49.90	25.40	13.94	4.66	6.11	17.86	82.14
2009	Collective Firms	10.77	80.48	0.77	6.39	1.58	77.82	22.18
2009	Private Firms	9.30	69.88	1.71	11.84	7.28	89.63	10.37
2009	All Firms	26.02	54.14	6.73	8.76	4.36	50.20	49.80
2010	State Owned Firms	6.96	77.52	1.10	11.06	3.37	76.95	23.05
2010	Joint Venture Firms	25.33	50.66	5.97	15.52	2.53	52.77	47.23
2010	Whole Foreign Owned	42.93	29.71	11.65	8.64	7.07	36.06	63.94
2010	Collective Firms	11.07	79.90	0.58	7.32	1.13	80.62	19.38
2010	Private Firms	8.50	71.46	1.20	12.26	6.58	90.21	9.79
2010	All Firms	23.21	55.10	5.68	11.05	4.95	58.65	41.35
2010	State Owned Firms	5.98	81.36	0.73	8.88	3.05	75.71	24.29
2010	Joint Venture Firms	26.13	56.40	6.44	8.23	2.81	45.20	54.80
2010	Whole Foreign Owned	44.68	27.18	11.70	6.80	9.64	19.98	80.02
2010	Collective Firms	10.70	83.12	0.50	4.33	1.34	81.48	18.52
2010	Private Firms	7.99	71.93	0.96	12.68	6.43	89.09	10.91
2010	All Firms	22.00	58.55	5.17	8.64	5.64	54.79	45.21

Note: estimation based on Chinese custom data and the UN BEC classification

Table 2: Non-competitive I/O table with separate production account for both Chinese and Foreign invested firm and processing trade

Output / Input		Intermediate use by COEs		Intermediate use by FIEs		Final use	Exports	Gross Output or Imports
		N	P	N	P			
Domestic Intermediate input of COEs	N	Z^{CCN}	Z^{CCP}	Z^{CFN}	Z^{CFP}	Y^{C}	E^{CN}	$X^{C}-E^{CP}$
	P	0	0	0	0	0	E^{CP}	E^{CP}
Domestic Intermediate input of FIEs	N	Z^{FCN}	Z^{FCP}	Z^{FFN}	Z^{FFP}	Y^{F}	E^{FN}	$X^{F}-E^{FP}$
	P	0	0	0	0	0	E^{FP}	E^{FP}
Imports		Z^{MCN}	Z^{MCP}	Z^{MFN}	Z^{MFP}	Y^{M}	0	M
Value added		V^{CN}	V^{CP}	V^{FN}	V^{FP}			
Gross Input		$X^{C}-E^{CP}$	E^{CP}	$X^{F}-E^{FP}$	E^{FP}			
Foreign income		G^{CN}	G^{CP}	G^{FN}	G^{FP}			

Note: Where superscript *C* and *F* represent COEs and FIEs, respectively, *P* and *N* represent processing exports, domestic sales and normal exports, respectively. *X* is gross output, E is gross exports, *M* is imports, *Z* is intermediate inputs, *Y* is total final demand except for exports, *V* is value added, and *G* is foreign income.

The direct input coefficients based on this estimated I/O table can be expressed as:

$$A^{CCN}=[a_{ij}^{ccn}]=[\frac{z_{ij}^{ccn}}{x_j^c-e_j^{cp}}],\ A^{FCN}=[a_{ij}^{fcn}]=[\frac{z_{ij}^{fcn}}{x_j^c-e_j^{cp}}],\ A^{MCD}=[a_{ij}^{mcn}]=[\frac{z_{ij}^{mcn}}{x_j^c-e_j^{cp}}],$$

$$A^{CFN}=[a_{ij}^{cfn}]=[\frac{z_{ij}^{cfn}}{x_j^f-e_j^{fp}}],\ A^{FFN}=[a_{ij}^{ffn}]=[\frac{z_{ij}^{ffn}}{x_j^f-e_j^{fp}}],\ A^{MFN}=[a_{ij}^{mfn}]=[\frac{z_{ij}^{mfn}}{x_j^f-e_j^{fp}}],$$

$$A^{CCP}=[a_{ij}^{ccp}]=[\frac{z_{ij}^{ccp}}{e_j^{cp}}],\ A^{FCP}=[a_{ij}^{fcp}]=[\frac{z_{ij}^{fcp}}{e_j^{cp}}],\ A^{MCP}=[a_{ij}^{mcp}]=[\frac{z_{ij}^{mcp}}{e_j^{cp}}],$$

$$A^{FCP}=[a_{ij}^{fcp}]=[\frac{z_{ij}^{fcp}}{e_j^{fp}}],\ A^{FFP}=[a_{ij}^{ffp}]=[\frac{z_{ij}^{ffp}}{e_j^{fp}}],\ A^{MFP}=[a_{ij}^{mfp}]=[\frac{z_{ij}^{mfp}}{e_j^{fp}}],$$

$$A_v^{CN} = [a_j^{vcn}] = [\frac{v_j^{cn}}{x_j^c - e_j^{cp}}], A_v^{CP} = [a_j^{vcp}] = [\frac{v_j^{cp}}{e_j^{cp}}], A_v^{FN} = [a_j^{vfn}] = [\frac{v_j^{fn}}{x_j^f - e_j^{fp}}], A_v^{FP} = [a_j^{vfp}] = [\frac{v_j^{fp}}{e_j^{fp}}]$$

$$A^{GCN} = [a_j^{gcn}] = [\frac{g_j^{cn}}{x_j^c - e_j^{cp}}], A^{GCP} = [a_j^{gcp}] = [\frac{g_j^{cp}}{e_j^{cp}}], A^{GFN} = [a_j^{gfn}] = [\frac{g_j^{fn}}{x_j^f - e_j^{fp}}], A^{GFP} = [a_j^{gfp}] = [\frac{g_j^{fp}}{e_j^{fp}}]$$

Where *i* represents rows and *j* represents columns, superscript *G* denotes foreign income.

Table 3A: Mean and percentile comparisons in input intensity among groups

type	Freq.	mean	variance	p25	p50	p75	p90	p99
Imported input over input								
CP	4,112	0.144	0.127	0.003	0.028	0.124	0.392	1.635
FP	22,495	0.436	0.655	0.049	0.217	0.536	0.899	4.300
CN	41,885	0.003	0.000	0.000	0.000	0.000	0.000	0.086
FN	24,136	0.037	0.015	0.000	0.000	0.002	0.089	0.687
Total		0.123	0.201	0.000	0.000	0.041	0.372	1.612
Imported input over output								
CP	4,112	0.103	0.059	0.002	0.021	0.096	0.288	1.035
FP	22,495	0.287	0.202	0.036	0.159	0.388	0.656	2.113
CN	41,885	0.002	0.000	0.000	0.000	0.000	0.000	0.063
FN	24,136	0.027	0.009	0.000	0.000	0.001	0.063	0.494
Total		0.082	0.068	0.000	0.000	0.030	0.270	0.969

Source: the merged sample of customs data and ASIP

Table 3B: Mean differences in imported input intensity, Scheffe multiple-comparison test

Comparison of	Imported input / input			Imported input / output		
Row Mean - Column Mean	CP	FP	CN	CP	FP	CN
FP	0.291			0.184		
CN	-0.141	-0.433		-0.101	-0.285	
FN	-0.107	-0.399	0.034	-0.076	-0.259	0.025

Note: We do the analysis of variance using the Scheffe multiple-comparison test. Input intensity is defined as the value of imported input over total output. Differences defined as row mean - column mean. All are significant at 1% level.

Source: the merged sample of customs data and ASIP

Table 3C: Mean and between- and within group variance by major I/O sectors

sector no.	sector_name	# firms	# exporters	# processing exporters	b/w group variance	Within group mean [variance]			
					Mean Square	CP	FP	CN	CP
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
6	Food and tobacco	28,141	5,455	1,185	22.2	0.207*[0.170]*	0.291*[0.467]*	0.001*[0.000]*	0.010*[0.003]*
7	Textile	27,210	9,617	2,100	49.5	0.089 *[0.037]*	0.335 *[0.299]*	0.002 *[0.000]*	0.008 *[0.003]*
8	Apparel, leather, furs, down	21,584	12,692	4,593	324.6	0.162*[0.158]*	0.614*[1.350]*	0.001*[0.000]*	0.005*[0.002]*
9	Sawmills and furniture	11,704	3,867	992	19.6	0.219*[0.395]*	0.303*[0.502]*	0.002 *[0.000]*	0.018*[0.006]*
10	Paper & printing	17,039	4,645	1,649	37.4	0.129*[0.102]*	0.351*[0.359]*	0.004*[0.001]*	0.026*[0.008]*
11	Petroleum	1,955	89	10	0.2	0.104*[0.019]*	0.303*[0.091]*	0.004*[0.001]*	0.054 *[0.008]*
12	Chemicals	47,691	12,503	4,054	151.4	0.167*[0.099]*	0.465*[0.478]*	0.004 *[0.001]*	0.065 *[0.026]*
13	Nonmetal mineral products	23,598	3,889	612	9.4	0.165 *[0.227]*	0.258 *[0.166]*	0.003 *[0.000]*	0.032 *[0.013]*
14	Metals smelting and pressing	12,976	1,720	306	25.6	0.176 *[0.089]*	0.635 *[1.254]*	0.002 *[0.000]*	0.045 *[0.025]*
15	Metal products	17,522	5,697	1,362	28.8	0.086 *[0.025]*	0.313 *[0.296]*	0.001 *[0.000]*	0.033 *[0.016]*
16	Equipment	39,098	10,372	1,864	43.0	0.069 *[0.041]*	0.325 *[0.339]*	0.003 *[0.000]*	0.068 *[0.025]*
17	Transport equipment	13,503	3,711	882	26.7	0.063 *[0.016]*	0.395 *[0.354]*	0.003 *[0.000]*	0.092 *[0.036]*
18	Electric equipment and machinery	18,728	6,520	2,166	55.6	0.091 *[0.133]*	0.369 *[0.468]*	0.002 *[0.000]*	0.038 *[0.015]*
19	Telecom, computer, other electronics	10,446	6,007	3,227	128.8	0.202 *[0.126]*	0.558 *[0.916]*	0.010 *[0.002]*	0.069 *[0.029]*
20	Instruments, office machinery	4,337	1,905	695	21.5	0.166 *[0.172]*	0.419 *[0.488]*	0.005 *[0.001]*	0.066 *[0.026]*
21	Other manufacturing	6,242	3,939	910	22.7	0.145 *[0.326]*	0.332 *[0.475]*	0.001 *[0.000]*	0.007 *[0.001]*
	Total	301,774	92,628	26,607	991.4	0.144 *[0.127]*	0.436 *[0.655]*	0.003 *[0.00]*	0.037 *[0.015]*

Note: Columns (3) - (5) give the number of firms, the number of exporters, the number of processing exporters respectively. Column (6) gives the between group variances (mean of sum of squares errors) and columns (7)-(10) give the within group mean and variance of imported input intensity (imported input/total input) respectively, within-group variances are in bracket. The imported input/output gives very similar pattern.

Source: the merged sample of customs data and ASIP.

Table 4: The domestic and foreign value added share of China's exports (%), 2007

Total Merchandise	Direct domestic value-added	Total domestic value-added	Direct foreign value-added	Total foreign value-added
Based on 42 Sectors I-O Table				
Processing exports by COEs	20.86	36.95	60.00	63.05
Non-processing exports by COEs	22.04	84.90	4.41	15.10
Total exports by COEs	**21.82**	**76.00**	**14.74**	**24.00**
Processing exports by FIEs	17.54	36.81	58.87	63.19
Non-processing exports by FIEs	21.34	78.95	10.85	21.05
Total exports by FIEs	**18.42**	**46.62**	**47.69**	**53.38**
Total gross exports	**19.89**	**59.28**	**33.49**	**40.72**
Based on 135 Sectors I-O Table				
Processing exports by COEs	15.58	35.46	60.64	64.52
Non-processing exports by COEs	22.14	84.11	4.64	15.89
Total exports by COEs	**20.92**	**75.07**	**15.04**	**24.92**
Processing exports by FIEs	16.64	37.30	57.73	62.70
Non-processing exports by FIEs	23.00	79.53	9.76	20.46
Total exports by FIEs	**18.12**	**47.13**	**46.56**	**52.86**
Total gross exports	**19.33**	**59.17**	**32.98**	**40.82**

Table 5: Decomposition of Chinese gross exports (%), 2007

	HIY (2001)	KWW (2012)	Chen et. al (2012)	**Based on 42 Sectors IO Table**	**Based on 135 Sectors IO Table**
Manufactures					
Direct domestic value-added	24.6	16.5	18.4	**19.39**	**18.80**
Total Domestic Value-added	72.9	59.7	57.3	**59.19**	**58.99**
Direct foreign value-added	16.3	32.4	34.7	**33.50**	**33.08**
Total Foreign value-added	27.1	40.3	42.7	**40.81**	**41.00**
Total Merchandise					
Direct domestic value-added	20.3	17.1	19.6	**19.89**	**19.33**
Total Domestic Value-added	71.3	60.6	60.6	**59.28**	**59.17**
Direct foreign value-added	13.7	31.6	31.5	**33.49**	**32.98**
Total Foreign value-added	28.7	39.4	39.4	**40.72**	**40.82**

Table 6: **Distribution of Domestic Value Added and VAX by firm type (%), 2007**

	COEs exports		FIEs exports	
	normal	processing	normal	processing
% share in gross exports	43.66	8.00	13.25	35.08
Based on 42 Sectors I-O Table:				
% share in total domestic value added exports	50.25	4.99	17.65	27.11
VAX ratio	84.9	36.95	78.95	36.81
Based on 135 Sectors I-O Table:				
% share in total domestic value added exports	49.87	4.80	17.82	27.52
VAX ratio	84.11	35.46	79.53	37.30

Note: VAX is defined as value added exports over total exports

Table 7: Decomposition of Domestic Value Added by Sectors (Share), 2007

7.1: based on 42 sectors I-O table

	industry	CP		FP		CN		FN		Aggregate
		DVAs	Exports share	DVAs	Exports share	DVAs	Exports share	DVAs	Exports share	
7	Manufacture of Textile	43.06	5.67	29.79	12.33	89.08	67.14	86.94	14.86	**78.84**
8	Textile Wearing Apparel, Footwear, Caps, Leather, Fur, Feather(Down) and Its products	53.88	8.26	47.85	23.99	89.41	52.14	88.73	15.62	**76.40**
9	Processing of Timbers and Manufacture of Furniture	31.04	4.39	48.90	23.94	89.29	47.01	84.83	24.66	**75.97**
	Below 75Share									
13	Nonmetallic Mineral Products	26.59	2.10	26.81	18.72	88.68	57.80	82.83	21.39	**74.55**
21	Artwork and Other Manufacture	51.45	11.83	35.92	24.46	88.02	46.46	85.54	17.25	**70.52**
6	Manufacture of Foods and Tobacco	24.52	9.65	20.31	18.22	90.98	40.69	86.40	31.43	**70.25**
14	Smelting and Rolling of Metals	19.36	5.31	16.19	7.07	79.42	70.87	69.73	16.75	**70.13**
15	Manufacture of Metal Products	20.74	2.95	34.67	29.77	84.11	47.73	80.26	19.56	**66.77**
16	General Purpose and Special Purpose Machinery	22.72	4.88	22.27	26.70	84.13	46.57	76.77	21.84	**63.01**
10	Papermaking, Printing and Manufacture of Articles for Culture, Education and Sports Activities	45.69	11.76	49.66	51.98	87.10	24.49	72.22	11.77	**61.02**
17	Transport Equipment	42.33	23.18	19.39	19.05	84.07	40.34	73.24	17.43	**60.18**
12	Chemical Industry	19.79	10.71	20.85	25.67	83.01	47.70	77.73	15.91	**59.44**
20	Measuring Instrument and Machinery for Cultural Activity & Office Work	54.74	8.94	50.72	76.83	80.30	8.91	65.94	5.32	**54.52**
18	Electrical Machinery and Equipment	42.08	11.65	30.43	48.09	81.89	25.90	75.86	14.36	**51.64**
11	Processing of Petroleum, Coking, Processing of Nuclear Fuel	16.94	24.25	15.91	13.98	72.44	51.74	69.30	10.03	**50.76**
	Below 50Share									
19	Communication Equipment, Computer and Other Electronic Equipment	35.30	6.03	37.79	83.53	72.82	5.89	73.53	4.56	**41.33**
	Total	36.89	8.00	36.78	43.66	84.68	35.08	78.99	13.25	**59.19**

Note: Out of the 42 sectors, 16 belonging to manufacturing are studied in this table.

7.2: based on 135 sectors I-O table

	industry	CP		FP		CN		FN		Aggregate
		DVAs	Exports share	DVAs	Exports share	DVAs	Exports share	DVAs	Exports share	
24	Tobacco	7.64	0.43	7.64	0.89	95.23	98.68	82.06	0.00	**94.08**
38	Coking	0.00	0.00	0.00	0.00	90.76	88.57	73.88	11.43	**88.83**
15	Slaughtering and Processing of Meat	63.95	1.46	61.15	12.16	93.30	65.48	91.31	20.89	**88.54**
50	Cement, Lime and Plaster	61.22	0.09	42.96	2.72	89.76	69.53	81.72	27.66	**86.23**
12	Processing of Forage	61.81	0.36	51.96	6.48	89.43	56.56	86.82	36.60	**85.95**
17	Processing of Other Foods	63.14	2.41	59.77	6.38	89.42	50.28	86.17	40.93	**85.57**
22	Alcohol and Wine	62.54	1.03	44.19	7.62	90.74	59.36	86.17	31.99	**85.44**
27	Spinning and Weaving of Hemp and Tiffany	64.10	3.78	62.54	6.07	87.95	80.80	80.66	9.35	**84.83**
11	Grinding of Grains	62.70	1.19	59.62	10.67	90.17	35.02	85.55	53.12	**84.13**
46	Medicines	60.02	4.86	58.11	9.02	87.85	63.95	83.65	22.17	**82.88**
55	Fire-resistant Materials	63.08	0.55	60.05	8.84	88.19	46.19	81.31	44.41	**82.51**
56	Graphite and Other Nonmetallic Mineral Products	65.16	1.20	62.67	10.14	87.51	73.58	72.69	15.07	**82.48**
52	Brick, Stone and Other Building Materials	64.19	2.32	61.17	12.10	86.96	70.31	79.82	15.27	**82.22**
29	Knitted Fabric and Its Products	40.76	3.43	49.28	12.21	87.90	70.68	87.04	13.68	**81.45**
19	Liquid Milk and Dairy Products	60.48	0.15	56.54	8.48	88.87	39.91	79.52	51.45	**81.27**
28	Textile Products	45.15	7.85	60.14	12.83	88.75	58.75	86.52	20.57	**81.20**
58	Steelmaking	0.00	0.00	17.35	0.18	81.66	92.91	75.97	6.91	**81.16**
54	Pottery and Porcelain	65.01	0.78	63.81	7.65	84.31	67.21	78.23	24.37	**81.11**
14	Sugar	63.31	12.81	62.03	8.88	89.92	52.58	75.78	25.73	**80.40**
32	Processing of Timbers, Wood, Bamboo, Rattan, Palm and Straw Products	57.36	5.23	61.30	10.85	84.81	61.67	82.14	22.25	**80.23**
	Below 80Share									
21	Other Foods	60.20	7.85	58.49	15.41	87.94	41.60	84.29	35.13	**79.94**
69	Special Purpose Machinery for Mining, Metallurgy and Construction	58.14	4.93	62.99	7.45	84.14	65.51	77.01	22.11	**79.70**
20	Flavoring and Ferment Products	61.87	1.10	60.06	16.83	85.77	34.39	82.36	47.68	**79.55**
70	Special Purpose Machinery for Chemical Industry, Processing of Timber	63.84	2.51	64.57	16.78	82.75	45.30	83.00	35.41	**79.32**
35	Printing, Reproduction of Recording Media	63.02	9.93	68.78	29.10	86.90	45.60	85.48	15.36	**79.04**
23	Processing of Soft Drinks and Purified Tea	60.65	13.80	61.57	16.94	86.73	39.83	86.12	29.44	**78.69**
65	Metalworking Machinery	63.44	0.87	61.62	15.16	82.75	62.72	78.23	21.24	**78.42**
18	Convenience Food	63.38	3.42	61.63	26.09	87.10	32.83	83.73	37.66	**78.37**
40	Fertilizers	55.69	12.87	59.97	0.09	82.76	77.77	72.35	9.27	**78.29**
26	Spinning and Weaving, Dyeing and Finishing of Wool	61.90	11.15	64.03	28.66	90.42	42.07	79.28	18.11	**77.66**
60	Smelting of Ferroalloy	62.36	0.12	57.07	0.29	78.18	91.10	71.53	8.49	**77.54**
25	Spinning and Weaving, Printing and Dyeing of Cotton and Chemical Fiber	30.00	10.20	43.34	11.42	87.87	63.57	86.86	14.81	**76.73**

45	Chemical Products for Daily Use	64.83	3.42	66.80	26.53	79.90	45.27	81.49	24.78	**76.30**
71	Special Purpose Machinery for Agriculture, Forestry, Animal Husbandry a	63.87	6.37	62.26	15.77	82.56	57.34	73.03	20.52	**76.21**
57	Iron-smelting	40.45	0.57	45.46	0.48	76.78	75.10	73.88	23.84	**75.73**
64	Boiler and Prime Mover	59.06	7.27	63.74	17.73	82.31	56.48	71.43	18.52	**75.31**
59	Rolling of Steel	33.89	4.81	52.81	3.48	80.37	72.56	70.24	19.16	**75.23**
13	Refining of Vegetable Oil	63.42	6.69	61.19	31.32	87.11	25.95	80.24	36.04	**74.93**
30	Textile Wearing Apparel, Footwear and Caps	36.90	8.21	39.26	21.44	89.73	54.91	88.22	15.43	**74.34**
51	Products of Cement and Plaster	63.03	4.04	59.43	33.83	88.18	41.41	73.19	20.72	**74.33**
68	Other General Purpose Machinery	50.29	4.98	48.71	23.62	84.68	50.99	80.00	20.41	**73.52**
39	Basic Chemical Raw Materials	28.57	7.65	54.27	8.30	81.45	65.59	72.38	18.46	**73.47**
67	Pump, Valve and Similar Machinery	62.31	1.54	46.73	21.78	83.38	45.99	78.12	30.70	**73.46**
74	Automobiles	43.03	5.21	45.26	18.25	83.40	53.06	79.64	23.48	**73.45**
41	Pesticides	59.81	3.00	60.24	2.37	73.55	77.68	75.87	16.94	**73.21**
42	Paints, Printing Inks, Pigments and Similar Products	63.13	1.36	61.36	18.77	76.95	51.35	74.49	28.52	**73.13**
90	Artwork, Other Manufacture	39.76	11.83	53.52	24.46	86.55	46.46	84.37	17.25	**72.56**
73	Railroad Transport Equipment	58.67	32.43	62.07	4.55	81.11	55.34	67.31	7.68	**71.90**
76	Other Transport Equipment	56.96	4.86	50.22	23.14	82.29	48.15	73.79	23.85	**71.61**
33	Furniture	52.99	3.98	42.18	30.18	87.14	40.03	84.67	25.81	**71.57**
61	Smelting of Non-Ferrous Metals and Alloys	49.32	6.44	57.30	12.19	76.71	72.24	63.72	9.13	**71.39**
31	Leather, Fur, Feather(Down) and Its Products	35.34	8.34	41.09	28.38	89.33	47.33	89.10	15.94	**71.10**
53	Glass and Its Products	63.53	3.56	50.95	34.82	84.45	42.75	78.03	18.88	**70.83**
62	Rolling of Non-Ferrous Metals	41.09	9.70	52.98	20.80	77.73	50.89	77.45	18.61	**68.98**
44	Special Chemical Products	62.48	3.14	51.80	28.03	76.47	48.86	73.26	19.97	**68.47**
63	Metal Products	39.09	2.95	30.51	29.77	84.95	47.73	82.33	19.56	**66.88**
66	Lifters	56.52	9.30	52.20	40.77	83.32	30.57	71.67	19.36	**65.89**
34	Paper and Paper Products	59.02	9.89	50.77	50.90	85.01	25.20	81.96	14.00	**64.58**
87	Other Electronic Equipment	61.77	9.97	60.81	70.65	81.23	14.36	72.35	5.03	**64.42**
16	Processing of Aquatic Product	25.65	17.70	33.05	28.51	92.91	30.51	89.51	23.29	**63.15**
77	Generators	42.62	13.84	45.37	34.07	81.45	35.59	76.31	16.50	**62.93**
81	Other Electrical Machinery and Equipment	37.77	5.85	36.87	35.36	79.63	38.90	76.92	19.89	**61.52**
47	Chemical Fiber	37.99	19.79	50.95	34.61	76.18	32.75	74.84	12.85	**59.72**
72	Other Special Purpose Machinery	46.86	6.65	39.08	49.20	82.87	29.60	74.55	14.56	**57.72**
36	Articles for Culture, Education and Sports Activities	34.27	12.26	46.39	53.89	83.23	22.78	74.37	11.08	**56.40**
48	Rubber	25.20	19.55	31.06	32.29	81.51	38.60	77.53	9.56	**53.83**
49	Plastic	31.11	11.69	27.61	39.99	79.28	33.66	75.67	14.66	**52.45**
75	Boats and Ships and Floating Devices	39.71	68.67	65.16	18.02	84.76	11.01	74.72	2.29	**50.06**
	Below 50Share									
43	Synthetic Materials	40.25	12.13	34.21	55.60	75.28	21.78	69.41	10.50	**47.58**
79	Wire, Cable, Optical Cable and Electrical Appliances	43.16	8.71	27.90	56.80	79.53	22.18	78.90	12.30	**46.95**

80	Household Electric and Non-electric Appliances	26.80	16.43	27.20	47.62	82.31	22.30	78.18	13.65	**46.38**
37	Processing of Petroleum and Nuclear Fuel	15.15	32.11	37.46	18.51	68.06	39.81	69.23	9.57	**45.52**
88	Measuring Instruments	41.54	8.76	34.55	72.58	80.96	11.80	71.85	6.86	**43.19**
84	Computer	19.69	5.16	42.38	89.57	66.24	3.74	70.86	1.52	**42.54**
78	Equipments for Power Transmission and Distribution and Control	31.25	10.40	26.95	63.52	80.45	16.20	71.06	9.87	**40.42**
83	Radar and Broadcasting Equipment	40.70	9.47	32.45	73.19	71.98	12.01	71.45	5.34	**40.06**
82	Communication Equipment	33.27	4.95	33.22	78.19	74.72	8.49	66.83	8.38	**39.56**
89	Machinery for Cultural Activity & Office Work	37.68	9.13	27.64	81.38	75.22	5.81	75.54	3.67	**33.08**
85	Electronic Component	36.78	3.36	21.93	79.73	72.83	6.81	76.70	10.09	**31.42**
86	Household Audiovisual Apparatus	27.51	15.52	25.43	75.50	77.30	6.21	74.65	2.76	**30.34**
	Total	34.34	8.00	36.62	43.66	84.00	35.08	79.69	13.25	**58.77**

Note: Note: Out of the 135 sectors, 80 belonging to manufacturing are studied in this table.

Table 8. The national income and foreign income share of China's exports in 2007 (Share)

	Processing exports by COEs	Processing exports by FIEs	Normal exports by COEs	Normal exports by FIEs	Aggregate
Based on 42 Sectors I-O Table					
Total Domestic Value-added Share	36.95	36.81	84.90	78.95	59.28
Total Foreign Value-added Share	63.05	63.19	15.10	21.05	40.72
Total Foreign Income Share in Domestic Value-added	0.50	16.34	0.76	32.74	11.78
Total Domestic Income Share	36.45	20.47	84.14	46.20	47.50
Total Foreign Income Share	63.55	79.53	15.86	53.80	52.50

Note: TFI denotes total foreign incomes in total domestic value added, TDNI and TFNI denotes total domestic nation incomes and foreign incomes of gross exports.

Table 9: Direct domestic value added and Total domestic value added under different initial values.

	Scenario	Processing exports by COEs	Processing exports by FIEs	Normal exports by COEs	Normal exports by FIEs	Aggregate
Based on 42 Sectors I-O Table						
Direct domestic value added	benchmark	20.86	17.54	22.04	21.34	**19.89**
	alternative 1	20.73	17.55	22.05	21.34	**19.89**
	alternative 2	6.94	8.90	22.43	24.70	**15.58**
	alternative 3	6.61	17.62	22.44	21.36	**18.93**
	P&A Imports added	20.12	16.69	21.74	21.03	**19.31**
Total domestic value added	benchmark	36.95	36.81	84.90	78.95	**59.28**
	alternative 1	37.12	36.87	85.48	79.19	**59.55**
	alternative 2	34.99	35.79	85.08	79.87	**58.86**
	alternative 3	35.51	36.90	85.59	79.25	**59.48**
	P&A Imports added	34.85	34.71	84.06	77.47	**57.70**
Based on 135 Sectors I-O Table						
Direct domestic value added	benchmark	15.58	16.64	22.14	23.00	**19.33**
	alternative 1	11.43	16.32	22.30	23.22	**18.94**
	alternative 2	8.25	10.70	22.40	25.20	**16.53**
	alternative 3	8.58	15.77	22.46	23.77	**18.60**
Toal domestic value added	benchmark	35.46	37.30	84.11	79.53	**59.17**
	alternative 1	34.49	37.26	84.27	79.00	**59.06**
	alternative 2	34.49	36.72	84.25	79.93	**58.94**
	alternative 3	33.89	37.14	84.34	79.11	**59.00**

Note: P&A presents processing and assembling trade.

Appendix A: The non-competitive IO tables

Table A1 the General IO table of Non-Competitive Imports type

Input \ Output		Intermediate Uses	Final Uses (C+I+G)	Exports	Total Output or Imports
Intermediate Inputs	Domestic	Z^D	Y^D	E	X
	Imports	Z^M	Y^M		M
Primary Inputs		V			
Total Inputs		X			

Note: the superscript *D* denotes domestic goods, superscript *M* denotes imported goods, superscript, Z^D and Z^M denote domestic and imported intermediate inputs, respectively; Y^D and Y^M denotes final demand vectors for domestic products and imported ones, respectively; *V* denotes value added, *X*, *E* and M denotes outputs, exports and imports vector, respectively.

Table A2 the Non-Competitive Input-Output model with processing trade and normal trade

Input \ Output		Intermediate use		Final use	Exports	Gross Output or Imports
		N	P			
Intermediate Inputs	Domestic use & normal exports (N)	Z^{NN}	Z^{NP}	Y^N	E^N	$X - E^P$
	Processing Exports (P)	0	0	0	E^P	E^P
	Imports	Z^{MN}	Z^{MP}	Y^M	0	M
Value-added		V^N	V^P			
Gross Input		$X - E^P$	E^P			

Note: superscript N, P and M represent domestic use and normal exports, processing exports, imports respectively.

Table A3: Trade share parameters used in estimation (Share, 2007)

Panel a: for 42 sectors I-O table

IO Code	Intermediates imports for				Capital goods for				Imports for final Consumption	Exports			
	Processing		Non-processing		Processing		Non-processing			Processing		Non-processing	
	COEs	FIEs	COEs	FIEs	COEs	FIEs	COEs	FIEs		COEs	FIEs	COEs	FIEs
1	7.78	8.15	47.80	30.33	0.11	0.01	0.00	0.00	5.82	0.00	0.00	78.26	21.74
2	0.00	0.00	95.80	4.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.97	0.03
3	5.74	2.77	86.81	4.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.85	80.15
4	1.14	0.23	86.49	12.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	95.80	4.20
5	7.58	37.67	41.30	13.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	73.65	26.35
6	7.95	13.02	32.10	19.94	0.00	0.00	0.00	0.00	27.00	9.65	18.22	40.69	31.43
7	20.10	63.20	7.35	6.62	0.00	0.00	0.00	0.00	2.74	5.67	12.33	67.14	14.86
8	14.03	55.33	9.22	9.31	0.00	0.00	0.00	0.00	12.11	8.26	23.99	52.14	15.62
9	7.07	28.75	35.11	19.26	0.82	0.65	0.02	0.10	8.23	4.39	23.94	47.01	24.66
10	6.51	26.76	31.60	27.71	0.14	0.02	0.12	0.23	6.93	11.76	51.98	24.49	11.77
11	1.37	0.93	85.25	12.18	0.27	0.00	0.00	0.00	0.01	24.25	13.98	51.74	10.03
12	8.26	29.08	32.13	27.34	0.00	0.00	0.00	0.00	3.19	10.71	25.67	47.70	15.91
13	5.31	54.17	14.62	24.55	0.00	0.00	0.00	0.00	1.35	2.10	18.72	57.80	21.39
14	11.36	35.41	32.88	20.35	0.00	0.00	0.00	0.00	0.00	5.31	7.07	70.87	16.75
15	5.35	36.84	19.52	27.71	1.41	1.51	0.40	5.51	1.76	2.95	29.77	47.73	19.56
16	2.63	10.48	12.37	12.50	22.68	7.81	2.74	28.32	0.47	4.88	26.70	46.57	21.84
17	1.09	2.21	9.00	24.37	25.11	5.63	0.66	8.66	23.27	23.18	19.05	40.34	17.43
18	3.45	36.95	11.56	17.57	9.94	5.99	1.91	11.80	0.84	11.65	48.09	25.90	14.36
19	4.41	64.81	9.10	9.55	2.86	2.78	0.61	5.57	0.30	6.03	83.53	5.89	4.56
20	1.42	19.33	2.16	3.79	10.39	7.78	4.77	46.57	3.80	8.94	76.83	8.91	5.32
21	20.22	49.68	1.67	7.38	0.15	0.13	0.00	0.01	20.77	11.83	24.46	46.46	17.25
22	1.82	9.04	63.49	25.65	0.00	0.00	0.00	0.00	0.00	0.42	6.09	73.81	19.68
23	0.00	0.00	99.03	0.97	0.00	0.00	0.00	0.00	0.00	0.00	40.98	29.49	29.52
41	4.38	49.63	0.00	0.00	0.00	0.00	0.00	0.00	45.98	15.01	67.15	11.62	6.22

Panel b: for 135 sectors I-O table

IO Code	Intermediates imports for				Capital goods for				Imports for final Consumption	Exports			
	Processing		Non-processing		Processing		Non-processing			Processing		Non-processing	
	COEs	FIEs	COEs	FIEs	COEs	FIEs	COEs	FIEs		COEs	FIEs	COEs	FIEs
1	3.68	3.73	39.55	44.63	0.00	0.00	0.00	0.00	8.41	0.00	0.00	79.07	20.93
2	15.69	15.49	63.36	5.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	89.71	10.29
3	11.93	18.75	61.03	5.80	1.81	0.22	0.00	0.00	0.47	0.00	0.00	77.83	22.17
4	5.55	7.42	0.47	0.64	0.00	0.00	0.00	0.00	85.91	0.00	0.00	71.47	28.53
5	14.11	0.14	84.33	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	80.63	19.37
6	0.00	0.00	95.80	4.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.97	0.03
7	5.74	2.77	86.81	4.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.85	80.15
8	0.00	0.00	92.89	7.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	97.86	2.14
9	3.59	0.73	72.84	22.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	95.78	4.22
10	7.58	37.67	41.30	13.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	73.65	26.35
11	1.96	10.63	25.08	12.48	0.00	0.00	0.00	0.00	49.85	1.19	10.67	35.02	53.13
12	0.02	1.89	66.31	28.48	0.00	0.00	0.00	0.00	3.29	0.36	6.48	56.56	36.60
13	1.51	1.19	52.02	40.94	0.00	0.00	0.00	0.00	4.33	6.69	31.32	25.95	36.04
14	3.44	10.07	62.89	6.70	0.00	0.00	0.00	0.00	16.90	12.81	8.88	52.57	25.73
15	2.08	7.29	19.04	9.69	0.00	0.00	0.00	0.00	61.91	1.46	12.16	65.48	20.89
16	23.55	35.30	20.09	4.52	0.00	0.00	0.00	0.00	16.53	17.70	28.51	30.51	23.29
17	18.72	26.81	18.00	6.97	0.00	0.00	0.00	0.00	29.49	2.41	6.38	50.28	40.93
18	0.36	11.14	11.31	0.00	0.00	0.00	0.00	0.00	77.19	3.42	26.09	32.83	37.66
19	0.05	0.88	37.02	24.13	0.00	0.00	0.00	0.00	37.92	0.15	8.48	39.91	51.45
20	10.48	42.82	2.79	6.33	0.00	0.00	0.00	0.00	37.58	1.10	16.83	34.39	47.68

21	1.27	5.40	7.62	14.04	0.00	0.00	0.00	0.00	71.66	7.85	15.41	41.60	35.13
22	0.02	0.48	0.38	0.70	0.00	0.00	0.00	0.00	98.42	1.03	7.62	59.36	31.99
23	0.55	5.76	5.79	8.65	0.00	0.00	0.00	0.00	79.24	13.80	16.94	39.83	29.44
24	0.00	0.16	0.40	0.00	0.00	0.00	0.00	0.00	99.43	0.43	0.89	98.68	0.00
25	23.97	66.38	5.89	3.72	0.00	0.00	0.00	0.00	0.04	10.20	11.42	63.57	14.81
26	15.17	58.22	19.81	6.64	0.00	0.00	0.00	0.00	0.16	11.15	28.66	42.07	18.11
27	23.02	41.53	23.81	11.63	0.00	0.00	0.00	0.00	0.01	3.78	6.07	80.80	9.35
28	10.30	59.37	8.11	18.92	0.00	0.00	0.00	0.00	3.30	7.85	12.83	58.75	20.57
29	19.28	65.17	1.85	3.21	0.00	0.00	0.00	0.00	10.49	3.43	12.21	70.68	13.68
30	8.39	49.12	0.01	0.01	0.00	0.00	0.00	0.00	42.47	8.21	21.44	54.91	15.43
31	14.93	56.33	10.69	10.80	0.00	0.00	0.00	0.00	7.25	8.34	28.38	47.33	15.94
32	9.44	36.60	42.72	10.97	0.00	0.00	0.00	0.00	0.27	5.23	10.85	61.67	22.25
33	0.66	7.62	14.62	41.61	3.01	2.38	0.06	0.36	29.68	3.98	30.18	40.03	25.81
34	6.24	21.50	36.03	31.05	0.00	0.00	0.00	0.00	5.18	9.89	50.90	25.20	14.00
35	9.54	50.36	9.32	13.46	0.00	0.00	0.00	0.00	17.32	9.93	29.10	45.60	15.36
36	7.09	62.97	2.68	4.15	1.57	0.27	1.36	2.60	17.30	12.26	53.89	22.78	11.08
37	1.38	0.93	85.22	12.20	0.27	0.00	0.00	0.00	0.01	32.11	18.51	39.81	9.57
38	0.36	0.22	92.73	6.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	88.57	11.43
39	5.68	14.13	43.13	37.07	0.00	0.00	0.00	0.00	0.00	7.65	8.30	65.59	18.46
40	0.16	0.09	90.19	9.56	0.00	0.00	0.00	0.00	0.00	12.87	0.09	77.77	9.27
41	0.07	0.46	0.00	0.00	0.00	0.00	0.00	0.00	99.47	3.00	2.37	77.68	16.94
42	6.26	35.57	30.99	27.12	0.00	0.00	0.00	0.00	0.04	1.36	18.77	51.35	28.52
43	16.03	42.83	24.11	17.03	0.00	0.00	0.00	0.00	0.00	12.13	55.60	21.78	10.50
44	4.16	39.14	24.66	31.52	0.00	0.00	0.00	0.00	0.52	3.14	28.03	48.86	19.97
45	2.35	13.55	30.36	28.93	0.00	0.00	0.00	0.00	24.81	3.42	26.53	45.27	24.78
46	1.26	9.27	14.03	26.91	0.00	0.00	0.00	0.00	48.52	4.86	9.02	63.95	22.17
47	15.95	34.48	30.72	18.84	0.00	0.00	0.00	0.00	0.01	19.79	34.61	32.75	12.85
48	2.63	25.05	30.45	38.70	0.00	0.00	0.00	0.00	3.18	19.55	32.29	38.60	9.56
49	6.22	58.00	10.48	18.01	0.00	0.00	0.00	0.00	7.29	11.69	39.99	33.66	14.66
50	0.43	8.30	37.42	53.85	0.00	0.00	0.00	0.00	0.00	0.09	2.72	69.53	27.66
51	5.56	10.57	66.98	16.89	0.00	0.00	0.00	0.00	0.00	4.04	33.83	41.41	20.72
52	10.03	25.16	40.85	23.96	0.00	0.00	0.00	0.00	0.00	2.32	12.10	70.31	15.27
53	5.20	68.23	6.19	18.84	0.00	0.00	0.00	0.00	1.54	3.56	34.82	42.75	18.88
54	2.08	31.02	33.80	28.46	0.00	0.00	0.00	0.00	4.64	0.78	7.65	67.21	24.37
55	2.03	17.99	33.57	46.41	0.00	0.00	0.00	0.00	0.00	0.55	8.84	46.19	44.41
56	7.19	34.11	24.64	33.56	0.00	0.00	0.00	0.00	0.51	1.20	10.14	73.58	15.07
57	0.22	7.71	70.60	21.47	0.00	0.00	0.00	0.00	0.00	0.57	0.48	75.10	23.84
58	0.10	3.32	19.22	77.36	0.00	0.00	0.00	0.00	0.00	0.00	0.18	92.91	6.91
59	7.36	41.91	26.60	24.13	0.00	0.00	0.00	0.00	0.00	4.81	3.48	72.55	19.16
60	16.40	0.32	59.90	23.39	0.00	0.00	0.00	0.00	0.00	0.12	0.29	91.10	8.49
61	14.07	23.36	45.34	17.24	0.00	0.00	0.00	0.00	0.00	6.44	12.19	72.24	9.13
62	12.72	56.05	14.03	17.21	0.00	0.00	0.00	0.00	0.00	9.70	20.80	50.89	18.61
63	5.35	36.84	19.52	27.71	1.41	1.51	0.40	5.51	1.76	2.95	29.77	47.73	19.56
64	12.84	6.39	27.16	23.51	10.98	11.47	3.37	4.08	0.20	7.27	17.73	56.48	18.52
65	0.11	2.18	5.23	5.28	25.19	5.57	2.88	53.57	0.00	0.87	15.16	62.72	21.24
66	0.00	0.00	0.00	0.00	36.36	14.67	9.41	39.56	0.00	9.30	40.77	30.57	19.36
67	1.76	9.59	22.10	18.89	20.57	11.71	4.94	10.43	0.00	1.54	21.78	45.99	30.70
68	3.73	17.36	18.16	25.27	12.64	4.66	1.62	16.52	0.04	4.98	23.62	50.99	20.41
69	0.97	6.82	19.32	16.16	34.82	6.91	0.46	14.53	0.00	4.93	7.45	65.51	22.11
70	0.03	1.64	0.92	1.94	15.17	17.04	4.22	59.05	0.00	2.51	16.78	45.30	35.41
71	0.04	3.85	5.32	7.86	47.78	20.26	0.00	6.15	8.74	6.37	15.77	57.34	20.52
72	1.20	16.03	4.93	4.77	28.33	5.03	1.97	36.36	1.38	6.65	49.20	29.60	14.56
73	1.72	0.18	60.40	7.98	27.96	1.77	0.00	0.00	0.00	32.43	4.55	55.34	7.68
74	0.45	1.85	9.90	40.13	4.46	0.53	0.15	0.19	42.36	5.21	18.25	53.06	23.48
75	3.03	3.21	5.15	2.81	25.11	6.16	3.45	50.58	0.50	68.67	18.02	11.01	2.30
76	1.07	2.56	3.05	7.63	67.96	16.46	0.00	0.00	1.27	4.86	23.14	48.15	23.85
77	2.39	9.43	10.28	8.87	26.72	15.53	7.96	18.83	0.00	13.84	34.07	35.59	16.50
78	3.70	35.75	14.17	22.59	7.08	5.82	1.02	9.87	0.00	10.40	63.52	16.20	9.87
79	6.31	53.78	12.34	22.96	0.82	1.56	0.15	1.74	0.34	8.71	56.80	22.18	12.30
80	1.60	14.27	10.84	14.65	15.76	7.82	2.04	28.15	4.86	16.43	47.62	22.30	13.65
81	3.32	62.22	6.79	11.36	6.50	1.41	0.82	6.57	1.00	5.85	35.36	38.90	19.89
82	1.73	40.91	13.67	23.07	1.09	11.10	0.19	8.17	0.08	4.95	78.19	8.49	8.38
83	1.69	22.28	0.29	1.56	20.53	22.27	8.58	22.60	0.21	9.47	73.19	12.01	5.34
84	1.38	31.39	2.28	7.67	18.26	13.20	2.72	23.10	0.00	5.16	89.57	3.74	1.52

85	5.05	71.97	9.89	8.98	0.48	0.45	0.25	2.66	0.28	3.36	79.73	6.81	10.09
86	7.35	64.31	4.13	8.46	0.77	4.31	0.92	0.48	9.28	15.52	75.50	6.21	2.76
87	0.00	0.00	0.00	0.00	41.45	17.94	2.59	38.02	0.00	9.97	70.65	14.36	5.03
88	1.35	14.13	1.34	2.63	11.74	8.56	5.54	53.97	0.75	8.76	72.58	11.80	6.86
89	1.88	51.18	7.14	10.86	2.11	2.99	0.06	1.32	22.45	9.13	81.38	5.81	3.67
90	20.22	49.68	1.67	7.38	0.15	0.13	0.00	0.01	20.77	11.83	24.46	46.46	17.25
91	1.82	9.04	63.49	25.65	0.00	0.00	0.00	0.00	0.00	0.42	6.09	73.81	19.68
92	0.00	0.00	99.03	0.97	0.00	0.00	0.00	0.00	0.00	0.00	40.98	29.49	29.52
130	4.38	49.63	0.00	0.00	0.00	0.00	0.00	0.00	45.98	15.01	67.15	11.62	6.22

Note: based on 135 sectors I-O table

Table A4 Mean Comparison acorss 4 types of firms

Comparison of	**Imported input over input**			**Imported input over output**		
Row Mean - Column Mean	CP	FP	CN	CP	FP	CN
all sector:						
FP	0.291			0.184		
CN	-0.141	-0.433		-0.101	-0.285	
FN	-0.107	-0.399	0.034	-0.076	-0.259	0.025
sector 6						
FP	0.083			0.059		
CN	-0.206	-0.289		-0.143	-0.202	
FN	-0.198	-0.281	0.008#	-0.137	-0.196	0.006#
sector 7						
FP	0.247			0.160		
CN	-0.087	-0.334		-0.064	-0.224	
FN	-0.081	-0.327	0.006#	-0.059	-0.219	0.005#
sector 8						
FP	0.451			0.249		
CN	-0.161	-0.613		-0.102	-0.351	
FN	-0.158	-0.609	0.004#	-0.100	-0.348	0.002#
sector 9						
FP	0.085			0.03#		
CN	-0.216	-0.301		-0.171	-0.200	
FN	-0.201	-0.286	0.015#	-0.159	-0.188	0.012#
sector 10						
FP	0.222			0.133		
CN	-0.125	-0.347		-0.085	-0.219	
FN	-0.103	-0.325	0.02#	-0.070	-0.203	0.016#
sector 11						
FP	0.20#			0.21063		
CN	-0.10#	-0.3		-0.073#	-0.284	
FN	-0.05#	-0.249	0.05#	-0.034#	-0.245	0.039#
sector 12						
FP	0.298			0.198		
CN	-0.163	-0.460		-0.119	-0.317	
FN	-0.102	-0.400	0.061	-0.075	-0.273	0.044
sector 13						
FP	0.093			0.070		

CN	-0.162	-0.255		-0.113	-0.183	
FN	-0.134	-0.226	0.029	-0.093	-0.163	0.020
sector 14						
FP	0.458			0.333		
CN	-0.174	-0.632		-0.139	-0.471	
FN	-0.132	-0.590	0.042#	-0.106	-0.438	0.033#
sector 15						
FP	0.227			0.133		
CN	-0.085	-0.312		-0.082	-0.215	
FN	-0.053#	-0.281	0.032	-0.058	-0.191	0.023
sector 16						
FP	0.257			0.163		
CN	-0.066	-0.322		-0.050	-0.213	
FN	-0.001#	-0.258	0.065	-0.004#	-0.167	0.046
sector 17						
FP	0.332			0.234		
CN	-0.06#	-0.392		-0.044#	-0.278	
FN	0.029	-0.303	0.09#	0.027#	-0.207	0.071
sector 18						
FP	0.278			0.197		
CN	-0.089	-0.366		-0.063	-0.260	
FN	-0.053#	-0.331	0.036#	-0.037#	-0.234	0.026
sector 19						
FP	0.357			0.242		
CN	-0.191	-0.548		-0.136	-0.378	
FN	-0.133	-0.490	0.058#	-0.092	-0.335	0.043#
sector 20						
FP	0.253			0.184		
CN	-0.161	-0.414		-0.102	-0.285	
FN	-0.10#	-0.353	0.06#	-0.06#	-0.245	0.04#
sector 21						
FP	0.188			0.118		
CN	-0.144	-0.332		-0.095	-0.213	
FN	-0.138	-0.326	0.006#	-0.091	-0.209	0.004#

Note numbers ending with # are not significant.

Table A5a. Sensitivity test at Sector level (%), 24 sectors

IO Code	Direct domestic value added					Total domestic value added				
	benchmark	P&A Imports added	Alternative 1	2	3	benchmark	P&A Imports added	alternative 1	2	3
1	60.14	60.14	60.14	60.14	60.14	92.23	92.01	92.46	92.22	92.46
2	46.07	46.07	46.07	46.07	46.07	91.57	91.22	91.22	91.62	91.23
3	60.84	60.84	60.84	60.84	60.84	75.49	80.91	83.63	75.26	83.62
4	35.39	35.34	35.39	35.39	35.39	84.43	84.10	84.27	84.48	84.28
5	39.46	38.76	39.46	39.46	39.46	84.01	83.59	85.13	83.99	85.15
6	22.86	22.78	22.90	19.01	19.12	70.25	70.71	74.49	66.22	73.28
7	19.51	19.31	19.50	17.86	17.90	78.84	76.80	80.61	79.49	80.67
8	22.28	21.57	22.26	19.21	23.50	76.40	72.80	78.04	76.89	78.74
9	22.93	22.78	22.91	20.35	22.36	75.97	75.00	79.99	76.73	80.02
10	27.94	27.20	27.90	24.74	25.20	61.02	58.77	64.02	63.59	63.97
11	17.26	17.10	17.31	13.01	13.13	50.76	50.72	51.99	46.43	48.28
12	20.44	20.34	20.47	16.17	21.04	59.44	59.21	62.78	55.95	62.64
13	27.34	27.30	27.38	24.69	26.34	74.55	74.81	76.67	71.63	75.97
14	19.01	18.96	19.01	17.87	17.65	70.13	69.89	69.69	68.93	68.59
15	20.42	20.31	20.41	17.54	18.49	66.77	65.69	71.66	67.10	71.35
16	22.82	22.73	22.85	19.86	22.20	63.01	62.90	64.81	59.72	64.55
17	19.45	19.42	19.45	16.20	16.77	60.18	59.45	58.98	60.30	59.25
18	16.56	16.26	16.54	11.83	15.23	51.64	49.85	53.32	53.09	53.81
19	15.66	14.69	15.66	7.30	14.84	41.33	39.23	39.16	40.68	39.09
20	19.63	16.91	19.60	19.69	19.39	54.52	50.80	44.66	57.36	45.30
21	24.99	24.26	24.95	20.97	22.39	70.52	68.78	75.14	71.38	74.79
22	80.50	79.02	78.89	75.62	75.64	93.64	93.60	93.55	88.70	92.07
23	30.60	30.42	30.62	30.94	22.32	59.09	64.50	66.09	59.35	57.58
41	41.47	41.35	41.36	38.95	37.88	53.80	59.38	63.97	56.58	62.66
Total	**19.89**	**19.31**	**19.89**	**15.58**	**18.93**	**59.28**	**57.70**	**59.55**	**58.86**	**59.48**

Note: based on 42 sectors I-O table

Table A5b Sensitivity test at Sector level (%), 93 sectors

IO Code	Direct DVA				Total DVA			
	benchmark	alternative 1	alternative 2	alternative 3	benchmark	alternative 1	alternative 2	alternative 3
1	67.38	67.38	67.38	67.38	93.89	94.14	93.92	94.15
2	69.76	69.76	69.76	69.76	93.72	93.25	93.86	93.30
3	50.04	50.04	50.04	50.04	93.77	94.16	93.75	94.16
4	63.49	63.49	63.49	63.49	93.92	93.43	94.02	93.46
5	49.07	49.07	49.07	49.07	90.29	89.82	90.47	89.88
6	46.07	46.07	46.07	46.07	91.70	91.39	91.78	91.41
7	69.02	69.02	69.02	69.02	89.67	89.61	89.67	89.63
8	33.22	33.22	33.22	33.22	82.75	81.98	82.95	82.05
9	38.07	38.07	38.07	38.07	84.95	84.27	85.17	84.33
10	41.07	41.07	41.07	41.07	86.01	85.63	86.14	85.68
11	17.66	17.65	17.72	17.63	84.13	76.47	83.73	76.14
12	15.88	15.88	15.88	15.88	85.95	82.78	85.95	82.65
13	15.61	15.53	19.09	15.41	74.93	74.48	76.00	74.21
14	19.49	19.48	19.50	19.49	80.40	80.38	80.54	80.43
15	15.10	15.06	15.02	14.97	88.54	88.74	88.44	88.69
16	18.51	17.53	16.60	17.98	63.15	61.94	62.41	62.12
17	15.98	15.96	15.96	15.94	85.57	82.01	85.51	81.85
18	17.32	17.28	17.30	17.23	78.37	77.68	78.63	77.73
19	19.17	19.17	19.18	19.17	81.27	80.68	81.68	80.75
20	18.35	18.34	18.35	18.34	79.55	78.01	79.97	78.02
21	21.42	20.67	20.72	20.22	79.94	80.03	79.63	79.73
22	31.70	31.69	31.70	31.69	85.44	84.96	85.62	84.96
23	20.39	19.97	19.99	19.84	78.69	78.89	78.75	78.86
24	63.39	63.39	63.39	63.39	94.08	94.16	94.09	94.16
25	17.29	16.53	15.91	15.99	76.73	77.70	75.50	80.17
26	17.32	16.36	15.29	15.24	77.66	77.84	76.65	77.36
27	17.55	17.54	17.56	17.54	84.83	84.90	85.03	84.95
28	21.49	21.10	20.15	20.31	81.20	80.51	81.02	79.66
29	21.72	21.69	21.07	21.50	81.45	81.11	81.93	80.75
30	23.34	23.21	20.64	24.61	74.34	76.02	74.32	77.95
31	19.98	19.53	17.37	20.28	71.10	72.41	69.59	72.93
32	21.32	20.91	20.33	20.55	80.23	80.71	79.72	80.59
33	24.01	23.70	22.11	22.88	71.57	72.22	71.28	71.29
34	18.22	17.58	13.75	14.12	64.58	70.65	59.94	68.23
35	28.15	25.70	25.43	28.87	79.04	78.87	77.37	80.20
36	22.09	21.58	21.24	21.19	56.40	52.77	59.63	52.39
37	11.31	10.81	9.70	11.72	45.52	49.56	43.53	50.70
38	32.11	32.11	32.11	32.11	88.83	88.47	88.88	88.50
39	20.82	20.54	20.66	19.90	73.47	75.15	72.75	74.57
40	17.31	17.17	17.08	17.15	78.29	78.52	78.39	78.49
41	16.77	16.77	16.77	16.77	73.21	72.69	73.58	72.80
42	16.24	15.72	15.44	19.09	73.13	72.67	72.77	74.01
43	16.00	15.14	11.23	9.43	47.58	51.25	42.77	46.41

44	15.29	15.09	14.52	14.71	68.47	70.00	67.79	70.05
45	24.68	22.32	21.54	43.00	76.30	76.00	74.90	84.09
46	27.75	27.18	27.67	28.42	82.88	83.89	82.69	84.48
47	14.61	13.90	10.58	10.21	59.72	64.14	56.45	61.42
48	18.29	17.28	14.23	14.88	53.83	54.31	50.22	51.77
49	17.29	16.35	14.59	17.80	52.45	54.60	49.98	56.08
50	27.24	27.24	27.24	27.24	86.23	85.82	86.43	85.88
51	17.38	17.36	17.42	17.44	74.33	74.45	74.36	74.52
52	22.16	22.10	22.13	22.69	82.22	82.05	82.32	82.35
53	25.48	25.00	23.16	21.80	70.83	72.45	68.71	69.92
54	26.20	26.14	26.25	26.20	81.11	80.62	81.35	80.71
55	40.15	40.14	40.15	40.14	82.51	82.13	82.65	82.18
56	27.95	27.94	28.03	27.94	82.48	82.03	82.70	82.09
57	18.83	18.83	18.83	18.83	75.73	75.35	75.80	75.34
58	27.67	27.67	27.67	27.67	81.16	80.99	81.27	81.01
59	16.72	16.31	16.20	16.96	75.23	76.19	74.80	76.82
60	26.12	26.12	26.12	26.12	77.54	76.59	77.76	76.68
61	15.42	15.05	15.48	14.79	71.39	72.64	71.35	72.58
62	20.81	19.99	18.04	18.35	68.98	71.91	66.11	71.07
63	20.10	19.93	18.62	17.82	66.88	68.35	65.66	66.04
64	21.07	20.81	21.16	20.79	75.31	75.63	75.43	75.60
65	22.49	22.35	22.49	23.89	78.42	77.72	78.65	78.36
66	16.90	16.57	16.71	16.97	65.88	68.94	65.82	69.05
67	22.21	22.13	21.13	21.65	73.46	75.29	72.24	74.65
68	21.66	21.34	20.40	22.42	73.52	75.74	72.27	76.33
69	21.65	21.36	21.31	21.77	79.70	79.22	79.73	79.42
70	24.08	23.33	23.47	23.90	79.32	78.03	79.25	78.23
71	18.35	18.32	18.38	18.44	76.21	75.65	76.45	75.76
72	25.00	24.65	28.04	24.79	57.72	57.99	62.10	57.91
73	15.92	16.24	15.86	16.22	71.90	71.38	72.27	71.52
74	18.23	17.86	21.21	26.00	73.45	75.04	75.73	79.01
75	27.86	23.82	24.07	17.39	50.06	65.70	56.83	64.82
76	18.70	18.54	19.01	18.76	71.61	72.99	71.81	72.97
77	18.38	17.34	14.54	17.52	62.93	64.62	60.05	64.81
78	16.87	16.28	16.06	16.04	40.42	41.49	40.73	41.39
79	13.13	12.53	7.07	8.19	46.95	51.51	41.45	47.18
80	15.12	14.66	11.15	13.51	46.38	47.06	44.65	45.96
81	20.07	19.76	17.32	19.83	61.52	62.31	58.84	62.42
82	13.61	13.50	8.94	12.05	39.56	35.31	41.29	34.87
83	15.13	15.07	13.74	15.24	40.06	37.34	43.57	37.13
84	13.73	13.62	7.44	10.97	42.54	39.18	43.00	38.26
85	18.47	18.24	8.32	22.56	31.42	34.01	24.95	38.13
86	15.95	15.27	8.79	14.18	30.34	27.26	31.24	26.13
87	22.89	22.55	18.44	23.53	64.42	66.11	62.00	66.47
88	24.12	23.61	23.08	23.08	43.19	41.96	44.47	41.34
89	13.92	13.58	11.54	13.31	33.08	28.46	37.94	28.15
90	25.15	24.00	22.53	23.20	72.56	73.04	70.88	72.68

91	75.63	75.63	75.63	75.63	92.22	92.36	92.23	92.37
92	21.29	21.07	31.65	20.90	71.22	73.09	75.25	73.02
130	28.96	28.86	29.09	28.82	72.30	74.74	72.18	74.65
Total	**19.33**	**18.94**	**16.53**	**18.60**	**59.17**	**59.06**	**58.94**	**59.00**

Note: based on 135 sectors I-O table.

Appendix B: Expressions for element matrices/vectors in equation (6).

$$B^{CCN} = [I - A^{CCN} - A^{CFN}(I - A^{FFN})^{-1}A^{FCN}]^{-1} \quad \text{(A1)}$$

$$B^{CCP} = [A^{CCP} + A^{CFN}(I - A^{FFN})^{-1}A^{FCP}][I - A^{CCN} - A^{CFN}(I - A^{FFN})^{-1}A^{FCN}]^{-1} \quad \text{(A2)}$$

$$B^{CFN} = A^{CFN}(I - A^{FFN})^{-1}[I - A^{CCN} - A^{CFN}(I - A^{FFN})^{-1}A^{FCN}]^{-1} \quad \text{(A3)}$$

$$B^{CFP} = [A^{CFP} + A^{CFN}(I - A^{FFN})^{-1}A^{FFP}][I - A^{CCN} - A^{CFN}(I - A^{FFN})^{-1}A^{FCN}]^{-1} \quad \text{(A4)}$$

$$B^{FCN} = A^{FCN}(I - A^{CCN})^{-1}[I - A^{FFN} - A^{CFN}(I - A^{CCN})^{-1}A^{FCN}]^{-1} \quad \text{(A5)}$$

$$B^{FCP} = [A^{FCP} + A^{CCP}(I - A^{CCN})^{-1}A^{FCN}][I - A^{FFN} - A^{CFN}(I - A^{CCN})^{-1}A^{FCN}]^{-1} \quad \text{(A6)}$$

$$B^{FFN} = [(I - A^{FFN} - A^{CFN}(I - A^{CCN})^{-1}A^{FCN}]^{-1} \quad \text{(A7)}$$

$$B^{FFP} = [A^{FFP} + A^{CFP}(I - A^{CCN})^{-1}A^{FCN}][I - A^{FFN} - A^{CFN}(I - A^{CCN})^{-1}A^{FCN}]^{-1} \quad \text{(A8)}$$

From equation (4) and using equations (A1)-(A4) we can obtain:

$$\begin{aligned} X^C - E^{CP} &= B^{CCN}(Y^C + E^{CN}) + B^{CCP}E^{CP} + B^{CFN}(Y^F + E^{FN}) + B^{CFP}E^{FP} \\ &= B^{CCN}(Y^C + E^{CN}) + [A^{CCP} + A^{CFN}(I - A^{FFD})^{-1}A^{FCP}]B^{CCN}E^{CP} \\ &+ A^{CFN}(I - A^{FFN})^{-1}B^{CCN}(Y^F + E^{FN}) + [A^{CFP} + A^{CFN}(I - A^{FFN})^{-1}A^{FFP}]B^{CCN}E^{FP} \end{aligned} \quad \text{(A9)}$$

From equation (4) and using equations (A5)-(A8) we can obtain:

$$\begin{aligned} X^F - E^{FP} &= B^{FCN}(Y^C + E^{CN}) + B^{FCP}E^{CP} + B^{FFN}(Y^F + E^{FN}) + B^{FFP}E^{FP} \\ &= A^{FCN}(I - A^{CCN})^{-1}B^{FFN}(Y^C + E^{CN}) + [A^{FCP} + A^{CCP}(I - A^{CCN})^{-1}A^{FCN}]B^{FFN}E^{CP} \\ &+ B^{FFN}(Y^F + E^{FN}) + [A^{FFP} + A^{CFP}(I - A^{CCN})^{-1}A^{FCN}]B^{FFN}E^{FP} \end{aligned} \quad \text{(A10)}$$

Substituting equations (A9) and (A10) into equation (3) and collect same terms:

$$\begin{aligned} M - Y^M &= A^{MCN}(X^C - E^{CP}) + A^{MCP}E^{CP} + A^{MFN}(X^F - E^{FP}) + A^{MFP}E^{FP} \\ &= [A^{MCN}B^{CCN} + A^{MFN}A^{FCN}(I - A^{CCN})^{-1}B^{FFN}](Y^C + E^{CN}) \\ &+ [A^{MCN}A^{CFN}(I - A^{FFN})^{-1}B^{CCN} + B^{FFN}](Y^F + E^{FN}) \\ &+ \{A^{MCN}(A^{CCP} + A^{CFN}(I - A^{FFN})^{-1}A^{FCP})B^{CCN} + A^{MFN}[A^{FCP} + A^{CCP}(I - A^{CCN})^{-1}A^{FCN}]B^{FFN} + A^{MCP}\}E^{CP} \\ &+ \{A^{MCN}[A^{CFP} + A^{CFN}(I - A^{FFN})^{-1}A^{FFP}]B^{CCN} + A^{MFN}[A^{FFP} + A^{CFP}(I - A^{CCN})^{-1}A^{FCD}]B^{FFN} + A^{MFP}\}E^{FP} \end{aligned} \quad \text{(A11)}$$

Appendix C: Data Appendix

Our major datasets include the ASIP data, the Customs export and import data, and the BOP table from the People's Bank of China:

1. *The ASIP data*

The ASIP data, developed and maintained by the National Bureau of Statistics of China (NBS), provide production side information. The data contains annual survey data of production and balance sheet information for all "above-scale" industrial firms in China. The data surveyed firms in industrial sector (i.e., manufacturing, mining, and utility) with non-SOEs with sales over 5 million RMB and all SOEs. As noted by Cai and Liu (2009), designed for computing the GDP, the information reported in this dataset should be quite reliable, because the NBS has implemented standard procedures and has strict double checking procedures for above-scale firms. Moreover, firms do not have clear incentives to misreport their information because such information cannot be used against them by other government agencies such as the tax authorities. Based on the General Accepted Accounting Principles, we follow Cai and Liu (2009) to rule out outliers and delete the following kinds of observations from the original data set:

(a). firms that reporting "not-in-operation" status;

(b). observations whose information on critical parameters (such as total assets, the number of employees, gross value of industrial output, net value of fixed assets, or sales) is missing;

(c). misclassified observations whose operation scales are clearly smaller than the classification standard of above scale firms, specifically, observations for which one of the following is true:

(i). the value of fixed assets is below RMB 10 million;

(ii). the value of total sales is below RMB 10 million; and

(iii). the number of employees is less than 10;

(d). observations that have a negative value for one of the following variables:

(i). total assets minus liquid assets;

(ii). total assets minus total fixed assets;

(iii). total assets minus net value of fixed assets; or

(iv). accumulated depreciation minus current depreciation;

(e). observations with extreme variable values (the values of key variables are either larger than the 99.5 percentile or smaller than the 0.5 percentile).

2. The Customs data on export and import

The firm-level trade data is compiled and maintained by the General Administration of Customs of China. It records annual import and export data for all merchandise trade from 2000 to 2007. The dataset contains value and quantity information for each exporter and importer, at 8 digit HS product level, to/from each country. It also keeps records of trade regimes such as processing versus normal trade.

3. Main procedures for matching the ASIP with the Customs data:

A. Use the universe of import data (with firm ID, HS8), and match with the IO industry, get info about each importer importing one or multiple IO inputs;
B. Match exporter (from customs) with producer (from ASIP); Aggregate it to the level of IO sector, so we know for each IO sector the total gross output and the total export in processing and nonprocessing trade;
C. Match the importer information with producers/exporters; Aggregate it to the level of IO sector, so we know for each IO sector the total import value in processing and ordinary inputs, as well as capital goods and final consumption;
D. Aggregate firm information to the IO level, then we get the IO matrix that match imported intermediate input to output and export by IO sector.
E. The matched sample also provides information on (1). imported input intensity by different types of firms; (2). capital share of foreign investors as a proxy for foreign investment benefit.
F. The matching efficiency is described in the table below:

Table C1: matching efficiency

	Matching success ratio in value of					
Year	processing export	total export	ordinary imported input	processing imported input	imported capital and final consumption	total output
2000	36.3%	49.5%	8.8%	35.0%	11.1%	29.2%
2001	37.0%	52.2%	9.5%	35.8%	10.8%	30.1%
2002	35.0%	53.0%	11.2%	32.3%	9.8%	31.8%
2003	32.5%	51.1%	10.8%	30.1%	9.3%	31.8%
2004	33.8%	57.5%	10.8%	33.1%	12.1%	33.3%
2005	32.6%	55.7%	11.0%	32.2%	10.5%	35.0%
2006	31.7%	58.9%	11.2%	31.0%	9.1%	33.8%
2007	29.3%	54.9%	9.5%	28.6%	9.8%	31.2%

4. Foreign Income Data

The Sector Level Income Table in Balance of Payment provided by the People's Bank of China (PBC) reports investment income and employee compensation for 97 sectors, for both income and expenditure. Our calculation uses the expenditure items. Foreign investment takes the lion's share, accounting for nearly 95% in total foreign factor income.

Based on the matched sample of ASIP and Customs data, we can estimate the foreign share in total paid-in capital for all four types of firms (CP, FP, CN, and FN). Multiplying those shares with operation surplus gives the foreign capital income in domestic value-added. Then we use the investment income data from the BOP table to make adjustment.

Under the hypothesis that the foreign employee only work for foreign firms, we split compensation to foreign employees in the sector level income into the FP and FN's foreign employee compensation according to the proportion of total employee compensation for FP and FN.

Table C2 reports the foreign factors income in each type of firms, as below:

Table C2 Share of Foreign factors income in Domestic Value added of exports, 2007

Sector	CP	FP	CN	FN	Sector	CP	FP	CN	FN
01	0.00%	0.00%	0.21%	4.02%	22	2.43%	95.69%	0.76%	95.44%
02	0.00%	0.00%	0.03%	34.55%	23	0.00%	37.71%	2.82%	37.71%
03	0.00%	0.00%	0.55%	55.12%	24	0.00%	0.00%	2.27%	30.47%
04	1.14%	44.81%	0.39%	44.69%	25	0.00%	0.00%	1.86%	24.87%
05	1.06%	41.75%	0.31%	42.71%	26	0.00%	0.00%	4.19%	27.65%
06	3.66%	34.79%	0.89%	37.16%	27	0.00%	0.00%	0.96%	37.64%
07	2.28%	39.98%	1.00%	40.05%	28	0.00%	0.00%	0.21%	7.95%
08	0.80%	32.21%	0.91%	31.95%	29	0.00%	0.00%	3.86%	74.91%
09	0.98%	38.08%	0.42%	38.64%	30	0.00%	0.00%	5.02%	43.00%
10	1.06%	42.66%	0.48%	41.88%	31	0.00%	0.00%	4.49%	48.78%
11	1.06%	40.33%	0.50%	42.15%	32	0.00%	0.00%	6.78%	48.58%
12	0.12%	50.29%	1.31%	49.47%	33	0.00%	0.00%	4.36%	62.77%
13	1.08%	42.51%	0.57%	41.75%	34	0.00%	0.00%	25.07%	49.30%
14	0.71%	46.44%	1.00%	46.01%	35	0.00%	0.00%	3.20%	33.13%
15	1.87%	45.92%	0.44%	45.20%	36	0.00%	0.00%	3.28%	33.77%
16	1.17%	42.67%	0.62%	41.25%	37	0.00%	0.00%	0.11%	66.14%
17	0.88%	35.31%	0.62%	35.08%	38	0.00%	0.00%	5.36%	55.32%
18	3.34%	49.40%	1.16%	48.31%	39	0.00%	0.00%	0.03%	43.47%
19	0.79%	46.54%	1.92%	46.03%	40	0.00%	0.00%	0.28%	26.03%
20	1.03%	40.83%	0.42%	40.72%	41	1.35%	35.06%	1.35%	35.06%
21	0.85%	33.99%	0.87%	33.90%	42	0.00%	0.00%	0.00%	43.49%

Appendix D: I/O Table Industry Concordance

42 Sector	Description	135 Sector	Description
1	Agriculture, Forestry, Animal Husbandry & Fishery	1	Farming
		2	Forestry
		3	Animal Husbandry
		4	Fishery
		5	Services in Support of Agriculture
2	Mining and Washing of Coal	6	Mining and Washing of Coal
3	Extraction of Petroleum and Natural Gas	7	Extraction of Petroleum and Natural Gas
4	Mining of Metal Ores	8	Mining of Ferrous Metal Ores
		9	Mining of Non-Ferrous Metal Ores
5	Mining and Processing of Nonmetal Ores and Other Ores	10	Mining and Processing of Nonmetal Ores and Other Ores
6	Manufacture of Foods and Tobacco	11	Grinding of Grains
		12	Processing of Forage
		13	Refining of Vegetable Oil
		14	Manufacture of Sugar
		15	Slaughtering and Processing of Meat
		16	Processing of Aquatic Product
		17	Processing of Other Foods
		18	Manufacture of Convenience Food
		19	Manufacture of Liquid Milk and Dairy Products
		20	Manufacture of Flavoring and Ferment Products
		21	Manufacture of Other Foods
		22	Manufacture of Alcohol and Wine
		23	Processing of Soft Drinks and Purified Tea
		24	Manufacture of Tobacco
7	Manufacture of Textile	25	Spinning and Weaving, Printing and Dyeing of Cotton and Chemical Fiber
		26	Spinning and Weaving, Dyeing and Finishing of Wool
		27	Spinning and Weaving of Hemp and Tiffany
		28	Manufacture of Textile Products
		29	Manufacture of Knitted Fabric and Its Products
8	Manufacture of Textile Wearing Apparel, Footwear, Caps, Leather, Fur, Feather(Down) and Its products	30	Manufacture of Textile Wearing Apparel, Footwear and Caps
		31	Manufacture of Leather, Fur, Feather(Down) and Its Products
9	Processing of Timbers and Manufacture of Furniture	32	Processing of Timbers, Manufacture of Wood, Bamboo, Rattan, Palm and Straw Products

		33	Manufacture of Furniture
10	Papermaking, Printing and Manufacture of Articles for Culture, Education and Sports Activities	34	Manufacture of Paper and Paper Products
		35	Printing, Reproduction of Recording Media
		36	Manufacture of Articles for Culture, Education and Sports Activities
11	Processing of Petroleum, Coking, Processing of Nuclear Fuel	37	Processing of Petroleum and Nuclear Fuel
		38	Coking
12	Chemical Industry	39	Manufacture of Basic Chemical Raw Materials
		40	Manufacture of Fertilizers
		41	Manufacture of Pesticides
		42	Manufacture of Paints, Printing Inks, Pigments and Similar Products
		43	Manufacture of Synthetic Materials
		44	Manufacture of Special Chemical Products
		45	Manufacture of Chemical Products for Daily Use
		46	Manufacture of Medicines
		47	Manufacture of Chemical Fiber
		48	Manufacture of Rubber
		49	Manufacture of Plastic
13	Manufacture of Nonmetallic Mineral Products	50	Manufacture of Cement, Lime and Plaster
		51	Manufacture of Products of Cement and Plaster
		52	Manufacture of Brick, Stone and Other Building Materials
		53	Manufacture of Glass and Its Products
		54	Manufacture of Pottery and Porcelain
		55	Manufacture of Fire-resistant Materials
		56	Manufacture of Graphite and Other Nonmetallic Mineral Products
14	Smelting and Rolling of Metals	57	Iron-smelting
		58	Steelmaking
		59	Rolling of Steel
		60	Smelting of Ferroalloy
		61	Smelting of Non-Ferrous Metals and Manufacture of Alloys
		62	Rolling of Non-Ferrous Metals
15	Manufacture of Metal Products	63	Manufacture of Metal Products
16	Manufacture of General Purpose and Special Purpose Machinery	64	Manufacture of Boiler and Prime Mover
		65	Manufacture of Metalworking Machinery
		66	Manufacture of Lifters
		67	Manufacture of Pump, Valve and Similar Machinery

		68	Manufacture of Other General Purpose Machinery
		69	Manufacture of Special Purpose Machinery for Mining, Metallurgy and Construction
		70	Manufacture of Special Purpose Machinery for Chemical Industry, Processing of Timber and Nonmetals
		71	Manufacture of Special Purpose Machinery for Agriculture, Forestry, Animal Husbandry and Fishery
		72	Manufacture of Other Special Purpose Machinery
17	Manufacture of Transport Equipment	73	Manufacture of Railroad Transport Equipment
		74	Manufacture of Automobiles
		75	Manufacture of Boats and Ships and Floating Devices
		76	Manufacture of Other Transport Equipment
18	Manufacture of Electrical Machinery and Equipment	77	Manufacture of Generators
		78	Manufacture of Equipments for Power Transmission and Distribution and Control
		79	Manufacture of Wire, Cable, Optical Cable and Electrical Appliances
		80	Manufacture of Household Electric and Non-electric Appliances
		81	Manufacture of Other Electrical Machinery and Equipment
19	Manufacture of Communication Equipment, Computer and Other Electronic Equipment	82	Manufacture of Communication Equipment
		83	Manufacture of Radar and Broadcasting Equipment
		84	Manufacture of Computer
		85	Manufacture of Electronic Component
		86	Manufacture of Household Audiovisual Apparatus
		87	Manufacture of Other Electronic Equipment
20	Manufacture of Measuring Instrument and Machinery for Cultural Activity & Office Work	88	Manufacture of Measuring Instruments
		89	Manufacture of Machinery for Cultural Activity & Office Work
21	Manufacture of Artwork, Other Manufacture	90	Manufacture of Artwork, Other Manufacture
22	Scrap and Waste	91	Scrap and Waste
23	Production and Supply of Electric Power and Heat Power	92	Production and Supply of Electric Power and Heat Power
24	Production and Distribution of Gas	93	Production and Distribution of Gas
25	Production and Distribution of Water	94	Production and Distribution of Water
26	Construction	95	Construction
27	Traffic, Transport and Storage	96	Transport Via Railway
		97	Transport Via Road

		98	Urban Public Traffic
		99	Water Transport
		100	Air Transport
		101	Transport Via Pipeline
		102	Loading, Unloading, Portage and Other Transport Services
		103	Storage
28	Post	104	Post
29	Information Transmission, Computer Services and Software	105	Telecom & Other Information Transmission Services
		106	Computer Services
		107	Software Industry
30	Wholesale and Retail Trades	108	Wholesale and Retail Trades
31	Hotels and Catering Services	109	Hotels
		110	Catering Services
32	Financial Intermediation	111	Banking, Security, Other Financial Activities
		112	Insurance
33	Real Estate	113	Real Estate
34	Leasing and Business Services	114	Leasing
		115	Business Services
		116	Tourism
36	Research and Experimental Development	117	Research and Experimental Development
37	Comprehensive Technical Services	118	Professional Technical Services
		119	Services of Science and Technology Exchanges and Promotion
		120	Geological Prospecting
38	Management of Water Conservancy, Environment and Public Facilities	121	Management of Water Conservancy
		122	Environment Management
		123	Management of Public Facilities
39	Services to Households and Other Services	124	Services to Households
		125	Other Services
39	Education	126	Education
40	Health，Social Security and Social Welfare	127	Health
		128	Social Security
		129	Social Welfare
41	Culture, Sports and Entertainment	130	Journalism and Publishing Activities
		131	Broadcasting, Movies, Televisions and Audiovisual Activities
		132	Cultural and Art Activities
		133	Sports Activities
		134	Entertainment
42	Public Management and Social Organization	135	Public Management and Social Organization