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The Domestic Segment of Global Supply Chains in China under State Capitalism

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Abstract

This paper proposes methods to incorporate firm heterogeneity in the standard input-output table–based approach to portray the domestic segment of global value chains in a country. The analysis uses Chinese firm census data for the manufacturing and service sectors, along with constrained optimization techniques. The conventional input-output table is split into sub-accounts, which are used to estimate direct and indirect domestic value added in exports of different types of firms. The analysis finds that in China, state-owned enterprises and small and medium domestic private enterprises have much higher shares of indirect exports and ratios of value-added exports to gross exports compared with foreign-invested and large domestic private firms. Based on input-output tables for 2007 and 2010, the paper finds increasing value-added export ratios for all firm types, particularly for state-owned enterprises. It also finds that state-owned enterprises are consistently more upstream while small and medium domestic private enterprises are consistently more downstream within industries. These findings suggest that state-owned enterprises still play an important role in shaping China's exports.

Keywords: Value-Added Trade, Global Supply Chain, Intra-National Trade, State Capitalism

JEL Classifications: F1, C67, C82

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1. Introduction

The stellar export growth of China is often attributed to its low labor costs, trade liberalization, and policies that promote processing trade and foreign direct investment (FDI) (Branstetter and Lardy, 2006). The way that China has integrated itself with the rest of the world resembles a typical catch-up story in East Asia – by first participating in the downstream of global value chains (GVCs) and gradually moving upstream. Concurrently, when China was globalizing, many state-owned enterprises (SOEs), especially those that are small in downstream sectors, were privatized or let go.[1] Years of privatization provided room for the entry of the more productive private firms, which have been shown to be an important driver of the drastic productivity growth in China (Brandt, et al., 2012; Zhu, 2012). While the shares of SOEs in China's total value added, employment, and gross exports have been declining substantially, recent evidence shows that SOEs still monopolize the key upstream and non-tradable sectors. SOEs also appeared to gain increasing prevalence and profits in the Chinese economy in recent years, especially after the global financial crises in 2008-2009.[2]

Against this backdrop, this paper aims to answer the following questions: In which sectors did SOEs still have a prominent presence? How did the sectoral distribution of the prevalence of SOEs and its evolution in recent years shape the trade patterns of other firms, as well as their own? How did this sectoral distribution affect the intra-national trade and income distribution in China when the country was globalizing? To answer these questions, we first propose methods to split a conventional input-output (IO) table into sub-accounts that feature input-output linkages between different firm types. Specifically, we use firm-level data to group firms based on their key characteristics, which include export intensity, value-added to sales ratio, and ownership type. We then estimate the coefficients of the split tables using constrained optimization techniques, based on known statistics from firm census data for both manufacturing and service sectors, as well as detailed trade statistics. We can then estimate the volume of inter-industry trade flows between different types of firms within China and quantify the importance of different channels of indirect (value added) exports. While the paper focuses on SOEs, our methods are general enough to portray the domestic input-output linkages of Chinese exports, and can be applied to assess value-added exports by firm type in other countries. Our results add to the "value added trade" literature, which has focused mainly on the relative contribution of different countries to GVC, by formally portraying the composition and dynamics of the domestic segment of GVC in a large developing country.

Specifically, we split the conventional IO tables of China for 2007 and 2010 into transactions between six groups of firms, defined by ownership type and firm size, namely large SOEs (LSOE), small and medium SOEs (SSOE), large foreign invested enterprises (LFIE), small and medium FIEs (SFIE),

[1] The 15th Congress of the Chinese Communist Party in 1997 marked the watershed of China's economic reforms. The Congress formally sanctioned ownership reforms of the state-owned firms and also legalized the development of private enterprises.

[2] See Zhu (2012) for a comprehensive review of China's growth experience and the decline role of SOEs. See He, et al. (2012) for a study showing the continuing importance of SOEs in shaping the Chinese economy. Wang et al. (2012) develop a theoretical model to rationalize the rising profits of surviving SOEs.

large private (LP), and small and medium private enterprises (SME). Based on the six-group split of the IO tables, we report our results for four types: SOEs, FIEs, LPs, and SMEs. We find that SOEs' value added (VA) exports are significantly larger than their gross exports, contrasting with the common finding of low value added in Chinese exports (Chen et al., 2012; Koopman, et al. 2012). Specifically, the value added to gross export (VAX) ratio of SOEs is estimated to be 1.2 in 2007 and 1.8 in 2010, compared to around 0.35 for FIEs in both years. These results contrast with the findings in developed countries, such as the United States, where large firms tend to have lower VAX. Among private firms, large firms' VAX is around 0.7 for both years, while SMEs' VAX exceeded 1 for both years, and increased from slightly above 1 in 2007 to 1.3 in 2010.

Another advantage of splitting the conventional IO table into sub-accounts based on available micro data is that we can analyze trade between different firm types in the domestic segment of GVC in great detail. About 80% of SOEs' VA exports are indirect (exporting through other firms) in 2007, which increased further in 2010. Of these indirect exports, about 40% is through small firms, both domestic and foreign. These findings suggest that although SOEs' direct participation in exporting has been low, its actual participation and impact on China's exports have remained high and have been overlooked. Similar to SOEs, LPs and SMEs both have a large share of indirect VA exports, though LPs have a much lower VAX. On the other hand, FIEs tend to export more directly.

We also investigate the reasons behind the high indirect export participation for both SOEs and SMEs. Turning to the industry distribution of indirect exports by firm type, we find that SOEs' indirect exports are due to their prevalence in upstream or non-tradable industries, such as energy and mining; metal and non-metallic mineral extraction; electricity; gas and water supply; and the financial sector. This may not be surprising, since we also observe high indirect export shares in similar industries for large domestic private firms. One can argue that this could also be true in other countries, almost by definition. However, what we intend to show is that SOEs, not only large firms, have been dominating the upstream of the domestic segment of GVC in China, possibly due to the sequential pattern of privatization. While the political economy factors behind this pattern are beyond the scope of this paper, we believe that a systematic documentation can already provide important insights for understanding China's past and future economic growth. The conventional view is that China's export growth is largely driven by the dynamic labor-intensive private sector, especially the foreign-dominated processing trade sector. Our findings add to this conventional view by showing that SOEs, through their protected position in the upstream, have been playing an important role in shaping Chinese export patterns and performance. Based on information from the IO tables for only two years (2007 and 2010), we find evidence of significant increases in SOEs' VAX ratio, indirect to direct VA export ratio, and share of VA in aggregate exports. These findings have important policy implications. For instance, to the extent that SOEs are less productive than non-state firms (e.g., Zhu, 2012), a deeper privatization of SOEs or lower entry barriers in upstream industries may increase the efficiency of direct exporters in the downstream, which in turn increases the speed of upgrading of Chinese exporters' along GVC.

We find that SOEs' dominance in upstream industries is observed not only between industries but also within industries. This fact is established by measuring an industry's upstreamness by firm ownership type, based on the methods proposed by Antras et al. (2012) and Fally (2012). Using the estimated coefficients of our extended IO table, we measure upstreamness by industry and firm type. Based on the IO table for 2007, Fig. 5 shows that SOEs tend to be more upstream than non-state firms within an industry (see Fig. 8). Figs. 4 and 5 further confirm that SOEs have larger output and export shares in upstream industries, while SMEs exhibit the opposite pattern (see Figs. 6-7). These findings suggest that SOE's prevalence in upstream industries can be a potential explanation for their high VAX, compared to other firms. Furthermore, we find that the upstreamness measure increases for more than two-third of the 40 sectors from 2007 to 2010 (see Fig. 9). The increase was across the board for all ownership types, suggesting that Chinese firms are "moving up" in GVC, a pattern that is opposite to what is observed for the U.S. (Fally, 2012).

Although SMEs are similar to SOEs in the sense that they also have high value added and indirect export ratios, the sources of the similarities appear to be quite different. In addition to the fact that SMEs are more likely to export through other private firms, their upstreamness measures are generally lower than those of other types of firms within an industry (see Fig. 8). These findings suggest that the high VAX and indirect export share of SMEs are probably due to their higher propensity to sell intermediate inputs and services to other large firms that eventually export, not due to their relative upstream position in the domestic input-output network like SOEs. The findings also highlight a subtle distinction between high upstreamness and high indirect export shares of an industry.

Did the increase in SOEs' VAX lead to rising profits for the upstream SOEs, as some recent studies claim? Using our split IO table, we can examine how much profit in the Chinese economy could be attributed to exports, both directly and indirectly, and through which type of firms. We find that while total export-related profits declined from 2007 to 2010, the decline fell largely on SMEs. On the other hand, SOEs, FIEs, and LPs all experienced an increase in export-related profits between 2007 and 2010. However, unlike the sharp increase in VAX for SOEs, we find no evidence that SOEs' export-related profits increased the most. In other words, rising SOEs' value added exports in recent years did not automatically translate into higher SOEs' profits.

Our paper makes several contributions to the literature. First, it adds to the growing literature on production fragmentation across national borders (e.g., Hummels, Ishii, and Yi, 2001, Johnson and Noguera, 2012a, 2012b; Koopman, Wang, and Wei, 2012; Koopman, Wang, and Wei, 2014). The focus of that literature has been on the relative shares of domestic versus foreign value added in international trade. While establishing these facts and providing accurate measures of trade flows is urgently needed in the increasingly globalized world, the composition and dynamics of the domestic segment of GVC have not been subject to the same level of scrutiny. In particular, understanding how trade liberalization affects intra-national trade between industries and in turn shapes the reallocation of resources and across industries and firms is important for designing development policies. Our

paper takes a first step by analyzing intra-national trade between different firm types, focusing on the roles of SOEs and SMEs in China.

Related to the value-added trade literature, our approach extends the IO-table based approach to incorporate the "new new" trade literature that emphasizes firm heterogeneity. In reality, firms differ substantially in their export intensity, import intensity, and position of participation along GVC. Other characteristics such as ownership structure (domestic/foreign, private/public), location, size can also directly affect the way firms respond to trade liberalization and other economic shocks. The usual method that relies on the aggregate IO tables ignores most of the underlying firm heterogeneity. The lack of information on between-firm transactions in the micro data also restricts the construction of IO tables by firm type. Moreover, a widely recognized drawback of using IO tables to measure VAX is the assumption that firms within an industry use the same technology for production. Proportionality assumptions are often made in order to distribute imports into different final uses and different source countries, as information on bilateral trade between suppliers and users is generally not available at the country-industry level.[3] Our paper provides a method to reduce the measurement bias due to heterogeneity in export and import intensities across firm sizes and ownership types.

Our paper also contributes to the literature on the determinants of firm export participation and other indirect export channels. Research in international trade shows that only a small fraction of enterprises, usually large, directly participate in international trade (e.g., Bernard, et al., 2007).[4] The standard argument is that exporting is usually associated with high fixed costs and only large (productive) firms can make sufficiently high export revenue to amortize them. However, many non-exporters may engage in international trade indirectly, through wholesalers and other intermediaries, as well as by providing intermediate inputs and services to exporters of all sizes, particularly large multinationals. While the first channel has received a lot of attention in the recent literature (e.g., Bernard et al., 2010 and Ahn et al., 2012), the second channel has not received the deserved attention, partly due to the lack of data on inter-firm transactions within a country.[5] Our paper provides a methodology that combine firm-level and industry-level data to quantify the volume of indirect exports, and through which channel "non-exporters" export indirectly.

Finally, our paper relates to the large literature on the role of SOEs in shaping the Chinese economy (e.g., Brandt et al, 2012; Zhu, 2012). As discussed before, the conventional view is that the Chinese

[3] These assumptions have been shown to lead to substantial biases in the estimation of countries' value added, factor content of trade, and our general inference of the impact of trade on countries' macro-economy (e.g., Puzzello, 2012). For instance, De La Cruz et al. (2011) and Koopman, Wang and Wei (2012) show that by allowing different imported material intensities for processing and non-processing exporters, the estimated foreign value added ratio in aggregate exports from both China and Mexico increases significantly.

[4] As Bernard et al. (2007) described "engaging in international trade is an exceedingly rare activity: of the 5.5 million firms operating in the United States in 2000, just 4 percent were exporters. Among these exporting firms, the top 10 percent accounted for 96 percent of total U.S. exports."

[5] A notable exception is the report by the USITC (2010), who also uses the constrained optimization methodology to estimate the contribution of small and medium enterprise (SMEs) to US exports. The report finds that SMEs' total contribution to U.S. exports increased from less than 28% to 41% in 2007, when the value of intermediates supplied by SMEs to exporting firms is taken into account.

government has been reducing the share of SOEs in the economy. Privatization of SOEs is often attributed to China's sharp productivity growth and industrial transformation. Little has been done about the effects of the sequential privatization observed in China. Notable exceptions include the recent theoretical work by Song et al. (2011) and Wang et al. (2012), who both highlight and rationalize the high profitability of SOEs.[6] Our papers focus on quantifying the export patterns of SOEs themselves and how they affect other types of exporters. Our estimation can be used to examine some of the specific predictions in these theoretical models.

The rest of this paper is organized as follows. Section 2 develops our conceptual model and estimation methods. Section 3 explains our data. Section 4 analyzes our estimation results. Section 5 concludes, with discussions on potential policy implications and future research.

2. Conceptual Model and Estimation Method

This section first develops a model to split a conventional IO table into sub-accounts that record domestic transactions between different firm types across sectors. It then describes how we use constrained optimization techniques along with various adding-up conditions to estimate those transactions. Readers who are primarily interested in the estimation outcomes can skip this section and go to Section 3 directly.

2.1 Conceptual Model

Our conceptual model is built on the conventional IO table, which includes information on sales of intermediate goods and services by one industry to another in the domestic economy. By construction, summing up entries horizontally across each row and vertically across each column will both give the total gross output of an industry. The vertical summation is analogous to the *cost* approach of measuring a country's gross output, which decomposes gross output into different types of intermediate and primary factor inputs. The horizontal summation is analogous to the *sales* approach of measuring a country's gross output, which decomposes an industry's gross output into its various domestic usages and exports. To study the intra-national trade between different types of firms based on their ownership and size, we first split the non-competitive IO table with 42 industries from China's National Statistics Bureau (NBS hereafter) into 6 sub-accounts.[7] The 6 sub-accounts are constructed based on 3 ownership types – SOEs, FIEs, and Others (i.e., non-FIE private), and 2 sizes – large and small-and-medium. Thus, there are altogether 252 groups (42 industries x 3 ownership types x 2

[6] Song et al. (2011) further uses the unique feature of SOEs in China to explain several macro outcomes, such as huge saving and current account surplus.

[7] The non-competitive IO table assumes that imported and domestic products are not substitutable, in contrast to the standard IO table that assumes perfect substitutability between imported and domestic products. When competitive IO tables are used, only one set IO coefficients are needed. The underlying Leontief or linear production functions assumed in either approach have their obvious drawbacks, but we consider our approach, which permits different IO coefficients on imported and domestic inputs across sector-pairs, to be more suitable for the purpose of our study.

sizes). To estimate the volume of domestic transactions between each pair of firm groups, there will be 252 x 252 (including the within-group transactions between different firms) unknowns to estimate. See Fig. 1 for an illustration of the extended IO table.

In the IO table, *Z, Y, E, X,* and *M* represent, respectively, intermediate inputs, domestic final demand, exports, total output, and imports. We use a two-alphabet superscript to denote one of the 6 firm groups. The first alphabet denotes ownership type (S, F, or O) while the second subscript denotes size (L or S). A combination of a size and an ownership type gives us a firm group, *g*. Specifically, *g* can be *SL*, *SS*, *FL*, *FS*, *OL*, or *OS*, which represent Large SOE, Small SOE, Large FIE, Small FIE, Large Others, and Small Others, respectively. Subscripts *i* and *j* are for supplying and buying product categories (42 of them), which we will mostly refer to as sectors from now on.

Fig. 1 shows our extended IO table with 6 firm types. The last two rows report value added and the column sum of gross output, respectively. The last three columns are respectively domestic final use, exports, and total gross output, which is equal to the row sum by construction (i.e., the IO balance condition). The remaining part of the matrix is a 6x6 block of square matrices, each of which is 42x42 in dimension. For example, $\mathrm{Z}^{\mathrm{SL,SL}}$ in the first row (SL) and first column (SL) is a 42x42 matrix, with an element in row *i* and column *j*, $z_{ij}^{SL,SL}$, representing output produced by LSOEs in sector *i* used as intermediate inputs by other LSOEs in sector *j*. Moving horizontally across the first row, each matrix, $\mathrm{Z}^{\mathrm{SL,g}}$, is a 42x42 matrix with an element $z_{ij}^{\mathrm{SL,g}}$ in row *i* and column *j* representing output that is still produced by LSOEs in sector *i* but is used as intermediate inputs by group-g firms (e.g., SS) in sector *j*. Similarly, when moving down vertically within a column, each entry is a 42x42 matrix, $\mathrm{Z}^{\mathrm{g1,g2}}$, with elements, $z_{ij}^{\mathrm{g1,g2}}$, being the output produced by firms in group g1 and sector *i*, and used as intermediate inputs by firms in group g2 and sector *j*.

Moving to the last three rows of the split IO table, the first 6 entries in row 7 (F) are 42x42 matrices, $Z^{\mathrm{F,g2}}$. The element in row *i* and column *j* of $Z^{F,g2}$, $z_{ij}^{\mathrm{F,g2}}$, represents product *i* imports that are used as intermediate inputs by group-g2 (e.g., SL) firms in sector *j*. The 7th entry, Y^{F}, is a 42x1 vector, with element, y_i^F, being the total amount of product *i* imports for final consumption. The last entry in row 7, M, is a 42x1 vector, with element m_i representing total imports of product *i*. By definition, m_i is the sum of the first 7 entries in the same row.

Rows 8 and 9 in Fig. 1 show sectoral value added and gross output of the 6 different firm groups, respectively. For example, in the first column in Row 8, V^{SL} is a 1x42 row vector that has element *i* equal to the direct value added of LSOE in sector *i* (cost of production factors). In the last row, $(\mathrm{X}^{\mathrm{SL}})^{\mathrm{T}}$ is a 1x42 row vector with element *i* being the gross output of LSOE in sector *i.* Superscript T represents the transpose operation. Other X and V matrices are defined similarly for different firm groups.

The direct IO coefficients in the expanded IO table can be expressed in matrix algebra as:

$$\mathrm{A}^{\mathrm{g1,g2}} = \left[a_{ij}^{g1,g2}\right] = \left[\frac{z_{ij}^{g1,g2}}{x_j^{g2}}\right]$$

$$\text{and} \quad \mathrm{A}^{\mathrm{F,g2}} = \left[a_{ij}^{F,g2}\right] = \left[\frac{z_{ij}^{F,g2}}{x_j^{g2}}\right]$$

where *i* is the row subscript and *j* is the column subscript. $\mathrm{A}^{\mathrm{g1,g2}}$ is a 42x42 block matrix, with each element being an IO coefficient representing the amount of output produced by firms in group g1 used as intermediate inputs in the production of one unit of output by group-g2 firms. More specifically, x_j^{g2} represents output by group-g2 firms in sector *j*, where g2 can be either LS, SS, LF, SF, OL, or OS, respectively. It is also the jth element in $(\mathrm{X}^{\mathrm{g2}})^{\mathrm{T}}$ in the last row of Fig. 1. $z_{ij}^{g1,g2}$ is the amount of sector *i* output produced by group-g1 firms that are used by group-g2 firms in sector *j*. It is the element in row *i* and column *j* of $\mathrm{Z}_{\mathrm{j}}^{\mathrm{g1,g2}}$. Similarly, $\mathrm{A}^{\mathrm{F,g2}}$ is a 42x42 matrix, with each element being an IO coefficient measuring the amount of imported goods used as intermediate inputs by group-g2 firms to produce one unit of gross output. In other words, the element in row *i* and column *j* of $\mathrm{Z}_{\mathrm{j}}^{\mathrm{F,g2}}$ in the 3rd row from the bottom of Fig. 1, $z_{ij}^{F,g2}$, is the amount of sector-i imports used by group-g2 firms in sector *j*.

We then obtain matrix A, with 294 (7x42) rows and 252 (6x42) columns, to represent all IO coefficients in the economy as follows:

$$\mathrm{A} = \begin{bmatrix} A^d \\ --- \\ A^m \end{bmatrix}$$

where

$$\mathrm{A}^{\mathrm{d}} = \begin{bmatrix} \mathrm{A}^{\mathrm{SL,SL}} & \mathrm{A}^{\mathrm{SL,SS}} & \mathrm{A}^{\mathrm{SL,FL}} & \mathrm{A}^{\mathrm{SL,FS}} & \mathrm{A}^{\mathrm{SL,OL}} & \mathrm{A}^{\mathrm{SL,OS}} \\ \mathrm{A}^{\mathrm{SS,SL}} & \mathrm{A}^{\mathrm{SS,SS}} & \mathrm{A}^{\mathrm{SS,FL}} & \mathrm{A}^{\mathrm{SS,FS}} & \mathrm{A}^{\mathrm{SS,OL}} & \mathrm{A}^{\mathrm{SS,OS}} \\ \mathrm{A}^{\mathrm{FL,SL}} & \mathrm{A}^{\mathrm{FL,SS}} & \mathrm{A}^{\mathrm{FL,FL}} & \mathrm{A}^{\mathrm{FL,FS}} & \mathrm{A}^{\mathrm{FL,OL}} & \mathrm{A}^{\mathrm{FL,OS}} \\ \mathrm{A}^{\mathrm{FS,SL}} & \mathrm{A}^{\mathrm{FS,SS}} & \mathrm{A}^{\mathrm{FS,FL}} & \mathrm{A}^{\mathrm{FS,FS}} & \mathrm{A}^{\mathrm{FS,OL}} & \mathrm{A}^{\mathrm{FS,OS}} \\ \mathrm{A}^{\mathrm{OL,SL}} & \mathrm{A}^{\mathrm{OL,SS}} & \mathrm{A}^{\mathrm{OL,FL}} & \mathrm{A}^{\mathrm{OL,FS}} & \mathrm{A}^{\mathrm{OL,OL}} & \mathrm{A}^{\mathrm{OL,OS}} \\ \mathrm{A}^{\mathrm{OS,SL}} & \mathrm{A}^{\mathrm{OS,SS}} & \mathrm{A}^{\mathrm{OS,FL}} & \mathrm{A}^{\mathrm{OS,FS}} & \mathrm{A}^{\mathrm{OS,OL}} & \mathrm{A}^{\mathrm{OS,OS}} \end{bmatrix},$$

and $A^m = [\mathrm{A}^{\mathrm{F,SL}} \quad \mathrm{A}^{\mathrm{F,SS}} \quad \mathrm{A}^{\mathrm{F,FL}} \quad \mathrm{A}^{\mathrm{F,FS}} \quad \mathrm{A}^{\mathrm{F,OL}} \quad \mathrm{A}^{\mathrm{F,OS}}]$.

Thus, final demand for domestically produced goods can be expressed as

$$\mathrm{X} = \mathrm{A}^{\mathrm{d}}\mathrm{X} + \mathrm{Y}^{\mathrm{d}} + \mathrm{E} \qquad (1)$$

where $\mathrm{X} = \begin{bmatrix} \mathrm{X}^{\mathrm{SL}} \\ \mathrm{X}^{\mathrm{SS}} \\ \mathrm{X}^{\mathrm{FL}} \\ \mathrm{X}^{\mathrm{FS}} \\ \mathrm{X}^{\mathrm{OL}} \\ \mathrm{X}^{\mathrm{OS}} \end{bmatrix}$, $\mathrm{Y}^{\mathrm{d}} = \begin{bmatrix} \mathrm{Y}^{\mathrm{SL}} \\ \mathrm{Y}^{\mathrm{SS}} \\ \mathrm{Y}^{\mathrm{FL}} \\ \mathrm{Y}^{\mathrm{FS}} \\ \mathrm{Y}^{\mathrm{OL}} \\ \mathrm{Y}^{\mathrm{OS}} \end{bmatrix}$, and $\mathrm{E} = \begin{bmatrix} \mathrm{E}^{\mathrm{SL}} \\ \mathrm{E}^{\mathrm{SS}} \\ \mathrm{E}^{\mathrm{FL}} \\ \mathrm{E}^{\mathrm{FS}} \\ \mathrm{E}^{\mathrm{OL}} \\ \mathrm{E}^{\mathrm{OS}} \end{bmatrix}$

(i.e., the gross output, domestic final use, and export vectors). Rearranging eq. (1) gives

$$\mathrm{X} = (\mathrm{I} - \mathrm{A}^{\mathrm{d}})^{-1}\mathrm{Y}^{\mathrm{d}} + (\mathrm{I} - \mathrm{A}^{\mathrm{d}})^{-1}\mathrm{E} \ = \mathrm{B}\mathrm{Y}^{\mathrm{d}} + \mathrm{B}\mathrm{E} \tag{2}$$

where B is the well-known Leontief matrix:

$$B = (\mathrm{I} - \mathrm{A}^{\mathrm{d}})^{-1} = \begin{bmatrix} \mathrm{B}^{\mathrm{SL,SL}} & \mathrm{B}^{\mathrm{SL,SS}} & \mathrm{B}^{\mathrm{SL,FL}} & \mathrm{B}^{\mathrm{SL,FS}} & \mathrm{B}^{\mathrm{SL,OL}} & \mathrm{B}^{\mathrm{SL,OS}} \\ \mathrm{B}^{\mathrm{SS,SL}} & \mathrm{B}^{\mathrm{SS,SS}} & \mathrm{B}^{\mathrm{SS,FL}} & \mathrm{B}^{\mathrm{SS,FS}} & \mathrm{B}^{\mathrm{SS,OL}} & \mathrm{B}^{\mathrm{SS,OS}} \\ \mathrm{B}^{\mathrm{FL,SL}} & \mathrm{B}^{\mathrm{FL,SS}} & \mathrm{B}^{\mathrm{FL,FL}} & \mathrm{B}^{\mathrm{FL,FS}} & \mathrm{B}^{\mathrm{FL,OL}} & \mathrm{B}^{\mathrm{FL,OS}} \\ \mathrm{B}^{\mathrm{FS,SL}} & \mathrm{B}^{\mathrm{FS,SS}} & \mathrm{B}^{\mathrm{FS,FL}} & \mathrm{B}^{\mathrm{FS,FS}} & \mathrm{B}^{\mathrm{FS,OL}} & \mathrm{B}^{\mathrm{FS,OS}} \\ \mathrm{B}^{\mathrm{OL,SL}} & \mathrm{B}^{\mathrm{OL,SS}} & \mathrm{B}^{\mathrm{OL,FL}} & \mathrm{B}^{\mathrm{OL,FS}} & \mathrm{B}^{\mathrm{OL,OL}} & \mathrm{B}^{\mathrm{OL,OS}} \\ \mathrm{B}^{\mathrm{OS,SL}} & \mathrm{B}^{\mathrm{OS,SS}} & \mathrm{B}^{\mathrm{OS,FL}} & \mathrm{B}^{\mathrm{OS,FS}} & \mathrm{B}^{\mathrm{OS,OL}} & \mathrm{B}^{\mathrm{OS,OS}} \end{bmatrix}$$

where $\mathrm{B}^{\mathrm{g1,g2}}$ is a 42x42 block matrix, each element in which is the total requirement coefficient that gives the amount of required gross output by firm group g1 for one additional unit of domestic final demand or exports. The intuition behind the Leontief matrix is as follows: for each dollar of exports, the first round of value added is generated by the direct exporters. This is the *direct* domestic value added. To produce that value added, intermediate inputs have to be used, which in turn generate additional value added, and so on. Such a process of value-added generation continues iteratively and can be traced throughout the domestic input-output linkage across firm types and sectors in the economy. The total domestic value added induced by one dollar of exports is thus equal to the sum of direct and all rounds of indirect domestic value added generated.

Before getting to the domestic input-output linkage, let us briefly discuss the import identity, which we will use to trace the indirect linkage across industries (from final sales back to the value-added embodied in all upstream intermediate inputs) to distribute export value back to different sources of supply, including foreign suppliers. As imports can be absorbed as final goods and used as intermediate inputs, the import matrix, M, can be expressed as

$$\mathrm{M} = \mathrm{A}^{\mathrm{m}}\mathrm{X} + \mathrm{Y}^{\mathrm{m}} \tag{3}$$

Substituting (2) into (3) yields

$$\mathrm{M} = \mathrm{A^m BY^d} + \mathrm{A^m BE} + \mathrm{Y^m} \tag{4}$$

The first term on the right hand side of eq. (4), $\mathrm{A^m BY^d}$, represents imports used (both directly and indirectly) to produce final products for domestic use, $\mathrm{A^m BE}$ stands for imports used (both directly and indirectly) through the domestic input-output network to produce exports. It will be used below to estimate foreign value-added in exports. $\mathrm{Y^m}$ represents the amount of imports that are consumed as final goods.

Let us define $\mathrm{A_V^{g1}} = \left[\frac{v_j^{g1}}{x_j^{g1}}\right]$ as the value added vector (1 by 42) for firm group g1 where v_j^{g1} is the jth element of V^{g1} in the second last row in Fig. 1; and $A_V = \left[\mathrm{A_V^{SL}}, \mathrm{A_V^{SS}}, \mathrm{A_V^{FL}}, \mathrm{A_V^{FS}}, \mathrm{A_V^{OL}}, \mathrm{A_V^{OS}}\right]$ as the 1x252 row vector of value added, covering all sectors and firm groups.

Because total gross output (X) in any sector has to be equal to the sum of direct value-added V, plus the cost of domestic intermediate inputs ($Z^{g1,g2}$) from all firm types and imported inputs, ($Z^{F,g}$), the following accounting identity always holds :

$$\mathrm{u} = A_V + \mathrm{uA^d} + \vartheta \mathrm{A^m}, \tag{5}$$

which means that each unit of output can be attributed to direct value added, domestic intermediate inputs, and imported intermediate inputs. u is a 1x252 row vector and ϑ is a 1x42 row vector, respectively.

Taking $\mathrm{uA^d}$ to the left hand side of eq. (5) and rearranging it yields

$$\mathrm{u} = A_V(\mathrm{I} - \mathrm{A^d})^{-1} + \vartheta \mathrm{A^m}(\mathrm{I} - \mathrm{A^d})^{-1} = A_V \mathrm{B} + \vartheta \mathrm{A^m B} \tag{6}$$

Post-multiplying both sides of eq. (6) by the diagonal matrix of exports, $\widehat{\mathrm{E}}$, yields

$$\mathrm{u\widehat{E}} = \mathrm{A_V B\widehat{E}} + \vartheta \mathrm{A^m B\widehat{E}} \tag{7}$$

Notice that $A_V = \mathrm{u}\hat{A}_V$, where $\hat{A}_V$ is the diagonal matrix of A_V with the dimension of 252x252. Thus, eq. (7) can be further be rewritten as

$$\mathrm{u\widehat{E}} = \mathrm{u\hat{A}_V B\widehat{E}} + \vartheta \mathrm{A^m B\widehat{E}} \tag{8}$$

Eq. (8) states that the country's total gross export value, $\mathrm{u\widehat{E}}$, a 1x252 row vector, can be decomposed into domestic value added in exports $\mathrm{u}\hat{A}_V \mathrm{B\widehat{E}}$ (either used directly for production of exported goods and services, or indirectly by firms that supply domestic inputs that are used eventually by exporters) and the value of imports embedded in exports $\vartheta \mathrm{A^m B\widehat{E}}$, which includes imported intermediates used directly

by exporters or embodied in other domestic intermediates finally used by them.

In eq. (8), the first term on the right hand side, $u\widehat{A}_V B\widehat{E}$, is the key to our quantification of domestic value added (DVA) in Chinese exports. Specifically, $\widehat{A}_V B\widehat{E}$ is a 252x252 square matrix, with each element representing the source (from which product category and firm type) and the channel (indirectly used in which product category and firm type) of domestic value added in exports. Depending on the research question, one can aggregate $\hat{A}_V B\widehat{E}$ horizontally or vertically to estimate DVA in exports. If the goal is to decompose DVA in exports of the direct exporting sectors by firm type into its various sources of value added, regardless of the sector or firm-type in which the value added is originally created, we should sum up the elements of $\hat{A}_V B\widehat{E}$ vertically down a column (the backward-linkage approach). If the goal is to measure DVA based on their source of contribution by industry-firm-type, we should sum up the elements of $\hat{A}_V B\widehat{E}$ horizontally along each row (the forward-linkage approach)[8]. In other words, we will first use the forward-linkage approach to examine how primary factors employed in a particular upstream sector-firm-type pair contributes value-added to every downstream sector-firm-type pair's exports. Then we will discuss the backward-linkage approach to examine how each downstream firm-type and sector's exports can be sourced back to each upstream sector-firm-type pair's value-added.

Since we need to deal with not only intermediate inputs supplied directly to the exporters, but also those through the domestic input-output network iteratively before reaching the direct exporting sectors and firm groups, we further decompose the Leontief matrix B to compute direct and indirect domestic value-added exports separately. Let us rewrite B as follows

$$B = \begin{bmatrix} B^{SL,SL} & B^{SL,SS} & B^{SL,FL} & B^{SL,FS} & B^{SL,OL} & B^{SL,OS} \\ B^{SS,SL} & B^{SS,SS} & B^{SS,FL} & B^{SS,FS} & B^{SS,OL} & B^{SS,OS} \\ B^{FL,SL} & B^{FL,SS} & B^{FL,FL} & B^{FL,FS} & B^{FL,OL} & B^{FL,OS} \\ B^{FS,SL} & B^{FS,SS} & B^{FS,FL} & B^{FS,FS} & B^{FS,OL} & B^{FS,OS} \\ B^{OL,SL} & B^{OL,SS} & B^{OL,FL} & B^{OL,FS} & B^{OL,OL} & B^{OL,OS} \\ B^{OS,SL} & B^{OS,SS} & B^{OS,FL} & B^{OS,FS} & B^{OS,OL} & B^{OS,OS} \end{bmatrix}$$

$$= \begin{bmatrix} B^{SL,SL} - I & B^{SL,SS} & B^{SL,FL} & B^{SL,FS} & B^{SL,OL} & B^{SL,OS} \\ B^{SS,SL} & B^{SS,SS} - I & B^{SS,FL} & B^{SS,FS} & B^{SS,OL} & B^{SS,OS} \\ B^{FL,SL} & B^{FL,SS} & B^{FL,FL} - I & B^{FL,FS} & B^{FL,OL} & B^{FL,OS} \\ B^{FS,SL} & B^{FS,SS} & B^{FS,FL} & B^{FS,FS} - I & B^{FS,OL} & B^{FS,OS} \\ B^{OL,SL} & B^{OL,SS} & B^{OL,FL} & B^{OL,FS} & B^{OL,OL} - I & B^{OL,OS} \\ B^{OS,SL} & B^{OS,SS} & B^{OS,FL} & B^{OS,FS} & B^{OS,OL} & B^{OS,OS} - I \end{bmatrix}$$

[8] See Wang, Wei and Zhu (2013) for a more detailed discussion on forward- and backward-linkage approaches to measure value-added exports.

$$+\begin{bmatrix} \mathrm{I} & & & & & \\ & \mathrm{I} & & & & \\ & & \mathrm{I} & & & \\ & & & \mathrm{I} & & \\ & & & & \mathrm{I} & \\ & & & & & \mathrm{I} \end{bmatrix}$$

Then DVA in exports at the most disaggregated level can be decomposed as

$$\mathrm{DVAX} = \widehat{\mathrm{A}}_{\mathrm{V}}\mathrm{B}\widehat{\mathrm{E}} = \widehat{\mathrm{A}}_{\mathrm{V}}\widehat{\mathrm{E}} + \widehat{\mathrm{A}}_{\mathrm{V}}(\mathrm{B}-\mathrm{I})\widehat{\mathrm{E}} \tag{9}$$

where $\mathrm{B}-\mathrm{I} = \begin{bmatrix} \mathrm{B}^{\mathrm{SL,SL}}-\mathrm{I} & \mathrm{B}^{\mathrm{SL,SS}} & \mathrm{B}^{\mathrm{SL,FL}} & \mathrm{B}^{\mathrm{SL,FS}} & \mathrm{B}^{\mathrm{SL,OL}} & \mathrm{B}^{\mathrm{SL,OS}} \\ \mathrm{B}^{\mathrm{SS,SL}} & \mathrm{B}^{\mathrm{SS,SS}}-\mathrm{I} & \mathrm{B}^{\mathrm{SS,FL}} & \mathrm{B}^{\mathrm{SS,FS}} & \mathrm{B}^{\mathrm{SS,OL}} & \mathrm{B}^{\mathrm{SS,OS}} \\ \mathrm{B}^{\mathrm{FL,SL}} & \mathrm{B}^{\mathrm{FL,SS}} & \mathrm{B}^{\mathrm{FL,FL}}-\mathrm{I} & \mathrm{B}^{\mathrm{FL,FS}} & \mathrm{B}^{\mathrm{FL,OL}} & \mathrm{B}^{\mathrm{FL,OS}} \\ \mathrm{B}^{\mathrm{FS,SL}} & \mathrm{B}^{\mathrm{FS,SS}} & \mathrm{B}^{\mathrm{FS,FL}} & \mathrm{B}^{\mathrm{FS,FS}}-\mathrm{I} & \mathrm{B}^{\mathrm{FS,OL}} & \mathrm{B}^{\mathrm{FS,OS}} \\ \mathrm{B}^{\mathrm{OL,SL}} & \mathrm{B}^{\mathrm{OL,SS}} & \mathrm{B}^{\mathrm{OL,FL}} & \mathrm{B}^{\mathrm{OL,FS}} & \mathrm{B}^{\mathrm{OL,OL}}-\mathrm{I} & \mathrm{B}^{\mathrm{OL,OS}} \\ \mathrm{B}^{\mathrm{OS,SL}} & \mathrm{B}^{\mathrm{OS,SS}} & \mathrm{B}^{\mathrm{OS,FL}} & \mathrm{B}^{\mathrm{OS,FS}} & \mathrm{B}^{\mathrm{OS,OL}} & \mathrm{B}^{\mathrm{OS,OS}}-\mathrm{I} \end{bmatrix}$

Notice that DVAX is a 252x252 square matrix with two separate terms: the first term on the right hand side of eq. (9), $\widehat{\mathrm{A}}_{\mathrm{V}}\widehat{\mathrm{E}}$, is direct DVA in exports, while the second term, $\widehat{\mathrm{A}}_{\mathrm{V}}(\mathrm{B}-\mathrm{I})\widehat{\mathrm{E}}$, is indirect DVA in exports. We can further decompose $\widehat{\mathrm{A}}_{\mathrm{V}}(\mathrm{B}-\mathrm{I})\widehat{\mathrm{E}}$ into indirect exports via other firms within the same firm group (e.g. SOEs exporting via SOEs) or via other firm groups (e.g., SOEs exporting via FIEs). The same-group indirect exports can be derived from the multiples involving only the diagonal of the block matrix inside the square brackets. The between-group indirect exports can be derived from the multiples involving only the off-diagonal part of the block matrix inside the square brackets.

To implement the forward-linkage (supply) approach so that we can trace the final use of VA created by primary factors employed in a particular sector-firm-type, we post-multiply both sides of eq. (9) by a 252x1 unit column vector, μ. This operation essentially sums up each sector-firm-type's VA horizontally to obtain a measure of DVA in exports at the sector-firm-type level, regardless of which downstream sector-firm-type the VA are embedded. Formally, the forward-linkage based DVA in exports is

$$\mathrm{DVAX_{fw}} = \mathrm{DVAX}\mu = \widehat{\mathrm{A}}_{\mathrm{V}}\widehat{\mathrm{E}}\mu + \widehat{\mathrm{A}}_{\mathrm{V}}(\mathrm{B}-\mathrm{I})\widehat{\mathrm{E}}\mu, \tag{10}$$

where $\mathrm{DVAX_{fw}}$ is a 252x1 column vector. $\hat{A}_{\mathrm{V}}\widehat{\mathrm{E}}\mu$ and $\hat{A}_{V}(B-I)\hat{E}\mu$ on the right hand side are direct and indirect value-added exports for each firm type at the sector level, respectively. Direct DVAX represents DVA that comes from the same sector-firm-group of the exporters. Indirect DVAX is the same sector-firm-group's DVA embodied in intermediate inputs supplied to other sectors and firms groups that eventually export.

Let us abstract from the sector dimension and focus on different firm groups for the moment. Eq. (10) can be further decomposed along the firm-type dimension. The first row in $\hat{A}_V\hat{E}\mu$ represents the direct VAX from large SOEs (SL). The first row of the second term, $\hat{A}_V(B-I)\hat{E}\mu$,, is the sum of 6 multiples as follows:

$$\begin{aligned}&\hat{A}_V^{\mathrm{SL}}(\mathrm{B}^{\mathrm{SL,SL}}-\mathrm{I})\widehat{\mathrm{E}}^{\mathrm{SL}}\tilde{\mu}+\hat{A}_V^{\mathrm{SL}}\mathrm{B}^{\mathrm{SL,SS}}\widehat{\mathrm{E}}^{\mathrm{SS}}\tilde{\mu}+\hat{A}_V^{\mathrm{SL}}\mathrm{B}^{\mathrm{SL,FL}}\widehat{\mathrm{E}}^{\mathrm{FL}}\tilde{\mu}\\&+\hat{A}_V^{\mathrm{SL}}\mathrm{B}^{\mathrm{SL,FS}}\widehat{\mathrm{E}}^{\mathrm{FS}}\tilde{\mu}+\hat{A}_V^{\mathrm{SL}}\mathrm{B}^{\mathrm{SL,OL}}\widehat{\mathrm{E}}^{\mathrm{OL}}\tilde{\mu}+\hat{A}_V^{\mathrm{SL}}\mathrm{B}^{\mathrm{SL,OS}}\widehat{\mathrm{E}}^{\mathrm{OS}}\tilde{\mu}\end{aligned}\tag{11}$$

where $\tilde{\mu}$ is a 42x1 column vector. $\hat{A}_V^{\mathrm{SL}}(\mathrm{B}^{\mathrm{SL,SL}}-\mathrm{I})\widehat{\mathrm{E}}^{\mathrm{SL}}\tilde{\mu}$ is indirect DVAX via large SOE firms, $\hat{A}_V^{\mathrm{SL}}\mathrm{B}^{\mathrm{SL,SS}}\widehat{\mathrm{E}}^{\mathrm{SS}}\tilde{\mu}$, $\hat{A}_V^{\mathrm{SL}}\mathrm{B}^{\mathrm{SL,FL}}\widehat{\mathrm{E}}^{\mathrm{FL}}\tilde{\mu}$, $\hat{A}_V^{\mathrm{SL}}\mathrm{B}^{\mathrm{SL,FS}}\widehat{\mathrm{E}}^{\mathrm{FS}}\tilde{\mu}$, $\hat{A}_V^{\mathrm{SL}}\mathrm{B}^{\mathrm{SL,OL}}\widehat{\mathrm{E}}^{\mathrm{OL}}\tilde{\mu}$, and $\hat{A}_V^{\mathrm{SL}}\mathrm{B}^{\mathrm{SL,OS}}\widehat{\mathrm{E}}^{\mathrm{OS}}\tilde{\mu}$ represent LSOEs' indirect VAX via SSOEs, LFIE, SFIE, LP, and SME's exports, respectively. Other rows in eq. (10) can be interpreted similarly for other firm types. Eq. (10) thus provides detailed information about the volume of direct and indirect DVAX, as well as through what types of firms that indirect exporting takes place. If we consider the 42 sectors within each firm-group-sector-pair, we can analyze these different components of VAX by sector. The estimates of direct and indirect VAX by 6 firm groups and 42 sectors are reported in Tables A4.1-4.6 in the appendix.

To implement the backward-linkage (user) approach that decomposes each firm type's exports into their original value-added source by sector and firm-type, we pre-multiply both sides of eq. (9) by the 1x252 unit row vector *u*. This operation essentially sums up each sector-firm-type's VA vertically to obtain a measure of DVA at the sector-firm-type level. Formally, the backward-linkage based DVA in exports is

$$\mathrm{DVAX_{bw}} = \mathrm{u}\mathrm{DVAX} = \mathrm{u}\widehat{\mathrm{A}}_{\mathrm{V}}\widehat{\mathrm{E}} + \mathrm{u}\widehat{\mathrm{A}}_{\mathrm{V}}(\mathrm{B}-\mathrm{I})\widehat{\mathrm{E}}\tag{12}$$

By replacing $\mathrm{u}\hat{A}_V\mathrm{B}\widehat{\mathrm{E}}$ in eq. (8) by eq. (12), we can completely decompose China's gross exports according to its various value-added sources as follows:

$$\mathrm{u}\widehat{\mathrm{E}} = \mathrm{u}\widehat{\mathrm{A}}_{\mathrm{V}}\widehat{\mathrm{E}} + \mathrm{u}\widehat{\mathrm{A}}_{\mathrm{V}}(\mathrm{B}-\mathrm{I})\widehat{\mathrm{E}} + \vartheta\mathrm{A}^{\mathrm{m}}\mathrm{B}\widehat{\mathrm{E}}\tag{13}$$

Notice that all terms in eq. (13) are 1x252 row vectors.

Similar to our analysis of the forward-linkage based approach, let us abstract from the sector dimension and ignore value added from foreign sources (i.e., the $\vartheta\mathrm{A}^{\mathrm{m}}\mathrm{B}\widehat{\mathrm{E}}$ term) for the moment, so that we can focus on different firm groups. The first column of the first term, $\mathrm{u}\widehat{\mathrm{A}}_{\mathrm{V}}\widehat{\mathrm{E}}$, represents the direct value added exports by large SOEs (SL) in all 42 sectors. Notice the direct value-added exports based on the forward-linkage and backward-linkage approaches are identical (i.e. $\left(u\hat{A}_V\hat{E}\right)^{\mathrm{T}}$ in eq. (13) = $\hat{A}_V\hat{E}\mu$ in eq. (11)).

However, the indirect value-added exports measures can be very different for each firm group-sector

pair. The two measures are only equal to each other at the country level (see WWZ, 2013 for details). In the second term, $u\hat{A}_V(B-I)\hat{E}$, the first column is the sum of 6 multiples as follows:

$$\tilde{u}\hat{A}_V^{SL}(B^{SL,SL}-I)\hat{E}^{SL}+\tilde{u}\hat{A}_V^{SS}B^{SS,SL}\hat{E}^{SL}+\tilde{u}\hat{A}_V^{FL}B^{FL,SL}\hat{E}^{SL}+\tilde{u}\hat{A}_V^{FS}B^{FS,SL}\hat{E}^{SL}+\tilde{u}\hat{A}_V^{SL}B^{OL,SL}\hat{E}^{SL}+\tilde{u}B^{OS,SL}\hat{E}^{SL} \quad (14)$$

Where $\tilde{u}$ is a 1x42 row vector. $\tilde{u}\hat{A}_V^{SL}(B^{SL,SL}-I)\hat{E}^{SL}$ is LSOEs' indirect VAX via large LSOEs; $\tilde{u}\hat{A}_V^{SS}B^{SS,SL}\hat{E}^{SL}$, $\tilde{u}\hat{A}_V^{FL}B^{FL,SL}\hat{E}^{SL}$, $\tilde{u}\hat{A}_V^{FS}B^{FS,SL}\hat{E}^{SL}$, $\tilde{u}\hat{A}_V^{SL}B^{OL,SL}\hat{E}^{SL}$, and $\tilde{u}\hat{A}_V^{SL}B^{OS,SL}\hat{E}^{SL}$ represent SSOEs, LFIE, SFIE, LP, and SME's value-added embodied in LSOE's gross exports, or these firm groups' indirect value-added exports via LSOE, respectively. Other columns of $u\hat{A}_V(B-I)\hat{E}$ in eq. (13) can be interpreted similarly for other firm groups. Therefore, eq. (14) thus provides detailed information about the value-added sources in exports produced by each firm group. If we consider the 42 sectors within each firm-group-pair, we can analyze the value-added composition for each firm group by sector. The full decomposition of each firm type's exports by value-added sourced from the 6 firm groups and 42 sectors are reported in Table A7 in the appendix.

2.2 Estimation Method

Eqs. (9)-(14) allow us to study the indirect value added by firm type at the aggregate and sector levels, decompose each firm group's sectoral exports into its various value-added sources, as well as shed light on the effects of exports on the distribution of operating surplus (an empirical measure of firm profit) across sectors and firm types. However, since statistical agencies in most countries normally provide only a conventional IO matrix, A, and not the disaggregated block matrices by firm groups, such as $A^{g1,g2}$ or $A^{F,g2}$, we need to develop a method to construct those subaccounts from the original IO tables using information available from official statistics. IO tables already include data on industry-level total output, value added, imports, and exports as well as aggregate inter-industry transactions. To estimate our extended model with 6 sub-accounts, we need to complement these aggregate data with firm-level data, which are from the 2008 National Bureau of Statistics of China (NBS hereafter) economic census. See Section 3 for details.[9]

The following data are observable from a conventional IO table at the broad sector level (42 groups of products) for 2007 and 2010:

x_i: gross output of sector *i*;

z_{ij}^D: domestic goods *i* used as intermediate inputs in sector *j*;

z_{ij}^F: imported goods *i* used as intermediate inputs in sector *j*;

v_j: value added in sector *j*;

[9] One may prefer to call our optimization exercise a "calibration", especially since our exercise does not provide standard errors to gauge the precision of our estimates. We are open to this alternative interpretation, but would like to emphasize that in research in progress, we are extending our current optimization program with a Monte-Carlo-type first stage, which will provide standard errors for our estimates.

e_i: total exports of sector *i* goods;

m_i: total imports of sector *i* goods;

y_i^D: total domestic final demand for sector *i* goods (excluding exports);

y_i^F: total final demand for imported goods *i*.

Using these data from the IO table as controls (constants) in the quadratic programming model, we make sure that the balance conditions in an official IO table are always satisfied. In other words, we can always aggregate values from our extended IO table with separate sub-accounts for firm groups back to the values in the original IO table.

We need to estimate the values of $\left[z_{ij}^{g1,g2}\right]$ for each g1 and g2, where g1 and g2 belong to one of the six firm types, namely, SL, SS, FL, FS, OL, and OS. Similarly, we estimate $\left[z_{ij}^{F,g}\right]$ for one of the six firm types, indexed by g at the sector-pair level, indexed by (i, j). We also need to estimate sector-level domestic final demand by firm group, $\left[y_j^g\right]$, which are not available from the official IO table but can be constructed using firm-level census data from the NBS and detailed trade statistics from China Custom Administration. We cast the estimation as a constrained optimization problem. Initial values are selected relying on proportionality assumptions (e.g., share of market demand in total output in each sector and firm group, which will be discussed next) and micro data from Chinese official sources. These initial values do not necessarily satisfy all economic and statistical restrictions on the split IO table.

Using the notations previously defined, the quadratic programming model is specified by the objective function in eq. (15) below, subject to the six constraints specified in eqs. (16) through (21) below. The initial values for the same variables in eq. (15) are denoted with an additional zero. Variables without a zero (the *z*'s, and *y*'s) are unknowns that are to be solved by minimization. Symbols with a zero in eqs. (16) through (21) represent parameters in the model and are kept constant throughout the optimization process.

Specifically, the minimization program is

$$\text{Min S} = \sum_{g1=SL}^{OS}\sum_{g2=SL}^{OS}\left\{\sum_{i=1}^{K}\sum_{j=1}^{K}\frac{\left(z_{ij}^{g1,g2}-z0_{ij}^{g1,g2}\right)^2}{z0_{ij}^{g,f}}\right\} + \sum_{g=SL}^{OS}\left\{\sum_{i=1}^{K}\sum_{j=1}^{K}\frac{\left(z_{ij}^{F,g}-z0_{ij}^{F,g}\right)^2}{z0_{ij}^{F,g}}\right\} + \sum_{g=SL}^{OS}\left\{\sum_{j=1}^{K}\frac{\left(y_j^{g}-y0_j^{g}\right)^2}{y0_j^{g}}\right\} \quad (15)$$

s.t.

$$\sum_{g2=SL}^{OS}\sum_{j=1}^{K}\left(z_{ij}^{g1,g2}\right)+y_i^{g1}+e0_i^{g1}=x0_i^{g1} \quad (16)$$

$$\sum_{g1=SL}^{OS}\sum_{i=1}^{K}\left(z_{ij}^{g1,g2}\right)+v0_i^{g2}=x0_i^{g2}, \quad (17)$$

$$\sum_{g1=SL}^{OS}\sum_{g2=SL}^{OS}z_{ij}^{g1,g2}=z0_{ij}^{D}, \quad (18)$$

$$\sum_{g=SL}^{OS}z_{ij}^{F,g}=z0_{ij}^{F}, \quad (19)$$

$$\sum_{g=SL}^{OS}y_i^{g}=y0_i^{D} \quad (20)$$

$$\sum_{g=SL}^{OS}\sum_{j=1}^{K}z_{ij}^{F,g}+y0_i^{F}=m0_i \quad (21)$$

And non-negativity constraints

$$z_{ij}^{g1,g2},\quad z_{ij}^{F,g},\quad y_i^{g}\geq 0. \quad (22)$$

All constraints need to be satisfied for all *i* (42 of them) and *j* (42 of them), *g* (6 of them), *g1* (6 of them), and *g2* (6 of them). These seven sets of constraints have straightforward economic interpretations. Eq. (16) is a set of supply-and-use balancing (row sum) constraints for the extended IO table. It states that total gross output by each type of firm in sector *i*, must equal the sum of their use of intermediate inputs, their exports, and their delivery to final domestic users in that sector. Eq. (17) is the set of production and cost balancing (column sum) constraints. It defines the value of gross output by each type of firm in sector *j* as the sum of intermediate inputs and primary factors used in the production process. Eqs. (18) to (21) are a set of adding-up constraints to ensure that the solutions from the model sum to the statistics (i.e., domestic final demand, imports, and inter-sector transactions) in the official IO table at the sector and sector-pair levels.

3. Data and Empirical Results

3.1 Data Sources and Model Variable Initialization

The model parameters and initial values of the model variables are derived by combining industry-level data from the 42-sector "non-competitive" IO tables, for 2007 and 2010, respectively, along with firm census data for 2008. These data sets are obtained from China's National Bureau of Statistics (NBS). Notice that all evolutions in value added by firm type reported below arise from the changes in the IO table coefficients, not from the census data as we only have access to one year of data. The economic census data cover over 5 million enterprises in China, including all state-owned and private enterprises spanning all manufacturing and non-manufacturing industries. Balance sheet information, such as registration ownership type, equity share by ownership, output, value added, four-digit industry code (about 900 categories), exports, employment, original value of fixed assets, and intermediate inputs. The ownership type of a firm in our analysis is defined based on the registration type and equity share by ownership. Specifically, a firm is considered state-owned (foreign-invested) if it is registered as a state (foreign) company *or* has more than (and equal to) 50% equity owned by state (foreign) investors.

There are 42 domestic and 42 imported product groups in the original "non-competitive" IO table. Each product group is further split into six sub-groups by ownership type and size: large SOEs (LSOE), small and medium SOEs (SSOE), large FIEs (LFIE), small and medium FIEs (SFIE), large private enterprises (LP), and small and medium private enterprises (SME). Firm size category (large and small-and-medium) is determined by firm employment and sales, with thresholds specified by the NBS. The classification criteria vary across industries, and are listed in Table A1 in the appendix.

The decision of putting firms into 6 groups is supported by the underlying firm distribution of export intensity and value added to sales ratios reported in the NBS micro data. Fig. 2 illustrates that firm average export intensity differs significantly across ownership types, not so much along the firm size dimension. In particular, FIEs are a lot more export-oriented than non-FIE firms. Fig. 3 illustrates that FIEs also appear to have higher value added to output ratios (VAY) than non-FIE firms. Within non-FIE firms, large firms tend to have higher VAY. Within FIEs, there is little difference in these key variables between Hong Kong SAR, China, Macau, and Taiwan, China (HKMT) firms and non-Chinese FIEs. Based on these findings, we separate firms based on 3 ownership types and 2 sizes, and group HKMT firms with other FIEs.

After assigning firms from the census to different groups, total sales/receipts at the group level are used to allocate gross output of each sector to each ownership-size type, while groups' annual payrolls are used to split labor and non-labor components of the value added within the group. We can also assign exports (but not imports) into firm types in almost all industries using the firm census

data.[10] Detailed import data, obtained from the statistical department of China Customs Administration, are disaggregated by firm ownership type within each 8-digit HS level. The UN BEC code is used to separate intermediates from final goods in imports at the 6 digit-HS level, which are then aggregated up to 42 product categories in the Chinese IO table. These data are used as import-related constraints and to set initial values for our minimization program.

All initial values $x0_j^g$ and $v0_j^g$ in the model, as well as an industry's total intermediate inputs were set based on official statistics. These values constrain the model solutions to a convex set. To initialize all $z0_{ij}$'s, we need to allocate each industry's total intermediate inputs, both domestic and imported, into different product groups by firm type. To this end, we first use the NBS firm census and the original IO table to compute for each firm type (6 of them), the sectoral (42 sectors) output $x0_j^g$ and value added $v0_j^g$. Then we compute total intermediate inputs $(x0_j^g - v0_j^g)$ for each sector and firm type, and compute the share of intermediate inputs of each firm type in sector *j*. Using these shares, we distribute the numbers $z0_{ij}^D$ and $z0_{ij}^F$ from the original IO table into 6 different firm types, e.g., $z0_{ij}^{g1,g2}$. Table A5-6 in the appendix shows these shares by firm type in all 42 sectors. The specific procedures to set the initial values for our minimization program are described below.

1. Setting the initial value for $z0_{ij}^{F,g}$ (the IO coefficients for imports for group g) involves two steps. For sectors that have zero intermediate imports in the trade statistics, but have positive values in the IO table, we simply use the shares of each firm type in the sector's total intermediate inputs and set the initial value for $z0_{ij}^{F,g}$ as:

$$z0_{ij}^{F,g} = \frac{x0_j^g - v0_j^g}{\sum_{g,j}(x0_j^g - v0_j^g)} z0_{ij}^F, \qquad (\mathrm{g} = \mathrm{SL}, \mathrm{SS}, \mathrm{FL}, \mathrm{FS}, \mathrm{OL}, \mathrm{OS}) \tag{23}$$

   On the other hand, for sectors that have positive imported intermediate inputs in the trade statistics, we first compute each firm group's share in the sector's imported inputs based on customs statistics, as shown in Table A6.2, to allocate imported inputs into SOEs, FIEs, and others. Using the adjusted $z0_{ij}^F$ and eq. (23), we further allocate the imported inputs belonging to each ownership type to large and small firms within the same ownership type, respectively.

2. To set the initial value for $z0_{ij}^{g1,g2}$ (the volume of domestic intermediates supplied by group g1 in sector *i* to group g2 in sector *j*), we first assume that the share of intermediate inputs produced by g1 in sector *i* equals the share of g1's gross output in sector *i*. Then on the receiving side, we assume that g2's share of intermediate input absorption in sector *j* equals their share of intermediate inputs in total intermediate inputs demanded by the same sector. All this information is available in the firm census data. Based on these two assumptions, we split the

[10] Export data are not available for most service sectors.

original $z0_{ij}^{D}$ based on the following formula:

$$z0_{ij}^{g1,g2} = \frac{x0_i^{g1}}{x0_i}\frac{(x0_j^{g2} - v0_j^{g2})}{(x0_j - v0_j)} z0_{ij}^{D}, \quad (\mathrm{g1, g2} = \mathrm{SL, SS, FL, FS, OL, OS}) \tag{24}$$

3. To set the initial value for $y0_i^g$, total domestic demand for goods and services supplied by firm group *g* in sector *i* (i.e., the sum of private consumption, government spending, fixed capital investment, and inventory changes), we use the following formula:

$$y0_i^g = x0_i^g - \frac{x0_i^g}{x0_i}\sum_{j=1}^{N} z0_{ij}^{D} - e0_i^g \tag{25}$$

Notice that we implicitly assume that the supply of intermediate products/inputs for domestic use from each firm type in a sector is proportional to their gross output in that sector. To make the model fully initialized and operational, we also need the relative shares of different firm types in the country's total exports and imports for each of the 42 sectors. Such information is readily available in the disaggregated trade statistics from China's Customs.

4. Estimating Indirect Contribution to Value-Added Exports by Firm Size and Ownership Type

4.1 Main Results

4.1.1 Relative Importance in the Aggregate Economy

Based on the estimates of the model described in Sections 2 and 3, we portray the domestic segment of GVC in China. Table 1 shows that SOEs account for 19% and 9% of value added and employment of China in 2008, respectively. The relatively small shares of SOEs are partly due to years of economic reforms led by the Chinese authorities to privatize and let go SOEs, especially the small ones in downstream sectors. SOEs' contributions to gross exports and value-added exports (VAX) in 2007 are 12% and 21%, respectively. The large difference between SOE's contributions to value added and gross exports suggests that SOEs have a higher share of indirect exports through other firms, compared to other firm ownership types. Notice that while SOEs' gross export share declined significantly from 12% in 2008 to 9% in 2010, their share in value added exports actually increased. We will focus on analyzing these opposite trends in greater detail below.

Table 1 also shows that SMEs are numerous and employ the majority of workers in China. They account for 55% and 79% of China's value added and employment in 2008, respectively. In terms of gross exports, their contribution is much smaller – only 28%. This low share of exports is consistent with the conventional view that most small firms do not export because of the potentially high fixed export costs. In terms of value added exports, they account for 42%. The much larger contribution to

VAX implies that SMEs have a higher share of indirect exports, either through other SMEs or other types of firms. In terms of the aggregate gross exports and VAX, SOEs and SMEs look similar, but both the share of gross and value added exports by SMEs decreased from 2007 to 2010. We will reveal key underlying differences in terms of their distributions across industries and the channels through which they achieve a high value added to gross export ratio below.

As expected, FIEs are much more export-oriented. They are small in number, similar to SOEs, but account for close to half of Chinese gross exports. Their share in total value added exports is much smaller (only 27%), consistent with the literature that finds low domestic value added in Chinese exports, particularly in processing exports (Koopman, Wang, and Wei, 2012; Kee and Tang, 2013). To the extent that most of the processing firms are FIEs, which include firms owned by investors from Hong Kong, Macau, and Taiwan (HKMT), the results are not surprising. Processing firms import a large fraction of intermediate inputs and are responsible for the final stage of production, by taking advantage of the low labor costs in China.

4.1.2 The Domestic Segment of GVCs (VAX Based on the Forward-Linkage Approach)

Next, we use our split IO tables to decompose VAX by firm type into direct and indirect VAX, based on both the forward- and backward-linkage approaches, as described in Section 2. We will first report results based on the forward-linkage approach.

For indirect VAX, we further measure the paths through which a firm type export indirectly. Table 2 presents these results, along with the volume of gross exports by firm type. Before turning to the details of indirect VAX, it is worth highlighting that for the 4 firm groups considered here, both SOE and SME have the VAXR exceeding 1. Specifically, Panel A shows that the VAXR of SOEs and SMEs are 1.17 and 1.02 in 2007, respectively. As a comparison, the VAXR of FIEs and LPs are 0.36 and 0.70, respectively. The finding of SOEs' VAXR larger than unity confirms the results in Table 1 that SOEs' contribution to Chinese exports is much larger if measured in value added terms than in gross terms. Moreover, these findings contrast sharply with the evidence for developed countries, such as the United States, where large firms' share in gross exports is usually higher than that in value-added exports (i.e., the VAXR is smaller than 1). In summary, the low VAX ratio of Chinese aggregate exports, as reported in the literature, hides substantial heterogeneity in VAX across firm ownership types and sizes.

Panel B of Table 2 shows the same set of estimates using the 2010 IO table. As reported, all but FIEs experienced an increase in VAX. The increase was particularly sharp for SOEs and SMEs. SOEs' VAXR increased by about 47% while that of SMEs increased by about 27%. The significant increase in the VAXR of SOEs lends some support to the anecdote that the state sector has advanced their prominence in the Chinese economy in recent years, especially after the global financial crisis in 2008 when the Chinese central government implemented policies to stimulate the economy.

The higher-than-unity VAXR of both SOEs and SMEs imply that many non-exporters from these two groups produce intermediate inputs and services that are embedded in Chinese exports. Table 2 reports the value of indirect exports. We find the following pecking order – SOEs have the highest share of indirect exports in VAX, followed by LPs and SMEs, with FIEs having the lowest share. Specifically, in 2007, about 80% of exports from SOEs are indirect (the numbers increased slightly in 2010). In other words, 80% of SOEs' exports are values embedded in inputs used by firms that eventually export. For LPs and SMEs, the indirect export shares are about 72% and 63%, respectively. The indirect export share of SMEs increased significantly by 10 percentage points from 2007 to 2010, consistent with the hypothesis that small exporters could be financially constrained after the global finance crisis and less likely to engage in direct exporting. Once again, FIEs are very different from domestic firms and have a much lower share of indirect exports (about 46% in 2007, which decreased to 43% in 2010). Given the prevalence of FIEs in processing trade and the prevalence of intra-firm trade associated with vertical FDI, the low indirect export ratio is not surprising.

By splitting the IO table along the size and ownership type dimensions, we can also estimate the amount of indirect exports through different types of firms. As reported in Table 2, most of SOEs' indirect exports are through non-SOEs. In particular, in 2007, FIEs account for over 40% (35/80) of SOEs' indirect exports, which increased to over 55% in 2010. On the other hand, SMEs account for 25% of SOEs' indirect exports in 2007, which declined to about 20% in 2010. Both LPs and SMEs also have high shares of indirect exports, but are both lower than that of SOEs. FIEs also play a more significant role in helping LPs to export indirectly, compared to SMEs. The role of SMEs in helping other firms export decreased from 2007 to 2010. For instance, when the SMEs' indirect export share increased from 2007 to 2010, the role of other SMEs in facilitating their exports declined, with FIEs taking up most of the increase. In summary, both SOEs and LPs have higher than average indirect export shares, with the former having a much higher VAX ratio. SMEs' participation in exporting, both direct and indirect, declined, while SOEs' indirect exports increased, consistent with an increasing VAX ratio as documented earlier.

How about the cross-industry pattern of indirect exports? Answering this question can shed light on the reasons for the similarity in the VAX ratio between SOEs and SMEs. Table 3 exhibits substantial heterogeneity in indirect export shares (in total value added exports) across 14 broad industries. "Upstream" industries, such as energy and mining; metal and non-metallic mineral extraction; electricity, gas and water supply; as well as financial sector all have very high indirect export shares (over 90%). Tables A4.1-A4.6 in the appendix shows these numbers for 40 disaggregated industries and 6 groups of firms, revealing similar patterns. One reason for their high indirect export shares is that the sectors with high indirect export share tend to be non-tradable, either by nature or restricted by the authorities. They tend to export indirectly by providing essential intermediate inputs and services to downstream exporters. Thus, focusing only on gross exports in analyzing firms' export participation can substantially underestimate their actual participation in GVC and thus the impact of trade liberalization on the economy.

In addition to the cross-industry variation, within a sector we also see a non-negligible variation in the indirect export share across firm types. For instance, in the "Light manufacturing" sector, the ratio of indirect to direct VA exports is 50% in 2007, one of the lowest, but the ratio for SOEs is 75%. A casual observation shows that SOEs tend to have a higher indirect export share in sectors that are associated with a lower average indirect export share, such as electronic equipment; while SMEs tend to have a higher indirect export share in industries that have a higher average indirect export share, such as energy and mining, and the financial sector. We will use the upstreamness measures proposed by Antras et al. (2012) to conduct a more systematic analysis below.

4.1.3 The Domestic Segment of GVCs (Export-Related Profits Based on the Forward-Linkage Approach)

We also apply our framework to answer an important policy-relevant question: how much profit was generated by exports in China, and how was the export-related profit distributed across different firm types? Similar to our analysis on value added exports, we can attribute export-related profit (the operating surplus term in an IO table) accruing to a firm type via direct and indirect exports, respectively. By "direct", we refer to profits accruing to direct exporters. By "indirect", we refer to profits accruing to firms that supply goods and services to downstream exporters, through the domestic input-output network. Column (1) in Panel A of Table 4 reports a total of 885 billion RMB profits (about 120 billion USD in 2007 exchange rate) accruing to direct exporters in 2007. Similar to our analysis of value added exports above, this value of profits for direct exporters may underestimate the actual export-induced profits in the domestic economy. Therefore, we also estimate profits accruing to firms that sell inputs and services, directly and indirectly, to exporters in the economy (defined in the same way in Table 2). When both direct and indirect exporters' profits are included (column (2)), total export-related profits increased to 2.3 trillion RMB (about 315 billion USD). As reported in Panel B, direct export-related and total export-related profits for 2010 were 763 billion and 2.2 trillion RMB, respectively.[11] The decline in both profit measures, despite the fact that value added exports increased between the two years, suggests that the Chinese economy may have become more competitive over time.

How important are export activities in generating profits in the Chinese economy? According to the IO tables, total profits (capital income) of the Chinese economy were about 8 trillion RMB in 2007 and 9.7 trillion RMB in 2010. In other words, if we focus on profit accrued to direct exporters only (i.e., 885 and 763 billion RMB), exports generated about 11% and 8% of China's total profits in 2007 and 2010, respectively. On the other hand, if we also include profit accrued to firms that also supply intermediate goods and services to exporters, profits that could be attributed to exports increased to about 29% in 2007 and 23% in 2010.

Similar to the decomposition of value added exports conducted in Table 2, we can also distribute

[11] Notice that we are still using 2008 firm census to measure aggregate surplus and surplus by firm type.

export-related profits to different firm types. As reported in column (3), we find that FIEs have the highest profit per worker derived from exports (both direct and indirect), while SMEs have the lowest export-related profit per worker. Specifically, profit per worker due to exports was 6140 RMB for FIEs in 2007, 1250 RMB for SOEs, 1720 RMB for LPs, and only 700 RMB for SMEs. Using 2008 firm census data, along with 2007 and 2010 IO tables, we find that export-related profit per worker declined from 1150 RMB in 2007 to 999 RMB in 2010 for the aggregate economy. Those for FIEs and LPs, however, increased to 6440 and 1980 RMB, respectively.

Column (4) reports each firm type's share in total export-related profits. SMEs are responsible for 47% of the export-related profits in 2007, followed by FIEs that account for 25%. Given that SMEs hire most of the workers in China (92% in 2007) and produce over half of the country's GDP (55%), their low share of total profit implies an uneven distribution of profits across firm types. Once again, we find a small increase in SOEs' share of export-related profit. Consistent with the slight increase in SOEs' share in value added exports, their share of profits increased from 18.5% in 2007 to 19.2% in 2010. Is this supporting evidence for the claim that SOEs have advanced in the Chinese economy at the expense of the private sector? Notice that both FIEs and LPs also experience an increase in their shares of export-related profits. The increase of SOEs' export-related profits was not the sharpest. It went up by 4%, compared to 9% for FIEs and LPs, respectively. In other words, the entire decline in export-related profits falls on SMEs, as the other three firm types all experienced an increase in profits.

The drastic differences in export-related profits across firm types hide substantial heterogeneity in the channels through which different firm types derive their profits from downstream exports. Column (9) shows that domestic firms (SOEs, LPs, and SMEs) derive most of their export-related profits indirectly. The share of profits that firms derive from indirect export ranges from 61% for SMEs to 79% for SOEs. Columns (5) to (8) show that FIEs play a dominant role in exporting for other upstream firms (ranging from 23 to 35% depending on upstream firm types). Perhaps surprisingly, SMEs also serve as an important channel through which other firms can derive profits from exports (between 11 to 20%). Panel B shows that from 2007 to 2010, the roles of FIEs in serving as downstream exporters to generate profits for other firm types increased from 28% in 2007 to 37% in 2010. Despite an increase in profit shares, SOEs become less important as a channel to pass on export-related profits from downstream exporters to upstream firms. As reported in column (5), the SOE channel, measured as the share of profits generated by indirect exporting, dropped from 9.2% (Pane A) to 6.3% (Panel B).

4.1.4 The Domestic Segment of GVCs (VAX Based on the Backward-Linkage Approach)

So far, we have been using the forward-linkage approach, which involves summing up the entries of $\widehat{\mathrm{A}}_{\mathrm{V}}\mathrm{B}\widehat{\mathrm{E}}$ (in eq. (7)) horizontally along each row, to estimate direct and indirect value added exports by different types of firms. In this section, we use the backward-linkage approach and ask "For each dollar of Chinese exports (aggregate or by firm type), how much of it is coming from SOEs, FIEs, etc.?" Different from the forward-linkage approach that focuses on the channels through which each firm type's VAX (by sector or at the aggregate) is generated, the backward-linkage approach decomposes

each firm type's gross exports into direct VA, indirect VA from the same type, and indirect VA from other firm types. For example, SOEs' gross exports now include not only VA of the SOE exporters themselves, but also domestic VA from all other upstream firm types, including other SOEs, as well as other firm types' VA embedded in inputs used to produce those exports.[12] This decomposition exercise permits an analysis on the distribution of VAX across firm types embedded in each firm type's downstream exports, complementing the forward-linkage approach that focuses on the "paths" of exporting.

By using this backward-linkage VAX measure, we provide another set of results to examine how the domestic VA in Chinese exports is distributed across firm types, and how the distribution changed between 2007 and 2010. As reported in Table 5, of the 10 trillion RMB Chinese gross exports in 2007, 14% can be attributed to SOEs, directly and indirectly; while the contribution by FIEs, LPs, and SMEs are 18%, 7% and 29%, respectively. The findings of high value added by SOEs and SMEs resonate well with the finding that both types of firms have high VAX, as reported in Table 2. Foreign VA in Chinese exports in 2007 is 32%. We also decompose each firm type's gross exports into contributions by different firm types' indirect exports. For instance, we find that for each dollar of SOEs' gross exports, SOEs themselves contribute about 39 cents (24 cents directly and 15 cents indirectly), followed by 18 cents from SMEs and 10 cents from FIEs. Foreign value added from abroad accounts for 26 cents, lower than its contribution in aggregate export. Notice that the numbers along the diagonal is always the highest compared to other numbers in the same column, suggesting that each firm type contributes the most VA to its own gross exports, compared to other firm types.

The lower panel of Table 5 reveals that while Chinese gross exports increased by only 9.7% from 2007 to 2010, the contribution of SOEs in terms of VA increased by 14.8%. Specifically, for each dollar of Chinese gross exports, 14.2 cents ultimately came from SOEs in 2007, while 16.3 cents came from them in 2010. SOEs are not the only group that experienced an increase in VA shares between the two years. All three other groups also experienced an increase, at the expense of foreign VA. However, it is the SOEs that experienced the sharpest increase in VA contribution, followed by FIEs that had its VA share increased by 9.2%. Another fact revealed in Table 5 is that SOEs' VA shares increased for exports by all firm types. This is not observed for other firm types. For instance, FIEs' VA shares increased only for FIEs' exports but not for other firm types.

The backward-linkage approach can be used to distribute sectoral DVA in exports into different sources of firm types. Such an exercise provides another perspective to portray the cross-sector pattern of contributions by different firm types. As reported in Table 6, a few sectors have more than 30% DVA originating from SOEs. In 2007, these sectors include "Mining and Washing of Coal" (SOEs' share in total sector's VAX = 39.98%), "Extraction of Petroleum and Natural Gas" (49.56%), "Mining of Non-Ferrous Metal Ores" (32.50), "Processing of Petroleum, Coking and Nuclear Fuel" (44.16), "Smelting and Rolling of Metals" (36.67), "Production and Supply of Electricity and Heat" (52.05).

[12] Such a backward-linkage perspective aligns well with case studies of GVC of specific sectors and products, such as the iPod or iPhone examples frequently cited in the literature.

These are obviously "upstream" sectors that provide essential inputs to downstream exporters. In the next section, we will conduct a systematic analysis on SOEs' potential dominance in "upstream" sectors, using Antras et al.'s (2012) measures.

While SOEs appear to have a dominant position in some sectors, they are not the firm group that has the highest VA shares for most sectors. It is the SMEs that often contribute more than 30% of VAX in most sectors. In fact, SOEs' VA share exceeded 30% for only 13 sectors (out of 40) compared to 24 for SMEs. For example, SMEs' shares of VAX in "Foods and Tobacco" and "Manufacture of Textile Products" are 60% and 52%, respectively. These findings suggest that SMEs have been playing an important role driving Chinese exports. This is consistent with the hypothesis that a lot of SMEs do not export directly, possibly because of high fixed export costs. Instead, they participate actively by supplying intermediate inputs and services to larger downstream exporters. In 2010, the number of sectors in which SOEs' share in VAX exceeded 30% actually dropped from 13 to 11. However, in those sectors that SOEs had the highest VAX share in 2007, SOEs' VAX shares have increased substantially. For example, in the "Mining and Washing of Coal" sector, SOEs' VAX share was 40% in 2007, which increased to 56% in 2010.

4.2 Industry Upstreamness by Firm Type

Table 3 shows a vast heterogeneity in indirect export shares across industries, consistent with the conventional view that non-tradable sectors do not export much and typically participate in exports indirectly. Table 6 further shows that SOEs seem to prevail in "upstream" sectors. These findings hint that SOEs and SMEs derive their large indirect exports through different channels. To analyze these channels more systemically, we use the method proposed by Antras et al. (2012) to measure industry upstreamness. We make two important extensions to the original method. First, given our split IO table, we can measure an industry's upstreamness by firm size and ownership type. With these measures in hand, we can then examine whether within an industry, some firm types are relatively more upstream on average. We construct the upstreamness measure for 40 industries and 6 firm groups.[13] The second extension is that we relax the proportionality assumptions they make about the allocation of imports and exports in each industry pair. Specifically, our estimated IO coefficients already have imports taken out by explicitly including A^m in our model. When dealing with exports from sector *i* to sector *j* by firm type, we use data on exported intermediate inputs from China's customs and assign the bi-sectoral exports to different firm types based on their shares in each IO link in the domestic economy. See the appendix for details. Table A3 in the appendix report the 240 upstreamness measures, along with the industry upstreamness estimated based on the conventional IO table (without any split).

Table 7 reports the top 5 and bottom 5 industry upstreamess measures based on the conventional IO table. By construction, the upstreamness measure ranges between 1 and the maximum number of

[13] The original IO table has 42 industries, but we dropped

the industries in the country's IO table. The top 5 most "upstream" industries (out of 40) are "Extraction of Petroleum and Natural Gas", "Mining of Ferrous Metal Ores", "Mining and Washing of Coal", "Production and supply of Electricity and heat", "Processing of Petroleum, Coking and Nuclear Fuel". The values of upstreamness for these industries range between 4 and 5, meaning that these industries are on average 4-5 industries away before reaching final consumers. These raw material and energy industries sell intermediate inputs to many other industries, including other upstream industries. They are expected to rank high up in the domestic production network. The bottom 5 "upstream" industries are "Real Estate", "Health and Social service", "Education", "Construction industry", "Public administration and social organization". They tend to sell final goods and services directly to customers.

By using the split IO table, we can estimate the upstreamness measures for different firm groups. Consistent with the high indirect export ratio, SOEs, particularly the small ones, tend to have the highest upstreamness measure among all firms types within each industry, while SMEs tend to have the lowest upstreamness, particularly in the least upstream industries, among all firm types. Fig. 4 plots the SOEs', FIEs', LPs' and SMEs' upstreamness measures against the industry overall measures, which are estimated using the original aggregate IO table. Most measures for the SOEs (blue squares) are above the 45-degree line, suggesting that SOEs are often more upstream than other firm types within the same industry. SMEs, on the other hand, are often the most "downstream" within industries.

Another way to show that SOEs have a dominant position in the upstream industries is to examine the correlation between the share of SOEs in different aggregate outcomes and industry upstreamness. Fig. 5 shows a positive and (marginally) significant correlation between the share of SOEs in total industry output and industry upstreamness, suggesting that SOEs have a dominant position in upstream industries. Fig. 6 shows a positive and significant relationship between SOEs' share in the industry's gross exports and industry upstreamness. Figs. 7-8 show no particular relationship between upstreamness, output, and exports for SMEs. In sum, these findings confirm that the high VAX ratio for SOEs is partly driven by their dominance in the upstream sectors, while SMEs' high VAX is due to other reasons. One possibility is that exporting is associated with high fixed costs and only large (productive) firms can make sufficiently high export revenue to amortize them. Thus, SMEs tend to export indirectly and have a high VAX ratio.

We use the split IO table from 2010 and estimate the industry measures of upstreamness for different firm types again (see Table A3 in the appendix for the estimates). Fig. 9 shows that for 27 of the 40 industries, the upstreamness measure increased. This finding is exactly the opposite of what recent studies have documented for the U.S., where industries have shown to become more downstream over time (Fally, 2012). If more upstream activities are being offshored from the U.S. to China, our results can provide the "mirror-image" support to Fally (2012).

5. Concluding Remarks

This paper proposes methods to incorporate firm heterogeneity in the standard IO-table based approach to portray the domestic segment of global supply chains in a country. Using conventional IO tables, firm census data for both manufacturing and service sectors, and constrained optimization techniques, we are able to estimate direct and indirect value added exports (VAX) for different types of firms in China, and decompose a firm type's indirect VAX into different channels through which they are realized.

Based on our split IO table, we find that in China, both state-owned enterprises (SOEs) and small and medium domestic private enterprises (SMEs) have much higher shares of indirect exports and ratios of value-added exports (VAX) to gross exports, compared to foreign-invested and large domestic private firms. Using China's IO tables for 2007 and 2010 respectively, we find evidence of increasing VAX ratios for all firm types, particularly for SOEs. By extending the method proposed by Antras et al. (2012), we find that SOEs are consistently more upstream while SMEs are consistently more downstream within industries. These findings suggest that SOEs still play an important role in shaping China's downstream exports.

Our findings imply that years of privatization have led to the dominance of SOEs, not only large firms, in the upstream sectors. While the political economy factors behind such privatization outcomes are beyond the scope of this paper, documenting these unique patterns shed light on understanding China's past and future economic growth. The conventional view is that China's export growth is largely driven by the dynamic labor-intensive private sector, especially the foreign-dominated processing sector. We have documented coherent evidence that SOEs still play a significant role in shaping China's aggregate export patterns and performance.

Whereas SMEs are similar to SOEs in the sense that they also have high value added and indirect export ratios, the sources and the channels behind these similarities appear to be quite different. In addition to the fact that non-state SMEs are more likely to export through other non-state firms, their upstreamness is also lower within industries. This finding suggests that the higher VAX and indirect export share of SMEs are probably due to their higher propensity to sell intermediate inputs and services to other large firms who eventually export, rather than having an upstream position in the domestic production network, as have been enjoyed by SOEs.

References

Ahn, J., A. Khandelwal and S. J. Wei (2011), "The Role of Intermediaries in Facilitating Trade," *Journal of International Economics*, 84(1): 73-85.

Antras, P. and D. Chor (2012), "Organizing the Global Value Chain," Harvard University Working Papers.

Antras, P. and A. Costinot (2011), "Intermediated Trade," *Quarterly Journal of Economics*, 126(3): 1319-74.

Antras, P., D. Chor, T. Fally and R. Hillberry (2012), "Measuring the Upstreamness of Production and Trade Flows," *American Economic Review*, 102(3): 412-6.

Asiedu, E. and J. Freeman (2007), "The Effect of Globalization on the Performance of Small-and Medium-Sized Enterprises in the United States: Does Owners' Race/Ethnicity Matter?" *American Economic Review*, 97(2) (May, 2007): 368-72.

Bernard, A., Jensen, J. Bradford, S. Redding and P. K. Schott (2007), "Firms in International Trade," *Journal of Economic Perspectives*, 21(3): 105-30.

Bernard, A., B. Jensen, S. Redding and P. K. Schott (2010), "Wholesalers and Retailers in U.S. Trade," *American Economic Review*, 100(2): 408-13.

Branstetter, L. and L. Nicolas (2006), "China's Embrace of Globalization," NBER Working Paper.

Brandt, L., J. Van Biesebroeck and Y. Zhang (2012), "Creative Accounting or Creative Destruction? Firm-Level Productivity Growth in Chinese Manufacturing," *Journal of Development Economic*, 97(2): 339-51.

Brooke, K., Meeraus and Raman (2005), *GAMS - User's Guide*, Washington, DC: GAMS Development Cooperation.

Chen, X., L. K. Cheng, K. C. Fung, L. J. Lau, Y. W. Sung, K. Zhu and Y. Duan (2012), "Domestic Value Added and Employment Generated by Chinese Exports: A Quantitative Estimation," *China Economic Review*.

Costinot, A., J. Vogel and S. Wang, "Global Supply Chains and Wage Inequality," *American Economic Review Papers and Proceedings*, forthcoming.

Costinot, A., J. Vogel and S. Wang (2012), "An Elementary Theory of Global Supply Chains," *Review of Economic Studies*, forthcoming.

De La Cruz, J., R. Koopman, Z. Wang and S. J. Wei (2010), "Estimating Foreign Value-Added in Mexico's Manufacturing Exports," USITC Working Paper.

Hummels, D., J. Ishii and K-M. Yi (2001), "The Nature and Growth of Vertical Specialization in World Trade," *Journal of International Economics*, 54(1): 75-96.

Koopman, R., Z. Wang and S. J. Wei (2008), "How Much of Chinese Exports is Really Made in China? Assessing the Domestic Value-Added When Processing Trade is Pervasive," NBER Working Paper No.14109.

Koopman, R., Z. Wang and S. J. Wei (2012), "Estimating Domestic Content in Exports When Processing Trade is Pervasive," *Journal of Development Economics*, 99(1): 178-89.

Koopman, Robert, Zhi Wang and Shang-Jin Wei (2014), "Tracing Value-added and Double Counting in Gross Exports," *American Economic Review,* 104(2):459-94. Also available as NBER Working Paper No.18579.

National Research Council (2006), "Analyzing the U.S. Content of Imports and the Foreign Content of Exports," Committee on Analyzing the U.S. Content of Imports and the Foreign Content of Exports, Center for Economic, Governance, and International Studies, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

He, D., W. Zhang, G. Han and T. Wu (2012), "Productivity Growth of the Non-Tradable Sectors in China," HKIMR Working Papers No.08/2012, Hong Kong Institute for Monetary Research.

Puzzello, L. (2012), "A Proportionality Assumption and Measurement Biases in the Factor Content of Trade," *Journal of International Economics*, forthcoming.

Roberto, A. E. (2004), "Sources of Export Success in Small- and Medium-Sized Enterprises: The Impact of Public Programs," *International Business Review*, 13(3) (June 2004): 383–400.

Song, Z., K. Storesletten and F. Zilibotti (2011), "Growing Like China," *American Economic Review*, 101(1): 196-233.

USITC (2010), "Small and Medium-Sized Enterprises: Characteristics and Performance," Investigation No.332-510, USITC Publication 4189, November 2010.

Wang, Y., X. Li and X. Liu (2012), “A Model of China's State Capitalism,” HKUST Working Paper.

Wang, Z., S-J Wei and K. Zhu (2013), “Quantifying International Production Sharing at the Bilateral and Sector Level,” NBER Working Paper No.19677.

Zhu, X. (2012), “Understanding China’s Growth: Past, Present, and Future,” *Journal of Economic Perspective*.

Table 1. Estimated Contribution in Main Economic Activities by Firm Type

Firm Type	Number of Firms (08)	Value Added (08)	Employment (08)	Gross Exports (07)	Value Added Exports (07)	Gross Exports (10)	Value Added Exports (10)
Panel A: Share (%)							
SOE	4.73	19.16	9.24	12.07	20.81	9.40	22.02
FIE	3.01	16.34	6.49	49.47	26.50	56.65	26.67
Large Enterprise (LP)	0.22	9.91	4.82	10.08	10.35	10.41	10.10
Small and Medium Private (SME)	92.04	54.58	79.45	28.38	42.34	23.54	41.21
Panel B: Value (Billion for values; million for employment)							
SOE	188829	5098.20	71.16	1230.94	1445.75	1051.85	1820.57
FIE	120073	4348.44	49.94	5045.69	1841.05	6340.14	2205.26
Large Enterprise (LP)	8836	2637.43	37.09	1028.06	719.12	1164.47	834.88
Small and Medium Private (SME)	3674676	14520.31	611.71	2894.76	2941.58	2634.63	3407.06
Total	3992414	26604.38	769.91	10199.79	6947.49	11191.10	8268

Note: Data on value added and employment are from China's National Bureau of Statistics (NBS) firm census in 2008. Data on gross exports and value added exports are computed based on 2007 IO tables.

Table 2. Indirect Exports via Different Firm Types

Panel A: 2007	Value Added Exports (Bil RMB)	Share of Indirect VAX (%) via SOE	FIE	LGO	SMO	Total	VA Exp/ Gross Exp (VAXR)	
SOE	1446	13.14	35.27	10.94	20.19	79.54	1.17	
FIE	1841	6.56	23.35	5.72	10.68	46.31	0.36	
Large Enterprise (LP)	719	11.13	32.02	9.77	19.32	72.24	0.70	
Small and Medium Private (SME)	2942	7.66	26.70	7.22	21.65	63.23	1.02	
Total	6947	8.87	28.15	7.86	18.20	63.07	0.68	
Panel B: 2010								Change relative to 2007 (%)
SOE	1821	9.18	43.65	10.50	16.78	80.10	1.73	47.37
FIE	2205	3.86	26.40	5.18	7.71	43.15	0.35	-4.67
Large Enterprise (LP)	835	6.98	39.35	9.05	14.92	70.30	0.72	2.50
Small and Medium Private (SME)	3407	5.60	38.77	8.05	20.83	73.25	1.29	27.26
Total	8268	6.06	36.60	7.93	15.84	66.43	0.74	8.46

Note: Authors' estimation based on data from I/O tables for 2007 and 2010. Both from China's NBS.

Table 3. Indirect VAX/ Total VAX (4 types; 14 industries) (%)

Panel A: 2007

Industry	All	SOE	FIE	LP	SME
Energy and mining	94.03	94.57	92.30	93.01	**94.58**
Metal and non-metallic mineral extraction	90.14	89.15	88.18	**92.17**	91.17
Light manufacturng	49.61	**74.83**	36.87	58.18	51.70
Petrochemical	74.89	**87.58**	62.67	75.69	79.79
Metal and non-metal processing	67.29	68.87	69.00	**75.37**	60.58
Machinery and equipment	47.02	**72.52**	36.86	53.35	46.90
Electronic equipment	20.75	**45.45**	16.71	34.41	36.29
Other manufacturing	76.35	59.75	29.67	36.68	**87.02**
Electricity, gas and water supply	99.41	**99.51**	**99.56**	98.85	98.95
Building industry	33.63	33.18	**35.94**	33.39	33.38
Transportation and warehousing	52.87	59.78	87.92	**90.06**	40.50
Wholesale and retail trade	42.72	72.22	**82.72**	76.36	24.26
Financial sector	98.18	97.94	97.82	97.78	**98.51**
Other Services	66.02	75.35	79.31	**80.82**	45.23
Total	63.07	**79.54**	46.31	72.24	63.23

Panel B: 2010

Industry	All	SOE	FIE	LP	SME
Energy and mining	96.55	95.95	93.34	96.64	**99.23**
Metal and non-metallic mineral extraction	94.77	97.65	81.86	**99.53**	94.27
Light manufacturng	53.61	**91.84**	32.43	61.02	68.09
Petrochemical	74.41	79.82	55.62	78.30	**87.82**
Metal and non-metal processing	73.16	76.08	56.37	79.06	**82.83**
Machinery and equipment	48.18	**72.16**	34.08	48.43	65.87
Electronic equipment	31.85	**71.90**	24.54	46.09	**71.75**
Other manufacturing	55.35	**92.84**	44.74	67.41	65.20
Electricity, gas and water supply	99.23	99.09	**99.88**	99.23	**99.69**
Building industry	17.82	28.08	**76.61**	26.66	9.65
Transportation and warehousing	69.10	71.17	74.42	**90.52**	66.08
Wholesale and retail trade	45.51	53.18	**60.98**	55.78	38.05
Financial sector	96.75	97.26	97.43	**97.90**	96.43
Other Services	70.49	71.60	77.65	**86.97**	61.10
Total	66.43	**80.10**	43.15	70.30	73.25

Note: Authors' estimation based on data from 2007 and 2010 IO tables from China's NBS. Italic fonts indicate industries that have indirect export share exeeding 90%. Bolded face denotes the highest among the four ownership types within the industry.

Table 4. Export-Related Profits via Different Firm Types

Panel A: 2007	Profits accrued to direct exporters (billion RMB)	Total export-related profits (billion RMB)	Exp-related profits per worker ('000)	% of total exp-related profits	Share of profits through indirect exporting (%)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					via SOE	via FIE	via LP	via SME	Total
SOE	89	427	1.25	18.51	13.32	35.32	10.95	19.57	79.17
FIE	307	568	6.14	24.60	6.50	23.26	5.66	10.59	46.01
Large Enterprise (LP)	64	232	1.72	10.06	11.19	31.99	9.90	19.40	72.48
Small and Medium Private (SME)	425	1081	0.70	46.82	8.57	26.30	7.50	18.29	60.66
Total	885	2308	1.15	100.00	9.20	27.79	7.93	16.75	61.67
Panel B: 2010									
SOE	86	427	1.21	19.23	9.16	44.04	10.53	16.13	79.85
FIE	322	594	6.44	26.77	4.24	27.56	5.73	8.27	45.80
Large Enterprise (LP)	74	244	1.98	10.99	7.02	39.07	9.14	14.60	69.83
Small and Medium Private (SME)	281	954	0.46	43.01	6.14	39.10	7.90	17.36	70.49
Total	763	2218	0.99	100.00	6.31	36.96	7.96	14.39	65.61

Note: Data on aggregate profits and those by firm type (col 2) are based on 2008 firm census. Profits related to indirect exports and its decomposition are estimated using data from IO tables for 2007 and 2010.

Table 5. Gross Exports and Distribution of the Source of VAX (Backward-linkage Approach)

2007		Total		SOE	FIE	LP	SME
Gross Exports		**10199**		1231	5046	1028	2895
VA Contribution (%)	SOE	14.17		39.46	10.11	15.38	10.08
				(24.03, 15.43)			
	FIE	18.05		9.81	28.11	10.25	6.79
					(19.59, 8.52)		
	LP	7.05		6.50	4.56	26.25	4.80
						(19.42, 6.83)	
	SME	28.84		18.30	15.56	20.66	59.37
							(37.37, 22.00)
	Abroad	31.88		25.92	41.66	27.47	18.95
2010		Total	change relative to 07	SOE	FIE	LP	SME
Gross Exports		**11191**	**9.72**	1052	6340	1164	2635
VA Contribution (%)	SOE	16.27	14.77	50.32	12.53	16.41	11.60
				(34.44, 15.89)			
	FIE	19.71	9.17	8.09	28.95	9.82	6.46
					(19.77, 9.18)		
	LP	7.46	5.81	5.54	5.18	27.78	4.73
						(21.29, 6.49)	
	SME	30.44	5.56	18.14	20.83	23.56	61.53
							(34.59, 26.93)
	Abroad	26.12	-18.07	17.90	32.50	22.42	15.69

Note: Estimation based 2007 and 2010 IO Table. Numbers in brackets are direct and indirect VA export share, respectively,

Table 6. Gross Exports via Different Firm Types (Backward-linkage Approach)

Sector #	Sector	2007 Share in Domestic VA (%)				2007 DVA share > 30%	2010 Share in Domestic VA (%)				2010 DVA share > 30%
		SOE	FIE	LP	SME		SOE	FIE	LP	SME	
2	Mining and Washing of Coal	39.98	17.57	13.93	28.52	SOE	55.60	7.64	16.67	20.09	SOE
3	Extraction of Petroleum and Natural Gas	49.56	16.52	23.31	10.61	SOE	61.64	10.52	14.37	13.47	SOE
4	Mining of Ferrous Metal Ores	27.17	21.78	7.10	43.95	SME	27.19	12.95	7.15	52.71	SME
5	Mining of Non-Ferrous Metal Ores	32.50	24.00	12.91	30.58	SOE, SME	25.67	17.53	7.59	49.21	SME
6	Foods and Tobacco	15.56	17.32	7.25	59.86	SME	13.34	17.90	6.58	62.18	SME
7	Manufacture of Textile Products	15.34	22.60	10.51	51.55	SME	13.56	23.04	10.20	53.20	SME
8	Wearing apparel, leather, fur, down and related products	14.53	32.29	8.76	44.41	FIE. SME	13.90	28.71	9.08	48.32	SME
9	Processing of wood and Manufacture of Furniture	16.01	20.61	9.25	54.13	SME	19.13	26.47	8.76	45.64	SME
10	Paper Products and Articles for Culture, Education and Sports Activities	16.07	23.26	7.79	52.88	SME	17.12	36.05	7.27	39.56	FIE, SME
11	Processing of Petroleum, Coking and Nuclear Fuel	44.16	17.63	15.57	22.64	SOE	53.60	13.27	17.64	15.49	SOE
12	Manufacture of Chemical Products	20.80	26.23	10.61	42.36	SME	24.01	26.92	11.36	37.71	SME
13	Manufacture of non-ferrous metal products	22.76	16.48	9.15	51.60	SME	24.41	25.88	11.00	38.71	SME
14	Smelting and Rolling of metals	36.67	14.04	19.08	30.21	SOE, SME	38.12	16.25	15.62	30.01	SOE, SME
15	Manufacture of Metal Products	22.88	19.25	12.02	45.85	SME	25.36	29.05	11.80	33.79	SME
16	Manufacture of General Purpose and Special Purpose Machinery	20.98	26.46	11.43	41.14	SME	23.46	29.47	12.31	34.77	SME
17	Manufacture of Transport Equipment	25.58	29.49	15.85	29.07	None	24.71	29.44	15.25	30.60	SME
18	Manufacture of Electrical Machinery and Equipment	23.09	28.44	14.10	34.37	SME	22.80	31.43	12.87	32.90	FIE, SME
19	Manufacture of Communication Equipment, computers and Other Electronic Equipment	16.17	55.43	8.09	20.31	FIE	17.14	42.92	9.35	30.59	FIE, SME
20	Manufacture of Measuring Instruments and Machinery for Office Work	25.39	33.29	13.79	27.53	FIE	18.58	44.16	9.59	27.66	FIE
21	Handicrafts and other Manufacturing	17.25	26.26	11.71	44.78	SME	10.84	41.80	6.93	40.44	FIE, SME
22	Scrap and Waste	1.94	1.25	0.78	96.03	SME	-	-	-	-	None
23	production and supply of Electricity and heat	52.05	13.59	11.56	22.80	SOE	64.01	7.15	6.44	22.40	SOE

Table 6 (cont')

Sector #	Sector	2007 Share in Domestic VA (%)				2007 DVA share > 30%	2010 Share in Domestic VA (%)				2010 DVA share > 30%
24	Production and Supply of Gas	-	-	-	-	None	-	-	-	-	None
25	Production and Supply of Water	-	-	-	-	None	-	-	-	-	None
26	construction industry	29.70	17.39	13.40	39.51	SME	25.31	9.70	9.75	55.24	SME
27	Transportation and warehousing	32.17	7.58	5.00	55.25	SOE, SME	38.32	9.12	6.02	46.54	SOE, SME
28	Post service	30.21	30.79	12.14	26.86	SOE, FIE	65.71	11.71	5.53	17.05	SOE
29	IT industry	30.41	31.96	13.92	23.70	SOE, FIE	27.80	36.17	9.23	26.80	FIE
30	wholesale and retailing	13.85	7.10	4.96	74.09	SME	23.48	8.82	8.12	59.58	SME
31	Hotels and Catering Services	19.21	16.08	8.29	56.42	SME	19.16	13.18	6.08	61.58	SME
32	Finance	34.88	16.08	10.94	38.10	SOE, SME	27.85	6.97	2.58	62.61	SME
33	Real Estate	-	-	-	-	None	-	-	-	-	-
34	Leasing and commerce service	22.12	15.43	8.40	54.05	SME	30.00	15.85	6.87	47.28	SOE, SME
35	Research and test development industry	33.83	22.61	15.96	27.60	SOE	38.35	14.94	10.52	36.19	SOE, SME
36	Polytechnic Services	-	-	-	-	None	-	-	-	-	None
37	Water, environment and public facilities	-	-	-	-	None	-	-	-	-	None
38	Resident and Other Services	26.16	21.35	12.79	39.70	SME	15.45	10.26	10.22	64.07	SME
39	Education	26.88	20.64	14.81	37.67	SME	18.69	10.46	16.89	53.95	SME
40	Health and Social service	31.85	20.85	14.58	32.72	SOE, SME	31.79	12.40	14.20	41.61	SOE, SME
41	Culture , Sports and entertainment	34.84	21.85	14.51	28.80	SOE	48.37	9.05	4.51	38.08	SOE, SME

Table 7. Top and Bottom Industry Upstreamness

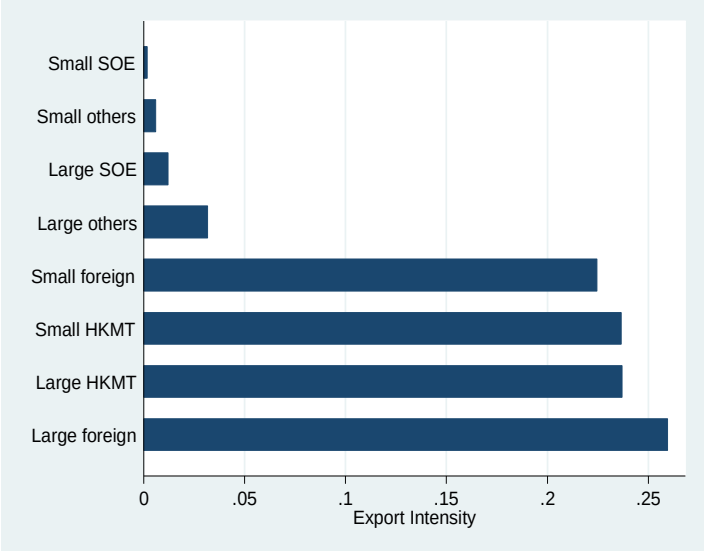
Code	Industry	All	By Type			
			SOE	FIE	LP	SME
	2007					
Top 5						
3	Extraction of Petroleum and Natural Gas	5.09	6.02	5.31	4.99	4.39
4	Mining of Ferrous Metal Ores	5.03	5.80	5.79	5.27	4.30
2	Mining and Washing of Coal	4.90	5.72	5.35	4.91	3.98
23	Production and supply of Electricity and heat	4.46	5.09	4.69	4.35	3.75
11	Processing of Petroleum, Coking and Nuclear Fuel	4.27	5.22	4.77	4.04	3.59
Bottom 5						
33	Real Estate	1.67	2.65	2.58	1.53	1.22
40	Health and Social service	1.26	1.50	1.48	1.48	1.08
39	Education	1.20	1.43	1.46	1.31	1.05
26	Construction industry	1.06	1.08	1.24	1.08	1.02
42	Public administration and social organization	1.02	1.05	1.10	1.05	1.01
	2010					
Top 5						
3	Extraction of Petroleum and Natural Gas	5.22	6.31	4.91	5.32	4.22
2	Mining and Washing of Coal	5.04	5.66	5.84	5.24	4.68
4	Mining of Ferrous Metal Ores	5.13	5.86	5.09	5.04	4.68
23	production and supply of Electricity and heat	4.60	5.31	4.30	4.14	3.85
11	Processing of Petroleum, Coking and Nuclear Fuel	4.38	5.57	5.08	4.19	4.06
Bottom 5						
33	Real Estate	1.60	3.41	3.00	1.46	1.22
40	Health and Social service	1.20	1.34	3.03	1.37	1.05
39	Education	1.09	1.39	1.77	1.11	1.02
26	Construction industry	1.06	1.10	2.83	1.09	1.02
42	Public administration and social organization	1.03	1.11	2.50	1.13	1.01

Note: Authors' estimation based on data from 2007 I/O tables. Bolded face denotes the highest in each row for the top 5, and the lowest in each row for the bottom 5. there are altogether 40 industries.

Figure 1. Input-Output Table with Separate Production Account for Firms by Ownerships and Size and Abroad

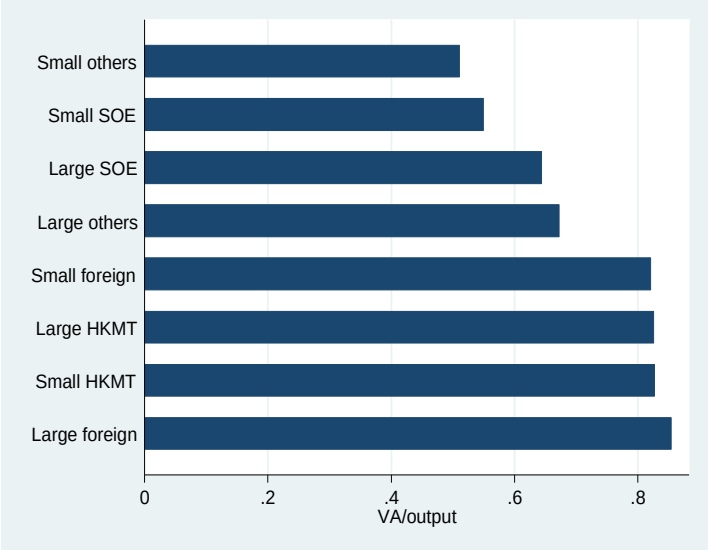
			Intermediate use								
		DIM	SOE Large (SL) 1,2,…, N	SOE SM (SS) 1,2,…, N	FIE Large (FL) 1,2,…, N	FIE SM (FS) 1,2,…, N	Others Large (OL) 1,2,…, N	Others SME (OS) 1,2,…, N	Domestic Final Use 1	Export 1	Total Gross Output 1
Domestic Intermediate Inputs	SOE Large (SL)	1 . . N	$Z^{SL,SL}$	$Z^{SL,SS}$	$Z^{SL,FL}$	$Z^{SL,FS}$	$Z^{SL,OL}$	$Z^{SL,OS}$	Y^{SL}	E^{SL}	X^{SL}
	SOE SM (SS)	1 . . N	$Z^{SS,SL}$	$Z^{SS,SS}$	$Z^{SS,FL}$	$Z^{SS,FS}$	$Z^{SS,OL}$	$Z^{SS,OS}$	Y^{SS}	E^{SS}	X^{SS}
	FIE Large (FL)	1 . . N	$Z^{FL,SL}$	$Z^{FL,SS}$	$Z^{FL,FL}$	$Z^{FL,FS}$	$Z^{FL,OL}$	$Z^{FL,OS}$	Y^{FL}	E^{FL}	X^{FL}
	FIE SME (FS)	1 . . N	$Z^{FS,SL}$	$Z^{FS,SS}$	$Z^{FS,FL}$	$Z^{FS,FS}$	$Z^{FS,OL}$	$Z^{FS,OS}$	Y^{FS}	E^{FS}	X^{FS}
	Others Large (OL)	1 . . N	$Z^{OL,SL}$	$Z^{OL,SS}$	$Z^{OL,FL}$	$Z^{OL,FS}$	$Z^{OL,OL}$	$Z^{OL,OS}$	Y^{OL}	E^{OL}	X^{OL}
	Others SME (OS)	1 . . N	$Z^{OS,SL}$	$Z^{OS,SS}$	$Z^{OS,FL}$	$Z^{OS,FS}$	$Z^{OS,OL}$	$Z^{OS,OS}$	Y^{OS}	E^{OS}	X^{OS}
Imported Intermediate Inputs	Abroad(F)	1 . . N	$Z^{F,SL}$	$Z^{F,SS}$	$Z^{F,FL}$	$Z^{F,FS}$	$Z^{F,OL}$	$Z^{F,OS}$	Y^{F}		M
Value-added		1	V^{SL}	V^{SS}	V^{FL}	V^{FS}	V^{OL}	V^{OS}			
Total Gross Output		1	$(X^{SL})^{T}$	$(X^{SS})^{T}$	$(X^{FL})^{T}$	$(X^{FS})^{T}$	$(X^{OL})^{T}$	$(X^{OS})^{T}$			

Figure 2. Firm Average Export Intensity



Source: China's National Bureau of Statistics Firm Census Data (2008)

Figure 3. Firm Average Value Added to Output Ratio



Source: China's National Bureau of Statistics Firm Census Data (2008)

Figure 4. Upstreamness of by Ownership Type

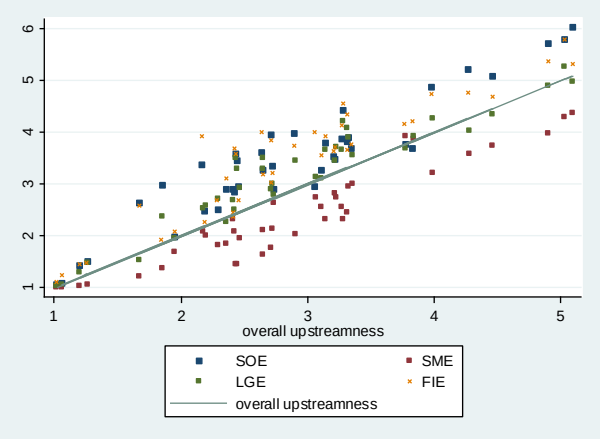


Figure 5. Share of SOEs in Sector Value Added and Sector Upstreamness

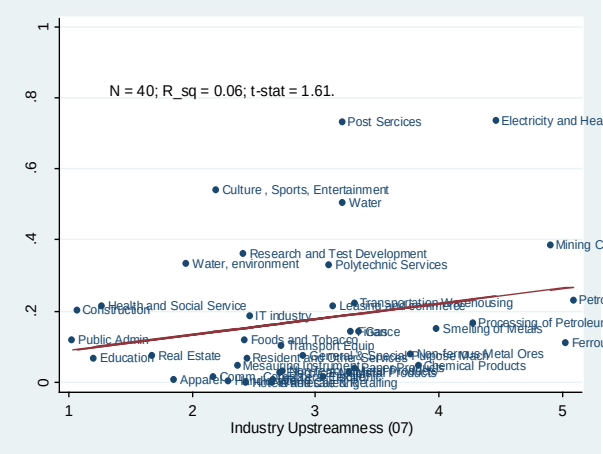


Figure 6. Share of SOEs in Sector Exports and Sector Upstreamness

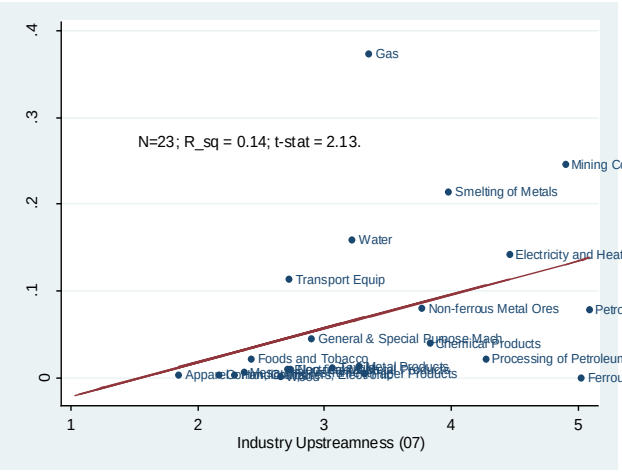


Figure 7. Share of SMEs in Sector Output versus Sector Upstreamness

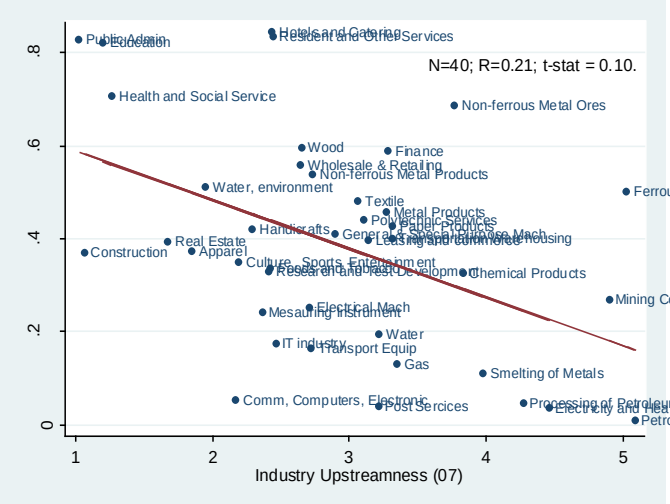


Figure 8. Share of SMEs in Sector Exports versus Sector Upstreamness

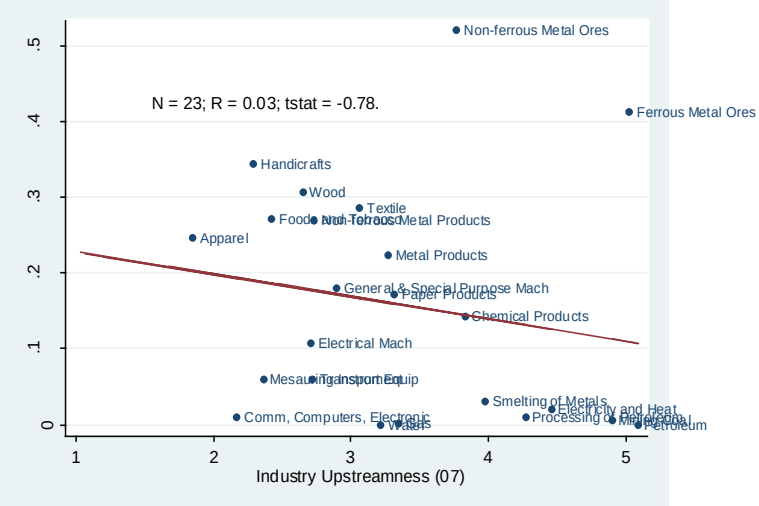
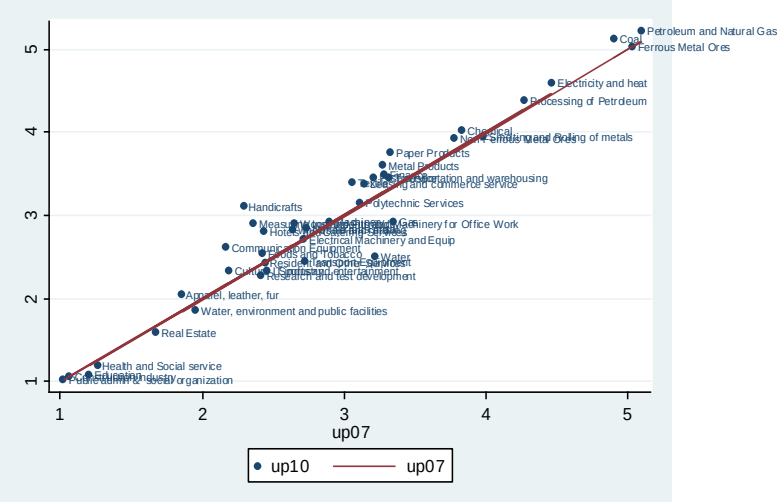


Figure 9: Upstreamness 2007 and 2010



Appendix A

Extending the method by Antras et al. (2012) to measure industry upstreamness

To measure industry upstream based on our IO table with 6 sub-accounts, we need to modify the method proposed by Antras et al. (2012). First, we construct a 42x42 matrix for each firm type g1 with the following elements

$$\delta_{\mathrm{ij}}^{g1} = \frac{\sum_p \mathrm{a}_{ij}^{g1,g2} \mathrm{X}_j^{g2} + E_{ij}^{g1}}{\mathrm{X}_i^{g1}} \tag{A1}$$

Where superscripts $g1, g2 = (SL, SS, FL, FS, OL, OS)$ represent 6 firm types, $\mathrm{a}_{ij}^{g1,g2}$ is the IO coefficient between a pair of firm-type-sector discussed in Section 2 in the text. X_j^{g1} and X_j^{g2} are gross output by group g1 and g2 in sector *j*, respectively. E_{ij}^{g1} represents exports from sector *i* by firm type g1 used in sector *j* abroad.

When computing industry upstreamness, Antras et al. (2012) assume that the share of imports (and exports) of sector *i* that is used by sector *j* is the same as the share of domestic intermediate inputs of sector *i* used by sector *j.* We improve upon their computation by relaxing both of these assumptions. First, in eq. (A1), we do not need to subtract imports from total intermediate inputs. It is because when we estimate our extended IO model, we already make the corresponding adjustment to deal with imported materials by having a separate A^m matrix. In other words, our IO coefficients, $\mathrm{a}_{ij}^{g1,g2}$ *,* do not include imported intermediate inputs. Thus, we do not need to make the proportionality assumptions as Antras et al. (2012) to exclude imports from domestic intermediate inputs in our computation of upstreamness.

Second, when computing E_{ij}^{g1}, we use data of exported intermediate inputs at the sector-pair level (i-j) from China's customs. To assign exported intermediate inputs to each firm type, we use the share of each supplier's firm type in domestic inter-sector transaction volume (i.e., $\frac{\sum_{g2} A_{ij}^{g1,g2}}{\sum_{g1,g2} A_{ij}^{g1,g2}}$) as the weight. For sectors that we do not have exported intermediate inputs from China's Customs (most of them are service sectors), we follow Antras et al. (2012) and make the same proportionality assumption to obtain E_{ij}^{g1}。

We also adjust for the change in inventory at the sector level carefully. First, we obtain inventory by firm type and sector. Then following the approach proposed by Antras et al., (2012), we subtract inventory from X_i^{g1} in eq. (A1). After obtaining a 42x42 block matrix of $\delta_{\mathrm{ij}}^{g1}$, we use eq. (4) in Antras et al. (2012) to compute upstreamness by sector and firm type.

Table A1. Classification of Large, Medium and small firms (by NBS of China, 2011)

Industry	Indicator	Unit	Large	Medium	Small
Manufacture	Employment	Persons	>=1000	300-1000	<300
	Total Sales	RMB10,000	>=40000	2000-40000	<2000
	Total Assets	RMB10,000	>=40000	4000-40000	<4000
Construction	Total Sales	RMB10,000	>=80000	6000-80000	<6000
	Total Assets	RMB10,000	>=80000	5000-80000	<5000
Wholesales	Employment	Persons	>=200	20-200	<20
	Total Sales	RMB10,000	>=40000	5000-40000	<5000
Retails	Employment	Persons	>=300	50-300	<50
	Total Sales	RMB10,000	>=20000	500-20000	<500
Transportation	Employment	Persons	>=1000	300-1000	<300
	Total Sales	RMB10,000	>=30000	3000-30000	<3000
Postal Services	Employment	Persons	>=1000	300-1000	<300
	Total Sales	RMB10,000	>=30000	2000-30000	<2000
Accommodation & Catering	Employment	Persons	>=300	100-300	<100
	Total Sales	RMB10,000	>=10000	2000-10000	<2000
Finance and Banking	Employment	Persons	>=200	<200	
	Total Sales	RMB10,000	>=30000	<30000	
Real Estates	Employment	Persons	>=200	<200	
	Total Sales	RMB10,000	>=30000	<30000	
Other Service Industries	Employment	Persons	>=500	<500	

1. Manufacture above includes three industries: mining, manufacturing and Electricity, Gas, and Utility production and supply.

2. Total sale in manufacturing industry is expressed by the annual sale/revenue of products calculated according to the current statistic system; total sale in construction firms is represented by the annual receipt from projects done according to the current statistic system; total sale of wholesales and retails is shown as the annual sales calculated according to the current accounting forms; total sale in transportation, postal services, accommodation and catering firms is the annual operating revenue calculated according to the current statistic system; the total asset is replaced by accumulated assets according to the current statistic system.

3. The large and medium firms should meet all the criteria defined for the large firm and medium firm, respectively. Otherwise, it will be classified to the next lower category of firm size.

Other definitions (authors' definition according to the rule of NBS of China):

Large firms of finance and banking industry are those firms with more than 200 employees and more than 300 million Yuan (RMB) in sales.

Large firms of real estate industry are those firms with more than 200 employees and more than 300 million Yuan (RMB) in sales.

Large firms of other service industries are those firms with more than 500 employees.

Remarks: the lowest standard of employment and the highest standard of total sale are used to define large firms considering the properties of finance and banking industry and real estate industry. The firm in other service industries will use the only criteria of employment to distinguish the large firm and SME.

Table A2. Indirect VAEX/ Total VAEX 2007 (6 types, 42 industries)

Industry	LSOE	SSOE	LFIE	SFIE	LGE	SME
Mining and Washing of Coal	0.96	0.93	0.92	0.90	0.93	0.95
Extraction of Petroleum and Natural Gas	0.92	0.84	1.00	0.85	0.88	0.99
Mining of Ferrous Metal Ores	1.00	0.95	0.90	1.00	1.00	0.95
Mining of Non-Ferrous Metal Ores	0.75	0.74	0.82	0.72	0.82	0.65
Foods and Tobacco	0.66	0.65	0.65	0.67	0.66	0.80
Manufacture of Textile Products	0.62	0.59	0.50	0.30	0.44	0.60
Wearing apparel, leather, fur, down and related products	0.67	0.66	0.40	0.13	0.48	0.23
Processing of wood and Manufacture of Furniture	-	0.69	0.57	0.40	0.58	0.40
Paper Products and Articles for Culture, Education and Sports Activities	0.87	0.84	0.74	0.46	0.81	0.55
Processing of Petroleum, Coking and Nuclear Fuel	0.88	0.91	0.84	0.85	0.90	0.89
Manufacture of Chemical Products	0.82	0.87	0.72	0.49	0.67	0.78
Manufacture of non-ferrous metal products	0.62	0.60	0.46	0.27	0.40	0.42
Smelting and Rolling of metals	0.66	0.89	0.86	0.81	0.76	0.88
Manufacture of Metal Products	0.80	0.79	0.70	0.41	0.74	0.36
Manufacture of General Purpose and Special Purpose Machinery	0.76	0.82	0.67	0.33	0.66	0.52
Manufacture of Transport Equipment	0.63	0.70	0.51	0.59	0.55	0.65
Manufacture of Electrical Machinery and Equipment	0.76	0.75	0.30	0.24	0.44	0.37
Manufacture of Communication Equipment, computers and Other Electronic Equipment	0.62	0.70	0.17	0.27	0.45	0.61
Manufacture of Measuring Instruments and Machinery for Office Work	0.18	0.20	0.06	0.09	0.14	0.10
Handicrafts and other Manufacturing	1.00	0.58	0.36	0.26	0.39	0.25
Scrap and Waste						0.98
production and supply of Electricity and heat	1.00	0.99	0.99	0.99	0.99	0.99
Production and Supply of Gas	1.00	1.00	1.00	1.00	1.00	1.00
Production and Supply of Water	1.00	1.00	1.00	1.00	1.00	1.00
construction industry	0.38	0.38	0.31	0.38	0.38	0.38
Transportation and warehousing	0.82	0.54	0.89	0.90	0.91	0.45
Post service	0.75	0.75	0.76	0.78	0.80	0.77
IT industry	0.76	0.76	0.76	0.76	0.76	0.76
wholesale and retailing	0.72	0.74	0.82	0.82	0.76	0.28
Hotels and Catering Services	0.74	0.75	0.75	0.75	0.75	0.75
Finance	0.98	0.98	0.88	0.98	0.98	0.99
Real Estate	1.00	1.00	1.00	1.00	1.00	1.00
Leasing and commerce service	0.56	0.44	0.60	0.57	0.60	0.18
Research and test development industry	0.91	0.91	0.91	0.90	0.91	0.91
Polytechnic Services	1.00	1.00	1.00	1.00	1.00	1.00
Water, environment and public facilities	1.00	1.00	1.00	1.00	1.00	1.00
Resident and Other Services	0.81	0.81	0.80	0.81	0.81	0.82
Education	0.86	0.87	0.86	0.87	0.87	0.87
Health and Social service	0.88	0.88	0.88	0.88	0.88	0.88
Culture , Sports and entertainment	0.57	0.57	0.57	0.57	0.57	0.57

Table A3. Industry Upstream Index

		2007					2010				
		All	By Type				All	By Type			
	Industry		SOE	LFIE	LGE	SME		SOE	LFIE	LGE	SME
3	Extraction of Petroleum and Natural Gas	5.09	6.02	5.31	4.99	4.39	5.22	6.31	4.91	5.32	4.22
4	Mining of Ferrous Metal Ores	5.03	5.80	5.79	5.27	4.30	5.04	5.66	5.84	5.24	4.68
2	Mining and Washing of Coal	4.90	5.72	5.35	4.91	3.98	5.13	5.86	5.09	5.04	4.68
23	production and supply of Electricity and heat	4.46	5.09	4.69	4.35	3.75	4.60	5.31	4.30	4.14	3.85
11	Processing of Petroleum, Coking and Nuclear Fuel	4.27	5.22	4.77	4.04	3.59	4.38	5.57	5.08	4.19	4.06
14	Smelting and Rolling of metals	3.98	4.86	4.73	4.27	3.22	3.95	5.00	4.92	4.31	3.52
12	Manufacture of Chemical Products	3.83	3.70	4.20	3.92	3.89	4.02	3.65	4.54	4.50	4.30
5	Mining of Non-Ferrous Metal Ores	3.77	3.78	4.16	3.70	3.92	3.94	3.84	4.86	3.94	3.98
24	Production and Supply of Gas	3.35	3.70	3.75	3.56	3.01	2.92	4.25	3.10	4.87	2.11
10	Paper Products and Articles for Culture, Education and Sports Activities	3.32	3.89	3.65	3.90	2.97	3.76	3.50	4.08	4.24	4.14
27	Transportation and warehousing	3.31	3.82	4.34	4.08	2.47	3.46	4.13	4.68	4.53	3.08
32	Finance	3.28	4.42	4.54	4.22	2.32	3.49	4.69	5.01	4.84	3.04
15	Manufacture of Metal Products	3.27	3.88	4.14	3.68	2.57	3.60	3.45	4.34	4.20	3.48
25	Production and Supply of Water	3.22	3.48	3.72	3.72	2.75	2.51	2.28	4.20	4.75	2.39
28	Post service	3.21	3.54	3.62	3.45	2.83	3.45	3.84	4.79	4.60	3.56
34	Leasing and commerce service	3.14	3.80	3.93	3.66	2.33	3.38	4.51	4.77	4.62	2.78
36	Polytechnic Services	3.11	3.28	3.54	3.12	2.56	3.15	3.56	4.74	3.87	2.46
7	Manufacture of Textile Products	3.06	2.96	4.01	3.14	2.76	3.40	3.67	3.12	4.38	3.54
16	Manufacture of General Purpose and Special Purpose Machinery	2.90	3.98	3.73	3.46	2.04	2.93	4.39	3.67	3.46	2.37
13	Manufacture of non-ferrous metal products	2.73	2.89	3.21	2.80	2.65	2.85	2.69	4.45	3.63	2.67
17	Manufacture of Transport Equipment	2.72	3.36	3.02	3.02	2.14	2.46	3.06	2.87	2.69	2.15
18	Manufacture of Electrical Machinery and Equipment	2.71	3.94	3.84	2.92	1.79	2.71	4.85	3.62	3.03	2.12
9	Processing of wood and Manufacture of Furniture	2.65	3.27	3.18	3.31	2.11	2.90	4.40	3.41	3.74	2.80
30	wholesale and retailing	2.64	3.60	4.01	3.52	1.66	2.84	4.09	4.72	4.22	2.23
29	IT industry	2.46	2.94	2.69	2.93	1.96	2.34	3.11	2.72	3.58	1.84
38	Resident and Other Services	2.44	3.45	3.57	3.29	1.46	2.43	4.65	4.99	4.48	1.83
31	Hotels and Catering Services	2.43	3.59	3.69	3.51	1.46	2.81	4.42	4.83	4.56	2.14
6	Foods and Tobacco	2.42	2.85	2.44	2.52	2.09	2.54	3.15	2.73	2.73	2.34
35	Research and test development industry	2.41	2.90	2.36	2.70	2.32	2.28	2.26	3.65	3.35	1.86
20	Manufacture of Measuring Instruments and Machinery for Office Work	2.36	2.90	3.11	2.28	1.86	2.91	4.59	2.67	3.73	3.44
21	Handicrafts and other Manufacturing	2.29	2.50	2.69	2.72	1.84	3.12	4.88	3.94	4.32	2.77
41	Culture , Sports and entertainment	2.19	2.48	2.26	2.58	2.02	2.33	2.35	4.76	4.42	1.99
19	Manufacture of Communication Equipment, computers and Other Electronic Equipment	2.17	3.38	3.91	2.54	2.10	2.62	4.80	2.56	3.90	3.38
37	Water, environment and public facilities	1.95	1.97	2.09	1.96	1.70	1.86	1.91	3.95	3.12	1.30
8	Wearing apparel, leather, fur, down and related products	1.85	2.97	1.92	2.37	1.39	2.05	4.89	2.34	3.32	1.66
33	Real Estate	1.67	2.65	2.58	1.53	1.22	1.60	3.41	3.00	1.46	1.22
40	Health and Social service	1.26	1.50	1.48	1.48	1.08	1.20	1.34	3.03	1.37	1.05
39	Education	1.20	1.43	1.46	1.31	1.05	1.09	1.39	1.77	1.11	1.02
26	Construction industry	1.06	1.08	1.24	1.08	1.02	1.06	1.10	2.83	1.09	1.02
42	Public administration and social organization	1.02	1.05	1.10	1.05	1.01	1.03	1.11	2.50	1.13	1.01

Table A4.1. Direct, Indirect, and VA Exports by Ownership-Sector (LSOE)

		Value Added Exports (VAEX)	Direct VAEX	Indirect VAEX via	LSOE	SSOE	LFIE	SFIE	L	SM	Gross Exports
2	Mining and Washing of Coal	69.98	2.68		6.33	4.69	11.33	17.49	9.89	17.57	3.98
3	Extraction of Petroleum and Natural Gas	120.95	9.76		12.14	9.57	17.08	25.83	17.94	28.64	11.99
4	Mining of Ferrous Metal Ores	8.74	0.00		1.29	0.44	1.38	1.92	1.44	2.27	0.00
5	Mining of Non-Ferrous Metal Ores	8.04	2.03		0.45	0.40	1.02	1.75	0.91	1.47	5.90
6	Foods and Tobacco	30.42	10.25		1.81	1.86	3.56	5.35	2.88	4.71	31.00
7	Manufacture of Textile Products	22.09	8.38		0.56	0.71	1.72	5.14	2.09	3.50	51.48
8	Wearing apparel, leather, fur, down and related products	5.29	1.72		0.21	0.23	0.56	1.22	0.48	0.87	15.26
9	Processing of wood and Manufacture of Furniture	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	Paper Products and Articles for Culture, Education and Sports Activities	10.97	1.40		0.78	0.83	1.84	2.52	1.31	2.29	7.73
11	Processing of Petroleum, Coking and Nuclear Fuel	16.22	1.90		1.19	1.46	2.09	3.29	1.80	4.48	26.28
12	Manufacture of Chemical Products	32.06	5.76		1.85	1.79	5.29	7.60	3.79	5.98	40.65
13	Manufacture of non-ferrous metal products	6.38	2.41		0.36	0.30	0.94	1.00	0.59	0.77	20.05
14	Smelting and Rolling of metals	151.80	52.00		9.90	4.44	16.02	22.09	14.60	32.74	218.56
15	Manufacture of Metal Products	12.33	2.50		0.77	0.70	2.27	2.60	1.37	2.12	15.71
16	Manufacture of General Purpose and Special Purpose Machinery	18.76	4.41		1.32	1.06	2.74	3.88	2.10	3.24	30.34
17	Manufacture of Transport Equipment	22.15	8.13		1.46	1.30	3.02	2.96	2.14	3.13	45.22
18	Manufacture of Electrical Machinery and Equipment	9.94	2.38		0.62	0.56	1.84	1.94	1.07	1.53	20.56
19	Manufacture of Communication Equipment, computers and Other Electronic Equipment	13.80	5.24		0.48	0.46	4.37	1.37	0.86	1.01	46.54
20	Manufacture of Measuring Instruments and Machinery for Office Work	8.07	6.62		0.15	0.14	0.28	0.36	0.22	0.32	37.27
21	Handicrafts and other Manufacturing	1.17	0.00		0.09	0.09	0.24	0.32	0.18	0.26	0.00
22	Scrap and Waste	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	production and supply of Electricity and heat	148.74	0.37		13.58	9.04	24.44	39.08	21.50	40.73	1.21
24	Production and Supply of Gas	0.92	0.00		0.09	0.07	0.17	0.25	0.14	0.21	0.00
25	Production and Supply of Water	2.21	0.00		0.20	0.18	0.42	0.59	0.32	0.49	0.00
26	construction industry	1.33	0.82		0.05	0.05	0.10	0.12	0.07	0.11	6.70
27	Transportation and warehousing	52.56	9.66		3.88	3.74	8.16	10.89	6.11	10.14	25.18
28	Post service	1.35	0.33		0.09	0.09	0.20	0.27	0.15	0.22	0.82
29	IT industry	14.65	3.59		1.07	0.92	2.43	2.67	1.58	2.40	7.42

		Value Added Exports (VAEX)	Direct VAEX	Indirect VAEX via	LSOE	SSOE	LFIE	SFIE	L	SM	Gross Exports
30	wholesale and retailing	50.51	14.16		3.09	2.80	8.66	9.22	5.14	7.44	31.71
31	Hotels and Catering Services	13.79	3.52		0.97	0.99	1.94	2.49	1.45	2.44	11.79
32	Finance	41.27	0.75		3.59	3.48	8.58	10.09	5.75	9.05	1.50
33	Real Estate	13.05	0.00		1.21	1.23	2.60	3.24	1.86	2.92	0.00
34	Leasing and commerce service	13.88	6.14		0.71	0.70	1.62	1.91	1.10	1.70	28.65
35	Research and test development industry	2.27	0.20		0.18	0.16	0.55	0.51	0.30	0.38	0.43
36	Polytechnic Services	8.50	0.00		0.76	0.67	1.69	2.23	1.23	1.92	0.00
37	Water, environment and public facilities	1.76	0.00		0.16	0.16	0.30	0.45	0.25	0.45	0.00
38	Resident and Other Services	5.12	0.99		0.41	0.42	0.74	0.98	0.58	1.00	4.74
39	education	0.76	0.10		0.06	0.06	0.13	0.16	0.09	0.15	0.55
40	Health and Social service	2.29	0.27		0.18	0.16	0.40	0.54	0.30	0.44	0.76
41	Culture , Sports and entertainment	6.11	2.61		0.34	0.32	0.69	0.88	0.51	0.76	5.54

Table A4.2. Direct, Indirect, and VA Exports by Ownership-Sector (SSOE)

		Value Added Exports (VAEX)	Direct VAEX	Indirect VAEX via LSOE	SSOE	LFIE	SFIE	L	SM	Gross Exports
2	Mining and Washing of Coal	18.11	1.26	1.59	1.24	2.90	4.48	2.53	4.11	3.88
3	Extraction of Petroleum and Natural Gas	28.27	4.49	2.29	1.97	4.12	6.18	3.48	5.74	9.34
4	Mining of Ferrous Metal Ores	8.39	0.46	1.17	0.41	1.26	1.75	1.30	2.06	1.87
5	Mining of Non-Ferrous Metal Ores	8.58	2.25	0.48	0.43	1.08	1.83	0.96	1.55	6.41
6	Foods and Tobacco	17.38	6.14	1.00	1.04	2.03	3.01	1.62	2.54	28.67
7	Manufacture of Textile Products	16.69	6.76	0.41	0.51	1.24	3.73	1.51	2.53	58.32
8	Wearing apparel, leather, fur, down and related products	7.93	2.73	0.30	0.34	0.81	1.81	0.68	1.25	19.33
9	Processing of wood and Manufacture of Furniture	6.84	2.11	0.26	0.33	0.75	1.23	0.59	1.56	13.64
10	Paper Products and Articles for Culture, Education and Sports Activities	11.88	1.84	0.80	0.87	1.92	2.64	1.36	2.44	10.29
11	Processing of Petroleum, Coking and Nuclear Fuel	14.94	1.35	1.31	1.20	2.33	3.43	1.95	3.37	8.55
12	Manufacture of Chemical Products	21.89	2.77	1.38	1.34	3.85	5.49	2.79	4.28	22.46
13	Manufacture of non-ferrous metal products	6.95	2.77	0.39	0.32	0.99	1.05	0.62	0.82	22.83
14	Smelting and Rolling of metals	10.03	1.10	0.82	0.54	1.82	2.40	1.29	2.05	15.62
15	Manufacture of Metal Products	12.64	2.70	0.78	0.71	2.30	2.64	1.38	2.15	17.36
16	Manufacture of General Purpose and Special Purpose Machinery	15.08	2.76	1.13	0.92	2.37	3.33	1.81	2.76	20.87
17	Manufacture of Transport Equipment	10.99	3.26	0.82	0.75	1.54	1.70	1.18	1.74	26.47
18	Manufacture of Electrical Machinery and Equipment	9.39	2.37	0.58	0.52	1.71	1.80	0.99	1.42	21.81
19	Manufacture of Communication Equipment, computers and Other Electronic Equipment	11.30	3.34	0.41	0.40	4.33	1.18	0.76	0.90	31.80
20	Manufacture of Measuring Instruments and Machinery for Office Work	7.03	5.64	0.14	0.13	0.27	0.34	0.21	0.30	33.41
21	Handicrafts and other Manufacturing	4.31	1.82	0.20	0.20	0.52	0.67	0.37	0.53	10.87
22	Scrap and Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	Production and supply of Electricity and heat	74.03	0.41	6.77	4.95	12.81	19.58	10.78	18.73	1.21
24	Production and Supply of Gas	0.92	0.00	0.09	0.07	0.17	0.24	0.14	0.20	0.00
25	Production and Supply of Water	2.85	0.00	0.26	0.24	0.54	0.76	0.42	0.64	0.00
26	construction industry	2.11	1.30	0.08	0.08	0.15	0.19	0.11	0.18	6.70
27	Transportation and warehousing	133.78	60.99	6.44	6.33	13.37	18.04	10.06	18.55	121.87
28	Post service	1.75	0.43	0.12	0.11	0.26	0.36	0.19	0.29	0.87

		Value Added Exports (VAEX)	Direct VAEX	via	Indirect VAEX LSOE	SSOE	LFIE	SFIE	L	SM	Gross Exports
29	IT industry	18.81	4.54		1.38	1.19	3.13	3.45	2.03	3.09	7.45
30	wholesale and retailing	44.55	11.66		2.81	2.55	7.70	8.39	4.68	6.77	28.27
31	Hotels and Catering Services	15.78	3.96		1.12	1.14	2.23	2.86	1.67	2.80	12.10
32	Finance	62.17	0.98		5.37	5.23	13.29	15.04	8.57	13.69	1.50
33	Real Estate	13.29	0.00		1.23	1.25	2.65	3.29	1.89	2.97	0.00
34	Leasing and commerce service	22.14	12.31		0.90	0.89	2.06	2.42	1.40	2.16	45.95
35	Research and test development industry	2.27	0.20		0.18	0.16	0.55	0.51	0.30	0.38	0.43
36	Polytechnic Services	7.76	0.00		0.69	0.61	1.55	2.03	1.13	1.75	0.00
37	Water, environment and public facilities	1.84	0.00		0.16	0.16	0.31	0.47	0.26	0.47	0.00
38	Resident and Other Services	5.74	1.09		0.46	0.47	0.83	1.10	0.65	1.13	4.75
39	Education	0.94	0.13		0.08	0.08	0.16	0.20	0.12	0.19	0.55
40	Health and Social service	1.99	0.23		0.16	0.14	0.35	0.47	0.26	0.38	0.76
41	Culture , Sports and entertainment	6.46	2.77		0.35	0.34	0.73	0.93	0.54	0.81	5.54

Table A4.3. Direct, Indirect, and VA Exports by Ownership-Sector (LFIE)

		Value Added Exports (VAEX)	Direct VAEX	Indirect VAEX via	LSOE	SSOE	LFIE	SFIE	L	SM	Gross Exports
2	Mining and Washing of Coal	15.40	1.21		1.33	1.05	2.44	3.80	2.14	3.44	3.92
3	Extraction of Petroleum and Natural Gas	4.86	0.00		0.46	0.38	0.83	1.29	0.72	1.18	0.00
4	Mining of Ferrous Metal Ores	7.70	0.75		1.01	0.36	1.10	1.54	1.14	1.80	3.35
5	Mining of Non-Ferrous Metal Ores	6.08	1.09		0.37	0.33	0.84	1.47	0.76	1.22	3.48
6	Foods and Tobacco	22.21	7.74		1.30	1.34	2.57	3.84	2.07	3.35	31.79
7	Manufacture of Textile Products	36.38	18.33		0.75	0.93	2.17	6.74	2.64	4.82	108.38
8	Wearing apparel, leather, fur, down and related products	18.43	11.02		0.46	0.52	1.17	2.61	0.95	1.71	61.84
9	Processing of wood and Manufacture of Furniture	10.28	4.42		0.33	0.44	0.96	1.52	0.75	1.87	24.80
10	Paper Products and Articles for Culture, Education and Sports Activities	16.88	4.45		0.99	1.06	2.34	3.27	1.65	3.11	22.19
11	Processing of Petroleum, Coking and Nuclear Fuel	15.45	2.43		1.26	1.15	2.25	3.30	1.87	3.19	13.33
12	Manufacture of Chemical Products	43.37	12.22		2.17	2.10	6.26	9.01	4.47	7.14	76.75
13	Manufacture of non-ferrous metal products	9.24	4.99		0.39	0.32	1.01	1.07	0.63	0.83	40.16
14	Smelting and Rolling of metals	29.45	4.25		2.37	1.48	5.03	6.64	3.62	6.06	29.05
15	Manufacture of Metal Products	15.90	4.79		0.88	0.80	2.59	2.93	1.53	2.38	28.77
16	Manufacture of General Purpose and Special Purpose Machinery	21.69	7.27		1.33	1.07	2.76	3.90	2.11	3.26	49.70
17	Manufacture of Transport Equipment	40.72	19.81		2.10	1.82	4.96	4.15	3.18	4.69	90.65
18	Manufacture of Electrical Machinery and Equipment	39.16	27.58		0.98	0.88	2.79	2.96	1.63	2.33	176.69
19	Manufacture of Communication Equipment, computers and Other Electronic Equipment	438.05	361.89		1.17	1.07	66.34	3.19	2.02	2.37	1793.26
20	Manufacture of Measuring Instruments and Machinery for Office Work	22.03	20.65		0.14	0.13	0.26	0.34	0.21	0.30	125.48
21	Handicrafts and other Manufacturing	8.36	5.32		0.25	0.25	0.63	0.81	0.46	0.64	26.20
22	Scrap and Waste	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	Production and supply of Electricity and heat	16.19	0.20		1.44	1.20	2.94	4.28	2.38	3.75	1.18
24	Production and Supply of Gas	0.92	0.00		0.09	0.07	0.17	0.25	0.14	0.21	0.00
25	Production and Supply of Water	2.18	0.00		0.19	0.18	0.42	0.58	0.32	0.49	0.00
26	construction industry	0.37	0.25		0.01	0.01	0.02	0.03	0.02	0.03	7.47
27	Transportation and warehousing	29.54	3.31		2.36	2.27	5.01	6.73	3.77	6.10	12.09
28	Post service	1.77	0.43		0.12	0.11	0.26	0.36	0.19	0.29	0.87
29	IT industry	18.57	4.48		1.36	1.17	3.09	3.41	2.01	3.05	7.45
30	wholesale and retailing	30.01	5.51		2.10	1.92	5.53	6.32	3.54	5.10	16.30

		Value Added Exports (VAEX)	Direct VAEX	Indirect VAEX via	LSOE	SSOE	LFIE	SFIE	L	SM	Gross Exports
31	Hotels and Catering Services	15.13	3.81		1.07	1.09	2.14	2.74	1.60	2.68	12.03
32	Finance	0.77	0.10		0.06	0.05	0.14	0.17	0.10	0.16	1.19
33	Real Estate	13.85	0.00		1.29	1.30	2.76	3.44	1.97	3.09	0.00
34	Leasing and commerce service	10.65	4.24		0.59	0.58	1.34	1.58	0.91	1.41	23.53
35	Research and test development industry	2.21	0.19		0.18	0.15	0.54	0.49	0.29	0.37	0.43
36	Polytechnic Services	7.94	0.00		0.71	0.62	1.59	2.08	1.16	1.78	0.00
37	Water, environment and public facilities	1.58	0.00		0.14	0.14	0.27	0.41	0.22	0.41	0.00
38	Resident and Other Services	4.45	0.88		0.35	0.37	0.64	0.85	0.50	0.87	4.74
39	education	0.71	0.10		0.06	0.06	0.12	0.15	0.09	0.14	0.55
40	Health and Social service	1.23	0.15		0.10	0.09	0.21	0.29	0.16	0.24	0.76
41	Culture , Sports and entertainment	4.77	2.04		0.26	0.25	0.54	0.69	0.40	0.60	5.44

Table A4.4. Direct, Indirect, and VA Exports by Ownership-Sector (SFIE)

		Value Added Exports (VAEX)	Direct VAEX	Indirect VAEX via	LSOE	SSOE	LFIE	SFIE	L	SM	Gross Exports
2	Mining and Washing of Coal	6.03	0.62		0.50	0.39	0.91	1.46	0.82	1.33	3.87
3	Extraction of Petroleum and Natural Gas	16.90	2.53		1.36	1.16	2.50	3.79	2.11	3.44	6.75
4	Mining of Ferrous Metal Ores	7.21	0.00		1.05	0.37	1.14	1.59	1.18	1.87	0.00
5	Mining of Non-Ferrous Metal Ores	8.80	2.44		0.48	0.43	1.08	1.84	0.96	1.57	7.10
6	Foods and Tobacco	24.53	8.01		1.41	1.45	2.75	4.34	2.28	4.29	37.60
7	Manufacture of Textile Products	113.82	79.71		1.39	1.67	3.74	12.17	4.66	10.48	362.36
8	Wearing apparel, leather, fur, down and related products	101.44	88.36		0.78	0.88	1.96	4.82	1.59	3.06	308.57
9	Processing of wood and Manufacture of Furniture	19.25	11.62		0.42	0.55	1.20	1.92	0.94	2.60	54.84
10	Paper Products and Articles for Culture, Education and Sports Activities	37.66	20.16		1.35	1.45	3.17	4.57	2.24	4.74	81.30
11	Processing of Petroleum, Coking and Nuclear Fuel	30.60	4.67		2.51	2.28	4.50	6.57	3.74	6.34	13.64
12	Manufacture of Chemical Products	152.90	78.37		4.11	3.92	14.05	21.29	9.44	21.72	384.56
13	Manufacture of non-ferrous metal products	22.56	16.42		0.57	0.47	1.45	1.54	0.90	1.21	99.58
14	Smelting and Rolling of metals	31.19	5.92		2.38	1.47	5.02	6.64	3.63	6.14	41.74
15	Manufacture of Metal Products	38.31	22.67		1.21	1.09	3.72	4.10	2.11	3.40	109.26
16	Manufacture of General Purpose and Special Purpose Machinery	86.23	57.36		2.64	2.09	5.40	7.77	4.16	6.81	222.35
17	Manufacture of Transport Equipment	23.02	9.46		1.42	1.26	2.91	2.87	2.07	3.03	53.77
18	Manufacture of Electrical Machinery and Equipment	56.17	42.43		1.14	1.02	3.38	3.52	1.91	2.77	245.68
19	Manufacture of Communication Equipment, computers and Other Electronic Equipment	32.47	23.63		0.33	0.30	6.07	0.90	0.57	0.68	371.83
20	Manufacture of Measuring Instruments and Machinery for Office Work	18.26	16.63		0.17	0.15	0.31	0.40	0.24	0.36	84.86
21	Handicrafts and other Manufacturing	14.98	11.03		0.33	0.33	0.82	1.05	0.59	0.83	41.97
22	Scrap and Waste	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	production and supply of Electricity and heat	23.21	0.12		2.10	1.74	4.25	6.17	3.42	5.41	0.53
24	Production and Supply of Gas	0.91	0.00		0.09	0.07	0.17	0.24	0.14	0.20	0.00
25	Production and Supply of Water	2.27	0.00		0.20	0.19	0.43	0.61	0.33	0.51	0.00
26	construction industry	0.80	0.50		0.03	0.03	0.06	0.07	0.04	0.07	6.70
27	Transportation and warehousing	7.88	0.81		0.61	0.59	1.34	1.83	1.03	1.68	8.10
28	Post service	1.94	0.42		0.13	0.13	0.30	0.41	0.22	0.33	0.80
29	IT industry	19.74	4.75		1.44	1.24	3.29	3.62	2.14	3.25	7.45
30	wholesale and retailing	27.83	4.95		1.95	1.79	5.16	5.91	3.31	4.77	15.45

		Value Added Exports (VAEX)	Direct VAEX	Indirect VAEX via	LSOE	SSOE	LFIE	SFIE	L	SM	Gross Exports
31	Hotels and Catering Services	14.31	3.62		1.01	1.03	2.02	2.59	1.51	2.53	11.92
32	Finance	31.72	0.67		2.72	2.65	6.51	7.79	4.44	6.93	1.50
33	Real Estate	13.16	0.00		1.22	1.24	2.62	3.26	1.87	2.94	0.00
34	Leasing and commerce service	12.66	5.39		0.66	0.66	1.52	1.80	1.04	1.59	26.65
35	Research and test development industry	1.64	0.16		0.13	0.11	0.40	0.36	0.21	0.27	0.46
36	Polytechnic Services	8.02	0.00		0.72	0.63	1.60	2.10	1.17	1.80	0.00
37	Water, environment and public facilities	1.70	0.00		0.15	0.15	0.28	0.44	0.24	0.44	0.00
38	Resident and Other Services	5.46	1.05		0.43	0.45	0.79	1.05	0.62	1.07	4.75
39	education	0.83	0.11		0.07	0.07	0.14	0.18	0.10	0.17	0.55
40	Health and Social service	1.50	0.18		0.12	0.11	0.26	0.36	0.19	0.29	0.76
41	Culture , Sports and entertainment	3.82	1.64		0.21	0.20	0.43	0.55	0.32	0.48	5.27

Table A4.5. Direct, Indirect, and VA Exports by Ownership-Sector (LGO)

		Value Added Exports (VAEX)	Direct VAEX	Indirect VAEX via	LSOE	SSOE	LFIE	SFIE	L	SM	Gross Exports
2	Agriculture, forestry, fishing, and husbandry	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Mining and Washing of Coal	18.68	1.26		1.65	1.29	3.01	4.63	2.61	4.23	3.76
4	Extraction of Petroleum and Natural Gas	55.09	6.77		4.91	4.05	8.12	12.11	7.15	11.98	10.29
5	Mining of Ferrous Metal Ores	8.29	0.00		1.22	0.42	1.31	1.82	1.36	2.15	0.00
6	Mining of Non-Ferrous Metal Ores	7.24	1.30		0.45	0.40	1.00	1.72	0.90	1.47	3.89
7	Foods and Tobacco	22.14	7.57		1.30	1.34	2.57	3.86	2.08	3.42	32.25
8	Manufacture of Textile Products	64.73	35.98		1.12	1.34	3.02	10.36	3.79	9.12	180.48
9	Wearing apparel, leather, fur, down and related products	15.44	7.95		0.46	0.52	1.17	2.65	0.95	1.73	44.72
10	Processing of wood and Manufacture of Furniture	10.42	4.35		0.34	0.45	0.98	1.56	0.76	1.98	24.22
11	Paper Products and Articles for Culture, Education and Sports Activities	14.12	2.67		0.92	0.98	2.16	3.01	1.53	2.85	14.12
12	Processing of Petroleum, Coking and Nuclear Fuel	18.19	1.89		1.41	1.61	2.47	3.84	2.11	4.87	19.99
13	Manufacture of Chemical Products	72.23	23.78		2.96	2.83	9.41	14.00	6.50	12.76	138.87
14	Manufacture of non-ferrous metal products	12.30	7.39		0.46	0.37	1.16	1.24	0.72	0.97	53.14
15	Smelting and Rolling of metals	141.38	33.35		10.91	4.57	16.60	23.35	15.61	36.98	151.21
16	Manufacture of Metal Products	15.19	3.93		0.88	0.80	2.64	2.97	1.55	2.42	23.77
17	Manufacture of General Purpose and Special Purpose Machinery	25.65	8.83		1.55	1.24	3.19	4.54	2.46	3.84	54.38
18	Manufacture of Transport Equipment	28.07	12.61		1.60	1.41	3.40	3.22	2.36	3.46	67.09
19	Manufacture of Electrical Machinery and Equipment	26.36	14.70		0.95	0.85	2.88	3.00	1.61	2.37	97.02
20	Manufacture of Communication Equipment, computers and Other Electronic Equipment	24.89	13.67		0.62	0.58	5.96	1.72	1.07	1.26	104.85
21	Manufacture of Measuring Instruments and Machinery for Office Work	11.49	9.92		0.16	0.15	0.30	0.38	0.24	0.34	51.31
22	Handicrafts and other Manufacturing	7.60	4.65		0.24	0.24	0.61	0.79	0.44	0.62	23.67
23	Scrap and Waste	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	production and supply of Electricity and heat	21.06	0.25		1.89	1.57	3.83	5.57	3.09	4.87	1.20
25	Production and Supply of Gas	0.92	0.00		0.09	0.07	0.17	0.24	0.14	0.20	0.00
26	Production and Supply of Water	1.79	0.00		0.16	0.15	0.34	0.48	0.26	0.40	0.00
27	construction industry	1.86	1.15		0.07	0.07	0.14	0.17	0.10	0.16	6.70
28	Transportation and warehousing	17.26	1.58		1.39	1.34	3.00	4.04	2.26	3.65	8.52
29	Post service	1.36	0.28		0.09	0.09	0.21	0.29	0.15	0.24	0.65

		Value Added Exports (VAEX)	Direct VAEX	Indirect VAEX via	LSOE	SSOE	LFIE	SFIE	L	SM	Gross Exports
30	IT industry	15.71	3.82		1.15	0.99	2.61	2.88	1.70	2.58	7.44
31	wholesale and retailing	39.34	9.32		2.57	2.33	6.98	7.68	4.28	6.19	24.21
32	Hotels and Catering Services	14.39	3.64		1.01	1.03	2.03	2.61	1.52	2.54	11.93
33	Finance	23.48	0.54		1.98	1.93	4.78	5.77	3.30	5.17	1.50
34	Real Estate	17.43	0.00		1.62	1.64	3.48	4.32	2.48	3.89	0.00
35	Leasing and commerce service	11.21	4.46		0.62	0.61	1.41	1.67	0.96	1.48	23.55
36	Research and test development industry	2.22	0.19		0.18	0.16	0.54	0.49	0.29	0.37	0.43
37	Polytechnic Services	7.87	0.00		0.70	0.62	1.57	2.06	1.14	1.78	0.00
38	Water, environment and public facilities	1.75	0.00		0.15	0.16	0.29	0.45	0.24	0.45	0.00
39	Resident and Other Services	5.91	1.13		0.47	0.49	0.86	1.14	0.67	1.16	4.75
40	education	1.50	0.20		0.12	0.12	0.25	0.32	0.18	0.30	0.55
41	Health and Social service	1.98	0.23		0.16	0.14	0.34	0.47	0.26	0.38	0.76
42	Culture , Sports and entertainment	5.16	2.21		0.28	0.27	0.58	0.74	0.43	0.65	5.49

Table A4.6. Direct, Indirect, and VA Exports by Ownership-Sector (SMO)

		Value Added Exports (VAEX)	Direct VAEX	via	Indirect VAEX LSOE	SSOE	LFIE	SFIE	L	SM	Gross Exports
2	Mining and Washing of Coal	34.89	2.59		3.28	2.23	5.54	8.45	4.56	8.23	4.63
3	Extraction of Petroleum and Natural Gas	15.13	0.11		1.63	1.13	2.48	3.92	2.09	3.77	0.27
4	Mining of Ferrous Metal Ores	40.18	2.14		5.91	1.58	5.40	7.31	6.89	10.96	3.64
5	Mining of Non-Ferrous Metal Ores	10.87	2.37		0.67	0.54	1.47	2.30	1.13	2.40	4.85
6	Foods and Tobacco	51.12	16.69		1.98	1.99	4.23	8.30	3.49	14.45	70.79
7	Manufacture of Textile Products	170.80	65.55		1.69	2.01	4.94	34.95	6.64	55.02	323.13
8	Wearing apparel, leather, fur, down and related products	51.12	40.18		0.57	0.62	1.50	4.48	1.18	2.59	171.03
9	Processing of wood and Manufacture of Furniture	60.77	37.06		0.69	1.00	2.30	3.95	1.78	13.99	123.14
10	Paper Products and Articles for Culture, Education and Sports Activities	79.14	39.98		2.13	2.24	5.14	8.99	3.38	17.27	135.47
11	Processing of Petroleum, Coking and Nuclear Fuel	43.97	4.60		3.74	3.55	6.32	9.71	5.14	10.92	13.04
12	Manufacture of Chemical Products	268.70	58.57		8.37	7.66	38.29	69.08	21.69	65.03	236.15
13	Manufacture of non-ferrous metal products	59.95	28.00		2.39	1.56	4.95	4.79	3.03	15.23	69.62
14	Smelting and Rolling of metals	107.47	14.73		9.57	3.70	14.04	19.20	13.50	32.73	74.00
15	Manufacture of Metal Products	91.23	59.24		2.05	1.70	7.58	7.97	3.54	9.15	225.98
16	Manufacture of General Purpose and Special Purpose Machinery	123.74	63.20		4.41	2.98	8.76	14.37	6.61	23.42	213.20
17	Manufacture of Transport Equipment	29.84	11.07		1.94	1.59	4.35	3.82	2.80	4.27	48.29
18	Manufacture of Electrical Machinery and Equipment	54.72	36.33		1.42	1.20	4.48	4.89	2.39	4.02	175.08
19	Manufacture of Communication Equipment, computers and Other Electronic Equipment	17.51	7.12		0.53	0.48	6.02	1.43	0.89	1.05	64.49
20	Manufacture of Measuring Instruments and Machinery for Office Work	15.12	13.67		0.15	0.13	0.28	0.36	0.21	0.33	69.83
21	Handicrafts and other Manufacturing	21.73	16.45		0.43	0.41	1.11	1.43	0.76	1.15	45.25
22	Scrap and Waste	124.99	2.59		13.69	6.26	20.03	30.13	18.10	34.19	3.20
23	production and supply of Electricity and heat	26.78	0.31		2.47	1.81	4.83	7.12	3.70	6.53	1.27
24	Production and Supply of Gas	0.79	0.00		0.07	0.06	0.15	0.21	0.11	0.19	0.00
25	Production and Supply of Water	2.36	0.00		0.21	0.18	0.45	0.64	0.32	0.56	0.00
26	Construction industry	3.55	2.36		0.12	0.12	0.22	0.29	0.16	0.28	7.20
27	Transportation and warehousing	246.41	146.61		8.62	8.41	17.35	23.88	12.39	29.14	225.34
28	Post service	2.27	0.53		0.15	0.14	0.33	0.48	0.24	0.40	0.85
29	IT industry	19.79	5.28		1.41	1.15	3.20	3.52	1.97	3.25	7.83

		Value Added Exports (VAEX)	Direct VAEX	via	Indirect VAEX LSOE	SSOE	LFIE	SFIE	L	SM	Gross Exports
30	wholesale and retailing	320.81	242.99		6.03	5.03	21.04	19.18	9.74	16.80	294.04
31	Hotels and Catering Services	31.61	15.43		1.51	1.48	3.00	3.91	2.13	4.15	33.39
32	Finance	136.24	2.03		10.94	10.97	32.67	30.60	16.21	32.82	2.31
33	Real Estate	16.49	0.00		1.50	1.47	3.27	4.16	2.21	3.88	0.00
34	Leasing and commerce service	115.73	96.02		1.77	1.67	4.12	4.93	2.65	4.57	166.93
35	Research and test development industry	2.52	0.23		0.20	0.16	0.63	0.56	0.32	0.42	0.46
36	Polytechnic Services	8.24	0.00		0.73	0.59	1.64	2.19	1.13	1.96	0.00
37	Water, environment and public facilities	1.77	0.00		0.15	0.15	0.29	0.47	0.23	0.49	0.00
38	Resident and Other Services	18.74	4.36		1.41	1.42	2.53	3.43	1.90	3.70	5.65
39	education	3.02	0.36		0.25	0.24	0.50	0.66	0.36	0.65	0.43
40	Health and Social service	2.42	0.29		0.19	0.16	0.42	0.58	0.30	0.48	0.72

Table A5. Original Data from NBS Firm Census (2008) and Customs (2007) Used to Split the IO Table

Unit: %	Output						Value Added						Exports					
	LSOE	SSOE	LFIE	SFIE	LGO	SMO	LSOE	SSOE	LFIE	SFIE	LGE	SME	LSOE	SSOE	LFIE	SFIE	LGE	SME
2 Mining and Washing of Coal	47	5	2	0	9	36	52	5	2	0	10	30	67	0	3	0	21	8
3 Extraction of Petroleum and Natural Gas	53	12	0	2	30	2	53	11	0	1	33	1	15	63	0	11	12	0
4 Mining of Ferrous Metal Ores	10	6	2	3	7	72	13	8	3	3	9	64	0	0	24	0	0	76
5 Mining of Non-Ferrous Metal Ores	3	7	1	6	4	78	5	9	1	6	6	73	5	8	1	30	1	56
6 Foods and Tobacco	11	3	9	18	11	48	27	3	9	15	11	35	2	1	8	43	11	34
7 Manufacture of Textile Products	1	1	4	19	18	57	1	1	4	19	17	57	1	1	10	38	15	35
8 Wearing apparel, leather, fur, down and related products	0	1	10	35	11	43	0	1	11	36	10	41	0	0	14	51	8	27
9 Processing of wood and Manufacture of Furniture	0	1	5	20	6	68	0	1	5	20	7	67	0	1	13	45	8	33
10 Paper Products and Articles for Culture, Education and Sports Activities	3	3	11	26	8	50	3	3	10	28	8	48	0	1	24	53	3	19
11 Processing of Petroleum, Coking and Nuclear Fuel	34	4	5	4	34	19	28	5	5	6	32	24	63	0	7	8	19	2
12 Manufacture of Chemical Products	7	3	8	22	14	46	7	3	9	22	15	44	6	1	14	45	13	21
13 Manufacture of non-ferrous metal products	1	4	3	14	9	69	1	4	4	14	9	67	1	1	9	43	12	34
14 Smelting and Rolling of metals	25	2	7	7	29	30	31	2	8	6	29	24	40	1	9	16	26	8
15 Manufacture of Metal Products	2	3	6	25	7	58	2	3	6	24	8	57	2	2	22	41	8	26
16 Manufacture of General Purpose and Special Purpose Machinery	7	4	7	19	11	52	8	4	8	20	11	48	5	1	16	40	14	23
17 Manufacture of Transport Equipment	16	3	25	14	18	24	15	3	29	14	17	21	13	2	29	20	25	11
18 Manufacture of Electrical Machinery and Equipment	2	2	15	21	18	42	2	2	16	21	18	41	1	1	34	36	14	15
19 Manufacture of Communication Equipment, computers and Other Electronic Equipment	2	1	63	19	8	8	3	1	51	22	11	12	1	0	76	16	6	2
20 Manufacture of Measuring Instruments and Machinery for Office Work	3	4	30	27	7	30	3	5	17	31	7	36	0	0	56	32	4	7
21 Handicrafts and other Manufacturing	0	2	8	30	6	55	0	1	9	31	6	52	0	0	12	43	6	39
22 Scrap and Waste	0	0	0	0	0	100	0	0	0	0	0	100	0	0	0	0	0	100
23 production and supply of Electricity and heat	54	25	2	5	3	10	49	29	2	6	4	10	14	82	0	0	1	2
24 Production and Supply of Gas	10	15	7	30	5	32	11	14	10	31	4	30	29	9	0	62	0	0
25 Production and Supply of Water	17	45	1	13	1	23	13	45	1	20	0	21	15	1	0	81	0	3
26 construction industry	18	13	0	1	15	53	6	10	0	1	6	77						
27 Transportation and warehousing	14	30	6	0	2	47	18	24	5	0	0	52						
28 Post service	48	39	6	1	0	5	40	43	6	2	0	9						
29 IT industry	5	18	18	21	10	27	7	21	21	23	8	20						
30 wholesale and retailing	13	12	4	3	10	58	14	10	5	3	9	59						
31 Hotels and Catering Services	3	12	9	5	6	66	5	21	9	8	6	50						
32 Finance	13	17	0	3	1	66	7	26	0	4	1	63						
33 Real Estate	5	5	9	5	32	44	5	7	11	5	32	40						

34 Leasing and commerce service	10	21	6	9	6	49	16	21	2	7	5	51							
35 Research and test development industry	22	28	5	7	11	27	29	15	9	8	8	32							
36 Polytechnic Services	27	13	3	4	16	36	26	14	3	4	13	40							
37 Water, environment and public facilities	10	26	2	5	7	51	10	23	3	5	10	50							
38 Resident and Other Services	3	6	2	4	8	77	2	5	1	3	8	80							
39 Education	1	6	1	2	18	72	2	6	1	2	19	71							
40 Health and Social service	15	11	1	1	11	61	12	12	1	1	10	64							
41 Culture , Sports and entertainment	29	34	2	3	4	29	24	31	3	3	4	34							
42 Public administration and social organization	0	12	0	0	2	86	0	11	0	0	2	87							
Total	14	8	9	10	14	46	15	9	9	11	13	44	5	1	39	30	11	15	

Data Source:

(1) 2008 China's NBS Firm Census. Data for Sector 27 (Transportation and warehousing) is inferred from information from 2008 NBS Economic Census and the railway sector in the 2007 135-sector I/O table. (2) Import data are from 2007 customs. (3) Total is the sum of all data for manufacturing, mining and services (agriculture is excluded).

Table A6. Original Data from NBS Firm Census (2008) and Customs (2007) Used to Split the IO Table (cont)

	Unit: %	Employment						Imported Materials		
		LSOE	SSOE	LFIE	SFIE	LGE	SME	SOE	FIE	Others
2	Mining and Washing of Coal	53	8	1	0	7	32	33	5	61
3	Extraction of Petroleum and Natural Gas	66	2	0	0	29	3	37	0	63
4	Mining of Ferrous Metal Ores	13	6	1	2	7	70	65	2	32
5	Mining of Non-Ferrous Metal Ores	4	15	1	4	4	71	19	47	34
6	Foods and Tobacco	4	4	8	16	11	57	18	30	52
7	Manufacture of Textile Products	1	3	4	22	13	58	9	51	40
8	Wearing apparel, leather, fur, down and related products	0	1	10	44	5	39	7	55	38
9	Processing of wood and Manufacture of Furniture	0	2	5	24	5	65	13	36	51
10	Paper Products and Articles for Culture, Education and Sports Activities	1	4	8	34	4	49	17	33	49
11	Processing of Petroleum, Coking and Nuclear Fuel	25	5	6	4	27	33	58	7	35
12	Manufacture of Chemical Products	6	4	6	21	11	52	15	40	45
13	Manufacture of non-ferrous metal products	1	6	3	12	7	71	10	51	39
14	Smelting and Rolling of metals	27	2	5	5	27	33	31	38	31
15	Manufacture of Metal Products	1	2	5	25	6	61	16	56	28
16	Manufacture of General Purpose and Special Purpose Machinery	5	6	5	18	7	59	24	42	35
17	Manufacture of Transport Equipment	10	5	11	16	15	42	16	18	66
18	Manufacture of Electrical Machinery and Equipment	1	2	15	27	11	44	13	57	30
19	Manufacture of Communication Equipment, computers and Other Electronic Equipment	2	2	45	31	6	15	7	68	25
20	Manufacture of Measuring Instruments and Machinery for Office Work	3	5	17	34	4	37	8	68	25
21	Handicrafts and other Manufacturing	0	1	4	43	4	48	7	53	40
22	Scrap and Waste	0	0	0	0	0	100	14	23	64
23	production and supply of Electricity and heat	40	36	2	3	5	15	97	0	3
24	Production and Supply of Gas	16	27	5	19	7	26			
25	Production and Supply of Water	12	66	0	5	0	16			
26	Construction industry	7	12	0	1	6	74			
27	Transportation and warehousing	1	31	2	0	0	66			

28	Post service	39	48	4	1	0	8			
29	IT industry	3	16	11	16	5	48			
30	wholesale and retailing	5	7	3	2	7	76			
31	Hotels and Catering Services	1	13	6	5	3	72			
32	Finance	8	9	0	2	3	79			
33	Real Estate	3	10	2	5	16	64			
34	Leasing and commerce service	3	19	1	5	2	71			
35	Research and test development industry	19	14	6	8	6	47			
36	Polytechnic Services	15	14	2	3	10	56			
37	Water, environment and public facilities	13	19	1	2	12	53			
38	Resident and Other Services	2	4	2	3	12	77			
39	Education	1	5	0	1	11	81			
40	Health and Social service	10	11	1	1	7	70			
41	Culture , Sports and entertainment	18	17	3	4	5	53	7	86	7
42	Public administration and social organization	1	4	0	0	7	87			
Total		7	9	3	8	8	65	19	44	36

Data Source:

(1) 2008 China's NBS Firm Census. Data for Sector 27 (Transportation and warehousing) is inferred from information from 2008 NBS Economic Census and the railway sector in the 2007 135-sector I/O table.

(2) Import data are from 2007 customs.

(3) Total is the sum of all data for manufacturing, mining and services (agriculture is excluded).