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Weighing China's Export Basket: An Account of the Chinese Export Boom, 2000--2007

By

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Abstract

In this paper we use new, detailed and comprehensive linked firm-product data to describe various dimensions of the Chinese export boom from 2000-2007. Our analysis indicates that firm entry played a larger role in China's export boom than is the case in other countries, and that processing firms were an important component of this. Our estimates of value-added suggest that the foreign content of China's exports is much higher than previously estimated. Finally, our estimates of technological intensity show that Chinese exports had been increasingly intensive in technology, but the overall intensity is lower when the exports are evaluated by domestic value-added than by final value.

JEL classification: F13, F14, O14

Keywords: Chinese Export Boom, Domestic Value-Added, Technology Intensity

Outline

Non-Technical Summary

This paper attempts to provide a systematic assessment of the Chinese export boom from 2000 to 2007, which made China rise from a top five exporter to a top two exporter. The surge was accompanied with dramatic changes in general trade environment resulting mainly from China's attainment of WTO membership. Such an extraordinary growth with institutional changes offers us an interesting setting to explore the growth structure of exports from both theoretical points of view and empirical points of view.

We find the net entry of exporting firms contributed half of the overall export growth, much larger than what is found in other studies. Meanwhile, processing firms are found to have significantly dominated other types of firms in the boom, especially in terms of the growth in their number. Firms entered into the export market more intensively in labour-intensive industries, while existing exporting firms expanded their exports more dramatically in capital-intensive industries. The above evidence is consistent with the fact that there were large reductions in trade barriers for Chinese firms but also uncovers the huge internal heterogeneity across sectors and the specific ways how the trade liberalisation impacted the export market through firm entry in China.

We then develop an accounting method to measure the domestic value-added in Chinese exports, which fits the Chinese case. The method is improved based on Hummels et al.'s (2001) (HIY) measuring framework of vertical specialisation by taking into account the difference between processing trade and ordinary trade. The share of China's value-added in exports is shown to be only 30%, lower than what would be obtained by the HIY method.

Finally, as expected, we find general technological improvement in Chinese exports, although the lower-technology industries are still found to have tended to export higher proportions of their products than higher technology industries. More interestingly, the technology intensity of Chinese value-added in exports was lower than that of exports measured in export value. This finding is novel and it seems that the ``surprising" big numbers might be to some extent misleading and might have covered some important facts: technological improvement during the export boom had not changed the product composition of China's own domestic content in exports as much as its final export value implied to many researchers.

1 Introduction

China's export growth in the first decade of the 21st Century has been remarkable. The average growth rate of manufactured exports between 2000 and 2007 was over 30% per year, some 10 percentage points higher than during the previous eight years. China's share in world's trade in merchandize almost tripled, jumping from 4.7% in 2000 to 12% in 2007. This period was also one in which China became increasingly integrated into the institutions of world trade, most notably via its inclusion in the World Trade Organisation (WTO) in 2001.

WTO accession has had a two-fold effect on China. On the one hand, trade barriers of various kinds have had to be removed to create a fairer and freer environment for investment and trade. Import tariffs were eliminated or reduced, and all import quotas on industrial goods were removed by 2005. As a result, the unweighted average tariff rate decreased from 16.4% in 2000 to below 10% by 2007. At the same time, export subsidies to domestic firms which were inconsistent with WTO rules were largely removed, foreign suppliers were allowed to retail their products, and foreign investment approvals were no longer subject to some mandatory requirements such as technology transfer or local content requirements (Rumbaugh and Blancher, 2004).

On the other hand, China also began to benefit from easier access to overseas markets. Chinese exports no longer faced discriminative tariffs and quotas as compared to exports from other countries, although for some specific products (for example, textiles and apparels) safeguards provisions and surveillance strategies would continue to operate. More fundamentally, upon entry into the WTO, all trade began to be supervised and regulated under uniform and transparent WTO rules, including those regarding the settlement of conflicts. Together, these changes not only brought about a climate which was increasingly favourable for the influx of foreign capital and goods, but also encouraged Chinese firms to engage export activities.

In this paper we use new, detailed and comprehensive linked firm-transaction data to describe various dimensions of the export boom. We contribute both to the growing literature which describes the Chinese export boom, and to the literature on the microeconomic mechanisms which underly a trade liberalisation. China provides a fascinating example in this regard because of the scale of the liberalisation, the size of the subsequent increase in exports and the increasing role of China as part of global production chains.

The data we use comprise an annual census of all large manufacturing firms in China over the period 2000-2007, and a monthly transaction-level database of all merchandise passing through Chinese customs from January 2003 to December 2006. We are able to link the datasets together, and the linked firm-transaction information enables us to provide a series of new facts about the Chinese export boom.

This paper focuses on three main questions:

1. In an accounting sense, what is the *source* of the export boom? Is it due to an increase in the extensive or intensive margins of exporting? What types of firm, what types of exports and which industries account for the export boom?

2. How has the *domestic content* of Chinese exports changed? Does the fact that processing and assembly are such an important fraction of exports mean that the domestic content of exports is particularly small?

3. How has the *technology intensity* of Chinese exports changed? Have Chinese exporting firms become more skill and capital intensive, or does the reliance on processing and assembly mean that Chinese exporters are in fact still quite labour intensive?

An overview of this study is given as follows.

First, we are able to decompose the growth in exports into contributions at the intensive and extensive margin at both firm- and product-level. We show that the Chinese export market exhibited great turnover in the eight years after 2000, and the entry of new exporting firms contributed half of the export growth. The turnover is larger than what is found for other countries, and is consistent with the fact that China experienced some large degree of trade liberalization in this period, which was signified by its WTO entry.

Among all types of firms, processing firms dominate ordinary trade firms in export growth. Particularly, the growth in the number of processing firms alone explains 72% of all export growth in our matched firm-product sample. Apart from these, there exists huge internal inequality in China's export sector. Coastal region and foreign-invested firms had much higher growth in export value, probably due to their geographical superiority and more connections with foreign markets. We also find evidence that labour-intensive industries saw more export growth at the extensive margin while capital-intensive industries experienced more export growth at the intensive margin. The reason may be that it is easier for firms in labour-intensive industries to export and they are more responsive to reductions in trade barriers.

Second, because we observe imports and exports by firms, we are able to provide a new measure of the value-added in Chinese exports by examining the extents to which the export value is from imported intermediates and from domestic value-added. We show that the foreign content of Chinese exports is much higher than previously estimated, and therefore the domestic content lower. On average the foreign content in Chinese exports was about 70%, meaning that China's own value-added only accounted for 30% in its huge volume of exports. While coastal firms and foreign firms were the major sources of the increase in foreign content share, non-state domestic firms (mostly private firms) were the main contributor to the decrease in domestic content share. With regard to firm dynamics, entering firms had lower domestic content than others, while existing firms had much higher foreign content than others. This implies that engaging in processing trade could probably greatly reduce not only entry costs of exporting but also variable costs of exporting.

Third, we can examine the characteristics of firms which contributed to the growth in exports, because we have measures of firms' technological and human capital inputs. For example, we have information on the skill composition of the workforce, R&D expenditure and the development of new products. The results show that, in spite of this technological improvement, lower-technology industries tended to export higher proportions of their products than higher-technology industries did, which reflects China's comparative advantages had not been changed much. Moreover, it is also revealed that a higher proportion of domestic value-added in exports was distributed in sections of low-technology products than was final value of exports. This finding is novel and implies that the technological improvement during the export boom had not changed the overall technology intensity of Chinese domestic content in exports as much as the export value implied to many researchers.

The remainder of the paper is structured as follows. In Section 2 we describe the various sources of data to be used in this study in more detail. In Section 3 we provide a brief description of aggregate Chinese export patterns, using our data. Section 4 presents a simple decomposition which allows us to analyse the source of the export boom. Section 5 proposes a new measurement method of vertical specialization that fits the Chinese case. We then assess the technological intensity of Chinese exports evaluated both at the final export value and domestic value-added in exports in section 6. Section 7 summarises and concludes.

2 Data

There are two main sources of micro data, firm-level and transaction-level. The firm-level data comes from the Chinese Annual Survey of Industrial Firms (CASIF) from the National Bureau of Statistics in China (NBSC). The transaction-level data comes from the database of the Chinese Customs Trade Statistics (CCTS) which is compiled and maintained by the General Administration of Customs of China. Because these data have not been used together previously, we describe them in some detail.[1]

2.1 Firm-level data

The CASIF survey data that we use covers the period 2000–2007. According to Cai and Liu (2009), firms are given assurances that information from this survey will not be released to the public or be used against them by other governmental agencies, such as tax authorities. For these reasons, firms have less incentive to misreport the information and the data is less likely to be manipulated by local governments.

Two groups of firms are included in the survey. The first is all state-owned firms, and the second is firms of other ownership types with annual sales above 5 million RMB (equivalent to around 700 thousand USD). Because this threshold is in nominal terms, there exists the possibility that the sample will get larger over time purely because of price changes. On average, more than 200 thousand firms are included each year and they account for around 95% of total Chinese industrial output and 98% of industrial exports, covering over 39 two-digit industries, of which 30 belong to manufacturing

[1] Appendix A contains further details.

industries, spread across all 31 mainland provinces and municipalities. In practice, the NBSC implemented standard procedures to ask firms to report required details on their production activities, accounting statement, and other basic characteristics such as ownership structure, location and industry. In addition, each firm also reports their total export value of shipments (if any) including products exported by the production firms themselves (with export licence) and those exported through trading agents.

An important feature of the CASIF data for our purposes is that it has information on firms' technological and human capital inputs.[2] The data include details of the qualifications of the workforce, expenditure on training, research and development (R&D) expenditure, and value of new products.

We drop firms classified as being in the mining, energy, tobacco, and handicrafts industries.[3] We also remove from the data those observations for which any of the following conditions is satisfied:[4]

- Observations which report their *location* information in wrong formats.
- Observations which have missing or non-positive values on any of the variables related to *output*, *sales*, *capital*, and *intermediate inputs*.
- Observations whose *number of employees* is missing or less than 8.
- Observations which have missing or negative values on any of the variables related to *ownership structure* and *export value*.
- Observations whose value of *sales* are less than *export value*.

[2]Data on human capital is only available in 2004, so we are not able to study changes in these inputs over time.

[3]See Appendix A.1 for more details on the cleaning procedures and the reasons for removing firms in these industries.

[4]We drop observations rather than firms here because we want to keep as many observations in the sample as possible. This could generate spurious gaps for some firms as their observations in certain years are dropped by the above cleaning procedures. However, after checking the data, we find only 1% of the firms in the original data have their gaps increased after cleaning. Moreover, the definition of firm entry in the formal analysis later is only based on the data of the initial year (2000) and the ending year (2007). By these two reasons, we believe the cleaning procedures here will not generate serious problems to our analysis of firm dynamics.

Firms removed from the sample comprise 17.8% of the total number of firms, and contribute 21% of total export volume. The remaining sample consists of 1,404,934 observations (firm-years) on 483,869 firms from 27 two-digit manufacturing industries over the period 2000–2007. A brief description of the cleaned CASIF sample is given in table 1. The number of firms in our sample increases by 140% over the sample period and the number of exporters by nearly 130%. Even more remarkably, output increased by over 300% and export value by over 400% in real terms. Note that because the sample excludes smaller firms, some of the apparent increase in the number of firms may be caused by firms crossing the sampling threshold of 5-million-RMB annual sales either from being smaller firms or due to inflation. However, In Appendix B we use information on firms' age and the First National Economic Census data of 2004 to establish how much of this entry is genuine. We show that the identification of "new exporting firms" is very unlikely to be misleading: the likelihood for the identification to be correct is 98.3% on a year-to-year basis, or 88.7% on an eight-year basis.

Table 1. Cleaned CASIF sample

Year	Number of firms	Number of exporters	Output (bn RMB)		Exports (bn RMB)	
			Nominal	Real	Nominal	Real
2000	113,590	27,864	6,135.8	6,135.8	1,118.5	1,118.5
2001	117,085	29,392	6,646.4	6,750.5	1,158.7	1,180.7
2002	124,478	32,553	7,858.6	8,182.3	1,502.9	1,579.6
2003	138,262	36,800	10,259.6	10,572.4	2,059.9	2,182.4
2004	202,007	56,002	13,836.2	13,522.7	2,915.6	3,021.4
2005	204,965	57,852	17,747.1	16,814.6	3,735.0	3,843.8
2006	232,842	61,552	22,312.3	20,870.9	4,704.4	4,849.2
2007	271,705	63,648	29,798.1	26,878.7	5,693.5	5,825.9

Note: Real terms are in 2000 prices. See Appendix A.3 for more details on the construction of the deflators.

For some of our analysis we will use a balanced panel of firms. Largely because of the extraordinarily high entry rate of firms, the balanced panel is much smaller: only 14% of firms in the sample in 2000 are still in the sample in 2007, and only 6% of firms in the sample in 2007 were also in the sample in 2000. Basic sample statistics are shown in table 2.

Table 2. Cleaned CASIF balanced panel

Year	Number of firms	Number of exporters	Output (bn RMB)		Exports (bn RMB)	
			Nominal	Real	Nominal	Real
2000	16,205	4,980	1,341.2	1,341.2	239.8	239.8
2001	16,205	5,083	1,521.7	1,549.0	260.8	266.0
2002	16,205	5,250	1,766.4	1,844.3	318.3	334.9
2003	16,205	5,313	2,162.0	2,242.7	387.5	410.7
2004	16,205	5,608	2,541.6	2,493.4	494.0	510.9
2005	16,205	5,668	3,120.2	2,971.2	596.7	609.8
2006	16,205	5,604	3,668.2	3,472.5	727.2	740.1
2007	16,205	5,230	4,356.7	3,982.7	831.5	837.0

Note: Real terms are in 2000 prices. See Appendix A.3 for more details on the construction of the deflators.

In the balanced panel the growth of the number of exporting firms is much lower (5% compared to 128% in the full sample), suggesting that firm entry is particularly important in explaining export growth. We investigate this in more detail in Section 4. But even in the balanced panel there is still a 200% increase in real output and a 250% increase in real export values.

Figure 1 illustrates the export boom from official statistics[5] and compares with the cleaned firm-level data (cleaned sample) and the customs trade data.[6] The official statistics and the customs statistics are almost the same because the former is from the latter and thus should be identical. The tiny gap between the two statistics is due to the small difference in the classification of manufactured goods.[7] The growth of exports in our full sample follows the growth in official statistics quite closely, typically representing about 70% of officially recorded total exports. As noted earlier, the growth in export values in the balanced panel is much smaller.

[5]See *China Statistical Yearbooks* published annually by National Bureau of Statistics of China.

[6]Here we extract manufactures exports from the original customs data, which is described later, by HS2002-ISIC Rev.3.1 concordance table downloadable from the United Nations website (`http://unstats.un.org/unsd/cr/registry/regdnld.asp?Lg=1`). These export values are then converted from USD to RMB in the year 2000 price.

[7]The Chinese statistical office identifies manufactures in customs trade using its own criterion which is not available to us, while we use, as was mentioned before, the concordance table from the United States to do this.

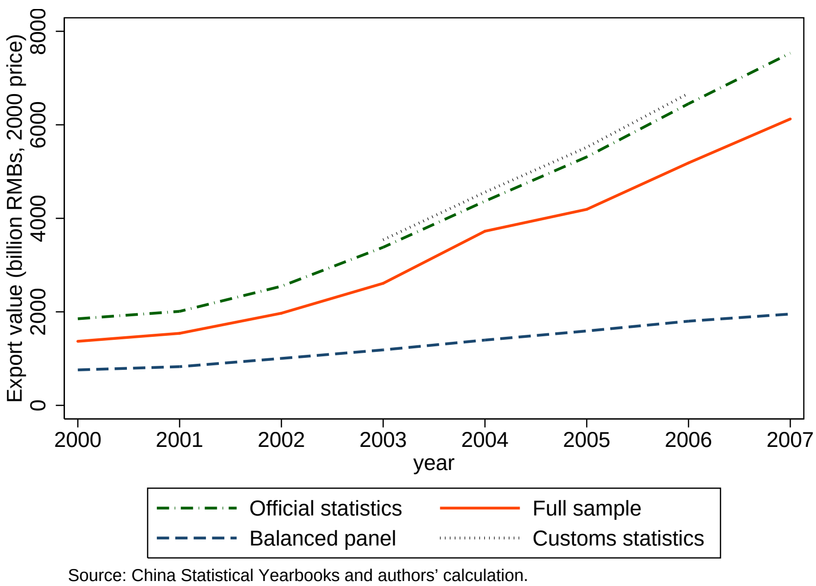

Fig 1. Export Values

2.2 Trade data

The second major data source is the database of Chinese Customs Trade Statistics (CCTS) which is compiled and maintained by the General Administration of Customs of China. It records monthly all merchandise transactions passing through Chinese customs from 1 January 2003 to 31 December 2006, containing information on firm basic information (name, address, ownership, etc.), product code, value of imports and exports, quantity of goods, customs regimes, means of transportation, customs code, origin and destination country. We collapse the data to yearly frequency for consistency with the firm-level data.[8]

The product codes of traded goods are 8-digit Harmonized Commodity Description and Coding System (HS) codes. The export and import values are reported as free on board (FOB) values in $US. The corresponding quantity of goods are also reported in various units depending on the nature of goods (for example, kilograms, sets, pairs, meters, square meters, etc.). Each transaction is also classified under one of 18 customs regimes, which enables us to identify whether a transaction is, for example, for the purpose of processing trade or not. This enables us to distinguish imported intermediates from other imports.[9]

[8]Both the firm survey and the customs data record information from the 1 January to 31 December of the year.

[9]Table A3 in Appendix A.5 defines each regime in detail.

Because our firm data covers only the manufacturing sector, we drop service trade from the original CCTS data.[10] Table 3 summarises the remaining manufacturing trade data from the CCTS. Over this period imports grew by 91%, while exports grew by 120%. The growth in trade is greater than either the growth in the number of transactions and the number of firms registered with customs.

Table 3. CCTS data, excluding services trade

Year	Number of transactions	Number of customs-registered firms	Value of imports (bn USD)	Value of exports (bn USD)	Value of exports[a] (bn RMB)	Value of exports[b] (bn RMB)
2003	16,613,175	124,263	411.8	437.5	3,496.7	3,541.1
2004	19,697,828	153,602	559.3	592.5	4,776.3	4,558.8
2005	22,812,443	179,317	658.1	760.0	6,066.4	5,519.6
2006	25,658,033	208,017	788.3	966.4	7,553.3	6,672.4

[a] Converted from USD to RMB using average exchange rate of each year.

[b] Converted from USD to RMB using average exchange rate of each year and deflated to the year 2000 prices by the ex-factory price index.

Among the 18 customs regimes, three stand out in terms of trade value. These are "ordinary trade", "processing and assembly trade", and "processing with imported materials trade". Under the second of these regimes foreign suppliers provide raw materials, parts or components for subsequent re-export, and these inputs remain property of the foreign supplier. The final regime differs in that the inputs are the property of the exporting firm. Table 4 shows that such processing accounts for around 40% of all imports and 50% of all exports. However, these shares have remained quite stable over the limited period of the customs data.

2.3 Matched firm-transaction data

Merging the two datasets described above allows us to link firm production with firm trade. We can then examine, for example, the contribution of imported intermediates to total exports and the skill intensity of exports. The firm- and trade- data do not use consistent firm identification numbers, so we use firm name as the matching criteria. Firm name is a reliable match variable as it is ruled that no firms can have the same

[10] See Appendix A.5 for further details.

Table 4. Shares of imports and exports by major customs regimes

	Imports (%)			
Year	Ordinary	Processing and assembling	Processing with imported materials	Others
2003	45.58	9.30	30.05	15.06
2004	44.25	9.42	30.01	16.32
2005	42.41	10.01	31.42	16.17
2006	42.12	9.20	31.33	17.35
	Exports (%)			
Year	Ordinary	Processing and assembling	Processing with imported materials	Others
2003	41.47	12.39	42.83	3.31
2004	40.98	11.56	43.80	3.66
2005	41.25	11.03	43.74	3.99
2006	42.90	9.76	42.96	4.38

name in the same administrative region and given that virtually all firms contain their local region name as part of their firm name. About 50% of the exporting firms in the cleaned CASIF data are finally matched to the customs trade records and they account for 60% of exports recorded in the cleaned CASIF data.[11] The remaining 50% of the exporting firms do not get matched because they are believed to export via trading agents and therefore do not appear in the customs records. The sample of matched firms is summarised in Table 5.

Three points are worth noting. First, there are gaps between the number of firms and the number of exporters in Table 5. For example in 2003, there are 22,787 firms in the CASIF data appearing in the matched sample, but only 16,972 of them are exporters. The reason is that some firms are importers and do not export anything in some years. These importers account for about one-fourth of all matched firms.

Second, normally each firm in the matched sample should have a unique firm code and a unique customs registration code. But Table 5 shows the number of customs-registered firms is slightly less than that of firms identified by firm codes in the CASIF data,

[11]See Appendix A.4 for details regarding the matching procedures.

Table 5. Profile of the Matched CASIF-CCTS Sample

Year	Number of firms[a]	Number of exporters[a]	Output (bn RMB)[a]		Exports (bn RMB)[a]		Number of customs-registered firms[b]	Imports (bn)[b]		Exports (bn)[b]	
			Nominal	Real	Nominal	Real		USD	RMB	USD	RMB
2003	22,787	16,972	3,839.1	4,026.9	1,188.2	1,260.1	22,781	103.4	855.4	123.6	1023.5
2004	34,410	27,748	5,315.5	5,347.3	1,724.4	1,787.8	34,397	145.6	1207.4	174.9	1447.3
2005	37,787	27,979	6,762.1	6,640.2	2,125.1	2,182.1	37,766	173.4	1417.9	235.9	1930.8
2006	42,492	31,281	8,289.4	8,129.6	2,805.5	2,898.0	42,470	203.9	1620.7	293.4	2236.4

[a]Information originally from the CASIF sample.

[b]Information originally from the CCTS sample and converted to the currency unit of RMB when necessary.

implying that some customs registration codes correspond to multiple firm codes. This could happen if some firms changed their firm codes in the CASIF data (for example because of ownership changes or simply misinput) but did not change their registration code in the the customs data. However, such cases are very rare and are unlikely to have a significant effect on our analysis.

Second, we have two different measures of exports from the two data sets, in different currency units. After we convert USD into RMB using yearly average exchange rate, we find that exports from the CASIF data are consistently 10%-25% higher than exports from the CCTS data. Apart from inaccuracy of using yearly average exchange rates instead of actual exchange rates for each transaction, the most likely explanation of this discrepancy is that some of the matched firms export products themselves, and at the same time export through trading agents. While the goods exported through trading agents are counted as part of the production firms' exports in the CASIF data, they are recorded under the name of the trading agents in the CCTS data.

3 Preliminary Evidence

In this section we briefly document the export boom from an aggregate perspective, focussing on industry, geographic location and ownership. Chinese export shares have moved strongly away from traditional labour-intensive industries such as textiles and clothing, towards capital- and skill-intensive industries such as electronic equipment. This is shown in Table 6, where the shares of export value are calculated for each two-digit industry. The increase in the share of electronics amngst all exports dwarfs any of the other sectors — this industry alone now accounts for 35% of all Chines exports. This is consistent with the findings in the recent literature such as Amiti and Freund (2010).

Figures 2 and 3 show how the proportion of exporting firms and the value of exports has evolved over the sample period, split by geographic location and ownership. Figure 2 shows that exporting firms are most likely to be found in Coastal regions,[12] and that

[12]The Coastal regions include the provincial-level administrative regions of Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan. Although strictly speaking Beijing is not a coastal region but it is included here because it is the capital city and one of

Table 6. Reshuffling in the Industrial Structure of Export Value (%)

Industry	2000	2007	Change
Textiles	12.36	6.04	−6.32
Clothing	8.44	4.80	−3.64
Leather/fur/feather	5.71	3.17	−2.54
Office equipments	3.05	1.83	−1.22
Processing of foods	3.30	2.33	−0.97
Plastics	3.06	2.43	−0.63
Petroleum/coking	1.05	0.44	−0.61
Metal products	4.47	3.88	−0.59
Medicines	1.43	0.93	−0.50
Raw chemical material	3.95	3.63	−0.32
Manufacturing of foods	0.87	0.76	−0.11
Measuring instruments	2.72	2.63	−0.09
Beverages	0.37	0.29	−0.08
Non-ferrous metals	1.76	1.72	−0.04
Paper products	0.87	0.80	−0.07
Rubber	1.35	1.28	−0.07
General machinery	3.52	3.47	−0.05
Non-metallic minerals	2.21	2.13	−0.08
Printing	0.23	0.32	0.09
Chemical fibers	0.27	0.36	0.09
Timber/wood	0.64	0.88	0.24
Furniture	1.08	1.43	0.35
Special machinery	1.23	1.74	0.51
Ferrous metals	2.74	3.96	1.22
Transport equipments	3.90	5.15	1.25
Electrical equipments	6.38	8.19	1.81
Electronic equipments	23.06	35.42	12.36

Note: The industries are arranged in ascending order of percentage change in export value share.

foreign-owned firms[13] are more likely to be exporters.[14] However, within all categories the *proportion* of exporting firms is quite stable. From Table 1, we can see that the growth in the total number of firms has approximately equalled the growth in the number of exporting firms.

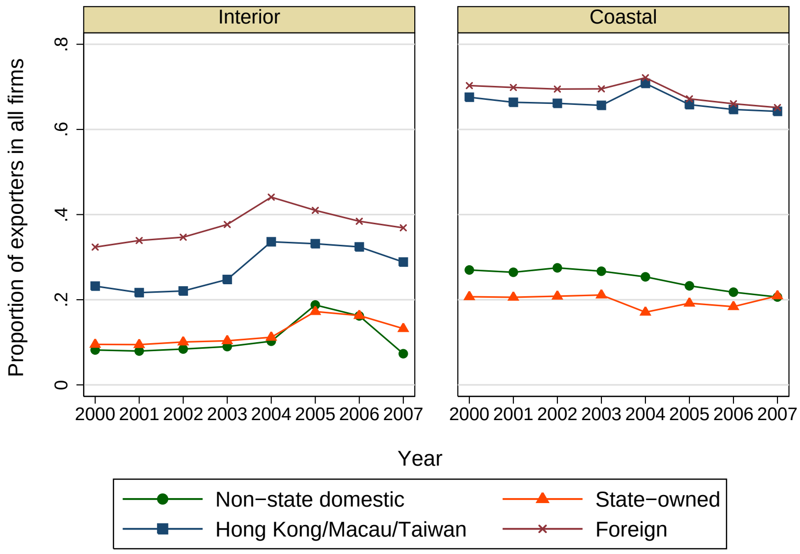

Fig 2. Proportion of exporting firms across ownership types and regions

Figure 3 shows that the increase in export value has been dominated by firms in coastal regions. Within coastal regions, only state-owned firms experienced no dramatic increase in export values. The largest increase came from foreign-owned firms, with average annual growth of more than 35%. The export expansion of firms located in coastal regions further strengthened the role of these regions, which in 2007 accounted for 93% of China's manufacturing exports.

There are two main reasons for the inferior export performance of state-owned firms. The first is the government-directed reform which closed or merged a large number of

the major economic centres in China.

[13]Foreign-owned firms are defined as firms with foreign share of paid-in capital higher than 50%.

[14]The superior export performance either in terms of participation rate or in terms of export intensity by foreign firms have been documented in some empirical studies, including Bernard and Jensen (2004b) on the U.S. firms sample and Kneller *et al.* (2008) on the U.K. firms sample. Zhang and Song (2001) and Zhang and Felmingham (2001) find that foreign firms in China are also more intensively engaged in export activities, but their conclusions are from trade data sources either at the national level or at the provincial level.

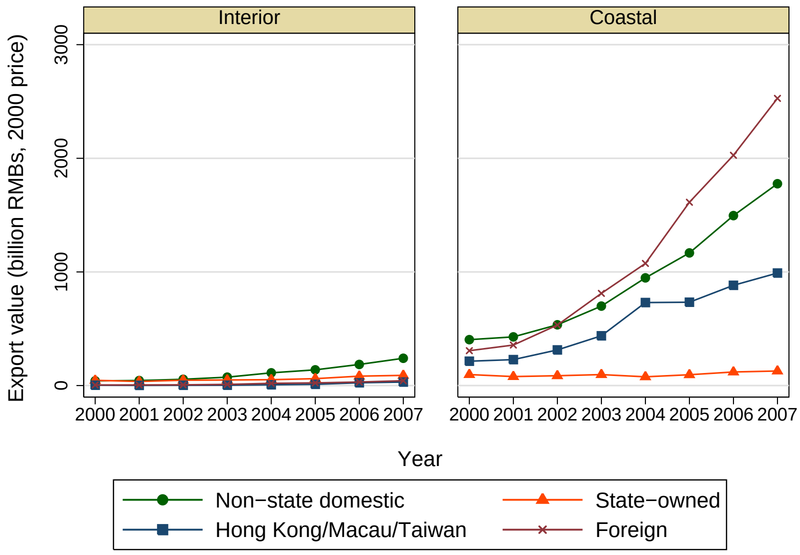

Fig 3. Export Values across ownership types and regions

the state-owned firms in order to enhance their efficiency and make the market more open to other participants. Second, the relatively low efficiency of state-owned firms significantly accelerated their exit rate in an increasingly competitive market. At the same time, industrial policies introduced and implemented by the central government encouraged more foreign investment and domestic non-state firms to enter into the market, driving out less efficient firms. These factors collectively lead to the rapid reduction in the market and export share of state-owned firms.

4 A Decomposition of Chinese Export Growth

Firm entry, exit, growth, and changes in export intensity within firms can all contribute to the aggregate growth of exports. This ties in closely with the theoretical literature which suggests the importance of fixed entry costs to exporting (see, for example, Melitz (2003), Melitz and Ottaviano (2008) and Bernard *et al.* (2007)). Evidence from a large number of empirical works have confirmed the role of sunk costs (see, for example, Roberts and Tybout (1997), Aw *et al.* (2000), Aw *et al.* (2001), and Bernard and Jensen (2004a,b)), and have also documented the positive effect of trade liberalization on aggregate industry productivity by reallocation of resources from less efficient firms to more efficient firms (see, for example, Pavcnik (2002), Eslava *et al.* (2004), and Amiti and Konings (2007)). However, the main focus of most of these papers is on productivity rather than the sources of export growth. One exception is Bernard and Jensen (2004b) which decomposes the U.S. export boom from 1987-1992 into firm entry, firm expansion, and export intensity. One of their key findings is that firm entry plays a relatively smaller role than export intensity and this lends support to the importance of sunk entry costs in the export market. With the Chinese customs trade data, Amiti and Freund (2010) recently examined the issue of Chinese export growth in terms of product variety change, but had no discussion of the role of firm dynamics. This is implausible with the customs trade data as it contains little information of the firm activities.

There are at least two reasons why the Chinese boom might provide a different setting for the decomposition of export growth. First, because of WTO accession, China underwent a much deeper liberalisation in the sample period than the U.S. from 1987–1992, where the main external drive was Dollar depreciation (Bernard and Jensen, 2004a). Second, as Table 4 showed, half of all Chinese exports are via processing and assembly trade regimes. It seems likely that the role of firm entry and growth is quite different for exports which form part of a global production chain.

Our decomposition contributes to the literature in the following ways. First, we propose a simple decomposition method which provides direct quantitative measurements of the contributions from firm net entry (firm entry net of firm exit) and firm export expansion in the export market. The former refers to the extensive margin while the latter refers to the intensive margin. This definition of the two margins stems from some recent work such as Helpman *et al.* (2008) which models the impact of international trade frictions on trade flows as being of two sources: trade volume per exporter (intensive margins) and number of exporters (extensive margins).[15] On the other hand, our decomposition method also relates to the empirical work by Bernard and Jensen (2004a). To obtain the relative contributions of firm entry, firm expansion, and export intensity change, Bernard and Jensen decompose export growth into growth effect (shipment growth) and intensity effect (change in proportion of exports in shipments) and then compare the results for export starters, export stoppers, and continuing exports. While their approach is focused more on firm entry/exit dynamics, our method offers a simple,

[15] Helpman *et al.* (2008) also conduct empirical estimates of the two margins but their estimation equations are derived from their model and thus highly structural.

convenient tool that serves the purpose of simply comparing intensive margins and extensive margins.

Second, the decomposition method is applied flexibly from different angles throughout our thorough investigation of the sources of export growth. We study the export growth in general and also look into different firm ownership types and different industries. Our unique micro data also allows us to have a detailed analysis of the roles of firms with different technology levels. This could help us understand the technology level of Chinese exports better and adds value to the current debate on the technological sophistication of Chinese exports. Another important issue is change in product variety versus product value. An emerging literature has emphasised the importance of extensive margins and intensive margins at the product level in explaining trade growth and has provided supporting evidence, mainly including studies of the U.S. (Bernard *et al.*, 2009a,b, 2010), study of India (Goldberg *et al.*, 2010), and study of China (Manova and Zhang, 2009). Our within-firm product-level decomposition is in line with this literature but adds new evidence on the change in product varieties within firms, by which we can see how firms adjusted their number of product varieties exported and how this contributed to the overall export growth.

4.1 Basic decomposition

Define E_t as aggregate real export value, $\bar{E}_t$ as the mean export value of exporting firms, and N_t^E as the total number of exporting firms at time t. Since $E_t = \bar{E}_t N_t^E$, it follows that

$$\Delta E_t = E_t - E_{t-1} = N_t^E \Delta \bar{E}_t + \bar{E}_{t-1} \Delta N_t^E. \tag{1}$$

Alternatively, we can also write

$$\Delta E_t = \bar{E}_t \Delta N_t^E + N_{t-1}^E \Delta \bar{E}_t. \tag{2}$$

Summing up (1) and (2) and dividing both sides by 2 yields

$$\Delta E_t = \frac{N_{t-1}^E + N_t^E}{2} \Delta \bar{E}_t^E + \frac{\bar{E}_{t-1}^E + \bar{E}_t^E}{2} \Delta N_t^E. \tag{3}$$

The first term of the right hand side of (3) is a measure of the *intensive margin* of export growth, the share of export growth arising from the growth in exports per exporting firm. The second term is defined as the *extensive margin* of export growth, the share of export growth due to the increase in the number of exporting firms.

The first column of Table 7 presents the results of decomposition (3), expressed as a percentage of the total export value growth. In the whole sample, the intensive and extensive margin are equally important: exactly half of export growth was from exporting firms increasing their exports, and half was from the net effect of firms entering and exiting the export market. As we examine in Appendix B, about 11.3% of the identified "new" exporting firms may in fact be existing exporting firms which cross the size threshold. Therefore we are overestimating to some extent the role of the extensive margin.

However, even allowing for this overestimation, the contribution of the extensive margin is much higher than found for other countries. For example, in a study of U.S. export growth from 1987 to 1992, Bernard and Jensen (2004a) find that only 13% of the growth is attributed to the net entry of firms into the export market. Bernard and Jensen take this finding as evidence of the importance of sunk costs in firms' decisions to export. While the relatively small role of the extensive margin is seen as a reflection of the existence of fixed export costs, the role will be larger if the fixed export costs are reduced over time. In the heterogeneous firm models, this happens because decreasing fixed export costs reduces the productivity cutoff for firm entry into the export market. When fixed export costs are lower, some of the firms that were not productive enough to export are now able to do so because they are now capable of overcoming the reduced fixed costs. In the Chinese setting, where trade costs have presumably reduced more dramatically than in the U.S. case of Bernard and Jensen (2004a), the role of the extensive margin is expected to be much larger, as is found here.

The second column of Table 7 repeats decomposition (3) for the balanced panel only. The extensive margin is reduced dramatically because it now comprises only firms in the sample in every year which enter the export market at some point. The huge gap in the extensive margin between the two samples shows that most of the extensive margin is from new firms rather than from pre-existing non-exporting firms entering into the export market. This finding is quite interesting and urges us to rethink about the division of market selection in the heterogeneous firm models. The key reason why

Table 7. Sources of the Growth in Export Value

	Full sample	Balanced panel
Export value (2000)	1118.5	239.8
Export value (2007)	5825.8	837.0
Change (2000/2007)	4707.3	597.2
Intensive margin	0.500 (50.0%)	0.956 (95.6%)
Extensive margin	0.500 (50.0%)	0.044 (4.4%)

Note: Export values and their change are measured in billion RMB in 2000 prices. Numbers in parentheses are shares of intensive margin or extensive margin within each group.

firms have to be more productive to export than to sell products domestically is that exporting requires additional fixed costs. However, if fixed costs associated with being a domestic firm were higher than being an exporting firm, then the above prediction would be reversed: it would be easier to export than to sell products domestically. In reality, this could happen when there exists relatively huge fixed costs with doing business in the domestic market compared to exporting, especially when export costs are reduced to a sufficiently low level. This explanation is supported by many empirical studies which find large interregional trade costs in China (Amiti and Javorcik, 2008; Bai *et al.*, 2004; Poncet, 2003, 2005; Young, 2000).

4.2 Export growth by firm type and industry

We can shed some light on the remarkably large share of new firms in the growth of Chinese exports by repeating the decomposition for various different types of firm. If we have $j = 1, \ldots, J$ mutually exclusive types of firm (for example foreign- and domestically-owned firms), then decomposition 3 can be calculated for each type of firm. Thus the growth in E_t can be written as

$$\Delta E_t = \sum_j \Delta E_{jt} = \sum_j \left(\frac{N^E_{jt-1} + N^E_{jt}}{2} \Delta \bar{E}_{jt} + \frac{\bar{E}_{jt-1} + \bar{E}_{jt}}{2} \Delta N_{jt} \right), \quad (4)$$

which allows us to compute and compare the contribution of firms of each type to the intensive and extensive margins.

We categories firms according to: ownership (domestic, foreign or state-owned); location (coastal or inland) and trade regime (ordinary or processing trade). We expect that some of these firm types will face much lower entry costs, and will therefore have a larger contribution from the extensive margin. For example, foreign-owned firms or firms which are merely assembling imported materials for re-export may be able to set up new plants and start exporting within a short space of time, compared to traditional domestically-owned firms which are exporting products developed in China.

Table 8 summarises the results of these decompositions by firm type. The top panel separates firms into four main ownership types. This shows that although foreign-owned firms were responsible for nearly half of the total export growth (0.211 + 0.269), the importance of the extensive margin does not vary greatly across the three non-state firm types. In fact, domestically-owned private firms have a slightly higher extensive margin than foreign-owned firms.

The second panel of Table 8 decomposes export growth by firm location. This shows that over 90% of the export value growth came from exporting firms located in the coastal region. In addition, the coastal region had a higher proportion of export growth from the extensive margin, consistent with the idea that export entry costs are lower for firms located in coastal regions. It might also reflect other characteristics of firms which are located in these regions.

The third panel of Table 8 decomposes export growth by customs regime. In order to identify the trade regime used by each firm, we turn to the matched firm-product sample. The three most important regimes are given in Table 4, namely: ordinary trade, processing and assembling, processing with imported materials. We define an exporting firm as using a particular customs regime if its exports of that regime contribute more than 50% of its total exports.

Processing firms account for almost all (97%) of the export growth (0.199 + 0.053 + 0.647 + 0.070), and the extensive margin is particularly important for these firms compared to other firm types. Note that almost all this growth is from firms which import materials independently (processing with imported materials) rather than simply engaging in assembly work for foreign companies (processing and assembling).

A further possible explanation for the very high extensive margin is the industrial composition of export growth. Table 9 reports the decomposition for each industry, ordered by the contribution of the extensive margin. Electronic equipment dominates the

Table 8. Sources of Export Value Growth by Firm Type

	Export value (2000)	Export value (2007)	Change (2000/2007)	Intensive margin	Extensive margin
(a) Ownership type					
Non-state domestic	445.9	2016.6	1057.7	0.143 (42.8%)	0.191 (57.2%)
State-owned	143.0	218.0	75.0	0.088 (550.0%)	-0.072 (-450%)
HMT	217.6	1021.1	803.5	0.067 (39.2%)	0.104 (60.8%)
Foreign	312.0	2570.1	2258.1	0.211 (44.0%)	0.269 (56.0%)
(b) Location					
Coast	1022.4	5422.2	4399.8	0.452 (48.3%)	0.483 (51.7%)
Inland	96.1	403.7	307.6	0.041 (63.1%)	0.024 (36.9%)
	Export value (2003)	Export value (2006)	Change (2003/2006)	Intensive margin	Extensive margin
(c) Trade regime					
Ordinary trade	49.9	94.0	44.1	0.011 (40.7%)	0.016 (59.3%)
Processing and assembling	161.5	363.1	201.6	0.053 (43.1%)	0.070 (56.9%)
Processing with imported materials	1042.0	2429.4	1387.4	0.199 (23.5%)	0.647 (76.5%)
Other firms	4.2	10.7	6.5	0.003 (75.0%)	0.001 (25.0%)

Note: Export values and their change are measured in billion RMB in 2000 price. Numbers in parentheses are shares of intensive margin or extensive margin within each group.

growth in exports, contributing 45% $(0.236 + 0.2195)$. Other important industries are electrical equipment (8.5%), transport equipment (6.1%) and textiles (4.1%). However, apart from textiles, none of these industries has a particularly high extensive margin. There does appear to be a higher extensive margin in more labour-intensive industries, which is consistent with the idea that these industries have lower entry costs. There were also some significant reductions in trade barriers in textile and clothing industries as a result of the termination of the MFA quota restrictions in 2005.[16]

4.3 Export growth by firm technology level

A key aim of this paper is to examine whether Chinese exports became more technologically sophisticated over this period. Here technology sophistication refers to the level of technology used in production. Apart from rapid volume growth, a major concern with Chinese exports is that its technology level might be increasing fast, imposing higher pressure on high-income countries' producers. Some widely cited studies pay special attention to this issue, and find that the product composition of Chinese exports have been similar to higher-income countries more than China's real income per capita would imply (Rodrik, 2006; Schott, 2008). While we will look into this question more formally and more carefully in Section 6, here we just have a brief discussion of it in terms of firm dynamics. By having a picture of how firms with different technology levels had their shares in total exports changed over time, the analysis is expected to provide some evidence of the degree of technological improvement in Chinese exports. Again, we apply the decomposition method used before. An advantage of our firm-level data is that it contains detailed technology information related to, for example, workers' educations, skills, R&D investment, and so on. However, these measures are only available in one year of the sample period. We therefore restrict our sample to the balanced panel and make the assumption that individual firms' technology levels are constant over time. To some extent therefore we will underestimate any changes in the technological content of exports because we ignore this within-firm component.

[16]There were some cases of reimposition of quantity restrictions on imports of Chinese textile products after 2005, for example those in the U.S., the E.U., and South Africa. But generally speaking, the new quotas were temporary and were negotiated to increase gradually until being completely eliminated.

Table 9. Sources of the Growth in Export Value by Industry

Industry	Exp. val. (2000)	Exp. val. (2007)	Change (2000/2007)	Int. margin	Ext. margin	% Int. margin	% Ext. margin
Leather/fur/feather	63.8	168.4	104.5	0.0038	0.0184	17.3%	82.7%
Non-metallic minerals	24.7	67.5	42.7	0.0018	0.0073	19.6%	80.4%
Plastics	34.2	120.2	86.0	0.0037	0.0146	20.3%	79.7%
Metal products	50.0	166.0	116.0	0.0053	0.0193	21.7%	78.3%
Textiles	138.2	333.1	194.9	0.0117	0.0297	28.3%	71.7%
Furniture	12.1	79.9	67.8	0.0042	0.0102	29.2%	70.8%
Clothing	94.5	270.5	176.0	0.0131	0.0243	35.1%	64.9%
Office equipments	34.1	107.7	73.6	0.0055	0.0101	35.4%	64.6%
Non-ferrous metals	19.7	54.6	34.9	0.0029	0.0045	38.8%	61.2%
Timber/wood	7.2	46.7	39.5	0.0033	0.0051	39.4%	60.6%
Electrical equipments	71.3	470.0	398.6	0.0358	0.0488	42.3%	57.7%
Printing	2.6	19.5	16.9	0.0016	0.0020	43.5%	56.5%
Processing of foods	36.9	107.4	70.5	0.0065	0.0085	43.6%	56.4%
Rubber	15.1	60.5	45.4	0.0042	0.0054	43.9%	56.1%
General machinery	39.4	218.1	178.8	0.0172	0.0208	45.2%	54.8%
Transport equipments	43.6	330.2	286.5	0.0296	0.0312	48.7%	51.3%
Special machinery	13.7	108.4	94.7	0.0099	0.0102	49.2%	50.8%
Electronic equipments	257.9	2402.2	2144.3	0.2360	0.2195	51.8%	48.2%
Measuring instruments	30.4	171.0	140.6	0.0160	0.0139	53.6%	46.4%
Raw chemical materials	44.2	178.0	133.8	0.0156	0.0128	55.1%	44.9%
Chemical fibers	3.0	17.7	14.7	0.0018	0.0013	58.2%	41.8%
Manufacturing of foods	9.7	38.3	28.6	0.0035	0.0025	58.3%	41.7%
Paper products	9.8	45.3	35.5	0.0046	0.0029	61.4%	38.6%
Medicines	16.0	47.1	31.1	0.0043	0.0023	64.8%	35.2%
Ferrous metals	30.6	169.7	139.1	0.0192	0.0104	64.9%	35.1%
Beverages	4.1	14.8	10.7	0.0016	0.0006	71.7%	28.3%
Petroleum/coking	11.7	13.3	1.5	0.0003	0.0000	100.0%	0.0%

Note: Export values and their change are measured in billion RMB in 2000 price. The industries are arranged in ascending order of the share of intensive margin.

We label two groups of firms within each industry. High technology firms are those in the top quartile within their industry for a particular technology measure. Low technology firms are those in the bottom quartile. We use six measures of technological sophistication, defined below.

1. *Education* is defined as the proportion of workers with higher-education degrees in 2004.[17]

2. *Skill* is defined as the proportion of workers with technical in 2004. They are usually those people whose jobs are related to research, product design, maintenance and repair of sophisticated machines, or other special skills.

3. *Computer* is defined as the number of computers used per worker in 2004.

4. *R&D intensity* is defined as the ratio of R&D expenditure to the final value of output. The value of this index represents how much value of R&D is invested to produce one monetary unit of output in a given industry.

5. *Worker-training* is measured as expenditure per worker on worker training in 2004.[18].

6. *New product intensity* is measured as the ratio of new product value over output in 2004. In the CASIF data, new product value is defined as value of output of those products made by new technology, or with new product designs, structural improvements, new materials, and so on.

[17]One practical reason why education intensity is measured this way is that China has a compulsory education law which rules that normally each citizen must receive at least nine years' school education. As a result, almost all workers have achieved the legally required compulsory education and therefore the variation in schooling only exists in education beyond the junior middle school level. Senior middle school education (including some vocational training education) is also very common and have almost become a prerequisite in any formal job market. However, many labour-intensive positions still do not necessarily require workers to have had higher-education degrees. Because of this, there is sufficient variation in the proportion of workers with higher-education degrees, which makes this measure effective as an proxy for education intensity.

[18]Although this is a flow measure, it captures the cross-firm differences in human capital if firms with high human capital intensity train their workers more than other firms in a given industry. It is similar to the measure of *R&D intensity* above

The resulting decompositions are given in Table 10. Firms in the top quartile of technological sophistication almost always contribute a larger share of export growth, in some cases dramatically so. For example, firms with highly educated workers contribute more than half of all export growth and firms which are in the top quartile of worker training contribute more than 60% of all export growth. Because all of the technology measures are constructed with each industry, cross-industry differences are excluded here. Therefore it is clear that firms with higher technology levels expanded their export market shares over time, crowding out technologically inferior firms. We see this as new evidence of increasing technology content of Chinese exports. Different from those studies which find increasing similarity of the Chinese export product mix to developed countries (Rodrik, 2006; Schott, 2008), our result here provides the direct evidence of the within-industry technological improvement in Chinese export activities.

Table 10 also shows that, in every case, the extensive margin is either zero or negative for low technology firms (indicating net exit of low technology firms from the export market), but is always positive for high technology firms.[19] This suggests that the large number of new exporting firms are predominantly high technology firms.

4.4 Sources of export growth at the product level

Because we also have product-level data on exports from the CCTS, we can further decompose exports into an intensive and extensive margin at the product level. The importance of the adjustment of trade at the product margin has been recognised by an emerging body of literature (e.g., Bernard *et al.*, 2009a,b, 2010; Goldberg *et al.*, 2010; Manova and Zhang, 2009; Amiti and Freund, 2010). Adjustment at the product margin result in changes in product varieties. The primary reason why changes in product varieties matter is similar to firm entry/exit in the export market: introducing a new product incurs fixed costs. In the models of Bernard *et al.* (2009b, 2010), the fixed costs of exporting a product lead to firm selection in the product-market participation, analogous to firm selection in the export market in the heterogeneous firm models. Compared to these existing studies, we employ a relatively simpler version of decomposition method as used before to examine two specific margins of export growth:

[19] Note that the extensive margins reported in Table 10 are much smaller because these results come from the balanced panel.

Table 10. Sources of the Growth in Export Value by Technology Group

(Balanced Panel)

	Share of exp. val. (2000)	Share of exp. val. (2007)	Contribution to exp. val. growth	%Int. margin	%Ext. margin
Education $\geq$ 75% pctl.	31.2%	47.6%	54.1%	91.2%	8.8%
Education $\leq$ 25% pctl.	14.2%	9.9%	8.2%	102.7%	-2.7%
Skill $\geq$ 75% pctl.	21.8%	34.7%	39.9%	96.0%	4.0%
Skill $\leq$ 25% pctl.	34.3%	25.7%	22.2%	99.0%	1.0%
Computer $\geq$ 75% pctl.	39.4%	54.7%	39.9%	91.5%	8.5%
Computer $\leq$ 25% pctl.	15.9%	12.2%	22.2%	106.0%	-6.0%
R&D intensity $\geq$ 50% pctl.	16.1%	30.2%	35.9%	85.4%	14.6%
No R&D expenditure	49.2%	34.4%	28.5%	102.2%	-2.2%
Worker-training $\geq$ 50% pctl.	38.9%	55.6%	62.3%	92.8%	7.2%
No worker-training	18.8%	11.8%	9.0%	100.9%	-0.9%
New product intensity $\geq$ 50% pctl.	16.9%	22.1%	24.4%	81.9%	18.1%
No new products	53.7%	33.6%	25.5%	102.0%	-2.0%

Note: The second and the third columns are the shares of different technology groups in the total export value of each year. The fourth column is the share of export value growth of different technology groups in total export value growth. The last two columns break down the fourth column into the intensive margin and the extensive margin.

change in export value per variety (intensive margin) and changes in the product varieties per exporting firm. Albeit simple in form, our decomposition, as will be seen below, provides within-firm changes in export product varieties, which will be helpful in understanding firm export behaviour in terms of export variety choice.

$\bar{E}_t$ can be expressed as the product of two components for the sample of exporting firms:

$$\bar{E}_t = \frac{\bar{e}_t \times n_t}{N_t^E} \equiv \bar{e}_t \times v_t, \tag{5}$$

where $\bar{e}_t$ is the mean export value of each product variety, n_t is the number of product varieties, N_t^E is the number of exporting firms, and v_t is the number of product varieties per exporting firm, defined as n_t/N_t^E. Then the intensive and extensive contributions to $\Delta\bar{E}_t$ can be written as

$$\Delta\bar{E}_t = \frac{v_{t-1}+v_t}{2}\Delta\bar{e}_t + \frac{\bar{e}_{t-1}+\bar{e}_t}{2}\Delta v_t. \tag{6}$$

The intensive margin ($\bar{e}$) here represents the export value per product and the extensive margin (v) represents the number of products exported per exporting firm. The decomposition of $\Delta\bar{E}$ are in table 11. We apply the decomposition both to the full CCTS sample and the matched CASIF-CCTS sample. The results are similar. The intensive margin is large and positive, while the extensive margin is large and negative. This shows that the growth in export value per firm was not driven by new products; indeed the number of products per exporting firm decreased over this period. The number of firms entering into the export market was far more than the growth of product categories and this consequently lead to an increasing export volume per product and a decreasing number of products per exporting firm. One the one hand, the result here is consistent with findings in other studies on China that variety growth plays a small part in China's export expansion (Manova and Zhang, 2009; Amiti and Freund, 2010). On the other hand, the result reveals a new channel of export growth, which is how product varieties are adjusted within firms. Once again, this confirms that new firms starting to export was a key driving force of Chinese export growth.

Table 11. Sources of Growth in the Mean Export Value $\bar{E}$

	Full CCTS	Matched sample
$\bar{E}_{2003}$	4,575,147.4	6,200,965.5
$\bar{E}_{2006}$	5,661,913.7	7,637,733.1
$\Delta\bar{E} = \bar{E}_{2006} - \bar{E}_{2003}$	1,086,766.3	1,436,767.6
Intensive margin ($\Delta\bar{e}$)	3.840 (384.0%)	3.961 (396.1%)
Extensive margin (Δv)	-2.840 (-284.0%)	-2.961 (-296.1%)

Note: $\bar{E}^E_t = \frac{\bar{e}_t \times n_t}{N^E_t} \equiv \bar{e}_t \times v_t$.

4.5 The role of export policy zones

Using the CCTS trade data, Wang and Wei (2010) reveal the positive effect of policy zones in China's export growth in a regression framework. However, very little is known about the kinds of firms which set up in EPZs. Undoubtedly, uncovering the mechanism underlying the relationship between export policies, firm behavior, and export growth, is a crucial step toward a deeper understanding of China's export boom. Since the CCTS data contains information on whether a firm is located within a policy zone of a specific type or not, our matched data makes the above task possible. A simple method for revealing the role of policy zones is to compare the characteristics of firms inside and outside EPZs over time.

We first do the comparison for EPZs in table 12. In four years (from 2003 to 2006), the number of firms in EPZs more than doubled.[20] More interestingly, we find that firms in EPZs are superior in any of the performances than their counterparts outside EPZs except in employment. Firms in EPZs produce more, export more, use more capital and intermediates, and are more productive, but employ less labour. This reflects the fact that firms are selected into the EPZs based more on their productive performance rather than on their capacity to increase employment. The t-test shows that over time the gap in performance between firms inside and outside EPZs gets even more significant. Further, when we expand our analysis to all kinds of policy zones, the result is very similar, as can be seen in table 13. Obviously, policy zones have been an increasingly more important driving force of China's export growth either via attracting more better-performance firms or via the learning effect of firms.

5 Measuring the Value-Added of Chinese Exports

An important part of the growth in world trade in recent decades is the results of *vertical specialisation*. Vertical specialisation refers to the phenomenon of fragmentation of global production across countries. In the global production network, each country only engages in certain stages of the whole production process where it has comparative advantages. With the development of global production, cross-border transfer of materials and goods with this purpose has been playing an increasingly dominant role in the world trade (Hummels *et al.*, 2001; Yi, 2003; Dean *et al.*, 2008).

Hummels *et al.* (2001) (HIY hereafter) first propose a rigorous measure of vertical specialisation, before which there have been many case studies and anecdotes spread

[20]It should be born in mind that trading companies and small firms, which actually make up a large proportion of the firms in EPZs, are not included here because of the matching.

Table 12. Mean Comparisons of Exporting Firms inside and outside Export Processing Zones (Matched Sample)

	2003			2006		
	NEPZ[a]	EPZ[a]	*t*-test	NEPZ[a]	EPZ[a]	*t*-test
Number of firms	16,861	111	n.a.	30,998	286	n.a.
Log(Output)	10.73	11.42	-5.02	10.76	11.33	-5.95
Log(Sales)	10.70	11.45	-5.75	10.73	11.34	-6.63
Log(Exports)	9.75	10.78	-6.55	9.77	10.82	-10.33
Log(Capital)	9.09	9.84	-3.01	8.89	9.55	-6.22
Log(Labour)	5.53	5.41	3.33	5.32	5.27	1.30
Log(Intermediates)	10.40	10.93	-3.59	10.28	10.69	-3.69
Labour Productivity[b]	0.62	0.63	-2.50	0.54	0.58	-4.86

Note: All monetary variables are in real terms (prices in 2000 as numeraire). *t*-test tests the equality of the means between the two firm groups.)

[a]NEPZ: exporting firms outside Export Processing Zones. EPZ: exporting firms inside Export Processing Zones.

[b]Labour productivity is measured as logarithm of output-labour ratio normalized within each 3-digit-industry-year cohort.

Table 13. Mean Comparisons of Exporting Firms inside and outside Policy Zones (Matched Sample)

	2003			2006		
	NPZ[a]	PZ[a]	*t*-test	NPZ[a]	PZ[a]	*t*-test
Number of firms	15,084	1,888	n.a.	27,868	3,416	n.a.
Log(Output)	10.69	11.08	-13.39	10.72	11.11	-15.89
Log(Sales)	10.66	11.07	-14.32	10.69	11.10	-17.01
Log(Exports)	9.73	9.96	-5.82	9.76	9.93	-5.44
Log(Capital)	9.05	9.44	-10.39	8.85	9.26	-12.66
Log(Labour)	5.54	5.45	5.76	5.32	5.27	5.87
Log(Intermediates)	10.37	10.67	-10.44	10.26	10.54	-10.34
Labour Productivity[b]	0.61	0.63	-10.24	0.53	0.57	-15.20

Note: All monetary variables are in real terms (prices in 2000 as numeraire). *t*-test tests the equality of the means between the two firm groups.)

[a]NPZ: exporting firms outside policy zones. PZ: exporting firms inside policy zones.

[b]Labour productivity is measured as logarithm of output-labour ratio normalized within each industry-year cohort. Industries are categorized at the 3-digit level.

widely in the economic and business study literature but none of them has a clear and tractable conceptual framework. The measure in Hummels *et al.* (2001) is defined as the value share of imported intermediates in exports and is thus interpreted as the "imported input content of exports". Specifically, it is constructed by scaling the value of exports by the proportion of imported intermediates in total output:

$$VS_{\text{HIY}} = \left(\frac{M}{Y}\right) \cdot X, \tag{7}$$

where M is imported intermediates, X is exports, and Y is total output. An assumption for the validity of this approach is that imported intermediates are used evenly in production for domestic sales and for export. But if, for example, imported intermediates are used much more intensively for exports then the domestic content of exports will be much lower, and the degree of vertical specialisation much higher.

By applying this measure to ten OECD countries using input/output tables (I/O tables), their empirical evidence shows that 21% of these countries' exports can be accounted for by vertical specialisation. Dean *et al.* (2007) apply this method to China by making use of the Chinese I/O tables and customs trade data. His result shows that about 35% of China's exports could be attributed to imported intermediates in 2002, and there had been a 6.5 percentage-point increase between 1997 and 2002.

Nevertheless, a problem with the HIY approach is that it assumes that imported inputs are used evenly in production for domestic sales and in production for exports. If imported inputs are used more intensively in production for exports, this approach will underestimate the degree of vertical specialisation. In the example of China, processing exports are prevailing and even dominant in some industries and this may result in a more intensive use of imported materials in processing exports and in production for normal exports or domestic sales. We have already known from Table 4 that processing trade plays a dominant role in Chinese exports. It was also clear from Section 4 that foreign firms and processing firms have contributed a large fraction of the growth in Chinese exports. This suggests an important role for vertical specialisation: Chinese exporters are possibly a relatively low value-added segment of an international production chain. The prevalence of processing trade in China, where firms import materials to produce final or semi-final products to export to original foreign suppliers, highlights the importance of considering vertical specialisation in China's trade.

In view of this problem, Chen *et al.* (2004) and Koopman *et al.* (2008) modify the method of Hummels *et al.* (2001) by splitting the standard I/O tales into separate tables for processing trade and other types of productions (productions for ordinary trade and domestic sales). Combining these new I/O tables with trade data, their calculations produce a higher degree of vertical specialisation. For example, by Koopman *et al.*'s (2008) estimation for the year 2002, China's share of vertical specialisation is around 50% in general and as high as 80% for some industries.[21] These numbers, as opposed to those in Dean *et al.* (2007), reflect in turn the significance of processing exports in China.[22]

The purpose of this section is to reveal how much China's domestic value-added is contained in its exports. Domestic value-added is the value of exports when the content of vertical specialisation is subtracted. We modify HIY method of measuring the extent of vertical specialisation in order to take into account the prevalence of processing trade in China. Because processing firms typically import a large fraction of their final output, ignoring this will lead to underestimates of the domestic content of Chinese exports. Different from the conventional approaches which rely on trade statistics and I/O tables to calculate the vertical specialisation or domestic content, we will go down directly to the firm level to see how much a typical firm imports its intermediates from abroad and how much it exports. To do this, we will base our analysis on a unique firm-transaction level data set which has never been used before. By focusing on pure exporting firms which sell all their products abroad, we are able to obtain the first micro-level evidence of how much foreign content is contained in Chinese exports.

We note that all the above works on China (Chen *et al.*, 2004; Koopman *et al.*, 2008) are basically cross-sectional and their time periods do not cover more recent years after 2002. For China, however, the period under our study, 2000 to 2007, is a time when China was increasingly more integrated to the world trade and the trade barriers were

[21] Chen *et al.*'s (2004) study gets a similar result, however it only focuses on the trade between China and the United States for 1995.

[22] In a later study, Dean *et al.* (2008) extend their previous work by comparing the method using standard I/O tables and that using separate I/O tables as in Koopman *et al.* (2008). The latter method is found to generate a systematically larger degree of vertical specialisation than the former, and more interestingly, the gap between the two estimates is positively correlated with the share of processing exports in total exports at the sector level.

also significantly reduced in order to be in accordance with the WTO rules. Over time, it had been easier not only for foreign goods to be imported into China but also for Chinese products to be sold in other countries. Therefore a natural result of this change in trade environment is that China could import more and export more simultaneously over time, which could have affected the domestic content. Our micro data allows for exploration of this over-time change.

As a first step, we identify two groups of imported intermediates in the trade data: imported intermediates for processing trade and imported intermediates for ordinary trade. Figure 4 illustrates the different modes of vertical specialisation for ordinary exports and processing exports, modified from Hummels (2001, Figure 1). For ordinary trade (see subfigure (a)), the imported intermediates can be partly used in production for domestic sales and partly used in production for ordinary exports. We identify imported intermediates in all ordinary imports (for example imports to be used as capital and consumption goods) by the classification of the Broad Economic Categories (BEC) and its HS concordance (See Appendix A.7 for the details). Then, because we cannot tell by the data how much proportion of the ordinary imported intermediates are used in production for domestic sales and how much proportion is used production for exports, we will in general still have to use their product values. HIY method to impute the proportion of ordinary imported intermediates in exports.

For processing trade (see subfigure (b)), firms import materials or parts through customs, and then export through customs after these materials are processed or assembled. According to the rule in China, all processing imports, classified either under the regime of *processing and assembling* or under the regime of *processing with imported materials*, should only be used for the purpose of processing exports. Therefore all processing imports are used as intermediate inputs and all of them are finally embedded in processing exports.

Based on the above reasoning, a revised formula for the measure of vertical specialisation is

$$VS_{\text{NEW}} = M^p + \frac{M^o}{Y - X^p} \cdot X^o. \tag{8}$$

Here the superscripts p and o denote processing trade and ordinary trade respectively. $Y - X^p$ is the value of domestic sales plus ordinary exports, and the whole fraction,

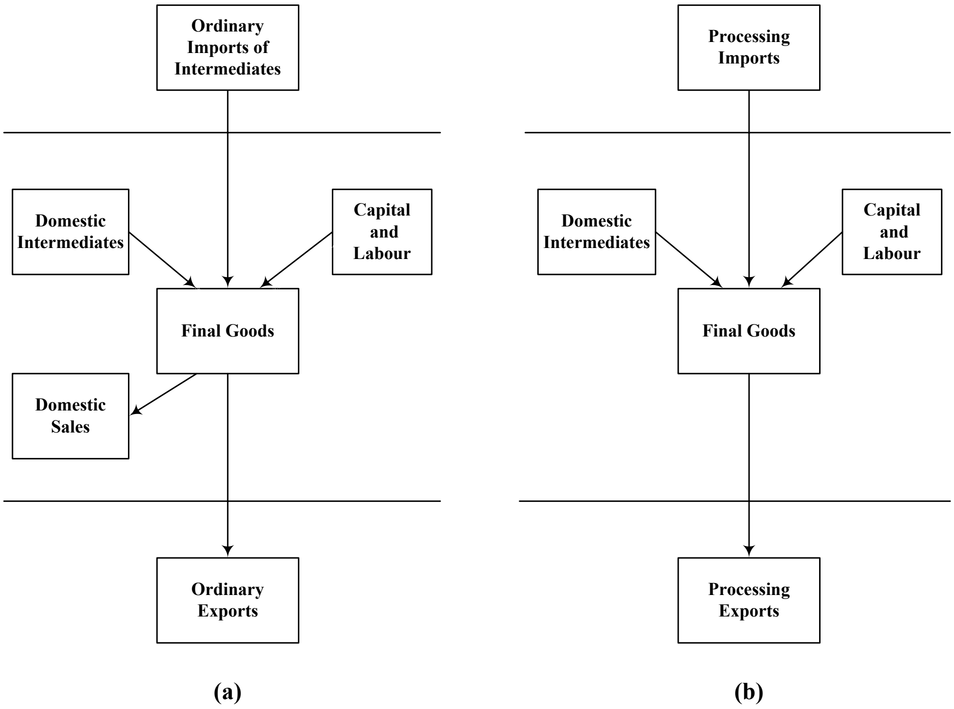

Fig 4. Modes of Vertical Specialisation for Ordinary Exports and Processing Exports

$M^o/(Y - X^p)$, gives us the proportion of ordinary imports of intermediates used in ordinary exports. If M^p and X^p were zero, this would be equivalent to VS_{HIY}.

To see how it has improved the HIY measurement, we can look at the difference between (7) and (8):

$$\begin{aligned} VS_{\text{HIY}} - VS_{\text{NEW}} &= \left(\frac{X^o + X^p}{Y} - 1\right) \cdot M^p \\ &+ \left(\frac{Y - X^o - X^p}{Y - X^p}\right) \cdot \left(\frac{X^p}{Y}\right) \cdot M^o. \end{aligned} \tag{9}$$

For exporting firms which sell their products both in the domestic market and in the foreign market, the first term is negative as output value always exceeds or is equal to export value, and the second term is also non-negative by the same reason. However, if processing trade is dominant in trade and the value of ordinary trade is close to zero (both X^o and M^o are close to zero), then the whole equation could well be negative because the second term is now close to zero. This is how the downward biased estimation of VS (or upward biased estimation of DV) caused by the HIY method takes place.

To make further refinements on these results, a possible correction is to restrict our sample to pure exporting firms which export all their goods abroad. The reason is straightforward: when these firms have no products sold in the domestic market, all their imported intermediates are used in production for exports. In this case, (7) and (8) collapse to the same equation:

$$VS_{\text{HIY}} = VS_{\text{NEW}} = M^o + M^p. \tag{10}$$

Once the measure of vertical specialisation VS_{NEW} is obtained, it is easy to calculate domestic value-added (domestic content) in exports:

$$DV = X - VS_{\text{NEW}}. \tag{11}$$

And the domestic value-added share in exports is:

$$DVS = \frac{DV}{X} = 1 - \frac{VS_{\text{NEW}}}{X}. \tag{12}$$

However, it needs to be born in mind that the estimate is a lower bound estimate of foreign content or upper bound estimate of domestic content of exports because it is not possible to trace back how much foreign intermediates are contained in the firm's domestic inputs.[23] Albeit the impossibility to get precise estimate of domestic content of exports, the micro-level evidence is a valuable supplement to the highly aggregated sector-level estimates and more importantly, enables us to explore within-firm variations such as changes over time and origin/destination variation.

5.1 Estimated domestic content from the matched sample

We apply the above methods to the matched CASIF-CCTS sample. The industry-level estimates are presented in Table 14. We have two findings here. First, it is found that paper products and electronics have the lowest share of domestic value-added in their

[23]It would be helpful to illustrate this by an example. Suppose a pure exporting firm has 30 thousand dollars of intermediates imported from abroad and another 20 thousand dollars of intermediates bought from the domestic market, and it combines these materials with capital and labour inputs to produce 100 thousand dollars of products which are later all sold to other countries. Our upper bound estimate of domestic content in the firm's exports is 70% ($(1 - \frac{30}{100}) \times 100\% = 70\%$). However, if the domestic intermediates were also produced with some foreign materials and have half of the value is foreign content (10 thousand dollars), then the precise estimate of domestic content should now be 60% ($(1 - \frac{30+10}{100}) \times 100\% = 60\%$).

exports. Electronics industry made up a large proportion of Chinese exports but also imported large amounts of materials from other countries. Therefore overall vertical specialisation could have been driven up by the electronics exports alone. Second, the HIY estimates of domestic value-added are generally higher than our estimates, which confirms that the HIY method tends to underestimate the real degree of vertical specialisation or overestimate the real share of domestic value-added.

Table 14. Estimated Domestic Value-Added Shares in Exports
(by Industry)

	Our method, all firms				HIY method, all firms			
Industry	03/04	04/05	05/06	**03/06**	03/04	04/05	05/06	**03/06**
Petroleum/coking	-0.091	-0.077	-0.138	**-0.111**	0.465	0.440	0.303	**0.380**
Paper products	-0.025	0.099	0.211	**0.134**	0.300	0.447	0.490	**0.421**
Electronic equipments	0.250	0.265	0.295	**0.281**	0.346	0.436	0.438	**0.405**
Plastics	0.305	0.366	0.447	**0.418**	0.432	0.491	0.569	**0.537**
Non-ferrous metals	0.459	0.446	0.441	**0.473**	0.683	0.728	0.730	**0.731**
Measuring instruments	0.488	0.515	0.521	**0.517**	0.520	0.556	0.572	**0.561**
Printing	0.457	0.533	0.589	**0.522**	0.560	0.631	0.650	**0.595**
Chemical fibers	0.592	0.503	0.479	**0.535**	0.766	0.705	0.692	**0.714**
Leather/fur/feather	0.504	0.539	0.561	**0.563**	0.585	0.604	0.620	**0.630**
Rubber	0.552	0.593	0.595	**0.583**	0.786	0.780	0.754	**0.767**
Transport equipments	0.625	0.632	0.646	**0.645**	0.705	0.698	0.707	**0.711**
Raw chemical materials	0.654	0.638	0.624	**0.647**	0.751	0.750	0.744	**0.759**
Clothing	0.583	0.637	0.694	**0.650**	0.635	0.686	0.742	**0.699**
Electrical equipments	0.649	0.681	0.719	**0.693**	0.705	0.737	0.773	**0.747**
Timber/wood	0.687	0.749	0.716	**0.717**	0.700	0.779	0.753	**0.745**
Ferrous metals	0.707	0.715	0.720	**0.719**	0.781	0.785	0.782	**0.783**
Metal products	0.665	0.710	0.757	**0.724**	0.700	0.752	0.814	**0.772**
Processing of foods	0.693	0.722	0.733	**0.728**	0.772	0.808	0.824	**0.805**
Special machinery	0.677	0.729	0.760	**0.737**	0.749	0.791	0.818	**0.798**
Textiles	0.710	0.742	0.758	**0.748**	0.769	0.798	0.816	**0.803**
Office equipments	0.732	0.742	0.767	**0.760**	0.756	0.769	0.785	**0.781**
General machinery	0.839	0.798	0.812	**0.798**	0.811	0.850	0.871	**0.854**
Medicines	0.819	0.801	0.779	**0.810**	0.901	0.899	0.893	**0.904**
Furniture	0.811	0.846	0.869	**0.850**	0.836	0.863	0.889	**0.870**
Manufacturing of foods	0.832	0.895	0.878	**0.855**	0.889	0.921	0.921	**0.902**
Non-metallic minerals	0.856	0.853	0.855	**0.863**	0.882	0.873	0.868	**0.880**
Beverages	0.898	0.920	0.930	**0.927**	0.937	0.947	0.964	**0.959**

In table 15, we redo the estimations by restricting the sample to the pure exporters of the matched sample, which are defined as firms with more than 95% of their output exported. For many industries which have large export values, such as electronic/electrical/transport equipments and textiles, the estimated domestic value-added share in exports are lower than the estimates with the matched sample in table 14. This fact implies that pure exporters have higher share of their intermediates imported than other exporting firms.

Table 15. Estimated Domestic Value-Added Shares in Exports
by the Sample of Pure Exporters
(by Industry)

Industry	Our method/HIY method, pure exporters			
	03/04	04/05	05/06	**03/06**
Ferrous metals	-17.362	-14.227	-11.915	**-13.469**
Electronic equipments	0.156	0.158	0.140	**0.166**
Raw chemical materials	0.591	0.606	0.396	**0.356**
Plastics	0.254	0.338	0.415	**0.376**
Paper products	0.502	0.579	0.730	**0.426**
Printing	0.475	0.520	0.566	**0.504**
Transport equipments	0.479	0.533	0.514	**0.505**
Measuring instruments	0.512	0.552	0.521	**0.566**
Rubber	0.529	0.601	0.590	**0.584**
Leather/fur/feather	0.521	0.506	0.585	**0.596**
Timber/wood	0.662	0.690	0.632	**0.627**
Clothing	0.560	0.626	0.682	**0.631**
Textiles	0.578	0.658	0.691	**0.634**
Non-ferrous metals	-0.001	0.716	0.659	**0.655**
Special machinery	0.646	0.694	0.685	**0.659**
Electrical equipments	0.635	0.654	0.676	**0.665**
Processing of foods	0.686	0.699	0.719	**0.706**
Metal products	0.672	0.738	0.778	**0.722**
Office equipments	0.725	0.716	0.743	**0.739**
Beverages	0.876	0.843	0.881	**0.797**
Furniture	0.814	0.835	0.862	**0.842**
General machinery	0.832	0.864	0.865	**0.853**
Manufacturing of foods	0.848	0.855	0.819	**0.855**
Non-metallic minerals	0.882	0.882	0.825	**0.859**
Medicines	0.961	0.908	0.792	**0.910**
Chemical fibers	0.638	0.868	0.964	**0.965**
Petroleum/coking	.	.	.	**.**

5.2 Further breakdown of the VS/DV shares

Breaking down the export value into vertical specialisation and domestic value-added could offer a new perspective on looking at the structure of the Chinese export boom.

For this purpose, Table 16 shows two groups of information: (1) the shares of vertical specialisation and domestic value-added, and (2) the breakdowns of the above shares among sectors. The upper panel of the table offers the first information. The share of vertical specialisation (VS share) is shown to have increased from 68% to 71% from 2003 to 2006, resulting in a decreasing share of domestic value-added (DV share) from 32% to 29%. This is because the VS share grew faster than the final export value and was the primary force of export growth compared to DV growth.

The lower panel gives the breakdown results of the two shares separately. First, not surprisingly, firms in the coastal region were the main source of the change in both the VS share and the DV share, as most exporting firms were agglomerated in the coastal region. Second, with regard to ownership differences, foreign firms were the dominant contributor to the VS share growth, while non-state domestic firms had the most DV share growth. Many foreign companies in China are vertically integrated with their mother companies in home countries. They engage in production of relatively sophisticated products with materials or key parts imported from abroad. In contrast, non-state domestic firms, mostly private firms, are primarily domestically funded. A number of them are involved in processing trade, but the vast majority have fewer institutional connections with overseas firms than foreign firms. An important reason is that non-state domestic firms are much less likely to be vertically integrated with international companies and thus have fewer chances to import technology-intensive parts. Finally, we find that in the export market, it is existing firms that largely pushed up the overall exports by increasing their imported intermediates. On the other hand, new exporting firms were responsible for the major part of the decrease in DV share, implying that these firms found it easier to import intermediates than purchase them domestically.

6 Technology Intensity

The issue of the technology intensity of Chinese exports is closely related to the recent discussion on China's export sophistication level. Rodrik (2006) and Schott (2008) consider the similarity of China's export bundle with high-income countries in order to reveal how sophisticated China's exports are. Their evidence suggests that the

Table 16. Sources of Share Changes in Vertical Specialisation and Domestic Value-added

Year	VS share	DV share
2003	0.679	0.321
2006	0.710	0.290
Sub-category	Δ VS share	Δ DV share
	0.031	−0.031
Of which:		
Coastal	99.8%	98.8%
Inland	0.2%	1.2%
Of which:		
Non-state domestic	4.6%	52.5%
State-owned	0.5%	9.1%
HMT	−1.8%	4.8%
Foreign	96.7%	33.6%
Of which:		
Entering	15.5%	63.8%
Existing	97.8%	57.1%
Exiting	−13.3%	−20.9%

structure of the Chinese export bundle is increasingly similar to that of high-income countries (Rodrik, 2006; Schott, 2008). However, a fundamental assumption underlying the export structure assessments is that the more similar a country's export bundle is to high-income countries, the more sophisticated its exports are. This approach could be misleading in that it does not take into account the fact that the production process of even the same exported product that actually takes place can be very different across countries.

It should also be noted that although Schott (2008), Xu (2007), and Xu and Lu (2009) have, to some extent, treat product quality quality as a possible factor to explain the within-product price gaps, their attentions have not been paid to the production side behind the product itself. Even if two countries exported exactly the same products of the same quality, what had happened with production of these products within each country could be completely different stories. Countries export the same products could have very different contributions in value-added to the products exported, given the increasingly complicated international divisions in production of commodities. In this case, even if quality was perfectly measured, it would still be far from a full description of the sophistication story.

Take the computer industry as an example, both China and the U.S. export laptops, but the U.S. designs and produces many of the key parts such as CPUs itself, while China usually imports those most sophisticated components from abroad, assemble them with relatively low-skill labour, and then export the computers as a whole. More generally, this is exactly what firms normally do in production for processing exports.[24] In this case, even if China's export structure is found to be over-sophisticated given its income level as in Rodrik (2006) and Schott (2008), this can well have been overestimated because the actual production activities involved in the production of many sophisticated products in China are in fact not as intensive in skill or technology as in developed countries. Actually, according to the calculation by Koopman *et al.* (2008), China's

[24] In this paper, the term "processing" is in practice equivalent to the concept of "inward processing" under which certain goods can be brought into China customs territory for manufacturing or processing with exportation. On the contrary, the regime of "outward processing" refers to trade under which goods in free circulation in China Customs territory may be temporarily exported for manufacturing, processing abroad, and then re-imported. However, this latter regime only accounts for 0.004% of China's total trade value in 2005.

own value-added in its exports is only 50% on average, and is even as low as 20% for seemingly sophisticated products such as electronic devices.

Since the prevalence of processing trade, or more generally, the presence of international division of production, can lead to biases with the measurement of sophistication on the product side, the production process should be taken into account when it is used to assess a country's export sophistication. Unfortunately, almost none of the currently available firm-level data contains matched information on imports and exports associated with export production due to consideration of commercial secrets and/or other reasons. One normally cannot tell how sophisticated a firm's contribution exactly is throughout its production process of exporting products. Therefore,given current data limitations, it is difficult to explicitly incorporate the production process of exported goods into rigorous econometric analysis and thus hard to measure the sophistication of export production process directly. However, despite the data restrictions, there may still exist some ways by which one can look into the sophistication of export production process *indirectly*. A possible approach is turn to examine the production technology associated with the exports.

Amiti and Freund (2010) recently provide the first evidence of China's export sophistication on the technology side by measuring its skill content indirectly. Their work is mainly based on Chinese product-level customs data. They plot the cumulative export share of Chinese industries which are ranked in ascending order of industry skill intensity along the horizontal axis. Since the cumulative distribution curve is shown to have been shifting rightward between 1992 and 2005, this is interpreted as evidence of increasing sophistication of Chinese exports, as exports are now concentrated more within industries with high skill intensity. However, when processing exports are excluded from the sample, hardly any shift is found in the cumulative distribution curve of industry export share. This difference implies that although the increasing share of exports from skill intensive industries has been observed, this may well have been due to the increase in processing exports which rely heavily on imported materials or parts. Furthermore, when they go on to examine the cumulative distribution curve of imported inputs share separately for processing imports and non-processing imports, a much larger increase in the skill content of imported inputs in found for processing imports than for non-processing imports. All together, these findings suggest that China's exports and imports have both been coming increasingly more from processing trades with high industry skill intensity, although the skill content change in net exports is still unclear.

However, this approach is problematic and the result can be misleading if the distribution of domestic value-added across industries (products) is largely different from that of final export value. To see this, suppose China exports only two goods, Christmas dolls and laptops. The total value of Christmas dolls is 15 million USDs with domestic value-added 10 million USDs, and the total value of laptops is 85 million USDs with domestic value-added also 10 million USDs because all the high-value parts are from the United States. Further, the skill intensity of Christmas dolls is 0.2 while that of laptops is 0.6. Now if we calculate the overall skill intensity of the exports in terms of final value, the results is 0.54 ($\frac{15}{15+85} \times 0.2 + \frac{85}{15+85} \times 0.6 = 0.54$). However, the result will be only 0.4 ($\frac{10}{10+10} \times 0.2 + \frac{10}{10+10} \times 0.6 = 0.4$) if we use domestic value-added instead. This simple example illustrates that final value and domestic value-added could attach very different weights to a product's skill intensity and could therefore lead to essentially different conclusions on the overall skill intensity of the export bundle.

Besides, the measurement of industry technology intensity in Amiti and Freund (2010) is also far from being satisfactory. They measure the skill intensities of Chinese industries in 1992 and 2005 by using Indonesian data in 1992 due to lack of Chinese data. This could generate bias if the relative skill intensities of Chinese industries in 2005 is significantly different from those in Indonesia in 1992. This gap could be even larger if Chinese industries achieved more rapid technical improvements than Indonesia did during the period of over ten years, whether through indigenous innovations or through foreign technology transfers.

In view of the drawbacks with the current literature, we will study the technology intensity of exports evaluated both at export value and at domestic value-added. The latter approach is new to the current literature but can help uncover the real technology content in Chinese exports. Besides, we will also compare the results obtained with the two measures to have a look at the discrepancy between them and thus to see how the previous method could bias the result.

In the meantime, the measure of skill intensity will also be improved. In this study, we construct both firm and sector level skill intensity measures directly based on China's own data within the period of export boom, as opposed to resorting to other country's data as in Amiti and Freund (2010). The way skill intensity is measured in Amiti and Freund (2010) is also questionable in that it is simply represented by the ratio of nonproduction workers to total employment. When skill improvement takes replace in other forms than increase in nonproduction workers or when there is much (product-related) skill heterogeneity among nonproduction workers (for example, marketing staff versus lab researchers), this simple measure obviously cannot capture the skill variation cross sections and over time. Fortunately, however, our data allows us to base our measurements on much richer firm skill information which includes worker education, worker skill qualification, firm investment on research and development, and firm expenditure on worker training. This rich skill information makes it possible to provide the first evidence from the production perspective on how skill intensive Chinese exports are and how it changed over time in the export boom after 2000.

By exploring the technology intensity of exports, our study is also related to the the factor content of Chinese exports. In the Heckscher-Ohlin-Vanek (HOV) model, factor endowment as well as factors embedded in net exports (exports minus imports) are key elements for predicting the trade pattern of a country. On the empirical side, however, little is known about the real factor content especially technology-related factors associated with Chinese exports. Although there still exists the difficulty of directly measuring the technology content of exports, our study uses micro-level data and is able to provide the first-hand evidence on the intensity of the use of technology inputs in exporting firms, and therefore can hopefully improve our understanding of the technology content of Chinese exports.

6.1 Cross-industry differences in technology levels

Here we use six indices to measure the technology levels for all two-digit industries, as in Section 4.3. All these measures are now constructed at the industry level. Because most of the source information that these indices are based on only exists for some specific years, we assign these values to other years for each industry, assuming that the industrial indices do not change over the period under study. This will not be unrealistic if we believe the relative levels of technology of these industries do not change within eight years.

As the above indices measure the technology levels in different ways and probably reflect different dimensions of technology, we plot them together in Figure 5, where the horizontal axis represents ranked position of an industry in ascending order in all 27 industries. These industries are arranged from top to bottom along the vertical axis according to their rankings in education index (proportion of workers with higher-education degrees).

Figure 5 shows that most of the measures are highly correlated, with their rankings increasing from top to bottom, although there seem to be a few outliers. One reason might be that technology can take different forms and different industries are inclined to use different types of technologies. For example, some industries such as plastics and metal products tend to have more laboratory experiments or analysis and thus use more computers than other industries. Some major labour-intensive industries, mainly clothing and textiles, are at the top part of the figure, which means that they are least technology-intensive. Located at the bottom part are industries such as electronic equipments, ferrous metals, transport equipments and medicines. They are of relatively high levels of technology in terms of most of the technology measures.

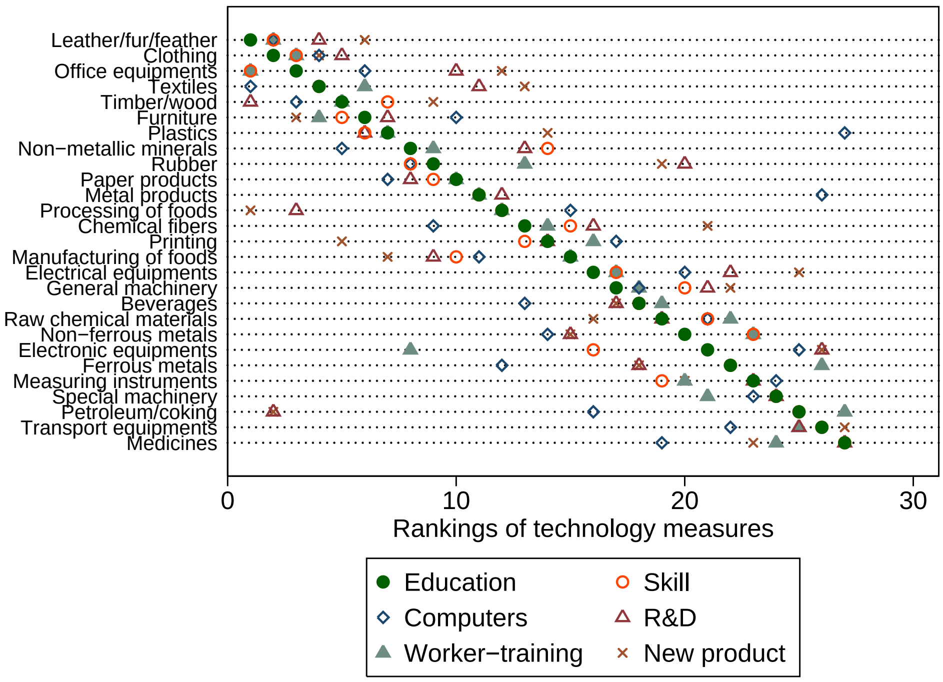

Fig 5. Rankings of Industries in Terms of Their Technology Measures

6.2 Within-industry technological change in exports

Since the above analysis reveals substantial differences in technology levels across industries, we plan to take a look at how firms of different technology levels contributed to exports *within* their corresponding industries in order to control these cross-industry technology differences. Within-industry examination could uncover useful information regarding technological change with industry-specific characteristics excluded. However, since the data set has information on different technology measures only for some specific years, we resort to the strategy adopted in Section 4 to expand our analysis to all the sample years. That is, we restrict our sample to the balanced panel of the CASIF firm data and categorize the firms into two groups: higher-technology group and lower-technology group by their technology rankings in each corresponding industry averaged over the years when the technology information is available. We then assign values of these group labels for each firm to other years when the technology information is not available, assuming that firms do not transit between these groups during the sample period.

By displaying the shares of export value by each technology group and by year, Figure 6 depicts a general picture of the evolution of skill content in exports. Firms with higher levels of technology saw their share of export value in the balanced panel significantly increased over time, while firms with lower levels of technology had their share decreased. It is suggestive of an rising technology content in Chinese exports regardless of how the technology is measured, consistent with the widely-existed conjectures and basic messages conveyed in some of the current studies (e.g., Rodrik, 2006; Schott, 2008).

A more rigorous way to examine this effect requires controlling for more influential effects. We do this by regressing the firm-level growth rate of export value over the eight-year horizon on firms' technology measures and dummies of years, industries, and ownership types. These dummies are included to capture the differences in export growth along the dimensions uncovered earlier in this paper. The results are reported in Table 17. The control group here comprise firms with medium levels of technology. The coefficients of the indicators of higher-technology groups are universally positive at high significance levels, while the coefficients of the indicators of lower-technology

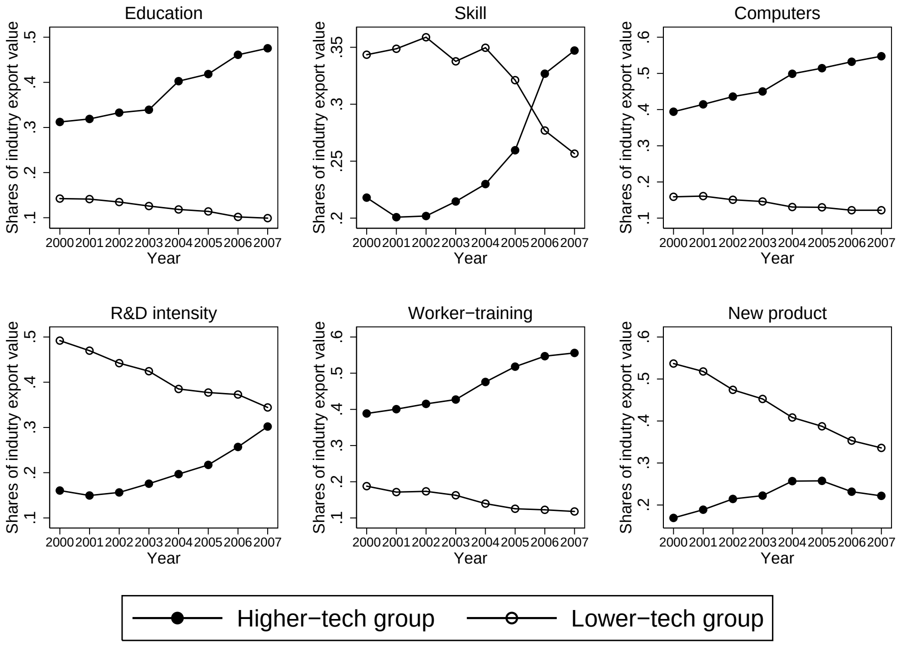

Fig 6. Shares of Export Value by Technology Group

groups are significantly negative. This further confirms the above conclusion that the technology content of exports increased as firms with higher technology levels appeared to play increasingly larger parts in exports, offering new evidence to the literature on the technology level of Chinese exports cited above in terms of firm composition. More generally, the evidence here emphasises the role of firms in shaping the technology level of exports, and thus directs the ongoing discussions at the aggregate level down to more fundamental economic activity, namely firm behaviour.

Table 17. Variations of Export Value Growth across Different Technology Groups (Balanced Panel)

	Education	Skill	Computer	R&D	Worker-training	New product intensity
Higher-tech group	0.353	0.294	0.314	0.116	0.361	0.272
	(0.056)	(0.059)	(0.054)	(0.079)	(0.053)	(0.091)
Lower-tech group	−0.152	−0.074	−0.099	−0.490	−0.092	−0.283
	(0.057)	(0.055)	(0.062)	(0.062)	(0.059)	(0.056)

Note: Dummies for years, industries, regions, and ownership types are included in the regressions as well.

6.3 Industry technology levels and export intensity

Another issue of interest that is related to our broad topic is to examine the differences in export behaviour across industries. Since the general technological improvement in exports have already been well documented, it will be helpful to take a further step to see how industries with different technology levels behaved in their export intensity, an aggregate measure of export propensity conditional on output. For this purpose, the matrix in Figure 7 plots the relationship between industry technology levels and industrial export intensity, which is here the proportion of industrial export value in sales. The matrix is essentially comprised of different scatter plots whose vertical and horizontal axes are pairwise combinations of export intensity and different measures of industry technology levels.

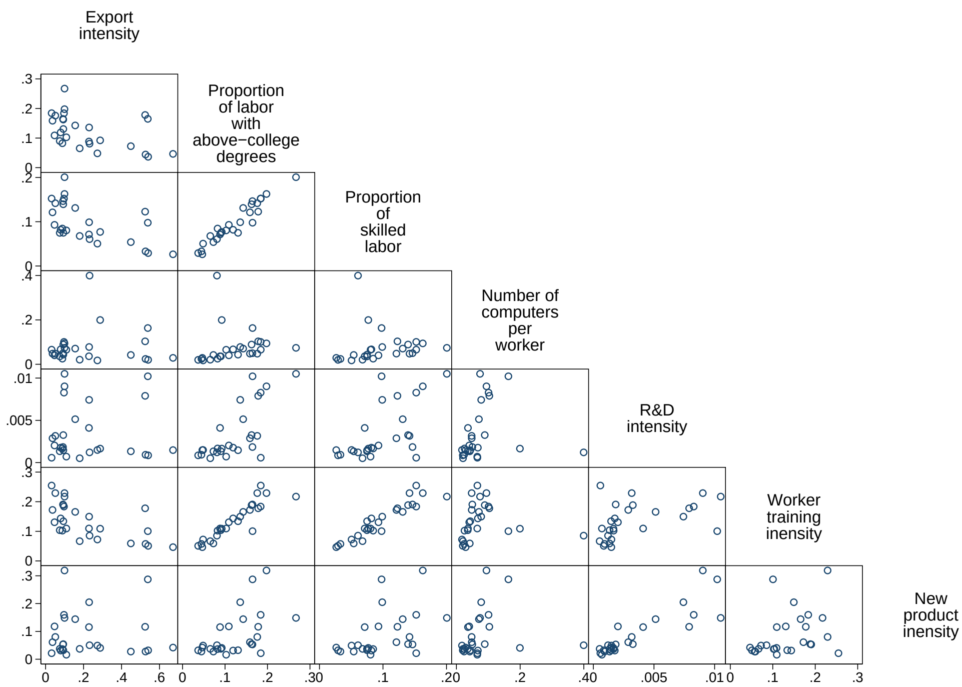

Fig 7. Industry Technology Measures and Export Intensity

First, the generally positive correlation between the six measures of technology is again seen in the matrix. Second, the the first column from left reveals a remarkable phenomenon — the negative relationships between industry export intensity and degrees of industry technology levels. The negative correlation indicates that less technologically advanced industries export higher proportion of their output than more technologically advanced industries.

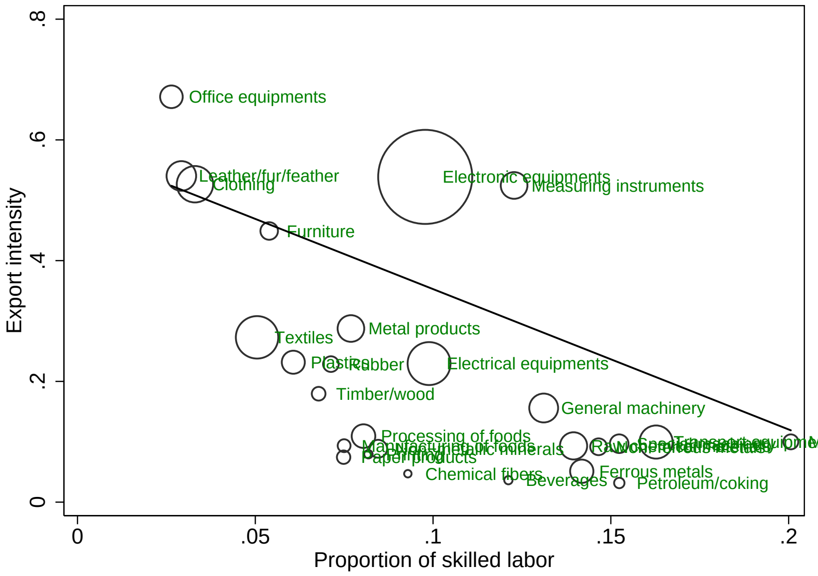

Fig 8. Skilled-Labour Proportion and Export Intensity

To further illustrate the last argument, the scatter plot of export intensity versus proportion of skilled labour is amplified and displayed separately as in Figure 8, where all the industries are now weighted by their exports to prevent the general trend implied from the figure being over-represented by industries with small sizes. In this scatter plot, less technologically sophisticated industries like office equipments, clothing, and leather/fur/feather have higher export intensities than most of other industries. Industries with high technology levels such as transport equipments and medicines export the least. The major exporting industry, electronic equipments, has medium level of technology but a high export intensity. All these evidence leads to one conclusion: Chinese exports was still mainly driven by lower-technology industries. If the names of the industries are seen as coarsely defined products, the above observation reflects China's comparative advantage in exports was still largely unchanged, albeit obvious within-industry technological improvement as uncovered before.

6.4 Technology intensity of export value

A simple but effective way to see how exports are distributed among industries with different domestic technology levels is to plot the cumulative distribution of export value against the industry technology levels, as in Amiti and Freund (2010). To make the classification of industries as disaggregated as possible, we calculate technology intensities for each 3-digit industries, and to utilise this information, all the analysis hereafter is based on the CASIF firm data.

Before looking into the technology intensity, it might be helpful to first plot the distribution against the industry capital intensities, because capital intensity is often adopted as a general proxy for sectoral or national technology level in the development literature. The output is shown in Figure 9. We can see that from 2000 to 2007, export value had been distributed towards industries with high capital intensities, which implies that the export basket was becoming increasingly "heavy". Further, the rightward shifts of the cumulative distribution curves from 2000 to 2007 are clear in Figure 10, indicating that the overall technology level was increasing as exports from higher-technology industries accounted for a higher proportion in total exports in 2007 than in 2000. In essence, this is a similar scenario to what is found in Amiti and Freund (2010).

However, Amiti and Freund (2010) also demonstrate with the tool of cumulative distribution curves that much of the improvement in technology intensity of exports should actually be attributed to processing exports, for which the technological improvement is shown to be accompanied by the technological improvement in imported intermediates. If this observation reflects the fact that the technological improvement, which has been shown in China's export final values, is in fact to a large extent from importing more high-technology intermediates, the conventional view of "over-sophistication" of Chinese exports should be challenged. This finding motivates us to reassess the technology intensity of Chinese exports measured by domestic value-added instead of by export value.

6.5 Technology intensity of domestic value-added in exports

To show how the above results will be altered when export value is replaced by domestic value-added in export value, we plot the cumulative distribution curves for both the share of export value and the share of domestic value-added in the same graph for the year 2006.[25] The results are illustrated in Figure 11 and Figure 12. In Figure 11, the dashed line lies above the solid line for the section of lower capital intensity. In comparison with Figure 9, it implies that the real capital intensity of exports is lower if we evaluate exports in terms of domestic value-added instead of final value. In Figure 12, most part of the dashed lines (only except the line for worker-training) lie

[25]In fact we also plot the cumulative distributions for other years, but the results are very similar.

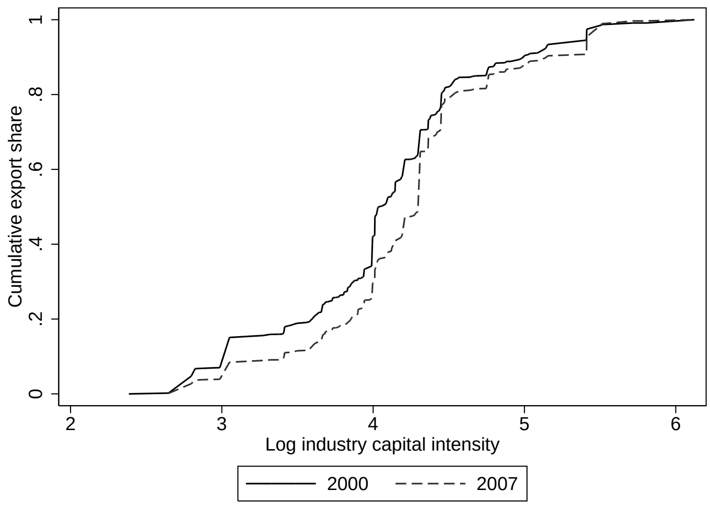

Fig 9. Cumulative Share of Exports with Respect to the Log Capital Intensity

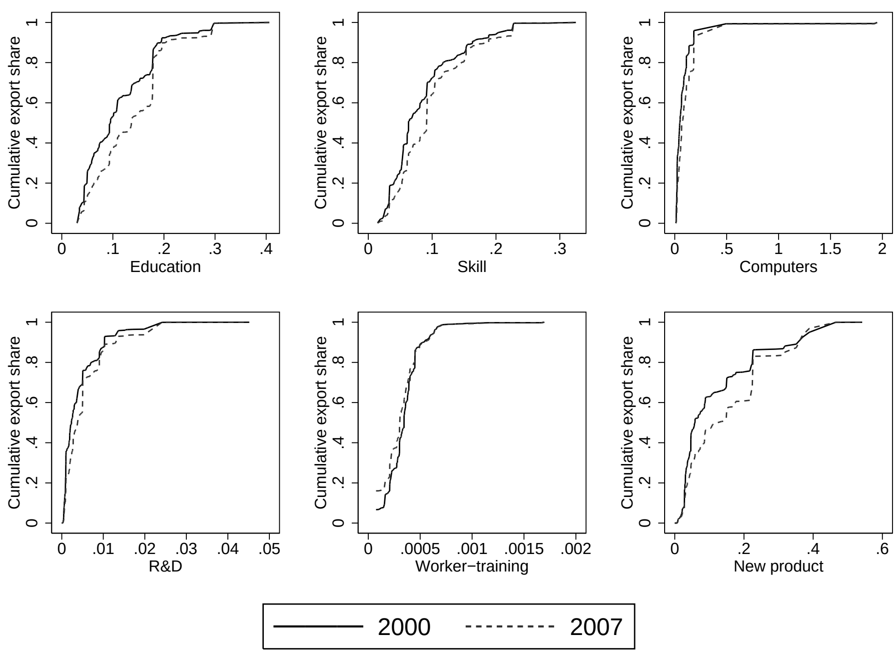

Fig 10. Cumulative Share of Exports with Respect to Technology Measures

above the solid lines, meaning that once export value is replaced by domestic content, less technology intensity is observed. To our knowledge, this is the first direct evidence on the technology intensity of the domestic value-added in Chinese exports ever offered in empirical literature.

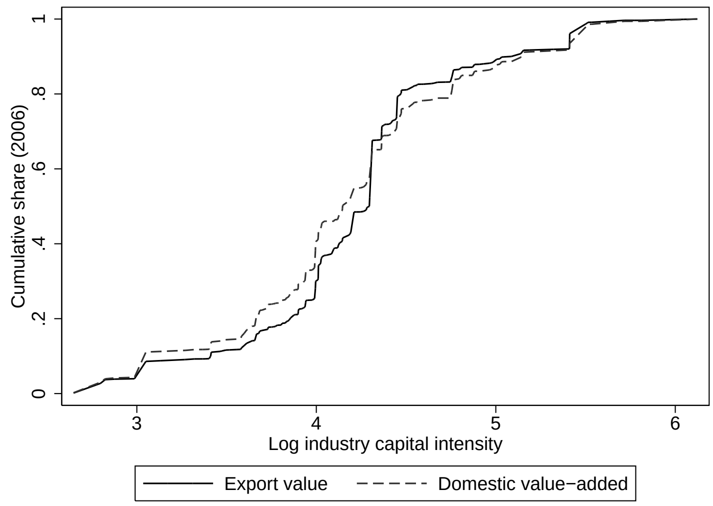

Fig 11. Cumulative Shares of Gross Exports vs. Domestic Value-Added in Exports with Respect to the Log Capital Intensity (2006)

7 Conclusion

This paper attempts to provide a systematic assessment of the Chinese export boom from 2000 to 2007, which made China rise from a top five exporter to a top two exporter. The surge was accompanied with dramatic changes in general trade environment resulting mainly from China's attainment of WTO membership. Such an extraordinary growth with institutional changes offers us an interesting setting to explore the growth structure of exports from both theoretical points of view and empirical points of view.

Our study relies on two micro data sets, the firm survey data and the customs trade records, and also a unique, comprehensive firm-product-level data constructed from them. We first analyse the respective roles of firm entry and firm expansion in the export market. The analysis produces some important results. We find the net entry of exporting firms contributed half of the overall export growth, much larger than what is found in other studies. Meanwhile, processing firms are found to have significantly dominated other types of firms in the boom, especially in terms of the growth in their

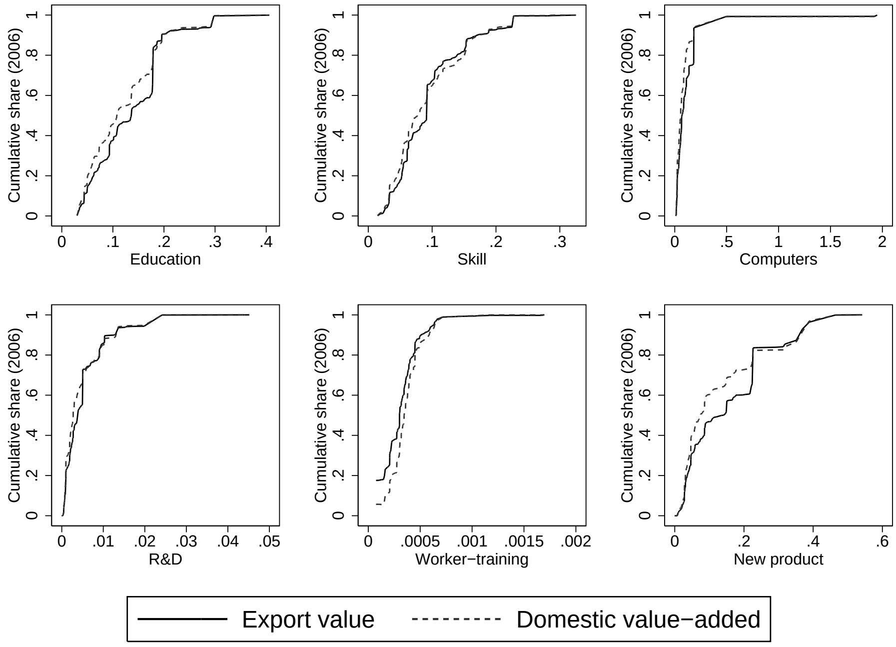

Fig 12. Cumulative Shares of Gross Exports vs. Domestic Value-Added in Exports with Respect to Technology Measures (2006)

number. Firms entered into the export market more intensively in labour-intensive industries, while existing exporting firms expanded their exports more dramatically in capital-intensive industries.

It seems that firm turnover was intensive, but was largely limited to processing trade and labour-intensive industries. This is probably because these sectors had lower entry costs of exporting and firm entry had been important margins whereby firms could maximise their gains from the changing trade environment. The above evidence is consistent with the fact that there were large reductions in trade barriers for Chinese firms but also uncovers the huge internal heterogeneity across sectors and the specific ways how the trade liberalisation impacted the export market through firm entry in China. Besides, we also find firms with best performance tended to agglomerate in policy zones with favourable export policies, highlighting the positive role of policies in the Chinese export boom.

We then develop an accounting method to measure the domestic value-added in Chinese exports, which fits the Chinese case. The method is improved based on Hummels *et al.*'s (2001) (HIY) measuring framework of vertical specialisation by taking into account the difference between processing trade and ordinary trade. The share of China's value-added in exports is shown to be only 30%, lower than what would be obtained by the HIY method. The foreign content increased moderately over time, which was primarily driven by coastal and foreign firms. We also find that entering exporting firms were the main source of decreasing domestic content, while existing exporting firms drove up the foreign content predominantly. Considering the previous finding that exporters are more likely to be processing firms, the implication here is that engaging in processing trade in China could greatly probably reduce not only entry costs of exporting but also variable costs of exporting.

Finally, we examine the technology intensity of Chinese exports. Different from previous studies, we use a wider range of technology measures based on China's own data to capture the picture more precisely. As expected, we find general technological improvement in Chinese exports, although the lower-technology industries are still found to have tended to export higher proportions of their products than higher-technology industries. More interestingly, the technology intensity of Chinese value-added in exports was lower than that of exports measured in export value. The export value was distributed more towards higher-technology industries but the domestic content showed less prominent trend. This finding is novel and it seems that the "surprising" big numbers might be to some extent misleading and might have covered some important facts: technological improvement during the export boom had not changed the product composition of China's own domestic content in exports as much as its final export value implied to many researchers.

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Appendix A Data Preparation

A.1 Firm-level data (CASIF)

The industries in the CASIF are coded by a unique coding system known as National Standards (GB/T). Each firm in the CASIF reports their industry by a four-digit GB/T code. The coding rule was changed after 2003 when a new version of GB/T was introduced. Because this change makes the industry codes inconsistent over time, we use our own concordance table to create a consistent set of three-digit industry codes across the sample period.[26]

We exclude several industries from the sample, based on two-digit industry codes: mining (codes: 06, 07, 08, 09, 10, 11), energy (codes: 44, 45, 46) tobacco (code: 16), handicrafts (code: 42) and recycling (code: 43). We exclude tobacco because the production and sales of tobacco in China is still highly regulated by the government and was not open to foreign investment even after China's entry into the WTO. We exclude handicrafts because products from this industry are potentially highly heterogeneous, as it can includes, for example, production of artworks. Recycling firms are excluded because most of the four-digit industries classified under recycling before 2003 were integrated into other two-digit manufacturing industries in the new industry coding system after 2003.

A.2 Transaction-level trade data (CCTS)

Since the focus of our study is on manufacturing exports, an ideal, clean trade data should only contain all exports of manufactures and their corresponding imports. However, the reality is that many manufacturing firms not only use imports of manufactures but also imports of primary (agricultural) goods to produce manufactures (for example, many firms in China import soy beans from abroad to produce cooking oils), we only exclude service trade from the raw CCTS data, leaving all agricultural and manufactured goods in the trade data. Service trade corresponds to 2-digit HS codes of 98 and 99.

A.3 Deflators and the capital stock

Output and export values are both deflated by an *ex-factory price index* at the two-digit industry level.

The real value of capital is calculated by the Perpetual Inventory Method (PIM). The formula

[26] It was not possible to create a consistent set of four-digit codes. The constructed concordance table is available on the author's personal page, at http://sites.google.com/site/ralphzwang/.

we use is

$$RK_t = RK_0 + \sum_{j=1}^{t} I_j/P_j = K_0 + \sum_{j=1}^{t} (K_j - K_{j-1})/P_j,$$

where RK is the real capital stock, K is the capital stock in book value, I is the investment in book value net of depreciations, P is the deflator for investment, and the subscripts denote time periods. In practice, we adopt the *net value of fixed assets*, which is nominal value of fixed assets net of depreciations, in the data set as K, and the province-specific *fixed asset investment price index* as the deflator for investment P. A practical problem with the above method is that different firms can have different initial years, which means that K_0 does not necessarily represent capital stocks in the same year. To overcome this inconsistency, we also deflate all K_0 by investment deflators.

Because the deflator for intermediate inputs is not directly available for each two-digit industry, we impute it by combining information from two sources: the year-specific *purchasing price index of materials, fuels, and power* and *China Input-Output Table 2002*. Since the *purchase price index of materials, fuels, and power* is available for eight broadly defined categories,[27] we then use information from *China Input-Output Table 2002* to construct a matrix that defines the input weights of these eight intermediate input categories for each two-digit industry.[28] With these weights, we then get the weighted-average of price index (deflator) of intermediate inputs for each two-digit industry.

All the deflators mentioned above are from *China Statistical Yearbooks* of various years. The 122-sector *China Input-Output Table 2002* is from the NBSC. We treat the price in the initial year (2000) as the numeraire for all price indices.[29]

A.4 Construction of firm-transaction data

Each firm in the CASIF and CCTS data has a unique registration code. However, different coding systems are used in each dataset and so this cannot be used to link the data. Our

[27] They are ferrous metals, non-ferrous metals, chemical materials, wood and paper pulp, construction materials, agriculture products, and textile materials.

[28] There are three input-output tables available for the sample period from 2000 to 2007, which are input-output tables for 2000, 2002, and 2005. However, the input-output table for 2002 is the most disaggregated (122 sectors versus 40 sectors for 2000 and 17 sectors for 2005), and therefore enables us to aggregate the those sectors to two-digit GB/T industries more precisely in order to be in line with the CASIF industries.

[29] All these deflators are available on the author's personal page, at http://sites.google.com/site/ralphzwang/.

solution is to use firm name, which is unique to the firm,[30] as a means to identify firms in both datasets. We find that matching by firm name is the most effective way because firm names are less likely to be missing or changed during the year than other profile information.

The two datasets do not completely intersect for a number of reasons. First, the CASIF data includes a large number of non-trade firms, which cannot appear in the CCTS data. Second, firms who export via trading agents are recorded as exporters in the CASIF data, but their exports will be recorded under the name of the trading agent in the CCTS data. Third, the CASIF data only includes larger firms in the manufacturing sector, while the CCTS data records all trade including that by small firms and firms outside the manufacturing sector. These inconsistencies are illustrated in figure A1.

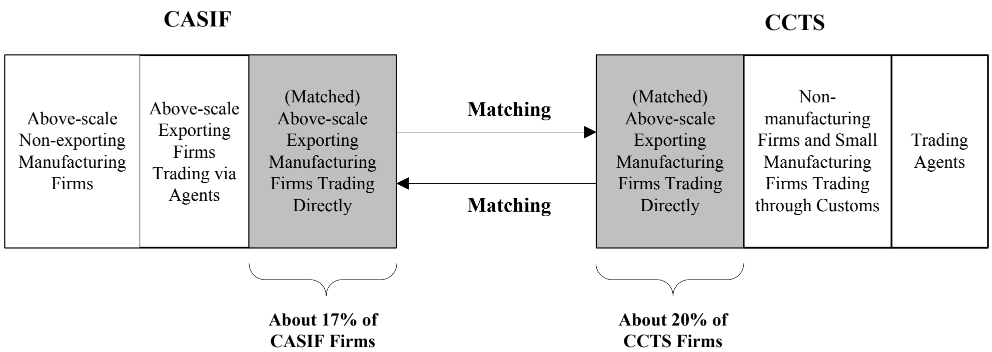

Fig A1. Graphical Illustration of the Matching Result

Table A1 gives information about the proportion of firms, output and exports in the CASIF data which appear in the matched CASIF-CCTS data. Less than 20% of firms in the CASIF data appear in the matched data, but this is partly because only about one-quarter of firms are exporters (see Table 1). However, we also see that only 50% of exporting firms in the CASIF appear in the matched data. As noted, the most plausible explanation for this is that the remaining firms classified as exporting in the CASIF are exporting via trading agents.

Table A2 gives information about the proportion of customs-registered firms, imports and exports in the CCTS data which also appear in the matched CASIF-CCTS data. The matched data contains about 20% of all customs-registered firms, about 25% of imports and about 30% of exports. There are three reasons for these "seemingly" big gaps. First, the cleaned CCTS

[30]The registration of firm in local administrative authorities does not allow any repetition of firm name in the same local administrative region. This means there exists the possibility that firms in different administrative regions can share the same name. However, after checking the data carefully, we find virtually all firms have the local region name (e.g., "Beijing City") as part of their firm name. This fact reduces the possibility of mismatching due to firm name repetition to a minimum level.

Table A1. Number of Firms, Number of Exporters, Output, and Exports of the Matched CASIF-CCTS Sample as Percentages of Those in the Cleaned CASIF Data (%)

Year	Number of firms	Number of exporters	Output		Exports	
			Nominal	Real	Nominal	Real
2003	16.48	46.12	37.42	38.09	57.68	57.74
2004	17.03	49.55	38.42	39.54	59.14	59.17
2005	18.44	48.36	38.10	39.49	56.90	56.77
2006	18.25	50.82	37.15	38.95	59.64	59.76

Table A2. Number of Customs-Registered Firms and Value of Customs Imports and Exports of the Matched CASIF-CCTS Data as Percentages of the Cleaned CCTS Data (%)

Year	Number of customs-registered firms	Value of imports	Value of exports
2003	18.33	25.12	28.26
2004	22.39	26.03	29.52
2005	21.06	26.34	31.04
2006	20.42	25.87	30.36

data contains the universe of all non-service trade, and therefore includes trade by small firms (whether by themselves or via agents) which are not included in the the CASIF data. Second, the cleaned CCTS data includes trade by the agricultural sector, which we have excluded from the cleaned CASIF data. Third, there exist a large number of trading agents in the CCTS data. Although there is no explicit indicator of trading agents in the CCTS data, we attempt to identify them by searching in their firm names for a set of keywords specifically related to trading agents.[31] Firms whose names contain these keywords make up approximately 16% of firms and about 20% of the trade volume recorded in the CCTS. Given these considerations, we believe that the matched sample is representative of large- and medium-sized firms which import and export themselves.

A.5 Definitions of Chinese customs regimes

The Chinese customs regimes recorded in the CCTS data are described in Table A3.

A.6 Product-industry concordance

We construct a concordance table which relates eight-digit HS product codes with four-digit GB/T industry codes, based on the handbook *Product Categories in Statistical Works* released by the NBSC. We finally obtain a concordance table which matches more than 5,600 eight-digit HS products with more than 460 four-digit GB/T industries.[32]

A.7 Identification of intermediate inputs in ordinary imports

Identifying imported intermediate inputs is important for computing vertical specialisation in exports. It is clear that all processing imports are used as intermediate inputs as they could only be used for the purpose of processing exports. Another group of imported intermediate inputs are in the category of ordinary imports. Since only some of ordinary imports are used as intermediate inputs in production, it is necessary to identify these intermediates from others (namely, consumption goods or capital goods) in ordinary imports. Following Dean *et al.* (2007), we first use the detailed classification of the Broad Economic Categories (BEC) to identify the BEC codes for intermediates as in Table A4. Then, we employ the BEC-HS

[31]We use 21 keywords, including the Chinese characters for "agent", "logistics", "cooperation", "storage", and so forth. The full list of keywords and the searching codes are available on the author's personal page, at `http://sites.google.com/site/ralphzwang/`.

[32]The concordance is is available on the author's personal page, at `http://sites.google.com/site/ralphzwang/`.

Table A3. Definitions of the Chinese Customs Regimes

Regime code	Regime name	Definition
10	Ordinary trade	Unilateral imports or exports through customs.
11	International aid	Aid or donations given gratis between governments or by international organizations.
12	Donation by overseas Chinese	Donations given by overseas Chinese or compatriots in Hong Kong, Macau or Taiwan.
13	Compensation trade	Imports of equipment supplied by foreign firms or by using foreign export credit under a contractual arrangement for the supplier to recover the cost with the subsequent exportation of products in installment.
14	Processing and assembling	The type of inward processing in which foreign suppliers provide raw materials, parts or components under a contractual arrangement for the subsequent re-exportation of the processed products. Under this type of transaction, the imported inputs and the finished outputs remain property of the foreign supplier.
15	Processing with imported materials	The type of inward processing other than processing and assembling in which raw materials or components are imported for the manufacture of the export-oriented products, including those imported into Export Processing Zone and the subsequent re-exportation of the processed products from the Zone.
16	Goods on consignment	Goods traded by arrangement in which a seller sends goods to a buyer or reseller who pays the seller only as and when the goods are sold. The seller remains the owner (title holder) of the goods until they are paid for in full and, after a certain period, takes back the unsold goods.
19	Border trade	Petty trade carried out in the border towns of China, between the departments or enterprises designated by the governments of provinces or autonomous regions and the border towns on the other side, as well as to the mutual market trade between the border inhabitants of the two neighboring countries.
20	Equipment imported for processing trade	Imports of equipment for processing trade activities under the customs regimes of processing and assembling and processing with imported Materials.
22	Contracting projects	Exports of equipment or materials to be used for China-invested turnkey projects or constructing projects.
23	Goods on lease	Imports or exports under the financial lease arrangement with the duration of the lease for one year or more.
25	Equipment/materials investment by foreign-invested enterprise	Imports of equipment, parts or other materials by a foreign-invested enterprise as part of its total initial investment.
27	Outward processing	Exports of raw materials, parts or components under a contractual arrangement for processing or assembling abroad and the re-imports of the processed products.
30	Barter trade	Exported goods directly exchanged with the equivalent in imported goods without any currency medium.
31	Duty-free commodity	Duty-free import commodities sold in the specific shops to the specific individuals on payment of foreign currency according to the specific customs regulations.
33	Warehousing trade	Goods imported into or exported from the customs bonded warehouses located outside a Bonded Area.
34	Entrepot trade by bonded area	Goods imported into a Bonded Area for storage and the re-exports of the goods from the Area.
39	Others	Others

Source: The General Administration of Customs of China.

concordance table from the United Nations to further identify intermediates in the HS system.

Table A4. Intermediate Goods Classified under the Broad Economic Categories (BEC) and the Harmonised Commodity Description and Coding System (HS)

BEC code	Description	HS code
111	Primary food and beverages mainly for industry	See the BEC Rev.3 - HS 2002 correspondence table
121	Processed food and beverages mainly for industry	As above
21	Primary industrial supplies not elsewhere specified	As above
22	Processed industrial supplies not elsewhere specified	As above
31	Primary fuels and lubricants	As above
322	Other processed fuels and lubricants	As above
42	Parts and accessories of capital goods (except transport equipment), and parts and accessories thereof	As above
53	Parts and accessories of transport equipment, and parts and accessories thereof	As above

Note: The BEC classification of intermediate goods is from UCSD (2003). The BEC Rev.3 - HS 2002 correspondence table can be downloaded on the UN Statistics Division website, at http://unstats.un.org/unsd/cr/registry/regdnld.asp?Lg=1.

Appendix B Identification of firm entry into export markets

The CASIF data does not include "below-scale" firms (with annual sales roughly below 5 million RMB). It is therefore possible that a new entry in the data represents existing firms crossing the size threshold, or genuinely new firms. Similarly, firms which appear in the data as new exporters could be existing exporters which have crossed the size threshold or new firms which have set up as exporters.

The CASIF data contains information on the firm's first year of business, which allows us to calculate current firm age, and thus distinguish between genuinely new firms from firms which have crossed the size threshold. Table B1 compares the age distribution of new and existing firms. The first row shows that only 8.4% of firms which appear for the first time in the CASIF data are genuinely "new" in that their age is less than one year. This strongly suggests that the majority of entry into the data is caused by firms crossing the size threshold.

However, nearly 70% of these firms are less than five years old, compared to 40% of existing firms. This shows that firms which cross the size threshold tend to be young, and so interpreting entry into the data as firm entry is not too misleading.

Table B1. Distribution of the Ages of New Firms and New Exporting Firms, 2000–2007

		age=0	1≤age≤5	age>5
(a) All firms	New firms[a]	8.39%	61.26%	30.36%
	Existing firms[b]	0.29%	39.60%	60.10%
(b) New exporting firms[c]	New firms[d]	6.05%	44.17%	21.89%
	Existing firms[e]	0.10%	14.45%	13.34%

[a]Firms that appeared in the CASIF data for the first time at t.

[b]Firms that appeared in the CASIF at t and $t-1$.

[c]Firms that exported for the first time at t.

[d]Firms that appeared in the CASIF data for the first time at t and exported at t.

[e]Firms that appeared in the CASIF at t and $t-1$ and exported for the first time at t.

The third row of Table B1 shows that only 6% of firms which enter the data as exporters are genuinely new firms. We cannot tell whether the remaining 94% of these firms were exporters at $t-1$ because they were not in the CASIF sample. The final row of Table B1 shows that the transition rate from non-exporters to exporters in the "above-scale" sample is about 28%, comparable with studies such as Bernard and Jensen (2004b) (30% over eight years).

To address this problem more precisely, we will combine the CASIF data with the database of the First National Economic Census of China from the NBSC. The First National Economic Census of China was conducted in the end of the year 2004 and covers all firms and non-production organizations in 2004 in China, regardless of scale. We extract the whole population of manufacturing firms from the census database and then compare them with the sample of firms of 2005 from the CASIF data.

It is now possible to trace precisely the statuses of the "above-scale" exporting firms in 2005 back in 2004. The result is reported in Table B2. Only 1.7% of new exporting firms are misclassified as they did export in the "below-scale" cohort in the previous year. According to the 2004 Census database, 37.4% of manufacturing exporters are "below-scale" manufacturing firms, but they only account for 2.3% of total manufacturing exports. Therefore, only a very small part of "below-scale" exporters switched to "above-scale" exporters in the next year. On the contrary, about 93.3% (1.11%+92.15%=93.26%) of currently new exporting firms are from non-exporting firms in the previous year, of which the vast majority used to be non-exporting firms in the "above-scale" sample. All together, the evidence from the comparison between our sample and the Census data demonstrates that our identification of new exporting firms is 98.3% correct on a year-to-year basis, or 88.7% ($(98.3\%)^7$=88.7%) correct on an eight-year basis.

Table B2. Composition of New Exporting Firms

	Existing firms[b]		
Genuinely new firms[a]	Below-scale exporters at $(t-1)^c$	Below-scale non-exporters at $(t-1)^d$	Above-scale non-exporters at $(t-1)^e$
5.04%	1.69%	1.11%	92.15%

[a]Exporting firms in 2005 that did not exist in the 2004 Census.

[b]Exporting firms in 2005 that existed in the 2004 Census.

[c]Exporting firms in 2005 that existed as "below-scale" exporting firms in the 2004 Census.

[d]Exporting firms in 2005 that existed as "below-scale" non-exporting firms in the 2004 Census.

[e]Exporting firms in 2005 that existed as "above-scale" exporting firms in the 2004 Census.