

Working Paper No. 226

The Chinese Export Bundles:  
Patterns, Puzzles and Possible  
Explanations

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**November 2008**



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## Foreword

This paper was presented at the Conference on “India and China’s Role in International Trade and Finance and Global Economic Governance” organised by ICRIER, Konrad-Adenauer-Stiftung (KAS) and the International Monetary Fund (IMF) held at New Delhi, India from December 6-7, 2007 and is being published shortly in a book titled “Emerging Giants: China and India in the World Economy” edited by Barry Eichengreen, Poonam Gupta and Rajiv Kumar.

China’s exports have become increasingly sophisticated. This has generated anxiety in both developed and developing countries as the competitive pressure from Chinese firms may be increasingly felt outside labor-intensive industries. This paper investigates the contributing factors to the rising export sophistication. The paper is a part of ICRIER’s ongoing effort to focus on the Chinese economic development and draw implications for India and the rest of the world.



**(Rajiv Kumar)**

Director & Chief Executive

November 8, 2008

## Abstract

China's exports have become increasingly sophisticated. This has generated anxiety in developed countries as the competitive pressure may be increasingly felt outside labor-intensive industries. Using product-level data on exports from different cities within China, this paper investigates the contributing factors to the rising export sophistication. Somewhat surprisingly, neither processing trade nor foreign invested firms are found to play an important role in generating the increased overlap in the export structure between China and high-income countries. Instead, improvement in human capital and government policies in the form of tax-favored high-tech zones appear to be the key in the country's evolving export structure. On the other hand, processing trade, foreign invested firms, and government-sponsored high-tech zones all have contributed significantly to raising the unit values of China's exports within a given product category.

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**Keywords:** *China, India, Export sophistication, Export structure, high-tech zones, human capital*

**JEL Classifications:** *F1, F14*

# The Chinese Export Bundles: Patterns, Puzzles and Possible Explanations

Zhi Wang and Shang-Jin Wei\*

## 1. Introduction

Both China and India are major success stories in their integration with the world economy, and in their fast economic growth rates. At this stage, China's goods exports are somewhat ahead of India's. China's exports in 2007 were valued at \$1,218 billion according to statistics released by China's Ministry of Commerce, more than seven times India's estimated \$155 billion in exports in the same year (IMF, "India: 2007 Article IV Consultation-Staff Report"). On the other hand, India has been more successful in exports of business services and of information and IT services.

China exports a huge variety of goods in a way that makes the composition of its export bundles look increasingly similar to that of rich country bundles. This has been documented by Schott (2005), Rodrik (2006), Xu (2007), and Fontagne, Gaulier and Zignago (2007), and is perhaps surprising to many. Using data on Chinese exports at the level of product-producing region-customs type, Wang and Wei (2008) investigated possible reasons behind the apparent rise in the sophistication of Chinese exports.

The current paper has two objectives. First, it collects new product-level data on Indian exports and compares the evolution of export sophistication for both China and India. Second, it summarizes the key findings of Wang and Wei (2008). Because we do not have comparably detailed data for Indian exports as we do for China, we are not able to replicate all of the analyses performed in Wang and Wei (2008).

The rest of the paper is organized as follows. Section 2 documents the evolving export structure sophistication for both China and India. Section 3 explains the basic methodology, the underlying data, and the statistical analyses of Chinese exports. Section 4 concludes.

## 2. Evolving Sophistication in Export Structures: China versus

### India

To keep track of export sophistication, we adopt the methodology developed in Schott (2005) by comparing the export structure of each country in question with those of the high-income industrial economies. Specifically, we use as a benchmark the collective export structure of the United States, Japan and the European Union, which we will heretofore call the G-3 for short. The G-3 economies, on an *ex ante* basis, have a comparative advantage in producing and exporting the most skill-intensive products.

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\* The views in the paper are those of the authors and not the official views of the US ITC, or any other organization that the authors are or have been affiliated with. The authors thank Kyle Caswell and Chang Hong for their efficient research assistance, and Xuepeng Liu, William Power, participants of the NBER conference for the project, especially Galina Hale, for helpful comments.

Therefore, similarity in export structure to these economies is taken as a measure of export sophistication. By implication, if India and China's export structures become more similar to those of the G-3 economies over time, this should be taken as evidence that their exports have become increasingly more sophisticated.

This methodology allows us to avoid having to make a judgment on products' skill content, product by product. Since G-3 economies adjust their export structures over time in response to their evolving comparative advantage (and to competition from the rest of the world) the benchmark of the G-3 export structure is a moving target. In other words, there is no presumption that any developing country's export structure should automatically converge to those of the G-3 economies over time.

This definition of export sophistication has its drawbacks. First, even when China and India export the same type of product as do the high-income countries, they may not be producing the same variety within a given product category. Using unit value within a product category as a yardstick for the sophistication level of a variety, Schott (2006) and Wang and Wei (2008) confirm that the Chinese varieties tend to have lower unit values than those exported by the G-3 economies. Moreover, Wang and Wei (2008) showed that unit values tend to vary systematically across production by Chinese exporters. Private Chinese firms tend to produce the lowest unit values. Foreign-invested firms that engage in processing exports, and that are located in high-tech development zones, tend to produce the highest unit values. Second, half of Chinese exports are from processing trade, which could muddle the sophistication content of Chinese exports. Taking into account the role of processing exports, Koopman, Wang and Wei (2008) calculate that, on average, domestic value added as a share of Chinese exports is about 50%. Moreover, those sectors that are likely to be labeled as technically sophisticated, such as computers and telecommunications, tend to have even lower domestic content, on the order of 20% or less. These caveats about using export structure to judge a country's export sophistication should be kept in mind while interpreting subsequent results.

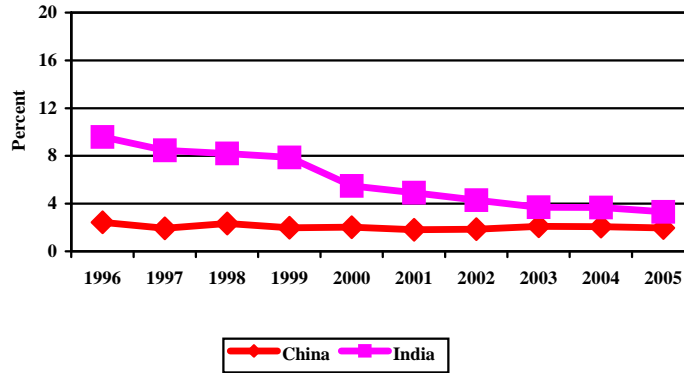
### **A Preliminary Look at Export Structure Sophistication**

We now start with a check on the sophistication of Chinese and Indian exports. The most detailed way to classify a country's exports while maintaining international comparability is to use the Harmonized System at the 6-digit level. With this classification, a country can export slightly over 5000 products. Figure 1 plots the fraction of HS 6-digit level products that the G-3 economies export but that China (or India) does not over the period from 1996-2005. By this metric, only 2-3% of all product lines fall into category for Chinese exports. In other words, there is very little difference in export bundles between China and the G-3 economies: China exports virtually all the things that the G-3 economies do. For India, the gap is somewhat more visible. In 1996, close to 10% of product lines that the G-3 exported were not also exported by India. The gap has shrunk over time, however, to about 3% by 2005.

We can also look at the flip side of the story, that is, the fraction of product lines that China or India exports but the G-3 economies do not. By this measure, overlap in the export bundles of China and the G-3 is astonishingly high. The overlap between India and the G-3 is only slightly less so but also very high (These results are left out to save space). From these admittedly naïve measures, one might think that China and France are producing and exporting more or less the same bundle of goods, or at least

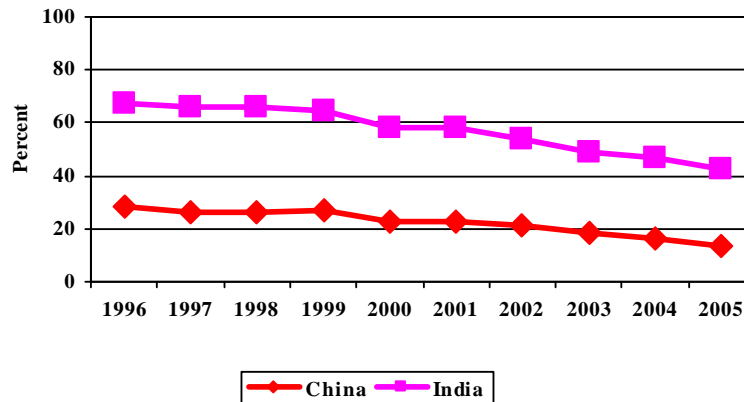
moving fast in that direction. India is not doing so yet, but is following in China's path with a lag of roughly ten years.

**Figure 1: Fraction of the HS-6 Codes that the G3 Export but that China and India Do Not, 1996 – 2005**



This method suffers from one serious drawback, in that it only ticks off whether any particular good is exported or not. Since both China and India are large economies, they may export virtually all products, but for some product lines, only by a tiny bit. If China and India are more likely to export those relatively sophisticated products in only a trivial amount, this metric may exaggerate the degree of overlap in export bundles. As a refinement, we apply some cutoff level to the value of exports before it is deemed significant. We choose \$1 million as our cutoff point. Specifically, we now look at the fraction of goods that G-3 export (in an amount of at least \$1 million) but that China or India does not. The results are represented in Figure 2. As we can see, this number was 29% in 1996, and declined more or less steadily to 14% in 2005. The line for India also traces out a steady decline in the part of exports that does not overlap with that of the G-3 economies, from about 65% in 1995 to about 40% in 2005. Note the degree to which India's area of no overlap in 2005 was bigger than that for China in 1995. This suggests that India still has some catching up to do in the development of its exports' sophistication.

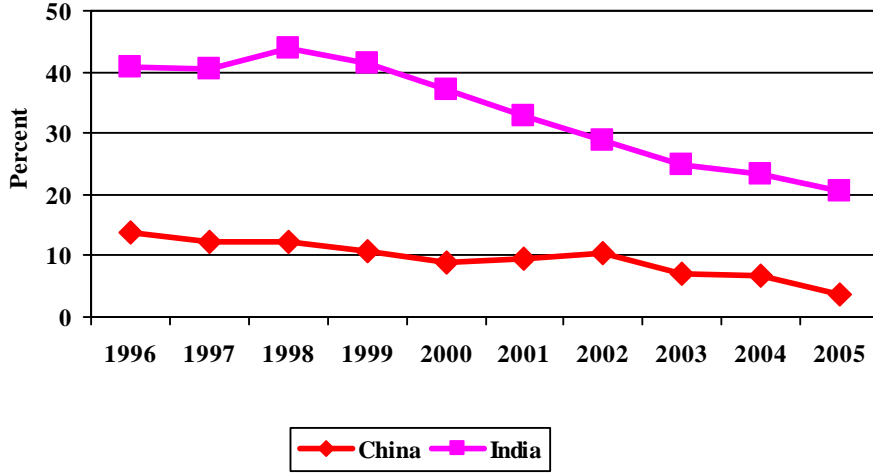
**Figure 2: Fraction of the HS-6 Codes that G-3 Economies Export by at Least a Million US Dollars but that China and India Do Not, 1996 – 2005**



*Source: Authors' calculations based on official trade statistics from the China Customs Administration and UN COMTRADE data.*

Rather than assigning equal weight to all products, one may assign a greater weight to products whose export values are greater. The results of this operation are presented in Figure 3. A pattern broadly similar to those shown above can be seen in this figure.

**Figure 3: Value-weighted Fraction of HS-6 Codes that G-3 Economies Export by at Least a Million US Dollars but that China and India Do Not, 1996 – 2005**



Rather than applying a blunt cutoff point such as that employed in Figures 2 and 3, we could explicitly take into account the share of each product in the export bundle. We do this later in the paper by constructing and analyzing an Export Dissimilarity Index (EDI). We note here, simply, that we arrive at broadly the same conclusions<sup>1</sup>.

### A Formal Index of Export Structure Dissimilarity

We define an index for a lack of sophistication in exports by the dissimilarity between the product structure of a region's exports and that of the G-3 economies' exports, or the export dissimilarity index (EDI) as:

$$EDI_{rft} = 100 \left( \sum_i \text{abs}(s_{irft} - s_{i,t}^{ref}) \right) \quad (2)$$

where

$$s_{irft} = \frac{E_{irft}}{\sum_i E_{irft}} \quad (3)$$

Where  $s_{irft}$  is the share of HS product  $i$  at the 6-digit level in Chinese city  $r$ 's exports by firm type  $f$  in year  $t$ , and  $s_{i,t}^{ref}$  is the share of HS product  $i$  in the 6-digit level

<sup>1</sup> Xu (2007) noted that the unit values of China's exports tend to be lower than those of the same products from rich countries, indicating China's varieties are of lower quality and presumably of lesser sophistication. Fontagne, Gaulier and Zignago (2007, Tables 1 and 2) show that China's export structure, defined as in Schott (2006) but at the HS 6-digit level, is more similar to those of Japan, the United States, and the European Union than to those of Brazil and Russia. However, judged on unit values, Chinese exports are more likely to be on the low end of the market than are those of the high-income countries.



exports of G-3 developed countries. The greater the value of the index, the more dissimilar the two export structures are. If the two export structures were to be identical, then the value of the index would be zero; if the two export structures were to have no overlap, then the index would take the value of 200. We regard an export structure as more sophisticated if the index takes a smaller value. Alternatively, one could use the similarity index proposed by Finger and Kreinin (1979) and used by Schott (2006) (except for the scale):

$$ESI_{rft} = 100 \sum_i \min(s_{irft}, s_{it}^{ref.}) \quad (4)$$

This index is bounded by zero and 100. If Chinese city  $r$ 's export structure has no overlap with that of the G-3 developed countries, then the ESI is zero; if the two export structures have a perfect overlap, then the index takes the value of 100. It can be verified that there is a one-to-one, linear mapping between ESI and EDI :

$$ESI_{rft} = (200 - EDI_{rft})/2 \quad (5)$$

While ESI and EDI are linearly related, log ESI and log EDI not linearly related. Wang and Wei (2008) show that in regressions, the sign of the coefficients associated with log EDI is more robust to small changes in specification than is log ESI. Therefore, we regard inferences drawn from log ESI as more reliable.

**Table 1: Comparing Export Structures: China Relative to the G-3 (1996-2005).**

Year	Number HS6-digit level product lines that G-3 economies export	Of which China exports	Number of HS6 product lines that G3 exports by at least US\$ 1 million	Of which China exports by at least US\$ 1 million	Share of No. HS-6 product that G-3 exports but China does not	Value Share of product that G-3 exports but China does not	Export Dissimilarity Index (EDI)
1996	4,143	4,042	4,126	2,942	28.7	13.7	133.7
1997	4,143	4,063	4,123	3,042	26.2	12.3	132.5
1998	4,143	4,046	4,121	3,041	26.2	12.3	130.8
1999	4,143	4,061	4,120	3,024	26.6	10.8	129.2
2000	4,143	4,059	4,116	3,172	22.9	8.8	125.5
2001	4,143	4,068	4,118	3,184	22.7	9.6	124.8
2002	4,213	4,135	4,184	3,306	21.0	10.5	125.4
2003	4,213	4,125	4,182	3,408	18.5	7.2	126.1
2004	4,213	4,126	4,186	3,515	16.0	6.8	123.1
2005	4,212	4,130	4,179	3,609	13.6	3.8	121.5

*Source: Authors' calculations based on official trade statistics from the China Customs Administration and from UN COMTRADE data.*

*Note: In the last three columns, the smaller the value, the greater the overlap. Value share is the sum of the shares of G-3 product lines for which China's export shares are zero. A US\$ 1 million cutoff is used in the second to the last column.*

We compute the values of the EDI for China and India (relative to the G-3 economies) and report them in Tables 1 and 2, respectively. They are also plotted in

**Table 2: Comparing Export Structures: India Relative to the G-3 (1996-2005).**

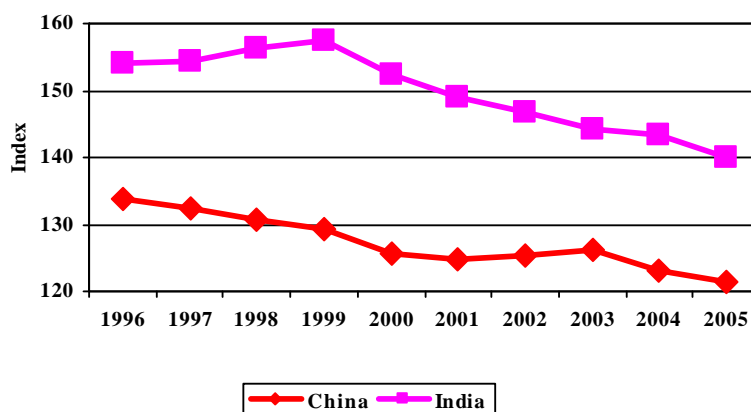
Year	Number of HS6-digit product lines that G-3 economies export	Of which India exports	Number of HS6 product lines that G3 exports by at least US\$ 1 million	Of which India exports by at least US\$ 1 million	Share of No. HS-6 product that G-3 exports but India does not	Value Share of product that G-3 exports but India does not	Export Dissimilarity Index (EDI)
1996	4,143	3,746	4,126	1,324	67.2	40.8	154.0
1997	4,143	3,792	4,123	1,387	65.9	40.5	154.5
1998	4,143	3,803	4,121	1,371	66.1	44.0	156.4
1999	4,143	3,817	4,120	1,443	64.5	41.5	157.5
2000	4,143	3,916	4,116	1,685	58.5	37.2	152.3
2001	4,143	3,940	4,118	1,691	58.4	32.9	149.1
2003	4,213	4,057	4,182	2,107	48.9	24.7	144.2
2004	4,213	4,058	4,186	2,206	46.5	23.2	143.4
2005	4,212	4,072	4,179	2,381	42.3	20.4	139.9

Source: Authors' calculations based on official trade statistics from UN COMTRADE data.

Note: In the last three columns, the smaller the value, the greater the overlap. Value share is the sum of the shares of G-3 product lines for which India's export shares are zero. A US\$ 1 million cutoff is used in the second to the last column.

Figure 4. A few features are worth noting. First, the dissimilarity index relative to the advanced economies has been declining for both China and India. For China, the dissimilarity index declined from 134 in 1996 to 122 in 2005. For India, it declined from 154 to 140 during the same period. Second, in contrast to the impression one gets from looking at the fraction of product lines that are common to China (or India) and the G-3 economies, this metric suggests that it is still premature to claim that China and France are exporting more or less the same bundle of goods. In fact, the value of the dissimilarity index (at 122 in 1995 for China) is a long way from consistency with an identical export bundle (i.e. a value of zero). Third, by this measure, India's export dissimilarity score in 2005 was still greater than China's in 1995. This suggests that it may take more than a decade for India to catch up with China in terms of the export structure sophistication in manufactured goods.

**Figure 4: China and India's Export Dissimilarity Index (Relative to G-3 Economies), 1996-2005**



Source: Authors' calculations based on official trade statistics from the China Customs Administration and UN COMTRADE data.

### **3. What Might Explain China's Precocious Export Sophistication?**

While our calculation does not support the claim that China already has a similar export structure to France, Japan and other high-income countries, it shows a clear trend in that direction. Moreover, as Fontagne, Gaulier, and Zignago (2007) show, China's export structure is already more similar to those of the high-income countries than to those of Brazil, Russia and middle-income countries. What could explain this precocious export structure sophistication?

Using detailed trade data at the level of product, producer location, producer ownership, and customs type (i.e., processing trade or not), Wang and Wei (2007) provide some useful clues to what the question's answer may be. As we do not have comparably detailed data for India, we are not able to conduct the same exercise for India. In this section, we summarize our methodology and some of the key findings of Wang and Wei (2007), and speculate over the implications for China.

#### **Some Qualitative Priors**

It is useful to think through some logical possibilities before we embark on a more rigorous analysis. First, the sophistication we have measured could be a statistical mirage due to processing trade. For example, both the United States and China may export notebook computers, but Chinese manufacturers may import the most sophisticated components of the computers, such as processors (CPUs) made by Intel or ADM in the United States. In such a case, Chinese producers may specialize in the unsophisticated stage of the production while the final product is classified as a sophisticated one. If one were able to classify a product further into its components, China and developed countries might be found to produce different components. That is, they might not compete directly with each other. In this scenario, there is very little for the developed countries to worry about.

Second, as a variation of this scenario, China and the high-income economies may export the same set of product lines, but the two may export very different varieties within each product line, with China exporting varieties of much lower quality. The competition between the high-income economies and China, in this case, would be moderate.

Third, on the other hand, the Chinese authorities, including governments at the regional and local levels, have actively promoted quality upgrading of China's product structure, through tax and other policy incentives. A particular manifestation of these incentives is the proliferation of economic and technological development zones, high-tech industrial zones, and export processing zones around the country. Their collective share in China's exports has risen from less than 6% in 1995 to about 25% by 2005. These policy incentives could increase the similarity of Chinese exports to those of developed countries, although it is unlikely the most efficient thing for China to do (unless there is significant positive externality from learning by doing). If this is the primary driver for China's rising sophistication, rather than the mis-measurement induced by processing trade, then China may increasingly be competing directly with developed countries.

Fourth, bearing on the two explanations, is the role of foreign invested firms in China. The share in China's total exports produced by wholly foreign-owned firms and by Sino-foreign joint ventures has risen steadily over time, from about 31% in 1995 to more than 58% by 2006 (Table 3). These foreign-invested firms may choose to produce and export products much more sophisticated than those indigenous Chinese firms would. In this scenario, while China-made products may compete with those from developed countries, at least the profits from such production also contribute directly to the GNPs of developed countries. Besides this direct effect of foreign invested firms in China's export upgrades, it is possible that the presence of foreign firms helps indirectly to raise the sophistication level of Chinese exports through various spillovers to domestic firms (Hale and Hong 2006). The above three possible explanations can reinforce each other, rather than being mutually exclusive. For example, a foreign-invested firm may engage in processing trade while located in a high-tech zone.

**Table 3: Percentage Breakdown of China's Exports by Firm Ownership, 1995-2006 (%)**

Year	SOE	Joint Venture	Wholly Foreign owned	Collective	Private
1995	66.7	19.8	11.7	1.5	0.0
1996	57.0	24.9	15.7	2.0	0.0
1997	56.2	23.9	17.1	2.5	0.0
1998	52.6	24.1	20.0	2.9	0.1
1999	50.5	23.2	22.2	3.5	0.3
2000	46.7	24.2	23.8	4.2	1.0
2001	42.6	24.1	25.9	5.3	2.0
2002	37.7	22.7	29.5	5.8	4.2
2003	31.5	21.5	33.3	5.7	7.9
2004	25.9	21.0	36.1	5.4	11.7
2005	22.2	19.9	38.4	4.8	14.7
2006	19.7	18.7	39.5	4.2	17.8
Average 1996-2004	39.8	22.7	27.8	4.7	4.9

*Source: Authors' computation based on official trade statistics from the China Customs Administration.*

To the best of our knowledge, direct evidence of the importance of these channels is provided only in Wang and Wei (2007). A key finding is that neither processing trade nor foreign-invested firms play an important role in generating increased overlap in the export structures of China and the high-income countries. Instead, improvement in human capital and government policies in the form of tax-favored high-tech zones appear to have contributed significantly to the rising sophistication of China's exports.

### **Specification and Basic Facts**

To link China's export structure dissimilarity to potential underlying factors, our strategy is to make use of variations across Chinese cities in both export

sophistication and its potential determinants. We consider several categories of the determinants, including the level of human capital, the use of processing trade, and the promotion of sophistication by governments through high-tech and economic development zones.

To start with, Table 3 reports a breakdown of export value by exporter firm ownership. A number of features are worth noting. First, there has been a steady decline in the share of state-owned firms in China's exports, from 66.7% in 1995 to 19.7% in 2006. This reduction in the role of state-owned firms in exports mirrors the reduction of the state's role in the economy in general. Second, foreign-invested firms (both wholly foreign-owned and Sino-foreign joint ventures) play a significant role in China's exports. Their share in China's exports has also increased steadily, from 31.5% in 1995 to 58.3% in 2005. The role played by foreign firms in China's exports is larger than that of such firms in most other countries with a population greater than 10 million. Third, exports by truly private domestic firms are relatively small, though their share in China's exports has also increased over time, from basically nothing until 1997, to 17.8% by 2005. Some of the growth in exports produced by domestic private firms has been achieved by a change in firm ownership. For example, when the laptop manufacturer Lenovo was first established, it was a partly state-owned firm. By 2003, it became a privately-owned firm. By now, it has added foreign investment, acquired the original IBM PC division, and exported some of its products under the IBM brand.

**Table 4: Share of processing trade and policy zones' production in China's total exports, 1996-2005 (%)**

Year	Special Economic Zones	Exports Processing Zones	Processing exports in High-tech Zones	Normal exports in High-tech Zones	Processing Exports Outside Policy Zones	Normal Exports Outside Policy Zones	All Other Exports <sup>a</sup>
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1995	10.6	0	3.2	2.1	39.8	42.1	2.2
1996	8.7	0	3.9	1.8	45.2	38.3	2.0
1997	8.8	0	4.6	1.7	43.9	39.0	1.9
1998	8.2	0	5.5	1.9	45.5	36.9	1.9
1999	7.0	0	6.4	2.2	45.5	37.0	1.9
2000	7.1	0	7.0	2.6	43.3	38.2	1.8
2001	6.8	0.1	7.4	2.8	43.0	38.0	1.9
2002	6.2	0.7	8.0	3.0	42.2	37.6	2.3
2003	5.3	2.4	9.5	3.4	39.6	37.1	2.7
2004	4.4	3.6	11.0	3.6	37.7	36.4	3.2
2005	4.3	4.6	11.8	3.6	35.6	36.8	3.5
1996-2004 average	6.3	1.3	8.0	2.8	41.7	37.4	2.4

*Source:* Authors' computations based on official trade statistics from the China Customs Administration.

*Note:* <sup>a</sup> This category includes international aid, compensation trade, goods on consignment, border trade, goods for foreign contracted projects, goods on lease, outward processing, barter trade, warehouse trade, and entrepôt trade by bonded area.

Table 4 reports a breakdown of China's exports into processing trade, normal trade, and others according to exporters' customs declarations. Processing exports come in three varieties: (a) those from export processing zones, (b) those from various high-tech zones, and (c) those from outside any policy zones. Collectively, their share in the country's total exports has increased from 43% (=0+3.2%+39.8%) in 1995 to 52% (=4.6%+11.8%+35.6%) in 2005. As we lack information on the share of processing exports for other countries, we cannot conduct a formal international comparison. Our conjecture is that very few developing countries would have a share of processing exports as high as China's. On the other hand, we conjecture that a portion of China's reported processing trade may be exaggerated due to some firms' desire to evade tariffs on imported inputs that are actually used for domestic sale<sup>2</sup>.

Additional tables in Wang and Wei (2008) indicate that foreign-invested firms are dominant in processing exports, accounting for 100% of exports out of export processing zones, 95% of processing exports out of high-tech zones, and 67% of processing exports from the rest of China. State-owned firms account for the bulk of the remaining processing trade. Therefore, processing exports are mostly the domain of wholly and partly foreign-owned firms. The reverse is not true, in that foreign firms also engage in normal (i.e. "non-processing") exports, accounting for 40% of non-processing exports out of high-tech zones and 24% of normal trade outside of policy zones in 2004.

For both wholly foreign-owned firms and Sino-foreign joint ventures, processing trade accounts for nearly 50% of exports produced. For state-owned firms and collectively owned firms, the share of processing exports in total exports produced is 18% and 13%, respectively. Domestic private firms engage in comparatively little processing trade, producing less than 7% of their total exports in this category.

China has established a number of special economic zones and areas where more incentive policies have been applied since 1979, as a part of its development strategy. Five special economic zones (SEZs) have been set up and are distinguished from other special economic areas. They include all of Hainan province, three cities (Shenzhen, Zhuhai, and Shantou) in Guangdong province, and a city (Xiamen) in Fujian Province. Other special economic areas are much smaller geographically, and classified as Economic and Technological Development Areas (ETDAs), Hi-Technology Industry Development Areas (HTIDA), and Export Processing Zones (EPZs). Some of these special incentive zones and areas fall within the five SEZs. We will also refer to these incentive zones or areas as "policy zones".

Among these policy zones, ETDAs and HTIDAs are tax-favored enclaves established by central or local governments (with the approval of the central government) to promote development of sectors that could be considered "high and new tech" by some imperfectly-defined criteria. There are differences in theory between the two types of zones. In practice, however, the line between the two is often blurred. Which firms should go into which type of zone is somewhat arbitrary. As a result, we group them together in our discussion. With progressively more ETDAs and HTIDAs being established in the sample, their share in China's exports has grown steadily, from only 4.3% in 1995 to 15.4% in 2005 (sum of Columns 4 and 5 in Table 4). Since most

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<sup>2</sup> Fisman and Wei (2004) provided evidence of massive tariff evasion in China's imports.

cities still do not have such zones, an unweighted average of their share in a city's exports across all cities and years yields only 2%.

Dedicated export processing zones (whose exports are exclusively in processing trade) were established starting in 2001 and are present in only 26 cities today. In national aggregate, only 4.6% of exports come from all the export processing zones taken together, by 2006 (Table 4, Column 3). On simple average (across cities and years), only 0.04% of exports come from EPZs. This means that most of China's processing exports are produced outside an export processing zone.

Foreign-invested firms dominate exports from EPZs and processing exports from high-tech zones in our sample period (99% and 95% respectively), and also took the lion's share in processing trade outside those policy zones (67%). State-owned firms are the major players in normal exports, accounting for 58% of normal exports from high-tech zones and 63% of normal exports outside policy zones during our sample period. Relative to processing trade, collectively-owned and private firms also played an important role in China's normal exports, accounting for 8.5% of normal exports from high-tech zones and 18% of exports originating outside policy zones.

We relate the sophistication level of a local export structure to its plausible determinants including the role of processing trade, foreign investment, and local human capital. Formally, the econometric specification is given by the following equation (or some variation of it):

$$\begin{aligned}
 \text{Ln}(EDI_{rft}) = & \text{city\_fixed} + \text{year\_fixed} + \beta_1 \text{EPZ\_share}_{rft} \\
 & + \beta_2 \text{High\_tech\_zone\_processing\_Share}_{rft} \\
 & + \beta_3 \text{Processing\_outside\_anyzone\_share}_{rft} \\
 & + \beta_4 \text{High\_tech\_zone\_nonprocessing\_share}_{rft} \\
 & + \beta_5 \text{Ln}(GDP_{rt}) + \beta_6 \text{SKILL}_{rt} + \text{other\_controls} + \mu_{rft}
 \end{aligned} \tag{1}$$

Where  $\text{Ln}(EDI)$  is the log of a **dissimilarity index** between a Chinese city's export structure and the general export structure of the United States, Japan, and the European Union combined.  $\beta_1 - \beta_6$  are the coefficients to be estimated.  $\mu_{rft}$  is the error term. Other regressors and the sources of the data are explained in Appendix Table 1. Robust standard errors, clustered around cities, are reported.

## Statistical Results

The regression results are reported in Table 5. In the first four columns, the sophistication of a city's export structure is measured by its similarity to that of the G-3 high income countries on a *year by year basis*. As a robustness check, in the last four columns, the city's export sophistication is measured against the export structure of the high-income countries in a fixed year (2004, the last year in our sample period). The change in the reference year for export sophistication does not turn out to matter qualitatively.

The coefficient on “export processing zone exports as a share of total city exports” is negative and significant, implying that exports from EPZs tend to be more similar to those of high-income countries than do typical Chinese exports. However, as a majority of Chinese cities do not have EPZs, this does not contribute much to explaining cross-city differences in export sophistication.

The coefficients on the two variables describing exports from high-tech zones (“processing exports from high-tech zones” and “non-processing exports from high-tech zones”) are negative and significant, implying that the high-tech zones do contribute to raising the export structure sophistication of China. Comparing the two point estimates, however, one sees that non-processing exports from the two types of high-tech zone, in fact, contribute more to raising export sophistication than do processing exports.

The share of processing exports outside any policy zone is positive and significant: the more processing trade takes place outside any policy zone, the less sophisticated a city’s exports become. Taking the discussion of the last three coefficients together, we might argue that the processing trade (outside policy zones) is unlikely to have promoted similarities between the Chinese export structure and that of the high-income countries. It is consistent with the intuition that processing trade in many areas of China, except in these policy zones, is relatively labor-intensive in nature.

The coefficient on student enrollment in colleges or graduate schools as a share of a city’s non-agricultural population—a proxy for a city’s level of human capital—is negative and significant, consistent with the notion that a city with more skilled labor tends to have a more sophisticated export structure. In column 2 of Table 5, we use per capita gross city product (per capita GCP) as an alternative measure of a city’s level of human capital. This variable also produces a negative coefficient, indicating an association between more human capital and a more sophisticated export structure.

In columns 3-4 of Table 5, we include measures of the presence of foreign firms in a city. The estimated coefficient for the share of exports by wholly foreign-owned firms in a city’s total exports is not significantly different from zero. Interestingly, the share of exports by joint-venture firms has a positive coefficient: the more a city’s exports come from joint-venture firms, the less the export structure resembles those of high-income countries. These results suggest that foreign-invested firms in China are not likely to be directly responsible for the rising sophistication of China’s export structure, or at least not in a simple linear fashion (e.g. the more FDI, the more sophisticated China’s export structure will be).

As we explained earlier, Columns 5-8 of Table 5 replicate the first four columns except that the left-hand-side variables are re-calibrated against the 2004 export structure of the G-3 economies. The qualitative results stay essentially the same. To summarize the key findings that emerge from the series of regressions in Table 5, we find that:

- (a) Cross-city differences in human capital are linked to cross-city differences in the sophistication level of the export structure. A higher level of human capital, measured either by per capita GDP or by college and graduate school enrollment, is associated with a more sophisticated export structure.



- (b) The high-tech zones are associated with more sophisticated export structure. The higher the share of a city's exports coming out of high-tech zones, the more likely the city's export structure resembles that of the G-3 high income economies.
- (c) The export processing zones (EPZs) contribute to the rising sophistication of the export structure. However, since only a small fraction of the cities have any EPZs, they play a very small quantitative role in explaining the cross-city differences in export structure sophistication.
- (d) Processing trade generally is not a major factor in explaining cross-city differences in export structure sophistication. This can be seen in two ways. First, for exports originating outside any policy zone (which represent the lion's share of all exports) more processing trade is in fact associated with less similarity to the export structure of the high-income countries. Second, for exports from high-tech zones, those products that are classified in processing trade do not appear to overlap more with high income countries' exports than do products classified in non-processing trade.
- (e) After controlling for exports from major policy zones, foreign investment does not appear to play a major role in explaining cross-city differences in the sophistication level of their export structures. If anything, joint-venture firms may create some divergence between a city's export structure and that of the high-income economies.

These findings reject the views that the rising sophistication of China's export structure is mostly generated by processing trade and/or foreign invested firms. At the same time, it confirms the importance of human capital and governmental policies in the establishment of the high-tech zones to promote the rising sophistication of China's export structure.

The specification used in Table 5 includes city fixed effects. This is the appropriate thing to do in a panel regression such as this. However, in order to make sure that the proposed explanatory variables—processing trade, foreign ownership, high-tech zones, human capital, etc.—collectively have enough explanatory power on their own to account for the observed cross-city differences in the export structure dissimilarity index, we have also run similar regressions without city fixed effects (the results are not reported here, to save space, but can be found as Appendix Table 8 in Wei and Wang 2008). The patterns on the signs of the coefficient estimates and the statistical significance are mostly the same as in Table 5. As important, the total R-squares in this set of regressions without city fixed effects are in the range of 66-68%. This suggests that much of the cross-city differences in export patterns are explained by the included regressors rather than merely by city fixed effects.

**Table 5: What Explains Cross-city Export Structure? Export Structure Dissimilarity between Chinese Cities and the G-3 Economies**

Explanatory Variables	Year-by-year benchmark				2004 benchmark			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Export Processing Zone Exports as a Share of Total City Exports	-	-	-	-	-	-	-	-
	0.351*** (0.074)	0.382*** (0.055)	0.350*** (0.071)	0.384*** (0.053)	0.552*** (0.116)	0.594*** (0.087)	0.544*** (0.111)	0.591*** (0.084)
Processing exports in High-tech Zones as a Share of Total City Exports	-	-	-	-	-	-	-	-
	0.065*** (0.018)	0.070*** (0.020)	0.067*** (0.018)	0.073*** (0.020)	0.083*** (0.020)	0.089*** (0.023)	0.082*** (0.020)	0.090*** (0.023)
Non-processing exports in High-tech Zones as a Share of Total City Exports	-	-	-	-	-	-	-	-
	-0.087* (0.045)	-0.108** (0.053)	-0.093** (0.044)	-0.115** (0.053)	-0.087* (0.049)	-0.116* (0.061)	-0.092* (0.049)	-0.122** (0.061)
Processing exports outside economic zones as a Share of Total City Exports	-	-	-	-	-	-	-	-
	0.005* (0.003)	0.004 (0.003)	0.004 (0.003)	0.002 (0.003)	0.006* (0.003)	0.004 (0.003)	0.005* (0.003)	0.003 (0.003)
Student Enrollment in Institutions of Higher Education as a Share of the City Non-Agricultural Population	-	-	-	-	-	-	-	-
	0.225*** (0.066)		0.229*** (0.066)		0.309*** (0.073)		0.315*** (0.072)	
per capita GCP		-0.006** (0.002)		-	0.007*** (0.003)		-	
						0.010*** (0.003)		0.010*** (0.003)
Gross City Product (GCP)	-0.003** (0.001)	-0.003** (0.001)	-0.003** (0.001)	-0.003** (0.001)	-0.003* (0.001)	-0.003* (0.002)	-0.003** (0.001)	-0.003** (0.002)
Foreign-invested firms' share in city exports			0.001 (0.006)	0.004 (0.006)			-0.004 (0.006)	-0.000 (0.007)
Joint venture firms' share in city exports			0.010*** (0.004)	0.010*** (0.004)			0.009** (0.004)	0.009** (0.004)
City Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
Robust, Cluster(city)	Y	Y	Y	Y	Y	Y	Y	Y
Observations	1981	1981	1981	1981	1981	1981	1981	1981
R-squared	0.98	0.98	0.98	0.98	0.98	0.97	0.98	0.97

Note: Standard errors in parentheses \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

#### 4. Conclusion

Are China and India's exports increasingly competing head to head with those of high-income countries? To address this question, this chapter undertakes two tasks. The first part of the chapter compares the product structures of China and India's exports with those of the G-3 economies (the United States, Japan, and the European Union). It finds that both emerging market giants have an export bundle that is becoming increasingly more similar to those of the high-income countries. However, by this metric, China is perhaps a bit more than ten years ahead of India.

The second part of the chapter sifts through various potential determinants of the rising sophistication of Chinese exports, drawing on our recent research (Wang and Wei 2008). The list of potential determinants includes government incentives, the use of imported inputs, foreign invested firms, and improved human capital. The underlying methodology makes use of variations in the key variables across different cities in China. As we do not have access to comparable data for India, this exercise is not replicated for Indian exports.

The estimation shows that, for the country as a whole, China's export structure does increasingly resemble that of the advanced economies, and the unit values of its exports are also rising over time. If these patterns are generated entirely by the rising use of processing trade, then there may not be much genuine increase in the sophistication level of China exports. If there is a real increase in sophistication, where the increment comes entirely from foreign-invested firms in China, then the economic profit associated with the improved sophistication accrues to foreign economies rather than to China. Of course, the increased sophistication can also come from an improved level of local human capital, or government policies such as high-tech policy zones set up specifically to promote the upgrading of the industrial structure. Regional variations in the use of processing trade, high-tech zones, and availability of skilled labor are used in this paper to assess the relative roles of these factors.

The econometric analysis conducted in Wang and Wei (2008) provides evidence on the relative importance of the three channels:

- (1) Cross-city differences in human capital are linked to cross-city differences in the sophistication of export structures. A higher level of human capital is associated with a more sophisticated export structure in Chinese cities.
- (2) High-tech zones are associated both with more sophisticated export structures and with higher unit values. This means that the policy zones (especially ETDZs and HTIDZs) set up by the central and local governments may have worked to induce firms to upgrade their product ladder to a higher level than it otherwise have achieved. In other words, these policy zones may not only have promoted processing trade, but they may have promoted greater sophistication of China's exports, too.
- (3) The export processing zones (EPZs) contribute both to the rising sophistication of export structures and to rising unit values. However, since only a tiny fraction of cities have EPZs and since most of their exports come

from foreign-invested firms, they do not contribute very much to explaining cross-city differences in export sophistication.

- (4) Processing trade generally is not a major factor in explaining cross-city differences in export structure sophistication. This can be seen in two ways. First, for exports outside any policy zone (which comprise the lion's share of China's total exports, about 42% during our sample period) more processing trade is in fact associated with less similarity to the export structure of advanced countries. Second, for exports out of the high-tech zones, those products that are classified as processing trade do not appear to overlap more with advanced countries' exports than do products associated with non-processing trade.

However, further analysis by Wang and Wei (2008) suggest that processing trade is significantly associated with higher unit values. How would one reconcile the findings on export structure and unit values? If most processing exports outside the policy zones are labor-intensive, a higher share will increase the dissimilarity of the export structure between the Chinese cities and G-3 advanced economies. However, processing exports could still be of higher quality (of more sophisticated varieties) than normal exports in the same product line, because of the use of high-quality imported materials in the former. In other words, processing trade moves China into producing and exporting more sophisticated varieties within a given product category, but not necessarily in those product categories that overlap heavily with the exports of the G-3 advanced economies<sup>3</sup>.

- (5) The export share of foreign-invested firms in a Chinese city does not appear to play a major role in explaining cross-city differences in the sophistication level of export structure. If anything, joint-venture firms may create some divergence between a city's export structure and that of the advanced economies. However, after controlling for processing trade, both types of foreign-invested firms are found to be strongly associated with higher export unit values. Therefore, foreign investment is conducive to raising China's within-product sophistication.

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<sup>3</sup> It is possible that the higher unit values associated with processing exports simply reflect higher costs of imported inputs as compared to domestically made inputs. This leaves open the question of whether processing exports generate more value-added when compared with normal exports that use more local and domestic inputs.

## Appendix: Data

Data on China's exports at the HS 8-digit level (the most disaggregated level of classification made available by Chinese customs) are obtained from the China Customs General Administration. The database reports the geographic origin of exports (from more than 400 cities in China) policy zone designation (i.e. whether an exporter is located in any type of policy zone) firm ownership, and transaction type (whether an export is processing trade by customs declaration) for the period from 1995 to 2005.

**Appendix Table 1. Definition of Key Variables and data sources**

Dependent variables	Description	Data Sources
$EDI_{irt} = \left( \sum_i abs(s_{irt} - s_{i,t}^{ref}) \right)$	Absolute export structure dissimilarity index	Calculated by the authors from 6 digit HS level. Chinese City exports based on official China Custom Statistics. Data on US, EU15 and Japan exports download from WITS
<b>Explanatory variables</b>		
GCP <sub>rt</sub>	Gross City Product (10,000 yuans); note that this is a value added concept, making GCP conceptually similar to GDP.	China City data, China data online
PCGCP <sub>rt</sub> = 100 GCP <sub>r</sub> / POP <sub>r</sub>	per capita GCP (yuan)	China City data, China data online
SKILL <sub>rt</sub> = 100 * (No. of College Students) <sub>rt</sub> / (non-agricultural population) <sub>rt</sub>	Student Enrollment in institutions of higher education as a share of a city's non-agricultural population	China City data, China data online
EPZ_share <sub>rtt</sub>	Export Processing Zone Exports as a Share of Total City Exports	China Custom Statistics.
High_tech_zone_processing_share <sub>rtt</sub>	Processing exports in the two High-tech Zones as a Share of Total City Exports	China Custom Statistics
High_tech_zone_nonprocessing_share <sub>rtt</sub>	Non-processing exports in the two types of High-tech Zones as a Share of Total City Exports	China Custom Statistics
Processing_outside_anyzone_share <sub>rtt</sub>	Processing exports outside policy zones as a Share of Total City Exports	China Custom Statistics
Expfiesh <sub>rtt</sub>	FIE firm exports as share of Total City Exports	China Custom Statistics.
Expjons <sub>rtt</sub>	Joint venture firm exports as Share of Total City Exports	China Custom Statistics
expoths <sub>rtt</sub>	Collective and Private firm exports as Share of Total City Exports	China Custom Statistics
expsoesh <sub>rtt</sub>	SOE firm exports as Share of Total City Exports	China Custom Statistics

We link this database with a separate database on Chinese cities, including per capita gross city product, population, college student enrollment and FDI data, from China-data-online, managed by the China Data Center at the University of Michigan. Unfortunately, the coverage of the second database is more limited (240 cities from 1996-2004).

Note that a ‘city,’ in our sample, refers to a geographic unit that includes a metropolis and adjacent rural counties under the jurisdiction of the metropolitan government.

Data on exports by the G-3 economies at the HS 6-digit level come from the United Nations’ COMTRADE database, downloaded from the World Integrated Trade Solution (WITS) site. We wish to focus on manufactured goods, not on natural resources, and therefore exclude the goods in HS Chapters 1-27 (agricultural and mineral products) and raw materials and their simple transformations (mostly at the HS 4-digit level) in other HS chapters.

**Appendix Table 2. Starting Years of Various Economic Zones with Policy Incentives**

City Code	City Name	Special Economic Zone	Economic & Technological Development Area	Hi-Technology Industry Development Area	Export Processing Zone
1100	Beijing CY		1996	1996	2001
1200	Tianjin CY		1996	1996	2001
1301	Shijiazhuang			1996	
1303	Qinhuangdao		1996		2005
1306	Baoding			1996	
1401	Taiyuan		2003	1996	
1502	Baotou			1997	
2101	Shenyang		1996	1996	
2102	Dalian		1996	1996	2001
2103	Anshan			1996	
2201	Changchun		1996	1996	
2202	Jilin			1996	
2301	Harbin		1996	1996	
2306	Daqing			1996	
3100	Shanghai CY		1996	1996	2001
3201	Nanjing			1996	2004
3202	Wuxi			1997	2003
3204	Changzhou			1997	
3205	Suzhou		1996	1997	2001
3206	Nantong		1996		2003
3207	Lianyungang		1996		2004
3211	Zhenjiang				2004
3301	Hangzhou		1996	1996	2001
3302	Ningbo		1996		2004
3303	Wenzhou		1996		
3401	Hefei		2005	1996	
3402	Wuhu		1996		2003
3501	Fuzhou		1996	1996	
3502	Xiamen	1995		1996	2002
3601	Nanchang			1996	
3701	Jinan			1996	
3702	Qingdao		1996	1997	2004
3703	Zibo			1999	

City Code	City Name	Special Economic Zone	Economic & Technological Development Area	Hi-Technology Industry Development Area	Export Processing Zone
3706	Yantai		1996		2001
3707	Weifang			1996	
3710	Weihai			1996	2001
4101	Zhengzhou			1996	2005
4103	Luoyang			1997	
4201	Wuhan		1996	1996	2001
4206	Xiangfan			1997	
4301	Changsha			1996	
4302	Zhuzhou			2000	
4401	Guangzhou		1996	1996	2001
4403	Shenzhen	1995		1996	2002
4404	Zhuhai	1995		1996	
4405	Shantou	1995			
4406	Foshan			1998	
4408	Zhanjiang		1996		
4413	Huizhou			1996	
4420	Zhongshan			1996	
4501	Nanning			1996	
4503	Guilin			1996	
4505	Beihai				2005
4601	Haikou	1995		1996	
4602	Sanya	1995			
5000	Chongqing		2002	2002	2002
5101	Chengdu		2001	1996	2001
5107	Mianyan			1996	
5201	Guiyang			1996	
5301	Kunming			1996	
6101	Xi'an			1996	2004
6103	Baoji			1997	
6104	Xianyang			2002	
6201	Lanzhou			1996	
6301	Xining		2005		
6501	Urumqi		1996	1997	

*Note: Cities that do not have any of the policy zones during 1996-2005 are not on the list.*

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