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What Accounts for the Rising Sophistication of China's Exports?

Zhi Wang and Shang-Jin Wei

Everyone knew that we would lose jobs in labor-intensive industries like textiles and apparel, but we thought we could hold our own in the capital-intensive, high-tech arena. The numbers we're seeing now put the lie to that hope—as China expands its share even in core industries such as autos and aerospace.
—Robert Scott, U.S. Economic Policy Institute

2.1 Introduction

China's rise as a trading power has taken the world by storm. Its exports have risen from 18 billion dollars or less than 4 percent of its gross domestic product (GDP) in 1980 to more than 760 billion dollars or about 35 percent of its GDP by 2005. Besides the rapid expansion of its trade volume, researchers have noted another feature: China's level of sophistication has been rising steadily. This sophistication can be seen in three aspects, two noted in the literature, and the third presented here, by us. First, as Schott (2006) noted, China's export structure increasingly resembles the collective export structure of the high-income countries in a way that seems unusual given China's endowment and level of development. Second, as Rodrik (2006) observed, the level of GDP per capita associated with countries exporting the same basket of goods as China is much higher than China's actual level of income per capita. Third, as we will show, the fraction of product lines that the United States, the fifteen-member European Union, and Japan (referred to hereafter as G3) export and that China does not is shrinking steadily. Obviously, these three trends are not independent from

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each other. Taken at their face value, they may suggest that China is competing head to head with producers from developed and developing nations alike. This has generated a tremendous amount of anxiety in many nations. Why would China, a country with an extreme abundance of labor but relative scarcity in capital, skilled labor, and research and development (R&D) investment, produce and export a bundle of goods that resembles those of developed countries? Schott (2006) conjectures that this results from a combination of a large variation in factor endowment and a low factor mobility across regions.

The evolution of China's export sophistication during 1996 to 2005 is traced out in table 2.1. This table shows that the level of dissimilarity between China's export structure and that of the G3 economies declined from 133.7 in 1996 to 121.5 by 2005.[1] During the same period, the number of Harmonized System (HS) six-digit product lines exported by G3 countries but not by China fell from 101 in 1996 to 83 in 2005, out of 4,143 and 4,212 in total, respectively. As a share of the product lines that the G3 export, those not manufactured by China fell from 2.44 percent of the total in 1996 to 1.97 percent in 2005. This count is somewhat misleading as China exports a very small volume (i.e., less than $1 million) in several product lines. Excluding these lines, the share of products exported by the G3 but not by China fell from 28.7 percent (1,189/4,143) in 1996 to 13.7 percent (578/4,212) in 2005.[2]

How much should developed countries be concerned with rising competitive pressure from increasingly sophisticated Chinese exports? The answer depends on the sources of China's rising sophistication. On the one hand, this sophistication, as 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 have to import the computer's most sophisticated components, such as central processing units (CPUs) made by Intel or AMD in the United States. In such a case, Chinese producers may specialize in the unsophisticated stage of production although the final product is classified as sophisticated. 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 do not compete directly with each other. In this scenario, there is very little for the developed countries to worry about.

As a variation of this scenario, China and the high-income economies may export the same set of product lines, but they may export very different varieties within each product line, with China exporting varieties of much lower quality.[3] Competition between the high-income economies and China need not be tense.

1. This is computed at national level using equation (2) and excluding the region subscript.
2. There is virtually no product that China exports but G3 does not.
3. Xu (2007) noted that for the same product, the unit value of China's exports tends to be lower than that of rich countries, indicating that China's varieties are of lower quality and pre-

Table 2.1 **Increasing overlaps in the export structure: China relative to the United States, the European Union, and Japan (1996–2005)**

Year	No. of HS six-digit product lines exported by the high-income countries (G3, at least U.S. $1 million) (1)	Also exported by China (at least U.S. $1 million) (2)	Fraction of the product lines exported by the G3 but not by China (3) = 1 – (2)/(1)	Export dissimilarity index (4)
1996	4,126	2,942	28.7	133.7
1997	4,123	3,042	26.2	132.5
1998	4,121	3,041	26.2	130.8
1999	4,120	3,024	26.6	129.2
2000	4,116	3,172	22.9	125.5
2001	4,118	3,184	22.7	124.8
2002	4,184	3,306	21.0	125.4
2003	4,182	3,408	18.5	126.1
2004	4,186	3,515	16.0	123.1
2005	4,179	3,609	13.6	121.5

Source: Authors' computation based on trade statistics from the China Customs Administration and on G3 data downloaded from the UN COMTRADE database.

Note: The export dissimilarity index is computed based on equation (2), explained in the text; smaller values indicate greater overlaps. HS = Harmonized System.

On the other hand, the Chinese authorities, including governments at the regional or local levels, have been actively promoting quality upgrades to 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 rose from less than 6 percent in 1995 to about 25 percent by 2005. These policy incentives could increase the similarity of Chinese exports to those of developed countries, though they are unlikely to be efficient (unless learning by doing confers a significant positive externality). If policy is the primary driver for rising sophistication (rather than the mismeasurement induced by processing trade), then China may come into more direct competition with developed countries.

Foreign-invested firms in China straddle these two explanations. The share of China's total exports produced by wholly foreign-owned firms and Sino-

sumably of lesser sophistication. Fontagne, Gaulier, and Zignago (2007, tables 1 and 2) show that China's export structure, defined the same way as in Schott (2006) but at the HS six-digit level, is more similar to 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 in the low end of the market than are those of the high-income countries.

Table 2.2 Breakdown of China's exports by firm ownership, 1995–2006 (%)

Year	State-owned enterprise	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 Custom Administration.

foreign joint ventures has risen steadily over time, from about 31 percent in 1995 to more than 58 percent by 2005 (table 2.2). These foreign-invested firms may choose to produce and export much more sophisticated products than would indigenous Chinese firms. In this scenario, while China-made products may compete with those from developed countries, the profits from such activities contribute directly to the gross national products (GNPs) of developed countries. Besides the direct effect of foreign-invested firms on China's export upgrading, the presence of foreign firms may help indirectly to raise the sophistication of Chinese exports through various spillovers to domestic firms (Hale and Long 2006). The preceding three possible explanations can reinforce each other rather than be mutually exclusive. For example, a foreign-invested firm may engage in processing trade while located in a high-tech zone.

To the best of our knowledge, direct evidence on the importance of these channels is not yet available in the literature until recently. Using a detailed product-level data set on Chinese exports, the chapter by Amiti and Freund (chapter 1 in this volume) examines the change in the skill content of the Chinese exports. They have found a dramatic transformation of the export structure since 1992. In particular, there has been a significant decline in the share of agriculture and traditional labor-intensive manufacturing products, such as textiles, garments, and shoes, with a growing share in nontraditional manufactures, such as consumer electronics, appliances, computers, and telecommunication equipment. This would seem to suggest a dramatic rise in the skill content of China's exports. They confirm this by measuring the skill content in a sector as the ratio of nonproduction workers to total

employment from the Indonesian manufacturing census at the five-digit International Standard Industrial Classification (ISIC) level for 1992 (they don't have access to comparable data for China). However, a prominent feature of the Chinese exports is the role of processing trade—the use of tariff-free imported inputs in the production for exports—accounting for more than half of China's total exports in recent years. It is possible the real skill content in processing exports is low even though they may appear in sectors that otherwise would be classified as having a high-skill content. Outside processing exports, they find very little skill upgrading associated with normal exports. They note, however, that they cannot rule out the possibility that within processing exports, "the Chinese value added has become more skill-intensive."

In this chapter, we measure China's evolving export sophistication, not by the changing share of nonproduction workers in employment, but, following Schott (2006), by an increase in the resemblance of its export bundle to those of high-income countries. Our data set is even more finely disaggregated than what is used in Amiti and Freund (chapter 1 in this volume): our product-level data set on Chinese exports is disaggregated by firm ownership type and incentive status of a production location in about 240 Chinese cities.

Our data set allows us to examine some questions that are not possible to examine in the previous chapter. For example, we can assess respective contributions by processing exports in a high-tech incentive zone, normal exports in a similar zone, and processing exports outside the incentive zones to China's export structure sophistication. This allows us to also reach somewhat different conclusions.

To preview some of our key findings, we will argue that it is important to look both at export structure and at the unit value of exports. We will report evidence that neither processing trade nor foreign-invested firms play an important role in generating the increased overlap between China's export structure and that of the high-income countries. Instead, improvement in human capital and government policies in the form of tax-favored high-tech zones appear to contribute significantly to the rising sophistication of China's exports.

Our finding on the role of processing trade in raising export sophistication appears to be different from the previous chapter in part due to the difference in the data sets (and in part due to the difference in the metric used to assess sophistication). Our more finely disaggregated data shows that the contributions to export structure sophistication from processing and normal exports in a high-tech incentive zone are about the same, and those from processing and normal exports outside any incentive zones are also about the same. This leads us to conclude that it is the incentive zones, not processing trade, that are associated with a more sophisticated export structure. Because processing exports are disproportionately located in vari-

ous incentive zones, one may not be able to isolate the effect of processing exports without the more disaggregated data.

An analysis of unit values adds important insights. Processing trade is positively associated with higher unit values. In the absence of data on value added from imported inputs versus domestic inputs, it is difficult to say whether processing trade has generated any skill upgrading for China. However, after controlling for processing trade, exports by foreign-invested firms tend to have systematically higher unit values, suggesting that they produce higher-end product varieties (beyond promoting processing exports). High-tech zones and other policy zones set up by the government are likewise associated with higher unit values (beyond promoting processing trade). Therefore, both foreign investment and government policy zones are conducive to greater product sophistication, by increasing the overlap in China's export structure with that of the advanced economies or by producing higher-end varieties within a given product category.

The rest of the chapter is organized as follows: section 2.2 explains the basic specification and the underlying data, section 2.3 reports a series of statistical analyses, and section 2.4 concludes.

2.2 Specification and Data

Our strategy is to make use of variations across Chinese cities in both export sophistication and its potential determinants to study their relationship. We look at two measures of export sophistication: (a) the similarity between local export structure to that of the G3 economies, and (b) the unit value of local exports. We consider several categories of 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.

2.2.1 Data and Basic Facts

Data on China's exports were obtained from the China Customs General Administration at the HS eight-digit level (the most disaggregated level of classification available). The administration's 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 related to processing trade, as determined by customs declarations) for the period from 1995 through 2005.

We link this database with a separate database on Chinese cities, including gross metropolitan product (GMP) per capita, population, college enrolment, and foreign direct investment (FDI) data, downloaded from China Data Online (a site managed by the University of Michigan China Data

Center). Unfortunately, the coverage of this second database is more limited (240 cities from 1996 through 2004), which effectively constrains the ultimate sample for the statistical analyses. Our sample of cities is listed in table 2A.3.

The exports by the G3 economies at the HS six-digit level come from the United Nations' COMTRADE database, downloaded from the World Integrated Trade Solution (WITS). We wish to focus on manufactured goods, not on natural resources, and have, therefore, excluded the goods in HS chapters 1 to 27 (agricultural and mineral products) and raw materials and their simple transformations (mostly at HS four-digit level) in other HS chapters. A list of excluded products is reported in table 2A.4.

Summary statistics are reported in tables 2.1 to 2.6. From table 2.1, we can see that the fraction of HS six-digit product lines that the advanced economies export but China does not declined over time, from 28.7 percent in 1996 to 13.6 percent in 2005. This is consistent with the possibility of a rapid rise in export sophistication by China.

Table 2.2 reports a breakdown of export value by the ownership of exporters. A number of features are worth noting. First, the share of China's exports produced by state-owned firms declined steadily from 66.7 percent in 1995 to 39.8 percent in 2005. This reduction in the role of state-owned firms in exports mirrors the reduced economic role of the state in general. Second, foreign-invested firms (both wholly foreign-owned firms and Sino-foreign joint ventures) play a significant role in China's exports. Their share of China's exports also grew steadily from 31.5 percent in 1995 to 58.3 percent in 2005. The role played by foreign firms in China's export industries is greater than their role in most other countries with a population over ten million. Third, exports by truly private domestic firms are relatively small, though their share in China's exports has similarly increased over time, from basically nothing before 1997 to 17.8 percent by 2005. Some growth in exports by domestic private firms is achieved by a change in firm ownership. For example, the laptop manufacturer Lenovo was established as a partly state-owned firm. By 2003, it was a privately owned firm. By now, Lenovo has attracted foreign investment, acquired the original IBM PC division, and exported products under the IBM brand.

Table 2.3 reports a breakdown of China's exports into processing trade, normal trade, and other categories according to exporters' customs declarations. Processing exports come from three areas: (a) export processing zones, (b) various high-tech zones, and (c) areas outside any policy zones. Collectively, their share of the country's total exports increased from 43 percent (= 0 + 3.2% + 39.8%) in 1995 to 52 percent (= 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 few developing countries would have a share of processing

Table 2.3 **Share of processing trade and policy zones in China's total exports, 1996–2005 (%)**

Year	Special economic zones (1)	Exports processing zones (2)	Processing exports in high-tech zones (3)	Normal exports in high-tech zones (4)	Processing exports outside policy zones (5)	Normal exports outside policy zones (6)	All other exports[a] (7)
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
Average 1996–2004	6.3	1.3	8.0	2.8	41.7	37.4	2.4

Source: Authors computed based on official trade statistics from China Custom Administration.

[a]Including 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 2.4 **Firm structure across trade and policy zones, 1996–2004 (%)**

	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[a]
1996–2004 average							
State-owned	23.7	0.0	4.8	58.3	28.3	62.5	44.3
Joint-venture	34.3	3.4	33.4	16.9	29.2	13.1	13.0
Wholly foreign	36.3	96.0	61.5	16.3	38.0	6.6	24.0
Collective	1.7	0.6	0.3	1.4	3.1	8.2	4.6
Private	3.8	0.0	0.1	7.1	1.5	9.5	10.4
Total	99.9	100.0	100.0	100.0	100.0	100.0	96.3
1996							
State-owned	29.4		15.6	79.7	40.5	85.7	63.0
Joint-venture	39.5		37.8	13.3	35.2	9.4	10.3
Wholly foreign	30.0		46.2	6.2	22.4	2.2	11.3
Collective	0.9		0.4	0.9	1.9	2.6	3.4
Private	0.0		0.0	0.0	0.0	0.0	0.2
Total	99.8		100.0	100.0	100.0	100.0	88.2
2004							
State-owned	20.5	0.0	2.5	44.0	18.3	41.8	30.3
Joint-venture	30.5	3.0	27.2	16.4	26.3	15.0	15.5
Wholly foreign	37.9	96.5	69.8	23.2	47.9	9.4	29.8
Collective	2.2	0.4	0.2	1.4	3.4	10.3	4.0
Private	9.0	d0.0	0.3	15.1	4.0	23.5	19.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	99.4

Source: Authors computed based on official trade statistics from China Custom Administration.

[a]Including 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 2.5 Summary statistics for city-level variables

	N	Mean	Median	Standard deviation	Min.	Max.
GMP per capita (in log)	1981	8.97	8.89	0.63	7.23	11.48
GMP (in log)	1981	14.74	14.71	0.96	11.16	18.13
Student enrollment in colleges and universities as a share of nonagricultural population	1986	0.016	0.009	0.019	0.000	0.155

Note: GMP = gross metropolitan product.

exports as large as China's. On the other hand, we conjecture that China's reported processing trade may be exaggerated due to some firms' desire to evade tariffs on the domestic sale of imported "inputs."[4]

Table 2.4 tabulates the distribution of firm ownership for exports from each type of policy zone. Foreign-invested firms are dominant in processing exports, accounting for 100 percent of exports out of export processing zones, 95 percent of processing exports out of high-tech zones, and 67 percent of processing exports from the rest of China. State-owned firms account for the bulk of the remaining processing trade. Therefore, wholly and partly foreign-owned firms handle most processing exports. The reverse is not true—foreign firms also engage in normal (i.e., nonprocessing) exports, accounting in 2004 for 40 percent of nonprocessing exports out of high-tech zones and for 24 percent of normal trade outside policy zones.

We can compute a breakdown of export type (processing or nonprocessing) by ownership. The result is reported in table 2.6. For both wholly foreign-owned firms and Sino-foreign joint ventures, processing trade accounts for nearly 50 percent of exports. For state-owned firms and collectively owned firms, the share of processing exports in their total exports is 18 percent and 13 percent, respectively. Domestic private firms engage in comparatively little processing trade, making less than 7 percent of their exports in this category.

As part of its development strategy, China established a number of special economic zones and other areas where special incentives were applied following 1979. Five special economic zones (SEZs) were set up and should be distinguished from other special economic areas. These include all of Hainan province, three cities in Guangdong province (Shenzhen, Zhuhai, and Shantou), and a city in Fujian Province (Xiamen). Other special eco-

4. Fisman and Wei (2004) provide evidence of massive tariff evasion on China's imports. Fisman, Moustakerski, and Wei (2008) suggest that entrepôt trade via Hong Kong may have been used as a conduit for part of the tariff evasion.

Table 2.6 **Summary statistics: other key variables in regression analysis**

	Export dissimilarity index (logged) (1)	Share of processing exports outside policy zones (2)	Share of processing exports in high-tech zones (3)	Share of non-processing exports in high-tech zones (4)	Share of export processing zones (5)
All firms					
N	1,986	1,986	1,986	1,986	1,986
Mean	5.24	0.259	0.0144	0.0068	0.0004
Median	5.26	0.196	0.0000	0.0000	0.0000
SD	0.07	0.233	0.0594	0.0253	0.0057
Min.	4.84	0.000	0.0000	0.0000	0.0000
Max.	5.30	0.996	0.5940	0.4206	0.1534
State-owned firms					
N	1,981	1,981	1,981	1,981	1,981
Mean	5.24	0.168	0.0016	0.0058	0.0000
Median	5.27	0.103	0.0000	0.0000	0.0000
SD	0.06	0.200	0.0105	0.0327	0.0000
Min.	4.92	0.000	0.0000	0.0000	0.0000
Max.	5.30	0.990	0.1822	0.5102	0.0013
Joint-venture firms					
N	1,835	1,835	1,835	1,835	1,835
Mean	5.27	0.430	0.0263	0.0143	0.0004
Median	5.28	0.418	0.0000	0.0000	0.0000
SD	0.04	0.321	0.0875	0.0663	0.0083
Min.	4.95	0.000	0.0000	0.0000	0.0000
Max.	5.30	1.000	0.6985	0.9543	0.3256
Wholly foreign-owned firms					
N	1,552	1,552	1,552	1,552	1,552
Mean	5.27	0.417	0.0448	0.0132	0.0019
Median	5.29	0.378	0.0000	0.0000	0.0000
SD	0.04	0.355	0.1433	0.0481	0.0214
Min.	4.99	0.000	0.0000	0.0000	0.0000
Max.	5.30	1.000	0.9470	0.9898	0.5395
Collectively owned firms					
N	1,640	1,640	1,640	1,640	1,640
Mean	5.28	0.117	0.0021	0.0037	0.0010
Median	5.29	0.001	0.0000	0.0000	0.0000
SD	0.03	0.203	0.0218	0.0228	0.0216
Min.	5.10	0.000	0.0000	0.0000	0.0000
Max.	5.30	1.000	0.5497	0.3115	0.5919
Private firms					
N	1,264	1,264	1,264	1,264	1,264
Mean	5.27	0.055	0.0025	0.0143	0.0000
Median	5.29	0.000	0.0000	0.0000	0.0000
SD	0.04	0.141	0.0378	0.0692	0.0002
Min.	4.96	0.000	0.0000	0.0000	0.0000
Max.	5.30	1.000	1.0000	1.0000	0.0051

Note: SD = standard deviation.

nomic areas are much smaller geographically and are 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 are located within the five SEZs. We will also refer to these incentive zones or areas as "policy zones."

The ETDAs and HTIDAs are tax-favored enclaves established by central or local governments (with approval by the central government) to promote development of sectors designated as "high and new tech," albeit by somewhat poorly defined criteria. In theory, there are differences between the two types of zones. In practice, however, the line between the two is often blurred. The determination of what firms should go into a particular type of zone is somewhat arbitrary; therefore, we group them together in our subsequent discussions. With progressively more ETDAs and HTIDAs being established, their share in China's exports has grown steadily in our sample, from only 4.3 percent in 1995 to 15.4 percent in 2005 (sum of columns [3] and [4] in table 2.3). Because most cities do not yet have such zones, an unweighted average of their share in a city's exports, across all cities and years, comes to only 2 percent (sum of columns [3] and [4] in the top panel of table 2.6).

Dedicated EPZs (which exclusively export processing trade) were first established in 2001 and are present in only twenty-six cities today. By 2005, only 3.5 percent of exports came from all the EPZs together (table 2.3). On simple average (across cities and years), only 0.04 percent of exports come from EPZs. This means that most of China's processing exports are produced outside EPZs. It is useful to bear this in mind when interpreting the regression coefficients in the subsequent tables.

Foreign-invested firms dominate processing exports from EPZs and high-tech zones (in our sample period, 99 percent and 95 percent respectively—see table 2.4) and also took a lion's share of processing trade (67 percent) outside those policy zones. State-owned firms are the major players in normal exports, accounting for 58 percent of normal exports from high-tech zones and 63 percent of normal exports outside policy zones, during our sample period. Though they played a small role in processing trade, collectively owned and private firms produced an important share of China's normal exports, accounting for 8.5 percent of normal exports from high-tech zones and 18 percent of exports outside policy zones (table 2.4).

2.2.2 Basic Specification

We relate the sophistication level of 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 by variations to be noted):

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

where Ln(EDI) is the log of a dissimilarity index between a Chinese city's export structure and the combined export structure of the United States, Japan, and the European Union. β_1 β_2, . . . , β_6 are coefficients to be estimated. μ_{rft} is the error term. Other regressors and the sources of our data are explained in table 2A.1. Robust standard errors, clustered by city, are reported.

We define an index for a lack of sophistication by the dissimilarity between the product structure of a region's exports and that of the G3 economies, or the export dissimilarity index (EDI), as:

$$(2)\qquad \text{EDI}_{rft} = 100\left[\sum_i \text{abs}(s_{irft} - s_{i,t}^{ref})\right],$$

$$(3)\qquad \text{where } s_{irft} = \frac{E_{irft}}{\sum_i E_{irft}},$$

where s_{irft} is the share of HS product i at six-digit level in Chinese city r's exports for firm type f in year t, and $s_{i,t}^{ref}$ is the share of HS product i in the six-digit level exports of G3 developed countries. The greater the value of the index, the more dissimilar the compared export structures are. If the two export structures were 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):

$$(4)\qquad \text{ESI}_{rft} = 100\sum_i \min(s_{irft}, s_{i,t}^{ref})$$

This index is bounded by zero and 100. If Chinese city r's export structure had no overlap with that of the G3 developed countries, then the export similarity index (ESI) would be zero; if the two export structures had a perfect overlap, then the index would take the value of 100. It can be verified that there is a one-to-one, linear mapping between ESI and EDI:

$$(5)\qquad \text{ESI}_{rft} = \frac{200 - \text{EDI}_{rft}}{2}$$

Table 2A.7 reports regressions that use ESI and EDI in levels, respectively, as the dependent variables. It can be seen that the coefficient on any given regressor always has the opposite sign in each of the two specifications. These linear specifications have the drawback that the error term is far from being normally distributed. A better specification would use logged EDI or logged ESI as the dependent variable. However, log(ESI) is related to log(EDI) only nonlinearly. Economic theory does not give much guidance to the exact functional form. Our experimentation suggests that using log(EDI) as the dependent variable is more likely to produce robustly significant coefficients. Most important, the sign patterns on the coefficient estimates are consistent between regressions using logged EDI and EDI, respectively, as the dependent variables, but they are inconsistent between regressions using logged ESI and ESI as the left-hand-side variables. Therefore, in our analysis, we use log(EDI) as the dependent variable.

2.3 Analysis

2.3.1 Basic Results

Our regression results are reported in table 2.7. In the first four columns, the sophistication of a city's export structure is measured on a year-by-year basis by its similarity with that of the G3 high-income countries. As a robustness check, in the last four columns, export sophistication is measured against the export structure of the high-income countries in a fixed year (2004, the last in our sample period). The change in 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 the G3 high-income countries than are 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 "nonprocessing exports from high-tech zones") are negative and significant, implying that the high-tech zones do contribute to raising the sophistication of the Chinese export structure. Comparing the two point estimates, however, one sees that the nonprocessing exports from the two types of high-tech zones in fact contribute more to raising export sophistication than do processing exports.

The coefficient on processing exports outside any policy zones is positive and significant: the more processing trade outside any policy zones, the less sophisticated a city's exports are. Taking the discussion of the last four coefficients together, we argue that processing trade (outside policy zones) is unlikely to have promoted the resemblance of the Chinese export structure

Table 2.7 **What explains cross-city export structure? (export structure dissimilarity between Chinese cities [all firms] and the G3 countries)**

	Yearly benchmark				2004 benchmark			
Explanatory variables	(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)
Nonprocessing 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 nonagricultural population	–0.225*** (0.066)		–0.229*** (0.066)		–0.309*** (0.073)		–0.315*** (0.072)	
Gross metropolitan product (GMP)	–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)
GMP per capita		–0.006** (0.002)		–0.007*** (0.003)		–0.010*** (0.003)		–0.010*** (0.003)
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 (clustered by city)	Y	Y	Y	Y	Y	Y	Y	Y
No. of observations	1,981	1,981	1,981	1,981	1,981	1,981	1,981	1,981
R^2	0.98	0.98	0.98	0.98	0.98	0.97	0.98	0.97

Note: Standard errors in parentheses.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

to that of the high-income countries. This argument is consistent with the intuition that processing trade in many areas of China, excepting policy zones, is relatively labor-intensive.

The coefficient on student enrollment in colleges or graduate schools as a share of a given city's nonagricultural population—a proxy for that 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 2.7, we use GMP per capita 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 more sophisticated export structure.

In columns (3) to (4) of table 2.7, we include measures of the presence of foreign firms in a city. The estimated coefficient for exports by wholly foreign-owned firms as a share of 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 that city's export structure resembles that of the high-income countries. These results suggest that foreign-invested firms in China are not directly responsible for the rising sophistication of China's export structure, or at least not in a simple linear fashion.

As we explained earlier, columns (5) to (8) of table 2.7 replicate the first four columns except that the left-hand-side variables are recalibrated against the export structure of the G3 economies in 2004. The qualitative results remain essentially the same. To summarize the key findings that emerge from the series of regressions in table 2.7, we find the following:

1. Cross-city differences in human capital are linked to cross-city differences in the level of sophistication of export structures. A higher level of human capital, measured either by GMP per capita or by college and graduate school enrollment, is associated with a more sophisticated export structure.
2. High-tech zones are associated with more sophisticated export structures. The higher the share of a city's exports produced in high-tech zones, the more likely that city's export structure is to resemble that of the G3 high-income economies.
3. The EPZs contribute to rising sophistication in export structures. However, because only a small fraction of Chinese cities have EPZs, these play a very small quantitative role in explaining cross-city differences in export-structure sophistication.
4. Processing trade is not generally a major factor in explaining cross-city differences in export-structure sophistication. This can be seen in two ways. First, with regard to exports outside policy zones (which represent the lion's share of all exports), more processing trade is in fact associated with less resemblance to the export structure of the high-income countries.

Second, with regard to exports produced in high-tech zones, nonprocessing trade is more responsible for a resemblance to the export structure of the high-income countries than processing trade.

5. After controlling for exports from major policy zones, foreign investment appears not to play a major role in explaining cross-city differences in the level of sophistication 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 view that China's increasingly sophisticated export structure is the product of processing trade or foreign-invested firms. Meanwhile, these findings confirm the importance of human capital and government-sponsored high-tech zones in increasing the sophistication of China's export structure.

The specification used in table 2.7 includes city fixed effects, as is expected in panel regressions such as ours. However, to ensure that the variables we have proposed—processing trade, foreign ownership, high-tech zones, human capital, and so on—collectively have sufficient explanatory power over observed cross-city export-structure dissimilarities, we have run similar regressions without city fixed effects (see table 2A.8). The signs on the coefficient estimates and their statistical significance are generally similar in table 2A.8 and in table 2.7. Equally important, the values of *R*-square in this second set of regressions lie in the range of 66 to 68 percent. This suggests that much of the cross-city differences in export patterns are explained by the included regressors and not by city fixed effects.

2.3.2 Exports by Firms of Different Ownership

Because China is still transitioning from a centrally planned system to a market-based economy and has become very open to foreign direct investment (as the greatest developing-country recipient of FDI since 1995), its exports are primarily generated by state-owned firms and foreign-invested firms rather than by domestic privately owned firms. State-owned and foreign-invested firms account for 40 percent and 51 percent of China's total exports during our sample period, respectively (table 2.2). It will be beneficial to examine the determinants of export-structure sophistication by firm ownership type.

Table 2.8 reports a series of regressions with the left-hand-side variable being the export-structure dissimilarity index for state-owned firms (but otherwise identically specified as those in table 2.7). The results shown in table 2.8 are qualitatively very similar to those in table 2.7. In particular, differences in the degree of processing trade (outside policy zones) are not shown to be responsible for cross-city differences in export-structure sophistication. If anything, processing trade outside policy zones may have reduced the resemblance of Chinese export structures to those of high-income coun-

Table 2.8 **State-owned firms' export structure dissimilarity relative to the G3 countries**

	Yearly benchmark				2004 benchmark			
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Export processing zone exports as a share of total city exports	–11.88*** (4.040)	–13.21*** (4.427)	–12.16*** (4.016)	–13.49*** (4.411)	–18.84*** (5.449)	–20.83*** (6.099)	–18.97*** (5.431)	–20.96*** (6.089)
Processing exports in high-tech zones as a share of total city exports	–0.010 (0.074)	–0.023 (0.073)	–0.013 (0.074)	–0.027 (0.074)	–0.023 (0.093)	–0.044 (0.091)	–0.025 (0.092)	–0.045 (0.091)
Nonprocessing exports in high-tech zones as a share of total city exports	–0.123** (0.052)	–0.136** (0.053)	–0.124** (0.053)	–0.138** (0.055)	–0.151** (0.066)	–0.171** (0.067)	–0.150** (0.065)	–0.170** (0.067)
Processing exports outside economic zones as a share of total city exports	0.007*** (0.003)	0.006** (0.003)	0.007*** (0.003)	0.007** (0.003)	0.007*** (0.003)	0.007** (0.003)	0.008*** (0.003)	0.007** (0.003)
Student enrollment in institutions of higher education as a share of the city nonagricultural population	–0.166** (0.069)		–0.170** (0.068)		–0.255*** (0.075)		–0.258*** (0.074)	

Gross metropolitan product (GMP)	–0.002* (0.001)	–0.003* (0.001)	–0.003* (0.001)	–0.003* (0.001)	–0.003* (0.001)	–0.003* (0.001)	–0.003* (0.001)	–0.003* (0.001)
GMP per capita		–0.005** (0.002)		–0.005** (0.002)		–0.008*** (0.003)		–0.008*** (0.003)
Foreign-invested firms' share in city exports			0.001 (0.007)	0.002 (0.007)			–0.003 (0.007)	–0.002 (0.007)
Joint-venture firms' share in city exports			0.006 (0.005)	0.005 (0.005)			0.004 (0.005)	0.003 (0.005)
	(0.023)	(0.035)	(0.023)	(0.036)	(0.023)	(0.043)	(0.023)	(0.044)
City fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Robust (clustered by city)	Y	Y	Y	Y	Y	Y	Y	Y
No. of observations	1,976	1,976	1,976	1,976	1,976	1,976	1,976	1,976
R^2	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97

Note: Standard errors in parentheses.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Table 2.9 **Wholly foreign-owned firms' export structure dissimilarity relative to the G3 countries**

	Yearly benchmarks		2004 benchmark	
Explanatory variables	(1)	(2)	(3)	(4)
Export processing zone exports as a share of total city exports	–0.095 (0.059)	–0.097* (0.057)	–0.112 (0.073)	–0.115 (0.071)
Processing exports in high-tech zones as a share of total city exports	–0.017 (0.012)	–0.016 (0.012)	–0.024* (0.014)	–0.022 (0.014)
Nonprocessing exports in high-tech zones as a share of total city exports	–0.013 (0.011)	–0.013 (0.011)	–0.019 (0.014)	–0.019 (0.014)
Processing exports outside economic zones as a share of total city exports	–0.001 (0.001)	–0.001 (0.001)	–0.007 (0.008)	–0.007 (0.008)
Student enrollment in institutions of higher education as a share of the city nonagricultural population	–0.078 (0.063)		–0.080 (0.074)	
Gross metropolitan product (GMP)	–0.005* (0.003)	–0.003 (0.003)	–0.005 (0.004)	–0.003 (0.003)
GMP per capita		–0.012** (0.005)		–0.012** (0.006)
City fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Robust (clustered by city)	Y	Y	Y	Y
No. of observations	1,548	1,548	1,548	1,548
R^2	0.95	0.95	0.81	0.81

Note: Standard errors in parentheses.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

tries. More human capital, as measured by either GMP per capita or college student enrollment, is associated with an increased resemblance of state-owned-enterprise export structures to that of the high-income countries.

Columns (3) to (4) and (7) to (8) of table 2.8 can be interpreted as a test of possible spillover from foreign-invested firms to local state-owned enterprises in any given city.[5] The coefficients on the shares of wholly foreign-owned firms or joint ventures in a city's total exports are essentially zero, statistically. Therefore, the presence by foreign firms in the same industry and in the same city does not appear to affect whether state-owned-enterprise exports resemble those of the high-income countries.

5. Hale and Long (2006) suggest that foreign firms in China generate technological spillover to local firms in part through the reemployment of skilled labor from foreign-invested firms by local firms.

Table 2.10 **Joint-venture firms' exports structure dissimilarity relative to the G3 countries**

	Yearly benchmark		2004 benchmark	
Explanatory variables	(1)	(2)	(3)	(4)
Export processing zone exports as a share of total city exports	0.013 (0.027)	–0.002 (0.030)	0.000 (0.033)	–0.016 (0.036)
Processing exports in high-tech zones as a share of total city exports	–0.005 (0.010)	–0.006 (0.009)	–0.014 (0.009)	–0.015* (0.009)
Nonprocessing exports in high-tech zones as a share of total city exports	0.001 (0.010)	–0.000 (0.009)	0.001 (0.008)	0.001 (0.008)
Processing exports outside economic zones as a share of total city exports	0.001 (0.001)	0.000 (0.001)	0.003* (0.002)	0.002 (0.001)
Student enrollment in institutions of higher education as a share of the city nonagricultural population	–0.094** (0.039)		–0.104** (0.035)	
Gross metropolitan product (GMP)	–0.001 (0.001)	–0.001 (0.001)	–0.001 (0.001)	–0.001 (0.001)
GMP per capita		–0.004* (0.002)		–0.005** (0.002)
City fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Robust (clustered by city)	Y	Y	Y	Y
No. of observations	1,831	1,831	1,831	1,831
R^2	0.97	0.97	0.96	0.96

Note: Standard errors in parentheses.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Tables 2.9 and 2.10 report similar regressions for wholly foreign-owned and Sino-foreign joint-venture firms, respectively. In these tables, unlike in tables 2.7 and 2.8, no regressor except the proxies for human capital is statistically significant. This reinforces our earlier conclusion that, during our sample period, foreign-invested firms did not contribute to the rising sophistication of China's export structure. Tables 2.9 and 2.10 suggest that this is true whether foreign firms are located in EPZs, high-tech zones, or elsewhere. Unfortunately, data limitations prevent us from examining whether FDI from different source countries has differentially promoted the sophistication of China's export structure.[6]

6. Xu and Lu (2007) report differences between firms from Hong Kong, Macao, and Taiwan, and those from the United States and other Organization for Economic Cooperation and Development (OECD) countries.

For completeness, we also examine the dissimilarity index of export structures relative to the G3 economies for collectively and privately owned firms, respectively (see tables 2.11 and 2.12). For each type of firm, a higher level of local human capital is associated with the greater resemblance of its exports to those of the high-income countries. For collectively owned firms alone, there is evidence that processing trade both within and without policy zones may have slowed the rise in the sophistication of these firms' export structures. This is consistent with the possibility that most of these collectively owned firms operate in labor-intensive industries.

For domestic private firms (but not for collectively owned firms), EPZs promote a similar export structure to that of the rich countries. However, EPZs do not exist in most cities. In contrast to the state-owned enterprises, wholly foreign-owned firms or joint ventures in the same city have some impact on private firms' export-structure sophistication; both coefficients are negative (the coefficient for wholly foreign-owned firms is statistically significant). This is evidence that the presence of foreign-invested firms may have helped Chinese private firms increase their export sophistication over the sample period.

2.3.3 Unit Value

Recent literature emphasizes the importance of specialization across varieties within a product (Schott 2004); we now look at cross-city differences in the unit value of the same product, where a product is defined both by its HS eight-digit code and by its physical unit code. For example, HS 94053000 refers to "lighting sets used for Christmas trees," but there are two different physical units used to measure the quantities of exports of this product: number of items and mass in kilograms. We take 94053000 (number of items) and 94503000 (kilograms) as two different products in our estimation.

Our assumption is that different unit values for the same product reflect different varieties (and statistical noise). For example, both high-end and low-end digital cameras fit into the same HS eight-digit product classification, but high-end cameras command a higher unit value. We note, however, that differences in unit value within an eight-digit product category may also reflect factors other than quality, such as differences in production costs (see Hallack 2006; Hallack and Schott 2006). We will assume that these factors generate noise in the mapping of unit value against product variety.

We now investigate the roles of processing trade, high-tech zones, and firm ownership in explaining differences in unit value (which proxy for differences in variety) within a product category. To fix intuition, let us look at two examples. As a first example, color video monitors (HS code 852821) were produced and exported in 2005 by local and foreign-invested firms located in EPZs and high-tech zones and also outside policy zones. The average unit value of monitors produced by foreign-invested firms was $241.50.

Table 2.11 **Collectively owned firms' export structure dissimilarity relative to the G3 countries**

	Yearly benchmark				2004 benchmark			
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Export processing zone exports as a share of total city exports	0.003	–0.005	0.002	–0.006	–0.003	–0.010	–0.004	–0.011
	(0.005)	(0.007)	(0.005)	(0.007)	(0.006)	(0.007)	(0.005)	(0.007)
Processing exports in high-tech zones as a share of total city exports	0.028**	0.020	0.028**	0.019	0.029**	0.020*	0.028**	0.020
	(0.012)	(0.013)	(0.012)	(0.013)	(0.011)	(0.012)	(0.011)	(0.012)
Nonprocessing exports in high-tech zones as a share of total city exports	–0.070**	–0.089**	–0.071**	–0.089**	–0.066**	–0.084**	–0.066**	–0.084**
	(0.029)	(0.036)	(0.029)	(0.036)	(0.028)	(0.034)	(0.029)	(0.035)
Processing exports outside economic zones as a share of total city exports	0.009***	0.008**	0.009***	0.007**	0.010***	0.008***	0.009***	0.008***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Student enrollment in institutions of higher education as a share of the city nonagricultural population	–0.38***		–0.39***		–0.38***		–0.38***	
	(0.075)		(0.075)		(0.078)		(0.078)	
Chinese gross metropolitan product (GMP)	–0.004	–0.005*	–0.004	–0.005*	–0.004	–0.006*	–0.004	–0.006*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Chinese GMP per capita		–0.016**		–0.016**		–0.016**		–0.016**
		(0.005)		(0.005)		(0.005)		(0.005)
Foreign-invested enterprise firms' share in city exports			–0.010	–0.011			–0.013	–0.013
			(0.008)	(0.009)			(0.008)	(0.009)
Joint-venture firms' share in city exports			0.004	0.001			0.003	–0.000
			(0.005)	(0.006)			(0.005)	(0.006)
City fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Robust (clustered by city)	Y	Y	Y	Y	Y	Y	Y	Y
No. of observations	1,636	1,636	1,636	1,636	1,636	1,636	1,636	1,636
R^2	0.89	0.87	0.89	0.88	0.87	0.86	0.87	0.86

Note: Standard errors in parentheses.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Table 2.12 **Private firms' export structure dissimilarity relative to the G3 countries**

	Yearly benchmark				2004 benchmark			
Explanatory variables	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Export processing zone exports as a share of total city exports	–14.28*** (3.640)	–15.86*** (3.825)	–14.02*** (3.589)	–15.51*** (3.896)	–14.97*** (3.778)	–16.68*** (4.016)	–14.44*** (3.782)	–16.00*** (4.224)
Processing exports in high-tech zones as a share of total city exports	–0.006 (0.014)	–0.012 (0.015)	–0.003 (0.014)	–0.009 (0.014)	–0.005 (0.015)	–0.010 (0.016)	0.002 (0.016)	–0.003 (0.016)
Nonprocessing exports in high-tech zones as a share of total city exports	–0.100 (0.072)	–0.109 (0.070)	–0.094 (0.066)	–0.103 (0.064)	–0.096 (0.072)	–0.105 (0.070)	–0.085 (0.061)	–0.093 (0.059)
Processing exports outside economic zones as a share of total city exports	0.007 (0.008)	0.008 (0.007)	0.008 (0.007)	0.008 (0.007)	0.010 (0.008)	0.010 (0.007)	0.010 (0.007)	0.010* (0.006)
Student enrollment in institutions of higher education as a share of the city nonagricultural population	–0.655*** (0.181)		–0.645*** (0.170)		–0.660*** (0.186)		–0.639*** (0.166)	

Gross metropolitan product (GMP)	–0.019 (0.015)	–0.024** (0.010)	–0.021 (0.015)	–0.025** (0.010)	–0.014 (0.014)	–0.020* (0.011)	–0.017 (0.013)	–0.022** (0.010)
GMP per capita		–0.048** (0.020)		–0.050*** (0.019)		–0.040** (0.020)		–0.043** (0.018)
Foreign-invested enterprise firm export share			–0.086*** (0.031)	–0.091*** (0.030)			–0.179** (0.086)	–0.184** (0.087)
Joint-venture firm export share			–0.003 (0.015)	–0.009 (0.015)			–0.009 (0.018)	–0.015 (0.018)
City fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Robust (clustered by city)	Y	Y	Y	Y	Y	Y	Y	Y
No. of observations	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262
R^2	0.75	0.74	0.76	0.76	0.63	0.62	0.68	0.67

Note: Standard errors in parentheses.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Even monitors produced entirely by foreign-invested firms in China showed variations in unit value dependent on where the producer was located and whether the export was of processing trade or normal trade. The unit value of monitors exported from an EPZ was $347.80; processing-export monitors from a high-tech zone were valued at $456.70, while normal-export monitors from the same zone were sold for $364.80; in distinction, processing-export monitors from outside any policy zone were valued at only $56.80, and normal-trade monitors from outside any policy zone cost $73.60. Ownership also matters. The unit value of a monitor was $207.00 when it was exported by a state-owned firm and only $77.20 when it was exported by a domestic private firm. For comparison, the average unit value of the same product, as exported by producers from the United States, the European Union, and Japan was $467.40.[7] Generally speaking, the unit values of the Chinese exports are lower than those from high-income countries. In this example, of the Chinese varieties, the processing-export monitor produced by a foreign firm located in a high-tech zone had the highest unit value, roughly 98 percent of the value of G3 exports, suggesting that it may substitute closely for the high-income countries' variety.

As a second example, video cameras (HS code 852540) were also produced and exported by firms of various ownership, located in areas with different policy incentives. The average unit value for video cameras exported by foreign-invested firms was $51.50 in 2005, compared to $30.20 for a similar camera made by state-owned firms. Both export type and firm location matter as well. Of processing-exports cameras produced by foreign-invested firms, the unit value was $154.60 for exports from a high-tech zone, $66.30 for those from outside any policy zone, and $51.50 for those assembled in an export processing zone. For normal-export cameras made by a foreign firm, the unit value was $21.60 for those from a high-tech zone, and only $13.20 for those from outside any policy zone. Again, processing exports from a high-tech zone had the highest unit value, and normal exports not from any policy zone had the lowest value. Cameras produced by foreign-invested firms generally had a higher unit value than did local firms. For comparison, the average unit value of a camera manufactured in the G3 countries (the United States, Japan, and the European Union) was $331.50. In this example, even China's priciest variety (a processing export made in a high-tech zone by a foreign firm) had a unit value only 47 percent that of the average G3-exported camera. In this example, the variety of video camera made in China is unlikely to substitute closely for that of a wealthy country.

While these examples are illustrative, we must turn to a regression framework to summarize patterns in the data more efficiently and systematically.

7. This figure is taken from information in the UN COMTRADE database; we thank Mark Gehlhar for providing this data.

Additionally, our regression framework explicitly accounts for differences in income across regions, as well as other factors that could account for the differences in unit value. Let $\ln(\text{Unit\_Value}_{rkt})$ denote the natural logarithm of the unit value of city r's export of product k in year t. Our specification relates this variable to city by year fixed effects, product fixed effects, the share of export processing zones in a city's export of a given product, the share of high-tech zones in that city's export of that product (distinguished in regressions between processing and nonprocessing exports), the share of processing trade in that city's export of that product from outside any policy zones, and other control variables.

$$\begin{aligned}(6)\quad \text{Ln}(\text{Unit\_Value}_{rkt}) = {} & \text{city\_year\_fixed} + \text{product\_fixed} \\ & + \beta_1\, \text{EPZ\_share}_{rkt} \\ & + \beta_2\, \text{High\_tech\_zone\_Processing\_Share}_{rkt} \\ & + \beta_3\, \text{Processing\_trade\_outside\_anyzone}_{rkt} \\ & + \beta_4\, \text{High\_tech\_zone\_nonprocessing\_share}_{rkt} \\ & + \text{other\_controls} + \mu_{rkt}\end{aligned}$$

Note that city by year fixed effects are more general than either year fixed effects or city fixed effects. Our regression results are reported in table 2.13. Column (1) shows that both export processing zones and high-tech zones are associated with higher unit values. Of the exports originated from the high-tech zones, those produced by processing trade are linked to higher unit values than those of nonprocessing trade. An increase of 10 percent in processing exports from a high-tech zone as a share of a city's total exports is associated with an increase of 5.9 percent in unit value, whereas an increase of the same magnitude in the share of nonprocessing trade from high-tech zones is associated with a 2.1 percent increase in unit value. An increase of 10 percent in the export share of EPZs in a city's total exports is associated with an increase of 2.1 percent in unit value. With regard to unit value, there is no difference between exports from an export processing zone and nonprocessing exports from a high-tech zone. In comparison, an increase of 10 percent in the share of processing exports originating outside any policy zone is associated with a 1.2 percent increase in unit value. Overall, processing trade appears to be associated with higher-quality varieties than ordinary trade.

To show the role of foreign investment in upgrading the quality of products, column (2) of table 2.13 includes the respective shares of wholly foreign-owned and joint-venture firms in a city's total exports (by HS eight-digit code) as additional regressors. Both new regressors have positive and statistically significant coefficients. An increase of 10 percent in the share of exports made by these two types of firms in a city's total exports of a

Table 2.13 What explains the cross-city difference in the unit values of exports?

Explanatory variables	(1)	(2)	(3)	(4)
Export processing zone exports as a share of total city exports	0.209** (0.058)	0.068 (0.058)	0.050 (0.058)	0.064 (0.058)
Processing exports in high-tech zones as a share of total city exports	0.589** (0.012)	0.429** (0.013)	0.428** (0.013)	0.434** (0.013)
Nonprocessing exports in high-tech zones as a share of total city exports	0.206** (0.008)	0.171** (0.008)	0.172** (0.008)	0.173** (0.008)
Processing exports outside economic zones as a share of total city exports	0.119** (0.004)	0.117** (0.005)	0.117** (0.005)	0.119** (0.005)
Foreign-investment enterprise firm export share		0.198** (0.005)		0.179** (0.005)
Joint-venture firm export share		0.222** (0.004)		0.207** (0.004)
Collective and private firm export share			–0.290** (0.005)	–0.094** (0.004)
State-owned enterprise firm export share			–0.196** (0.004)	
Product fixed effects	Y	Y	Y	Y
City year fixed effects	Y	Y	Y	Y
No. of unique cities	238	238	238	238
No. of unique products	6,473	6,473	6,473	6,473
No. of observations	1,256,999	1,256,999	1,256,999	1,256,999
Adjusted R^2	0.794	0.794	0.794	0.794

Notes: The dependent variable is the natural log of the unit value of Harmonized System six-digit products, from 1996 to 2004. The regressions include city by year fixed effects and product fixed effects. Standard errors are given in parentheses.

**Significant at the 5 percent level.

product tends to be associated with an increase in the unit value of the given product by 2.0 percent and 2.2 percent, respectively. This suggests that products from foreign-invested firms—assigned higher values—are generally of higher quality.

Interestingly, this adjustment renders the share of EPZs statistically insignificant. The coefficients on the shares of processing and ordinary trade out of high-tech zones, and on the share of processing trade outside policy zones, while still positive and statistically significant, are now smaller in magnitude (by more than 2 standard deviations, in two out of the three cases). This suggests that part of the higher–unit value effect, previously attributed to processing trade and high-tech zones, is in fact due to the presence of foreign-invested firms in these activities. As noted in the preceding (table 2.4), during the sample period more than 95 percent of exports originating from EPZs and from processing trade in high-tech zones were produced by foreign-invested firms.

Column (3) of table 2.13 includes a regressor of the combined share of collective and private firms in a city's total exports and one of the share of state-owned firms (this column excludes that of shares held by foreign-invested firms). Column (4) of table 2.13 includes the two types of foreign-invested firms plus the combined share of the collective and domestic private firms (leaving out that of state-owned firms). The shares of exports made by collective and domestic private firms, and by state-owned firms, have negative and statistically significant coefficients, indicating that a larger share of Chinese domestic firms in a city's exports is associated with a lower unit value of those exports. This confirms the intuition that, in a given HS eight-digit product line, foreign-invested firms in China produce relatively higher-quality varieties than do Chinese domestic firms.

Taking these unit value results together, we conclude that processing trade (regardless of its origin), high-tech zones, and foreign invested firms are all independently associated with higher unit values, suggesting that they have each individually played a role in leading China to produce and export higher-quality products than it otherwise would have.

2.4 Conclusion

Are China's exports competing head to head with those of high-income countries? This paper addresses this question by examining variations in export sophistication across different cities in China. It looks at both the overlap in product structure between a city's exports and those of the advanced economies and at the unit values of different products.

Estimation shows that China's export structure as a whole has begun increasingly to resemble that of the G3 advanced economies, and the unit values of its exports are also rising over time. If these patterns are generated entirely by the rise of processing trade, then there may not be much genuine increase in the sophistication of Chinese exports. If there has been increase in sophistication, but one brought about solely by foreign investment in China, then the economic profit associated with improved sophistication has accrued to foreign economies rather than to China's. Of course, increased sophistication can also come from a higher level of local human capital or from government policies set up expressly to promote the upgrading of industrial infrastructure, such as government initiatives establishing high-tech policy zones. Regional variations in the use of processing trade and high-tech zones and the availability of skilled labor are assessed in this paper to determine the relative importance of these factors. Econometric analysis conducted in this study helps to clarify this issue.

1. Cross-city differences in human capital are linked to cross-city differences in the sophistication of export structure. A higher level of human

capital is associated with more sophisticated export structures in Chinese cities.

2. High-tech zones are associated both with more sophisticated export structures and with higher unit values. This indicates that the policy zones (especially ETDZs and HTIDZs) set up by central and local governments may have worked to induce firms to upgrade their product ladder to a higher level than they would have otherwise done. In other words, these policy zones not only promoted processing trade, but they also promoted improvements in the sophistication of China's exports.

3. The EPZs contribute both to the rising sophistication of China's export structure and to the rising unit values of its exports. However, because only a tiny fraction of Chinese cities have EPZs and because most of their exports come from foreign-invested firms, EPZs do not contribute greatly to explaining cross-city differences in export sophistication.

4. Processing trade is not generally a major factor in explaining the cross-city differences in export-structure sophistication. This can be seen in two ways. First, with regard to exports originating outside policy zones (which took up the lion's share of China's total exports during our sample period, about 42 percent), more processing trade is in fact associated with a lesser resemblance to the export structure of advanced countries. Second, with regard to exports originating inside of the high-tech zones, products associated with the processing trade do not appear to overlap more with advanced countries' exports than do those associated with nonprocessing trade.

However, processing trade is significantly associated with higher unit values. How can our findings on export structure and unit values be reconciled? If processing-export production outside the policy zones is generally labor-intensive, a higher share in a given city will increase the dissimilarity of that city's export structure to that of the G3 advanced economies. However, processing exports could still be of higher quality (of greater sophistication) than normal trade exports in the same product line if higher-quality materials are used to manufacture the former. In other words, processing trade moves China into the production and export of more sophisticated varieties within a given product category, but not necessarily within those product categories heavily exported by the G3 advanced economies.[8]

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 structures. If anything, joint-venture firms may create some divergence between a city's export structure and that of the advanced

8. The higher unit values associated with processing exports may simply reflect the higher cost of using imported inputs rather than domestically made inputs. This leaves open the question of whether processing exports generate more value added than do normal exports that use more local or domestic inputs.

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 has been conducive to greater same-product sophistication in China.

Appendix

Table 2A.1 Definition of key variables and their data sources

	Description	Data sources
Dependent variable		
$EDI_{rft} = (iabs[s_{irft} - sref\backslash i,t])$	Absolute export structure dissimilarity index	Calculated by the authors from the Harmonized System six-digit level. Chinese city exports based on official China Customs Statistics. Data on U.S., EU15, and Japanese exports downloaded from World Integrated Trade Solution.
Explanatory variables		
GMP	Gross metropolitan product (10,000 yuan)	China city data, China Data Online
$GMPpc_{rt} = 100\ GMP_r/POP_r$	Chinese GMP per capita (yuan)	China city data, China Data Online
$SKILL_{rt} = 100$(no. of college students)rt/(nonagricultural population)$_{rt}$	Student enrollment in institutions of higher education as a share of the city nonagricultural population	China city data, China Data Online
EPZ_share_{rft}	Export processing zone exports as a share of total city exports	China Customs Statistics
$High\_tech\_zone\_processing\_share_{rft}$	Processing exports in the two high-tech zones as a share of total city exports	China Customs Statistics
$High\_tech\_zone\_nonprocessing\_share_{rft}$	Nonprocessing exports in the two high-tech zones as a share of total city exports	China Customs Statistics
$Processing\_outside\_anyzone\_share_{rft}$	Processing exports outside policy zones as a share of total city exports	China Customs Statistics

(*continued*)

Table 2A.1 (continued)

	Description	Data sources
$Expfiesh_{rft}$	Foreign-invested enterprise firm exports as share of total city exports	China Customs Statistics
$Expjonsh_{rft}$	Joint-venture firm exports as share of total city exports	China Customs Statistics
$expothsh_{rft}$	Collective and private firm exports as share of total city exports	China Customs Statistics
$expsoesh_{rft}$	State-owned enterprise firm exports as share of total city exports	China Customs Statistics

Table 2A.2 **Years of establishment of economic zones, by incentive type**

City code	City name	Special economic zone	Economic and 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

Table 2A.2 (continued)

City code	City name	Special economic zone	Economic and technological development area	Hi-technology industry development area	Export processing zone
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	
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 did not have any policy zone between 1996 and 2005 are not listed.

Table 2A.3 Chinese cities included in the sample used in regressions (236 in total)

Code	City name	Province	Code	City name	Province	Code	City name	Province
1100	Beijing	Beijing	3404	Huainan	Anhui	4313	Huaihua	Hunan
1200	Tianjin	Tianjin	3405	Maanshang	Anhui	4401	Guangzhou	Guangdong
1301	Shijiazhuang	Hebei	3406	Huaibei	Anhui	4402	Shaoguan	Guangdong
1302	Tangshan	Hebei	3407	Tongling	Anhui	4403	Shenzhen	Guangdong
1303	Qinhuangdao	Hebei	3408	Anqing	Anhui	4404	Zhuhai	Guangdong
1304	Handan	Hebei	3409	Huangshan	Anhui	4405	Shantou	Guangdong
1305	Xingtai	Hebei	3410	Fuyang	Anhui	4406	Foshan	Guangdong
1306	Baoding	Hebei	3411	Suxian	Anhui	4407	Jiangmen	Guangdong
1307	Zhangjiakou	Hebei	3412	Chuxian	Anhui	4408	Zhanjiang	Guangdong
1308	Chongde	Hebei	3413	Liuan	Anhui	4409	Maoming	Guangdong
1309	Changzhou	Hebei	3414	Xuancheng	Anhui	4412	Zhaoqing	Guangdong
1310	Langfang	Hebei	3415	Chaohu	Anhui	4413	Huizhou	Guangdong
1401	Taiyuan	Shanxi	3416	Chizhou	Anhui	4414	Meizhou	Guangdong
1402	Datong	Shanxi	3502	Xiamen	Fujian	4415	Shanwei	Guangdong
1403	Yangquan	Shanxi	3503	Putian	Fujian	4416	Heyuan	Guangdong
1404	Changzhi	Shanxi	3504	Sanming	Fujian	4417	Yangjiang	Guangdong
1405	Jincheng	Shanxi	3505	Quanzhou	Fujian	4418	Qingyuan	Guangdong
1406	Suozhou	Shanxi	3506	Zhangzhou	Fujian	4419	Dongguan	Guangdong
1410	Jinzhong	Shanxi	3507	Nanpin	Fujian	4420	Zhongshan	Guangdong
1501	Hohhot	Inner Mongolia AR	3509	Longyian	Fujian	4421	Chaozhou	Guangdong
1502	Baotou	Inner Mongolia AR	3601	Nanchang	Jiangxi	4424	Jieyang	Guangdong
1503	Wuhai	Inner Mongolia AR	3602	Jingdezhen	Jiangxi	4501	Nanning	Guangxi Zhuan AR
1504	Chifeng	Inner Mongolia AR	3603	Pingxiang	Jiangxi	4502	Liuzhou	Guangxi Zhuan AR
1507	Holunbeir	Inner Mongolia AR	3604	Jiujiang	Jiangxi	4503	Guilin	Guangxi Zhuan AR
2101	Shenyang	Liaoning	3605	Xingyu	Jiangxi	4504	Wuzhou	Guangxi Zhuan AR
2102	Dalian	Liaoning	3606	Yingtan	Jiangxi	4505	Beihai	Guangxi Zhuan AR
2103	Anshan	Liaoning	3607	Ganzhou	Jiangxi	4507	Baise	Guangxi Zhuan AR

2104	Fushen	Liaoning
2105	Benxi	Liaoning
2106	Dandong	Liaoning
2107	Jinzhou	Liaoning
2108	Yingkou	Liaoning
2109	Fuxin	Liaoning
2110	Liaoyang	Liaoning
2111	Panjin	Liaoning
2112	Tieling	Liaoning
2113	Chaoyang	Liaoning
2201	Changchun	JiLin
2202	Jilin	JiLin
2203	Sipin	JiLin
2204	Liaoyuan	JiLin
2205	Tonghua	JiLin
2209	Baicheng	JiLin
2301	Harbin	Heilongjing
2302	Qiqihar	Heilongjing
2303	Jixi	Heilongjing
2304	Hegang	Heilongjing
2305	Shuangyashan	Heilongjing
2306	Daqing	Heilongjing
2307	Yichun	Heilongjing
2308	Jiamusi	Heilongjing
2309	Qitaiher	Heilongjing
2310	Mudanjiang	Heilongjing
2311	Heihe	Heilongjing
3100	Shanghai CY	Shanghai CY
3201	Nanjing	Jiangsu
3202	Wuxi	Jiangsu
3203	Xuzhou	Jiangsu
3611	Fuzhou	Jiangxi
3701	Jinan	Shandong
3702	Qingdao	Shandong
3703	Zibo	Shandong
3704	Zaozhuang	Shandong
3705	Dongying	Shandong
3706	Yantai	Shandong
3707	Weifang	Shandong
3708	Jining	Shandong
3709	Taian	Shandong
3710	Weihai	Shandong
3711	Rizhao	Shandong
3713	Dezhou	Shandong
3714	Liaochen	Shandong
3715	Linyi	Shandong
3720	Laiwu	Shandong
4101	Zhengzhou	Henan
4102	Kaifeng	Henan
4103	Luoyang	Henan
4104	Pindinshan	Henan
4105	Anyang	Henan
4106	Hebi	Henan
4107	Xinxiang	Henan
4108	Jiaozhuo	Henan
4109	Puyang	Henan
4110	Xuchang	Henan
4111	Luohe	Henan
4112	Sanmenxia	Henan
4113	Shangqiu	Henan
4116	Nanyang	Henan
4117	Xinyang	Henan
4508	Hechi	Guangxi Zhuan AR
4509	Qinzhou	Guangxi Zhuan AR
4516	Hezhou Area	Guangxi Zhuan AR
4601	Haikou	Hainan
4602	Sanya	Hainan
5000	Chongqing	Chongqing
5101	Chengdu	Sichuan
5103	Zigong	Sichuan
5104	Panzhihua	Sichuan
5105	Luzhou	Sichuan
5106	Deyang	Sichuan
5107	Mianyan	Sichuan
5108	Guangyuan	Sichuan
5109	Suining	Sichuan
5110	Neijiang	Sichuan
5111	Leshan	Sichuan
5114	Yibin	Sichuan
5115	Nanchong	Sichuan
5116	Daxian	Sichuan
5201	Guiyang	Guizhou
5202	Liupanshan	Guizhou
5203	Zunyi	Guizhou
5301	Kunming	Yunnan
5303	Zhaotong	Yunnan
5304	Qujing	Yunnan
5306	Yuxi	Yunnan
5314	Lijiang	Yunnan
6101	Xi'an	Shanxi
6102	Tongzhou	Shanxi
6103	Baoji	Shanxi
6104	Xianyang	Shanxi

(*continued*)

Table 2A.3 (continued)

Code	City name	Province	Code	City name	Province	Code	City name	Province
3204	Changzhou	Jiangsu	4201	Wuhan	Hubei	6105	Weinan	Shanxi
3206	Nantong	Jiangsu	4202	Huangshi	Hubei	6106	Hanzhong	Shanxi
3207	Lianyungang	Jiangsu	4203	Shiyan	Hubei	6108	Shangluo	Shanxi
3208	Huaiyin	Jiangsu	4205	Yichang	Hubei	6109	Yanan	Shanxi
3209	Yancheng	Jiangsu	4206	Xiangfan	Hubei	6110	Yulin	Shanxi
3210	Yangzhou	Jiangsu	4207	Ezhou	Hubei	6201	Lanzhou	Gansu
3211	Zhenjiang	Jiangsu	4208	Jingmen	Hubei	6202	Jiayuguan	Gansu
3217	Suqian	Jiangsu	4209	Huanggang	Hubei	6203	Jinchang	Gansu
3301	Hangzhou	Zhejiang	4210	Xiaogan	Hubei	6204	Baiyin	Gansu
3302	Ningbo	Zhejiang	4211	Xianning	Hubei	6205	Tianshiu	Gansu
3303	Wenzhou	Zhejiang	4212	Jingzhou	Hubei	6206	Jiuquan	Gansu
3304	Jiaxing	Zhejiang	4301	Changsha	Hunan	6207	Zhangye	Gansu
3305	Huzhou	Zhejiang	4302	Zhuzhou	Hunan	6208	Wuwei	Gansu
3306	Shaoxing	Zhejiang	4303	Xiangtan	Hunan	6211	Pinliang	Gansu
3307	Jinhua	Zhejiang	4304	Hengyang	Hunan	6212	Qingyang	Gansu
3308	Quzhou	Zhejiang	4305	Shaoyang	Hunan	6301	Xining	Qinghai
3309	Zhoushan	Zhejiang	4306	Yueyang	Hunan	6401	Yinchuan	Ningxia Hui AR
3311	Taizhou	Zhejiang	4307	Changde	Hunan	6402	Shizuishan	Ningxia Hui AR
3401	Hefei	Anhui	4309	Yiyang	Hunan	6501	Urumqi	Xinjiang AR
3402	Wuhu	Anhui	4310	Loudi	Hunan	6502	Kelamayi	Xinjiang AR
3403	Bangbu	Anhui	4311	Chenzhou	Hunan			

Table 2A.4 Harmonized System (HS) products excluded from export data

HS code	Description	HS code	Description
01–24	Agricultural products	25–27	Mineral products
4103	Other raw hides and skins (fresh, o	8002	Tin waste and scrap
4104	Tanned or crust hides and skins of	8101	Tungsten (wolfram) and articles the
4105	Tanned or crust skins of sheep or l	8102	Molybdenum and articles thereof, in
4106	Tanned or crust hides and skins of	8103	Tantalum and articles thereof, incl
4402	Wood charcoal (including shell or n	8104	Magnesium and articles thereof, inc
4403	Wood in the rough, whether or not s	8105	Cobalt mattes and other intermediate
7201	Pig iron and spiegeleisen in pigs,	8106	Bismuth and articles thereof, inclu
7202	Ferro-alloys	8107	Cadmium and articles thereof, inclu
7204	Ferrous waste and scrap; remelting	8108	Titanium and articles thereof, incl
7404	Copper waste and scrap	8109	Zirconium and articles thereof, inc
7501	Nickel mattes, nickel oxide sinters	8110	Antimony and articles thereof, incl
7502	Unwrought nickel	8111	Manganese and articles thereof, inc
7503	Nickel waste and scrap	8112	Beryllium, chromium, germanium, van
7601	Unwrought aluminium	8113	Cermets and articles thereof, inclu
7602	Aluminium waste and scrap	9701	Paintings, drawings and pastels, ex
7801	Unwrought lead	9702	Original engravings, prints and lit
7802	Lead waste and scrap	9703	Original sculptures and statuary, i
7901	Unwrought zinc	9704	Postage or revenue stamps, stamp-po
7902	Zinc waste and scrap	9705	Collections and collectors' pieces
8001	Unwrought tin	9706	Antiques of an age exceeding 100 years
530521	Coconut, abaca (Manila hemp or Musa	811252	Beryllium, chromium, germanium, van

Table 2A.5 **Correlation matrix for key variables (all firms)**

	Export dissimilarity index (logged)	GMP per capita (logged)	GMP (in logged)	Share of joint-venture firm exports	Share of FIE firm exports	Student enrollment in colleges and universities as a share of nonagricultural population	Share of processing exports outside policy zones	Share of processing exports in the two high-tech zones	Share of nonprocessing exports in the two high-tech zones	Share of export processing zone
Export dissimilarity index (in log)	1.00									
GMP per capita (logged)	–0.61	1.00								
GMP (logged)	–0.72	0.62	1.00							
Share of joint-venture firm exports	–0.13	0.09	0.12	1.00						
Share of FIE firm exports	–0.35	0.26	0.23	0.05	1.00					
Student enrollment in colleges and universities as a share of nonagricultural population	–0.47	0.41	0.49	–0.06	0.03	1.00				
Share of processing exports outside policy zones	–0.20	0.08	0.05	0.40	0.33	–0.12	1.00			
Share of processing exports in the two high-tech zones	–0.47	0.32	0.34	0.09	0.43	0.19	0.03	1.00		
Share of nonprocessing exports in the two high-tech zones	–0.40	0.30	0.35	0.05	0.14	0.30	–0.03	0.42	1.00	
Share of export processing zone	–0.27	0.18	0.19	0.02	0.14	0.16	0.00	0.19	0.27	1.00

Notes: GMP = gross metropolitan product; FIE = foreign-invested enterprises.

Table 2A.6 **Correlation matrix for key variables, unit value (all firms)**

	Unit value of city exports (in log)	Share of joint-venture firm exports	Share of FIE firm exports	Share of processing exports outside policy zones	Share of processing exports in the two high-tech zones	Share of nonprocessing exports in the two high-tech zones	Share of export processing zone	Share of SOE exports	Share of collective and private firm exports
Unit value of city exports (in log)	1.00								
Share of joint-venture firm exports	0.03	1.00							
Share of FIE firm exports	0.01	–0.07	1.00						
Share of processing exports outside policy zones	0.01	0.29	0.30	1.00					
Share of processing exports in the two high-tech zones	0.05	0.10	0.19	–0.01	1.00				
Share of nonprocessing exports in the two high-tech zones	0.05	0.04	0.05	–0.06	0.02	1.00			
Share of export processing zone	0.01	0.00	0.06	0.00	0.00	0.00	1.00		
Share of SOE exports	–0.01	–0.52	–0.43	–0.30	–0.14	–0.05	–0.03	1.00	
Share of collective and private firm exports	–0.03	–0.13	–0.11	–0.10	–0.04	–0.01	0.00	–0.57	1.00

Note: FIE = foreign-invested enterprise; SOE = state-owned enterprise.

Table 2A.7 **What explains cross-city export structure?**

	Export dissimilarity index				Export similarity index			
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Export processing zone exports as a share of total city exports	–45.89*** (9.01)	–50.98*** (6.62)	–46.02*** (8.58)	–51.63*** (6.54)	22.94*** (4.50)	25.49*** (3.31)	23.01*** (4.29)	25.81*** (3.27)
Processing exports in high-tech zones as a share of total city exports	–10.73*** (2.88)	–11.49*** (3.34)	–11.22*** (2.82)	–12.16*** (3.27)	5.36*** (1.44)	5.75*** (1.67)	5.61*** (1.41)	6.08*** (1.64)
Nonprocessing exports in high-tech zones as a share of total city exports	–14.70** (7.37)	–18.24** (8.72)	–15.88** (7.35)	–19.47** (8.65)	7.35** (3.68)	9.12** (4.36)	7.94** (3.68)	9.73** (4.33)
Processing exports outside economic zones as a share of total city exports	0.956* (0.533)	0.725 (0.533)	0.722 (0.523)	0.445 (0.524)	–0.478* (0.266)	–0.363 (0.267)	–0.361 (0.261)	–0.222 (0.262)
Student enrollment in institutions of higher education as a share of the city nonagricultural population	–36.93*** (11.40)		–37.60*** (11.35)		18.46*** (5.70)		18.80*** (5.67)	
Gross metropolitan product (GMP)	–0.443* (0.233)	–0.467** (0.236)	–0.495** (0.242)	–0.520** (0.243)	0.222* (0.117)	0.234** (0.118)	0.248** (0.121)	0.260** (0.122)
GMP per capita		–1.04** (0.425)		–1.15*** (0.436)		0.520** (0.213)		0.575*** (0.218)
Foreign-invested firms' share in city exports			0.465 (0.989)	0.839 (1.018)			–0.233 (0.494)	–0.419 (0.509)
Joint-venture firms' share in city exports			1.91*** (0.68)	1.95*** (0.69)			–0.953*** (0.34)	–0.976*** (0.345)
City fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Robust (clustered by city)	Y	Y	Y	Y	Y	Y	Y	Y
No. of observations	1,981	1,981	1,981	1,981	1,981	1,981	1,981	1,981
R^2	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98

Notes: Standard errors in parentheses. Export dissimilarity index and export similarity index in levels as dependent variables.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Table 2A.8 What explains cross-city export structure, excluding city fixed effects?

	Yearly benchmark				2004 benchmark			
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Export processing zone exports as a share of total city exports	–1.139*** (0.271)	–1.101*** (0.261)	–1.049*** (0.26)	–1.044*** (0.256)	–1.208*** (0.269)	–1.175*** (0.253)	–1.120*** (0.258)	–1.119*** (0.247)
Processing exports in high-tech zones as a share of total city exports	–0.234*** (0.055)	–0.200*** (0.059)	–0.179*** (0.055)	–0.165*** (0.059)	–0.215*** (0.051)	–0.182*** (0.055)	–0.160*** (0.051)	–0.148*** (0.054)
Nonprocessing exports in high-tech zones as a share of total city exports	–0.15 (0.191)	–0.198 (0.185)	–0.169 (0.193)	–0.216 (0.186)	–0.143 (0.17)	–0.192 (0.168)	–0.161 (0.172)	–0.209 (0.169)
Processing exports outside economic zones as a share of total city exports	–0.047*** (0.012)	–0.036*** (0.011)	–0.037*** (0.012)	–0.032*** (0.011)	–0.044*** (0.011)	–0.032*** (0.01)	–0.034*** (0.011)	–0.029*** (0.01)
Student enrollment in institutions of higher education as a share of the city nonagricultural population	–0.741*** (0.149)		–0.787*** (0.151)		–0.733*** (0.138)		–0.779*** (0.14)	
Gross metropolitan product (GMP)	–0.039*** (0.004)	–0.035*** (0.004)	–0.038*** (0.005)	–0.036*** (0.004)	–0.036*** (0.004)	–0.034*** (0.004)	–0.036*** (0.004)	–0.034*** (0.004)
GMP per capita		–0.027*** (0.006)		–0.027*** (0.006)		–0.026*** (0.006)		–0.025*** (0.006)
Foreign-invested firms' share in city exports			–0.066*** (0.019)	–0.043** (0.019)			–0.064*** (0.018)	–0.043** (0.018)
Joint-venture firms' share in city exports			0.007 (0.011)	0.015 (0.01)			0.006 (0.01)	0.013 (0.01)
City fixed effects	N	N	N	N	N	N	N	N
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Robust (clustered by city)	Y	Y	Y	Y	Y	Y	Y	Y
No. of observations	1,981	1,981	1,981	1,981	1,981	1,981	1,981	1,981
R^2	0.66	0.67	0.67	0.67	0.67	0.67	0.68	0.68

Notes: Standard errors given in parentheses. (log [export dissimilarity index]) as the dependent variable.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

References

Finger, J. Michael, and M. E. Kreinin. 1979. A measure of "export similarity" and its possible uses. *Economic Journal* 89:905–12.
Fisman, Raymond, Peter Moustakerski, and Shang-Jin Wei. 2008. Outsourcing tariff evasion: A new explanation for entrepot trade. *Review of Economics and Statistics,* forthcoming.
Fisman, Raymond, and Shang-Jin Wei. 2004. Tax rates and tax evasion: Evidence from "missing trade" in China. *Journal of Political Economy* 112 (2): 471–96.
Fontagne, Lionel, Guillaume Gaulier, and Soledad Zignago. 2007. Specialisation across varieties within products and North-South competition. CEPII Working Paper no. 2007-06. Paris: Centre d'Etude Prospectives et d'Informations Internationales, May.
Hale, Galina, and Cheryl Long. 2006. What determines technological spillovers of foreign direct investment: Evidence from China. Federal Reserve Bank of San Francisco, Working Paper no. 2006-13. http://ideas.recpec.org/p/fip/fedfwp/2006-13.html.
Hallack, Juan Carlos. 2006. Product quality and the direction of trade. *Journal of International Economics* 68 (1): 238–65.
Hallack, Juan Carlos, and Peter Schott. 2005. Estimating cross-country differences in product quality. Yale University, Working Paper.
Hausmann, Ricardo, Jason Hwang, and Dani Rodrik. 2005. What you export matters. NBER Working Paper no. 11905. Cambridge, MA: National Bureau of Economic Research.
Hummels, David, and Peter Klenow. 2005. The variety and quality of a nation's exports. *American Economic Review* 95:704–23.
Rodrik, Dani. 2006. What's so special about China's exports? NBER Working Paper no. 11947. Cambridge, MA: National Bureau of Economic Research.
Schott, Peter. 2004. Across-product versus within-product specialization in international trade. *Quarterly Journal of Economics* 119 (2): 647–78.
———. 2006. The relative sophistication of Chinese exports. NBER working paper no. 12173. Cambridge, MA: National Bureau of Economic Research.
Xu, Bin. 2007. Measuring China's export sophistication. China Europe International Business School.
Xu, Bin, and Jiangyong Lu. 2007. The impact of foreign firms on the sophistication of Chinese exports. China Europe International Business School and Tsinghua University, Working Paper.

Comment Galina Hale

Zhi Wang and Shang-Jin Wei present us with a thorough and convincing study of the growing sophistication of Chinese exports in recent years and of the forces behind this trend. We learn that improvements in human capital and tax incentives for high-tech zones are responsible for the expansion

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