

# The Relative Sophistication of Chinese Exports\*

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## Abstract

This paper examines the relative “sophistication” of China’s exports to the United States across and within product markets. First, I analyze how the set of products China exports to the United States compares with that of the OECD. Second, I examine Chinese export prices relative to OECD export prices within product markets. Across products, I find China’s export overlap with the OECD to be much greater than one would predict given its size and relative level of development. Within product markets, however, I show that Chinese varieties are priced lower than OECD varieties, and that the Chinese relative price is falling over time in some industries. These results suggest that OECD countries may be adapting to competition from low-wage countries like China by moving up the quality ladder. Policies in developed economies that facilitate the relocation of workers from comparative-disadvantage to comparative-advantage industries will aid in distributing the welfare gains from trade associated with trade liberalization.

*Keywords:* Chinese exports; Product Trade; Export Unit Values

*JEL classification:* F1; F2; F4

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## 1. Introduction

Speculation about the impact Chinese growth will have on developed and developing countries over the coming decade varies widely. Some observers predict the imminent end of manufacturing in developed economies like the United States and Europe, while others believe low- and middle-income countries are the most at risk. This paper analyzes very detailed information about countries' international trade with the United States to gain a better understanding about which countries are most susceptible to competition from China. It considers both the breadth of product markets China has entered over the last three decades as well as changes in the relative quality of Chinese products within these product markets as identified by relative prices. These data show that China's penetration of the U.S. market has been substantial over the last three decades, and that its export bundle overlaps significantly more with developed economies than one would expect given its size and level of development. On the other hand, the quality of Chinese goods is below that of the OECD and does not appear to be catching up in most manufacturing industries.

Conventional models of international trade imply that developed countries like the United States and those in the EU have little to fear and much to gain from the emergence of China. In these models, comparative advantage drives countries to specialize in unique subsets of goods that don't compete directly on world markets. In models where comparative advantage flows from countries' relative endowments of capital, skill and labor, extremely labor-abundant countries like China are expected to produce and export relatively labor-intensive goods such as toys and t-shirts. More capital- and skill- abundant countries like Germany, on the other hand, ought to manufacture and export capital- and skill-intensive goods such as pharmaceuticals and electron microscopes.

The extent to which countries specialize in different sets of goods influences how directly their workers compete, and is therefore a key determinant of the distributional implications of globalization. When all countries produce the same products, price-wage arbitrage implies that reductions in the world price of goods influences wages in all countries. If China's entry into the world toy market leads to a sharp reduction in the price of toys, for example, then the wages of the low-skill workers that make toys will be driven down in every country. If, on the other hand, China produces toys and Germany does not, low-skill German workers only gain from the emergence of China: their nominal wages are unaffected by the surge in toy exports, and the decline in toy prices leads to an increase in the amount of income they can spend on other products.

Though the intuition for these outcomes is motivated by specialization that takes place *across* products, specialization might also occur within products. In that case, specialization may be merely an artifact of how products are classified in international trade datasets: if the product codes used to measure trade are too aggregate they will erroneously place goods that are essentially different into the same product clas-

sification. A product classification for televisions, for example, might include both high-definition televisions and conventional tube televisions.

On the other hand, differences in countries' exports even within very narrow product classifications may reflect a more subtle phenomenon – vertical differentiation: Japan and China might both produce and export high-definition televisions, for example, but the Japanese television might employ more sophisticated technology, be of much higher quality, or contain a richer set of attributes than the one being shipped from China. These vertical differences should manifest in prices, with Japanese televisions fetching a much higher price in the U.S. market than Chinese televisions. As with *across*-industry specialization, *within*-industry specialization based on vertical differentiation influences the degree to which workers in developed economies are insulated from workers in developing countries. Intuitively, the less substitutable goods of greater and less sophistication are, the less strong is price-wage arbitrage and the more insulated the workers in the two types of countries will be.

To learn more about potential impact of Chinese competition on developed country outcomes, this paper uses U.S. import data to assess the relative sophistication of the Chinese export bundle both across and within products over time. First, I compare the range of manufacturing product categories China exports to the United States between 1972 and 2001 with the range of manufacturing product categories exported by other countries, notably the developed economies in the OECD. I assume that the more similar a non-OECD country's export bundle is to the OECD, the more sophisticated its exports are revealed to be in the across-product dimension.

Surprisingly, I find that China's export bundle overlaps with that of the OECD much more substantially than one would expect given either its level of development or its size. In addition, I find that this "excess" similarity with the OECD on the part of China is increasing with time. Between 1972 and 2001, China's rank in terms of the similarity of its export bundle with the OECD jumped from nineteen to four. This increase was driven by relatively rapid penetration of U.S. product markets. Indeed, while China was present in just 9 percent of all manufacturing product categories in 1972, it was present in 70 percent of categories by 2001. No other country's growth in product penetration comes close to this increase. Even groups of countries have a hard time matching progress on this dimension during the sample period. Product penetration for all of Latin America, for example, increased from 38 percent in 1972 to 67 percent in 2001.

I examine export prices within product categories for evidence of vertical differentiation. It is well known in the international trade literature that countries' export prices vary positively with their level of development, that is, with their per capita GDP (PCGDP) or their relative endowments of capital and skill versus labor.<sup>1</sup> This finding is consistent with the idea that countries use their endowment or technological

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<sup>1</sup>See, for example, Schott (2004), Hummels and Klenow (2005) and Hallak (2006).

advantages to embed higher levels of sophistication in their goods, and that consumers pay a higher price for this higher sophistication.

In the analysis below, I compare the prices China receives for its exports in the U.S. market to those received by other countries as well as those received by the composite OECD. I find that Chinese export prices were relatively high compared with countries at a similar level of development during the 1970s and 1980s, but that this trend reversed in the 1990s. In comparison with the OECD, I find that Chinese export prices are consistently lower than those of OECD countries, and that this “quality” gap between China and the OECD is increasing with time in some industries.

This finding suggests that competition between China and the world’s most developed economies might be lower than their overlap in product markets suggests. Moreover, the increasing gap in export quality between the OECD and China suggests developing economies might be responding to the emergence of China and other low-wage countries by “moving up” or “moving out”, that is, by raising the sophistication of their exports or dropping the least-sophisticated varieties from their export bundle. Upgrading of this sort is consistent with models of product cycling in the international trade literature, and it implies that the world’s most skill- and capital- abundant economies will continue to specialize in the most sophisticated products even as they cede production of lower-end goods to less-developed economies. This churning induces a continuous reallocation of economic resources in developed economies to their highest and best use. Contrary to what some critics argue, it suggests that China will not drive manufacturing out of high-wage countries entirely.

The connection between globalization and international product cycling highlighted in this paper should be an important consideration in the development of public policy. Indeed, it implies that policy makers place greater emphasis on *workers* rather than on *jobs*, that is, on facilitating workers’ ability to move between firms rather than on maintaining jobs oriented toward the production of less-sophisticated goods that will disappear eventually anyway. Policies consistent with this goal should offer workers opportunities for retraining and education both during their working life as they transition between jobs as well as prior to their entering the workforce. Indeed, there should be no expectation on the part of workers in the most developed economies that their countries will remain technological leaders unless their relative levels of human capital per worker remain very high.

The remainder of this paper is structured as follows. Section 2 provides a brief overview of relevant theories of international trade; Section 3 describes the major results of the paper, Sections 4 and 5 discuss how these results might be interpreted, and Section 6 concludes by highlighting areas where future research might be most helpful.

## 2. Theory

The analysis in this paper is guided by the Heckscher-Ohlin model, which has countries' product mix varying with their relative factor endowments. This model can be used both to understand why countries specialize according to comparative advantage and to gain insight into the relationship between specialization and the distributional implications of international trade. This section also discusses so-called “new” trade theory models that predict a connection between country size and the number of horizontally differentiated varieties a country will produce, as well as the impact of horizontal differentiation on countries' terms of trade.

### 2.1. *The Heckscher-Ohlin Model*

A two-factor (capital,  $K$ , and labor,  $L$ ) version of the Heckscher-Ohlin model is displayed in the Lerner diagram in Figure 1. This diagram features dollar-value isoquants for four industries – Apparel, Textiles, Machinery and Chemicals – which differ in terms of their capital intensity. Each isoquant traces out the amounts of capital and labor that can be combined to produce one dollar's worth of output in the noted industry. Given their relative positions in the figure, apparel is the most labor-intensive industry while chemicals is the most capital intensive: it takes relatively more capital to produce a dollar's worth of chemicals than a dollar's worth of apparel. Under standard assumptions, the four industries' unit-value isoquants carve out three “cones of diversification”, i.e., three sets of relative endowment vectors selecting a unique mix of two industries.<sup>2</sup> A country's endowments of capital and labor determine the cone in which it resides. In the figure, the capital-abundant countries of the EU inhabit the most capital-abundant cone, while relatively capital scarce China is in the most labor-abundant cone. The countries of Latin America are assumed to reside in the middle cone.

Because production of an industry outside of the cone in which a country resides results in negative profit, GDP-maximizing countries specialize in the two industries anchoring their cones of diversification, i.e., the two industries whose input intensities are most closely related to their endowments.<sup>3</sup> The negative profits that the relatively capital-abundant countries of the European Union would earn in labor-intensive apparel and textiles, for example, can be seen by comparing the amount of capital and labor that can be bought for one dollar in the EU (via the downward sloping isocost line defined by  $r_{EU}$  and  $w_{EU}$ ) with the amount of capital and labor needed to produce one dollar's worth of output (via the dollar-value isoquants). A key message of Figure 1 is that relatively high production costs keep industries out of industries at

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<sup>2</sup>Dixit and Norman (1980) and Leamer (1980) provide detailed discussions of these assumptions and their implications.

<sup>3</sup>See Leamer (1987) for a generalization of these implications to higher-dimensional settings.

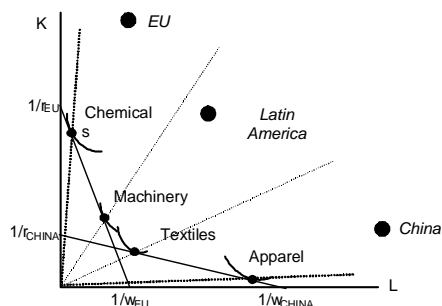


Figure 1: International Specialization in According to Relative Factor Endowments

odds with their comparative advantage.

The Heckscher-Ohlin model provides useful insight into the relationship between specialization and relative wages across countries. In the endowment-driven specialization depicted in Figure 1, for example, the EU is insulated from goods-price changes caused by the emergence of China. If China's entry into world markets drives down the price of labor-intensive Apparel, the relative returns to capital and labor in any country producing these goods will also change. In the figure, this is because of "price-wage" arbitrage, i.e., the fact that relative wage lines are defined by goods prices: when the price of a good falls, it takes more capital and labor to produce one dollar's worth of output, so the isocost lines tangent to the dollar-value isoquants adjust.

In Figure 1, relative wages in the EU are unaffected by China's entry into the Apparel market. That is because its specialization breaks wage-price arbitrage: its participation in industries other than those exported by China means that its relative wages are determined solely by prices in those other industries. Indeed, if China were to drive down the price of apparel, EU workers would benefit by having more income available to spend on other products.

Trade barriers, of course, can provide incentives for countries to act against their comparative advantage. Import tariffs (which are assumed to be zero in Figure 1) drive a wedge between the price of a good inside a country and its price on world markets, that is, the prices displayed in the figure. If the EU were to impose sufficiently high import tariffs on apparel, then production of apparel in the EU would be profitable because the distorted EU price would cover its relatively high production costs. In that case, trade liberalization would necessitate the loss of apparel industry jobs and their tariff-protected wages. As tariffs are removed, EU firms that found it profitable to produce apparel under tariff protection would drop those products or fail outright. Resources freed up from these adjustments would move towards

firms producing chemicals and machinery, that is, industries consistent with the EU's comparative advantage. As discussed in greater detail below, evidence in favor or such reallocations has been found in examinations of U.S. firms' responses to trade liberalization.

In a similar way, trade policies that promote exports in China can increase the range of products Chinese firms export to the United States. Under those circumstances, the observed export overlap between China and the OECD would be artificially high, a possibility pursued further below.

The specialization displayed in Figure 1 provides intuition for the first dimension of across-product sophistication developed in this paper. Because countries' product mix is a function of the relative similarity of their endowments, China and the EU are predicted to have few industries in common.<sup>4</sup> Thus, one method for gauging the "closeness" of competition between China and the OECD is to look across product categories and ask how many products they export in common to a third country like the United States.

A slight change in perspective also renders Figure 1 useful for understanding the second dimension of export sophistication relied upon in this paper – vertical differentiation. For that intuition, one should reinterpret the industry isoquants in Figure 1 as representing vertically differentiated products in a single industry. Instead of apparel, textiles, machinery and chemicals, consider four different types of televisions: cheap black-and-white tube televisions, color tube televisions, rear-projection televisions and plasma displays. These vertically differentiated products might each be located on a separate dollar-value isoquant in the figure, and countries would choose to produce a different level of quality in the television market depending upon their relative endowments. Empirically, if such vertical differentiation takes place within the product classification codes used to track countries' international trade, it might be discerned by examining the relative prices of countries' exports within these product categories. That is the strategy I rely upon below.

## 2.2. *New Trade Theory*

A key implication of the Heckscher-Ohlin model is that trade between two countries increases with the disparity in their comparative advantage. This implication is at first sight hard to reconcile with the observation that a large share of international trade takes place within industries between relatively similar trading partners (Grubel and Lloyd 1975). Germany and the United States, for example, carry on a robust two-way trade in automobiles.

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<sup>4</sup>In the figure, Latin America occupies the middle cone of diversification, with the labor-intensive portion of its product mix overlapping that of China and the capital-intensive portion of its product mix overlapping that of the EU. In a more general, three-factor setting, these overlaps might be less extreme given Latin American land abundance. For a more detailed discussion of the potential effects of Latin American resource abundance on development, see Leamer et al. (1999).

This dissonance between theory and data has led to the development of “new” trade theory models that emphasize consumer love of variety and horizontal product differentiation as drivers of international trade (see, for example, Krugman 1980). In these models, firms “specialize” in distinct horizontal varieties (e.g., Volkswagens and Fords), and consumers’ love of variety induces countries to engage in intra-product trade. An important implication of these models for the purposes of this study is that the number of horizontal varieties a country produces is predicted to be a function of the resources at its disposal – that is, the overall size of its economy or labor force. Hummels and Klenow (2005), for example, find a positive correlation between country size and the number of product categories countries export.

Besides being relatively skill scarce, China’s labor force, of course, is quite large. Thus, a key implication for China from new trade theory models is that China will produce a greater number of varieties than smaller countries, all else equal. To the extent that the industry or product classifications used to track international trade capture such horizontal differentiation, one would expect it to have greater product penetration than smaller countries, and this implication is consistent with the patterns observed below.

On the other hand, if horizontal product differentiation takes place within narrow product categories – e.g., green shoes versus brown shoes versus red shoes – our ability to detect it using existing trade datasets is greatly diminished. In any case, the relatively large price differences observed between countries within narrowly defined product categories is more suggestive of vertical rather than horizontal differentiation, as is the correlation between these prices and countries’ levels of development.<sup>5</sup>

### *2.3. GDP Growth and the Terms of Trade*

A third literature in international trade that provides insight into how the relative sophistication of countries’ export can be measured considers the impact of economic growth on countries’ terms of trade. The classical argument (e.g., Johnson 1958) is that economic growth depresses a countries’ terms of trade because the greater supply of exports associated with this growth leads to a decline in export prices. As noted above, this effect might be moderated or overturned by vertical differentiation, as the capital and skill deepening that occurs concomitant with development leads countries into cones of diversification anchored by more sophisticated products. Results in Schott (2004), for example, offer support for the view that developing countries’ on relatively fast development tracks experience relatively rapid growth in export prices.

A negative correlation between economic growth and export prices might also be mitigated by horizontal differentiation: by increasing exports via variety proliferation rather than by exporting more and more of a given variety, downward pressure on

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<sup>5</sup>See Hallak and Schott (2006) for a discussion of how to identify separately vertical and horizontal product differentiation within product categories.

export prices can be averted (Krugman 1989, Corsetti et al Forthcoming). As noted above, identifying this outcome in international trade datasets is difficult if horizontal differentiation occurs within product categories.

### 3. The Relative Sophistication of Chinese Exports

This section uses product-level U.S. international trade data to assess the relative sophistication of Chinese exports both across and within product markets. After describing the data and China’s overall trends in terms of market share and product penetration, I report the main results of the paper.

#### 3.1. Data

Product-level trade data provide much sharper resolution of the sophistication of countries’ export bundles than traditionally available industry-level trade data for two reasons. First, while all countries generally export in all industries (e.g., “machinery”), they exhibit substantial heterogeneity in their product participation within industries. Second, product-level international trade data permit examination of trading-partner heterogeneity *within* product markets via unit values (e.g., “dollars per dozen shirts”).

The data used in this paper are drawn from Feenstra et al. (2002). They record the customs value of all U.S. imports by exporting country and year from 1972 to 2001 according to thousands of finely detailed categories, which I refer to as ‘products’ or ‘goods’. Imports are classified according to seven-digit Tariff Schedule of the United States (TSUSA) codes from 1972 through 1988 and according to the ten-digit Harmonized System (HS) codes from 1989 through 2001. As discussed further below, this break in the use of product codes in 1989 places some limits on our ability to track countries’ exports at the product-level over time. I refer to imports at higher levels of aggregation, such as the one- or five-digit Standard International Trade Classification (SITC) system, as ‘industries’. Note that SITC industry codes are defined consistently throughout the sample period. I refer to country-specific imports within product categories as ‘varieties’.

Table 1 lists the number of product categories by one-digit SITC industry in both 1972 and 2001. SITC codes beginning with 0 through 4 comprise resource products, while those beginning with 5 through 8 encompass manufacturing goods, which are the focus of this study. Two of the manufacturing industries, Manufactured Materials (SITC 6) and Miscellaneous Manufactures (SITC 8) – which include textiles and apparel, respectively – account for the largest share of products in both periods. Machinery (SITC 7), on the other hand, experiences the largest increase in the number of product categories over the sample period. Because of their idiosyncrasy, I exclude products from SITC 9 (Not Elsewhere Classified) from the analysis.

One-Digit SITC	Two-Digit SITC Examples	Product Examples	Number of Five-Digit SITC	Number of Products (1972 / 2001)
0 Food	Meat, Dairy, Fruit	Live Sheep	197	703 / 1898
1 Beverage/Tobacco	Wine, Cigarettes	Carbonated softdrinks	17	75 / 167
2 Crude Materials	Rubber Cork, Wood, Textile Fibers	Silkworm cocoons suitable for reeling	175	646 / 812
3 Mineral Fuels	Coal, Coke, Petroleum	Unleaded gasoline	26	49 / 98
4 Animal/Vegetable Oils	Lard, Soybean Oil	Edible tallow	24	58 / 77
5 Chemicals	Organic Chemicals, Dyes, Medicines, Fertilizer, Plastics	Chloroform	251	757 / 2036
6 Manufactured Materials	Leather, Textile Yarn, Paper, Steel	Diaries and address books of paper or cardboard	445	2862 / 4426
7 Machinery	Generators, Computers, Autos	Ultrasonic scanning apparatus	298	648 / 3076
8 Misc Manufacturing	Apparel, Footwear, Scientific Equipment, Toys	Boys' shorts cotton playsuit parts, not knit	258	1869 / 3704
9 Not Elsewhere Classified	Special Transactions, Coins, Gold	Sound recordings for State Department use	9	50 / 86

Notes: Products refer to seven-digit TSUSA categories for 1972 and ten-digit Harmonized System (HS) categories for 2001. SITC industries are consistently defined across the sample period and are therefore the same in both 1972 and 2001

Table 1: Products by SITC1 Industry

To facilitate the comparison of countries' export bundles and unit values, I make use of the country-region assignments provided in Table 2. Three aspects of how countries are assigned to regions deserve mention. First, Latin America includes all of the countries of Central and South America, plus Mexico. Second, I define the OECD as the 23 members in place as of 1974 in order to exclude Korea, Mexico and other, more recent entrants. The resulting set of countries captures a more uniform mix of high-wage, developed economies during the sample period.<sup>6</sup> It should also be noted that my mapping of countries into regions places Japan in the OECD group rather than the Asia group. Finally, the actual set of countries within each region used in computing any given summary statistic may vary depending upon data availability.

<sup>6</sup>Even so, the 1974 cohort still includes Ireland and Turkey.

Country	Region	Country	Region	Country	Region
Afghanistan	AS	Bahamas	CAR	Suriname	LA
American Samoa	AS	Barbados	CAR	Uruguay	LA
Bangladesh	AS	Dom Rep	CAR	Venezuela	LA
Cambodia	AS	Guadeloupe	CAR	Australia	OECD
China	AS	Haiti	CAR	Austria	OECD
Fiji	AS	Jamaica	CAR	Belgium	OECD
Hong Kong	AS	Neth Antilles	CAR	Canada	OECD
India	AS	St. Kitts and Nevis	CAR	Denmark	OECD
Indonesia	AS	Trinidad	CAR	Finland	OECD
Kiribati	AS	Argentina	LA	France	OECD
Korea	AS	Belize	LA	Germany	OECD
Lao	AS	Bolivia	LA	Greece	OECD
Macao	AS	Brazil	LA	Iceland	OECD
Malaysia	AS	Chile	LA	Ireland	OECD
Mongolia	AS	Colombia	LA	Italy	OECD
Myanmar	AS	Costa Rica	LA	Japan	OECD
Nepal	AS	Ecuador	LA	Netherlands	OECD
New Caledonia	AS	El Salvador	LA	New Zealand	OECD
Pakistan	AS	Guatemala	LA	Norway	OECD
Papua New Guinea	AS	Guyana	LA	Portugal	OECD
Philippines	AS	Honduras	LA	Spain	OECD
Singapore	AS	Mexico	LA	Sweden	OECD
Sri Lanka	AS	Nicaragua	LA	Switzerland	OECD
Taiwan	AS	Panama	LA	Turkey	OECD
Thailand	AS	Paraguay	LA	UK	OECD
Vietnam	AS	Peru	LA		

Notes: Countries sorted alphabetically by region. Region affiliations are mutually exclusive. AS=Asia. CA=Caribbean; LA=Latin America. OECD definition excludes post-1973 entrants (e.g. Mexico and Korea).

Table 2: U.S. Trading Partners by Region

My comparison of Chinese and other countries' trade patterns proceeds under the assumption that U.S. trading partners' exports to the U.S. accurately reflects their domestic production as well as their exports to other markets. This assumption is partially justified by the relative openness of the U.S. economy and its attractiveness as an export destination. Nevertheless, the existence of tariff and non-tariff barriers (e.g., the Multifiber Arrangement), as well as more general trade costs such as transportation, can be influential in determining which of a country's goods are exported, and to which trading partner they are sent.<sup>7</sup>

### 3.2. The Sources of China's Export Growth

To provide greater context for understanding U.S. trading partners' export similarity, I briefly compare China's performance in the U.S. market in terms of market share and product penetration to that of other regions. Even cursory analysis reveals that China's performance in these dimensions has been exceptional.

Table 3 reports the U.S. market share of Asia, Latin America, the OECD and China in terms of import value ( $V$ ), by industry, for the first and last years of the sample. The market share of region  $r$  in year  $t$  and industry  $i$  is

$$MS_{tri} = 100 * \frac{\sum_{c \in r} V_{tci}}{\sum_c V_{tci}}, \quad (1)$$

<sup>7</sup>Deardorff 2004, for example, discusses how transport costs influences countries' "local" comparative advantage.

where  $c$  indexes countries and  $c \in r$  captures the set of countries in region  $r$ . Recall that the results for Asia *exclude* China and Japan and that market shares across the columns of Table 3 do not sum to 100 percent because all U.S. trading partners are not represented.

SITC1 Industry	China		Asia		Latin America		OECD	
	1972	2001	1972	2001	1972	2001	1972	2001
5 Chemicals	0	3	2	5	6	5	85	80
6 Manufactured Materials	0	9	10	14	5	12	79	54
7 Machinery	0	7	5	19	2	17	93	56
8 Misc Manufacturing	0	26	29	22	4	15	63	31
Overall Manufacturing	0	11	11	18	3	15	83	52

Notes: Cells display the market share of each region's or country's exports to the U.S. Asia results exclude China.

Table 3: U.S. Import Value Market Share by Region and Year

The market shares displayed in Table 3 convey several messages. First, they show that exports from the world's most developed economies, proxied here by the aggregate OECD, dominate the U.S. market, though less so over time. While the OECD accounted for 83 percent of manufacturing imports in 1972, this share falls to 52 percent by 2001. Second, they reveal that China is the main contributor to Asia's overall growth. China's share of manufacturing imports increases steadily from just above 0 percent in 1972 to 11 percent in 2001, driven by a relatively large gain in Miscellaneous Manufacturing (which includes apparel and toys). By comparison, over the same interval, the remaining countries in Asia saw their market share increase from 11 percent to 18 percent.

China's 11 percentage point jump in market share dominates all other U.S. trading partners except for Mexico. Table 4 reports the countries with the top ten absolute changes in manufacturing market share between 1972 and 2001. China tops the list, with only Mexico coming close.

Country	1972	2001	Change	%Change
China	0.04	10.99	10.95	27383
Mexico	1.96	12.08	10.12	516
Malaysia	0.42	2.35	1.93	465
Korea	1.79	3.70	1.92	107
Ireland	0.25	1.94	1.69	682
Thailand	0.19	1.34	1.15	590
Singapore	0.58	1.51	0.93	162
Philippines	0.27	1.16	0.89	335
Indonesia	0.04	0.92	0.88	2061
Israel	0.53	1.25	0.72	137
Brazil	0.50	1.16	0.65	130
Average	1.05	1.04	0.00	0

Notes: Table lists U.S. trading partners with the top ten absolute changes in U.S. manufacturing import market share between 1972 and 2001.

Table 4: U.S. Trading Partners with the Largest Gains in Market Share (Absolute and Percent Growth), 1972 to 2001

Table 5 summarizes regions' manufacturing product penetration by industry over the sample period. Each cell in the table reports the percent of products in each

industry exported by China or the countries in the other noted regions. Regional penetration is 100 percent if every product in the industry is exported by at least one country in the region and zero percent if no country exports any of the industry's products to the United States.<sup>8</sup> As above, results for Asia exclude China.

SITC1 Industry	China		Asia		Latin America		OECD	
	1972	2001	1972	2001	1972	2001	1972	2001
5 Chemicals	4	62	16	63	22	49	98	98
6 Manufactured Materials	7	63	45	79	34	68	96	98
7 Machinery	1	72	56	85	51	73	100	99
8 Misc Manufacturing	16	81	72	87	45	70	98	96
Overall Manufacturing	9	70	51	80	38	67	97	98

Notes: Cells display share of products in the industry that are exported to the U.S. by at least one country from the region. Asia results exclude China.

Table 5: Product Penetration by Region and Year

As indicated in the table, product penetration by the OECD is virtually 100 percent throughout the sample period. Table 5 also shows that product penetration by Asian and Latin American countries, though substantially lower than the OECD in 1972, has increased markedly over time. Finally, Table 5 reveals that China, by itself, has experienced a very large increase in product penetration, from 9 percent of all products in 1972 to 70 percent by 2001. Table 6, which ranks countries with the biggest absolute gains in penetration between 1972 and 2001, shows that China's 61 percentage point increase is the largest of any trading partner by a factor of two.

Country	1972	2001	Change	% Change
China	9	70	61	678
Korea	19	51	32	172
Mexico	26	56	29	112
Thailand	6	32	26	456
India	19	43	25	132
Taiwan	30	54	24	80
Indonesia	2	25	23	1145
Canada	52	73	21	40
Malaysia	3	23	19	568
Italy	51	69	18	35
Brazil	14	31	17	125
Average	7	12	5	82

Notes: Table lists U.S. trading partners with the top ten absolute changes in U.S. manufacturing import product penetration between 1972 and 2001.

Table 6: U.S. Trading Partners with the Largest Gains in Manufacturing Product Penetration, 1972 to 2001

Overall, China's nominal exports to the United States grew substantially from \$15 million to \$99 billion between 1972 and 2001. To help gauge the relative importance of product penetration in this increase, I decompose China's export growth into that which is attributable to continuously produced goods (the "intensive" margin) and that which is due to the net adding and dropping of products (the "extensive" margin). Table 7 performs this decomposition using five-digit SITC industries rather than the

<sup>8</sup>The total number of products in each industry in 1972 and 2001 is reported in the final column of Table 1.

product categories used in Table 5 because, as noted above, only SITC industries are consistent over the entire sample period.

Decompositions are performed by decade as well as for the entire sample period. Results are shown for overall manufacturing exports to the United States (final two rows) as well by manufacturing industry.

Industry	Margin	1972-81	1981-91	1991-2001	1972-2001
5 Chemicals	Intensive Margin	60	83	93	25
	Extensive Margin	40	17	7	75
6 Manufactured Materials	Intensive Margin	72	90	98	56
	Extensive Margin	28	10	2	44
7 Machinery	Intensive Margin	1	73	100	2
	Extensive Margin	99	27	0	98
8 Misc Manufacturing	Intensive Margin	67	73	100	64
	Extensive Margin	33	27	0	36
Overall Manufacturing	Intensive Margin	65	75	100	41
	Extensive Margin	35	25	0	59

Notes: Table decomposes nominal Chinese export growth to the United States over the noted intervals according to the net increase due to continuously exported five-digit SITC industries (the "intensive margin") and the net growth due to the adding and dropping of industries (the "extensive margin"). Amounts are rounded to the nearest integer; there are no true zeros in the table.

Table 7: Decomposing China's U.S. Export Growth, 1972 to 2001

As indicated in the table, the relative contributions of the intensive and extensive margins vary widely across time periods and industries. Nonetheless, across industries the extensive margin is relatively more important in the first two decades of the sample than in the last decade. This trend is particularly noticeable in Machinery, less so in Manufactured Materials and Miscellaneous Manufacturing. Across the entire 1972 to 2001 sample period, the extensive margin was responsible for 59 percent of China's total manufacturing export growth.

### 3.3. *Export-Bundle Similarity: Across-Product Sophistication*

This section gauges the relative sophistication of China's manufacturing export bundle in terms of its similarity to that of the aggregate OECD. Three findings stand out. First, China's export similarity with the OECD increases substantially over the sample period, and far more than for any other U.S. trading partner. Second, China's export similarity with the OECD is higher than one would expect given either its relative level of development or its size. Finally, China's "excess" similarity with the OECD appears to be increasing with time.

I measure the overlap in countries' export bundles via Finger and Kreinin's (1979) export similarity index ( $ESI$ ). For any two U.S. trading partners  $c$  and  $d$  in year  $t$ , the export similarity index is

$$ESI_{tcd} = \sum_p \min(s_{tpc}, s_{tpd}), \quad (2)$$



Note: Figure displays the distribution of non-OECD countries' export similarity index (ESI) vis a vis the OECD over ten-year intervals between 1972 and 2001. Boxes outline the interquartile range, while lines within each box report the median.

Figure 2: Distribution of Non-OECD Countries  $ESI$  with the OECD, 1972 to 2001

where  $s_{tpc}$  is the value share of country  $c$ 's exports in manufacturing product  $p$  in year  $t$ . This bilateral measure can be computed using all manufacturing products or by manufacturing industry. In either case the index is bounded by zero and unity:  $ESI_{tcd} = 0$  if countries  $c$  and  $d$  have no products in common in year  $t$  and  $ESI_{tcd} = 1$  if their exports are distributed identically across products. To compare two regions (or to compare a region with China), I sum exports over countries in the region and then use region-level rather than country-level export shares in equation 2.

Figure 2 displays a box-and-whisker plot of non-OECD U.S. trading partners'  $ESI$  with the OECD at ten-year intervals from 1972 to 2001. The box for each year spans the inter-quartile range of the data, while lines within the boxes record the median observations in each year. Circles above the whiskers represent individual observations. The key message of the figure is that non-OECD countries' product-mix overlap with the OECD is generally increasing with time.

Table 8 reports China's export similarity with Asia (which excludes China), Latin America and the OECD at ten-year intervals from 1972 to 2001. As indicated in the table, China's overlap is generally higher with the other countries of Asia than with either the OECD or Latin America. Over time, however, China's overlap with countries outside Asia has grown substantially.

Region	Export Similarity with China			
	1972	1981	1991	2001
Asia	0.14	0.28	0.40	0.36
Latin America	0.05	0.11	0.18	0.23
OECD	0.05	0.07	0.12	0.20

Notes: Table displays each region's export similarity index (see text) with China. Asia excludes China.

Table 8: Regions' Export Similarity with China

China's export overlap with the OECD has increased far more than for any other U.S. trading partner. Table 9 reports the twenty countries whose export bundle most resembles the OECD at ten-year intervals over the sample period. As indicated in the table, China's *ESI* increase from 0.05 to 0.20 results in its rank jumping from 19 in 1972 (near India) to a rank of 4 in 2001 (just behind Taiwan). In the table, China's rank is highlighted in bold text.

	1972		1981		1991		2001
Mexico	0.18	Korea	0.17	Mexico	0.29	Mexico	0.31
Brazil	0.15	Brazil	0.16	Korea	0.23	Korea	0.28
Taiwan	0.14	Mexico	0.16	Taiwan	0.21	Taiwan	0.22
Israel	0.11	Taiwan	0.15	Brazil	0.20	<b>China</b>	<b>0.20</b>
Korea	0.11	Israel	0.14	Hong Kong	0.17	Brazil	0.19
Argentina	0.11	Hong Kong	0.12	Singapore	0.16	Israel	0.17
Hong Kong	0.11	Singapore	0.11	Israel	0.15	Hong Kong	0.15
Czech Republic	0.10	Argentina	0.09	Thailand	0.13	Thailand	0.14
Poland	0.10	Poland	0.09	Malaysia	0.13	Poland	0.14
Yugoslavia	0.10	South Africa	0.09	<b>China</b>	<b>0.12</b>	India	0.13
Colombia	0.07	Czech Republic	0.08	Argentina	0.11	Singapore	0.13
South Africa	0.07	Yugoslavia	0.08	Venezuela	0.10	Malaysia	0.13
Venezuela	0.06	Romania	0.08	Yugoslavia	0.09	Indonesia	0.12
Singapore	0.06	India	0.08	Hungary	0.09	Philippines	0.11
Hungary	0.05	Hungary	0.08	Philippines	0.08	Argentina	0.10
Romania	0.05	Venezuela	0.08	India	0.07	Hungary	0.10
Cyprus	0.05	<b>China</b>	<b>0.07</b>	Poland	0.07	South Africa	0.09
Gibraltar	0.05	Philippines	0.06	Czech Republic	0.06	Panama	0.08
<b>China</b>	<b>0.05</b>	Panama	0.06	Indonesia	0.06	Romania	0.08
India	0.05	Colombia	0.05	Colombia	0.05	Venezuela	0.07

Notes: Table displays non-OECD countries with the highest manufacturing export similarity index (*ESI*) with the OECD at ten-year intervals from 1972 to 2001.

Table 9: Countries with the Highest Export Similarity to the OECD

Regression analysis reveals that China's manufacturing export similarity with the OECD is substantially higher than that of countries with similar relative endowments or overall size, and that China's premium in this dimension is increasing with time. Table 10 reports coefficients from an OLS regression of trading partners' *ESI* with the OECD on countries' relative development or size and a China dummy variable,

$$ESI_{tc} = \alpha_t + \beta X_{tc} + \gamma CHINA_{tc} + \varepsilon_{tpc}, \quad (3)$$

where  $X_{tc}$  is a country characteristic,  $CHINA_{tc}$  is a dummy variable equaling unity if the observation is for China, and  $\alpha_t$  is a year fixed effect. Robust standard errors adjusted for clustering at the country level are reported below coefficients, most of which are statistically significant at the 1 percent level. Two country characteristics are examined. The first, World Bank PPP-adjusted real per capita GDP, is a proxy for country's capital and skill abundance and is used to capture the influence of endowment-driven comparative advantage. I use PCGDP rather than an explicit measure of capital abundance because the latter are unavailable for a large set of countries or for the full 1972 to 2001 sample period.<sup>9</sup> The second country character-

<sup>9</sup>Results are qualitatively similar if a measure of educational attainment is used, though the number of observations drops substantially; see discussion below. Results using an explicit measure of capital per worker (e.g., from the Penn World Tables), based on a shorter time period and smaller

	ESI <sub>ct</sub>	ESI <sub>ct</sub>	ESI <sub>ct</sub>	ESI <sub>ct</sub>	ESI <sub>ct</sub>	ESI <sub>ct</sub>
Log (Real PCGDP <sub>ct</sub> )	0.014 *** 0.003		0.007 *** 0.002	0.014 *** 0.003		0.007 *** 0.002
Log (Real GDP <sub>ct</sub> )		0.015 *** 0.003	0.013 *** 0.003		0.015 *** 0.003	0.013 *** 0.003
China Dummy	0.093 *** 0.003	0.013 0.014	0.030 ** 0.013			
China 70s				0.049 *** 0.005	-0.031 *** 0.011	-0.010 0.012
China 80s				0.070 *** 0.003	-0.010 0.014	0.008 0.013
China 90s				0.141 *** 0.003	0.061 *** 0.016	0.075 *** 0.015
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,015	3,015	3,015	3,015	3,015	3,015
R <sup>2</sup>	0.22	0.42	0.45	0.22	0.42	0.45

Notes: Table reports OLS regression results of non-OECD countries' manufacturing export similarity with the OECD (ESI) on countries' real per capita GDP and GDP from 1972 to 2001. Explanatory variables include an aggregate China dummy as well as this dummy interacted with dummies for the 1970s (i.e.,1972-1979), 1980s (i.e.,1980-1989) and 1990s (i.e.,1990-2001). Robust standard errors adjusted for clustering at the country level reported below each coefficient. \*\*\* denotes statistical significance at the 1 percent level.

Table 10: Export Similarity Index with the OECD and Country Attributes

istic I examine is country size, measured by World Bank PPP-adjusted real GDP.<sup>10</sup> Examining the impact of country size captures the ideas driving new-trade-theory models, as noted above.

The results in the first three columns of Table 10 indicate that export similarity with the OECD is positively and significantly related to countries' level of development and size. As a result, these findings provide support for the implications of both conventional and new trade theory. Neither framework, however, is sufficient to explain China's performance. As indicated in the third column of the table, China's export similarity index with the OECD is approximately 3 percentage points higher than other countries even after controlling for both size and level of development.<sup>11</sup> Comparison of this increase with the distributions displayed in Figure 2 indicate that it is substantial.

The final three columns of Table 10 provide more insight into how China's excess overlap with the OECD is evolving over time. These columns replace the single China dummy variable in the first three columns with an interaction of the *CHINA* dummy and three decade dummies, i.e., one for the 1970s (1972 to 1979), one for the 1980s (1980 to 1989) and one for the 1990s (1990 to 2001). The sign and significance pattern

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set of countries, provides similar results. Below, I use Barro and Lee (2000) educational attainment data to proxy for skill abundance. Their use here leads to results that are qualitatively similar to the PCGDP results.

<sup>10</sup>Results are qualitatively similar if population is used instead.

<sup>11</sup>Rodrik (2006) also finds evidence in favor of the excess sophistication of Chinese exports in terms of China being an exporter of products that tend to be exported by high-income countries.

	5 - Chemicals ESI <sub>ct</sub>	6 - Manuf Materials ESI <sub>ct</sub>	7 - Machinery ESI <sub>ct</sub>	8 - Misc Manuf ESI <sub>ct</sub>
Log (Real PCGDP <sub>ct</sub> )	0.007 ** 0.003	0.006 ** 0.002	0.009 *** 0.003	0.012 *** 0.003
Log (Real GDP <sub>ct</sub> )	0.013 *** 0.002	0.016 *** 0.003	0.016 *** 0.003	0.019 *** 0.003
China 70s	-0.014 0.011	-0.024 * 0.014	-0.016 0.012	0.025 ** 0.012
China 80s	0.067 *** 0.011	0.013 0.016	0.026 * 0.014	0.025 ** 0.012
China 90s	0.106 *** 0.012	0.077 *** 0.017	0.080 *** 0.017	0.069 *** 0.013
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	2,364	2,902	2,598	2,975
R <sup>2</sup>	0.45	0.45	0.49	0.54

Notes: Table reports OLS regression results of non-OECD countries' manufacturing export similarity by industry with the OECD (ESI) on countries' real per capita GDP and GDP from 1972 to 2001. Explanatory variables include an aggregate China dummy interacted with dummies for the 1970s (i.e., 1972-1979), 1980s (i.e., 1980-1989) and 1990s (i.e., 1990-2001). Robust standard errors adjusted for clustering at the country level reported below each coefficient. \*\*\* and \*\* denote statistical significance at the 1 percent and 5 percent levels, respectively.

Table 11: Export Similarity Index with the OECD and Country Attributes, by Industry

of these coefficients indicates that China's excess similarity with respect to both its relative level of development and its size has increased steadily over time. Coefficients on the dummy variables in the final regression, for example, progress from -0.010 to 0.008 to 0.075, though only the latter is statistically significantly different from zero.

Table 11 reveals a similar patten of results across one-digit SITC manufacturing industries. As indicated in the table, China's excess similarity with respect to its level of development in 1990 is positive and significantly different from zero in each industry, ranging from a low of 0.069 in Miscellaneous Manufacturing to a high of 0.106 in Chemicals.

### 3.4. Unit-Value Similarity: Within-Product Sophistication

This section measures the relative sophistication of Chinese export varieties *within* products using relative prices. As discussed further below, prices are a sufficient statistics for quality when products possess only vertical attributes, that is, attributes for which all consumers agree to pay more. I find that Chinese varieties exhibit relatively high prices compared to countries with similar per capita GDP in the 1970s and 1980s, but that this trend reverses in the 1990s. *Vis a vis* the OECD, I find that Chinese relative export prices are low in all three decades, and decreasing over time in some industries.

An extremely useful feature of the Feenstra et al. (2002) data is the inclusion of both quantity and value information for a large number of goods and countries, rendering possible the calculation of unit values. I compute the unit value of product  $p$

from country  $c$ ,  $u_{pc}$ , by dividing import value by import quantity ( $Q$ ),  $u_{pc} = V_{pc}/Q_{pc}$ .<sup>12</sup> Examples of the units employed to classify products include dozens of shirts in apparel, square meters of carpet in textiles and pounds of folic acid in chemicals. Because units vary by products within industries, industry-level unit values cannot be computed.<sup>13</sup>

To assess the price of Chinese exports relative to similarly developed countries, I use the same methodology presented in the previous section to regress country-product unit values on country characteristics and a China dummy variable,

$$\log(u_{tpc}) = \alpha_{tp} + \beta X_{tc} + \gamma CHINA_{tc} + \varepsilon_{tpc}, \quad (4)$$

where  $u_{tpc}$  is the unit value of product  $p$  from country  $c$  in year  $t$ ,  $X_{tc}$  is a country characteristic,  $CHINA_{tc}$  is a dummy variable equaling unity if the product is from China, and  $\alpha_{tp}$  is a year-product fixed effect. Here, I display results using both PCGDP and skill abundance, where the latter is defined as the share of the population attaining a secondary or higher level of education according to Barro and Lee (2000).<sup>14</sup>

Regression coefficients and robust standard errors adjusted for clustering at the country level are displayed in Table 12. These coefficients demonstrate a positive and statistically significant relationship between countries' export prices and their relative level of development as measured either by PCGDP or skill abundance. These coefficients suggest that capital- and skill-abundant countries use their endowment advantage to produce goods that are vertically superior to goods emanating from labor-abundant countries.

Coefficients on the *CHINA* dummy variable in the first and second columns of the table show that Chinese products on average sell for a discount relative to countries with a similar level of PCGDP and skill abundance. Examining China dummies by decade, in the third and fourth columns of the table, reveal that this discount is greatest in the 1990s. In column three, the China-decade dummy flips from positive to negative over time relative to PCGDP. In column four, which controls for countries' skill abundance, the China dummy is negative in all three decades but is substantially more negative in the 1990s. This decline is not necessarily indicative of

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<sup>12</sup>For some years and products, there are multiple country observations of value and quantity. In those cases, I define the unit value to be a value-weighted average of the observations. Availability of unit values ranges from 77 percent of product-country observations in 1972 to 84 percent of observations in 2001.

<sup>13</sup>It is important to note that the unit values in this dataset are not perfect. A study by the U.S. General Accounting Office (1995) identified underlying product heterogeneity and classification error as two major sources of unit value error in an in-depth analysis of eight products. Identifying the results of variety heterogeneity within product categories is a focus of this section.

<sup>14</sup>Barro and Lee's (2000) educational attainment data are available at five-year intervals rather than annually. This feature of the data accounts for the large difference in the number of observations across the columns of Table 12. To increase the sample size, I use the 1970 value for 1972, so that there are two observations per decade.

	Log(uv <sub>pc1</sub> )	Log(uv <sub>pc2</sub> )	Log(uv <sub>pc3</sub> )	Log(uv <sub>pc4</sub> )
Log (Real PCGDP <sub>ct</sub> )	0.391 *** 0.041		0.397 *** 0.041	
Log (Skill Abundance <sub>ct</sub> )		0.411 *** 0.068		0.412 *** 0.068
China Dummy	-0.259 *** 0.067	-0.785 *** 0.069		
China 70s			0.409 *** 0.092	-0.466 *** 0.074
China 80s			0.161 ** 0.078	-0.421 *** 0.061
China 90s			-0.433 *** 0.062	-0.888 *** 0.074
Constant	-0.523 *** 0.368	1.474 *** 0.223	-0.579 *** 0.370	1.471 *** 0.223
Product-Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	2,986,558	669,900	2,986,558	669,900
R <sup>2</sup>	0.80	0.81	0.80	0.81

Notes: Table reports OLS regression results of country-product unit values on country real per capita GDP and skill abundance from 1972 to 2001. Explanatory variables include an aggregate China dummy as well as this dummy interacted with dummies for the 1970s (i.e.,1972-1979), 1980s (i.e.,1980-1989) and 1990s (i.e.,1990-2001). Robust standard errors adjusted for clustering at the country level reported below each coefficient. \*\*\* represent significance at the 1 percent level.

Table 12: China's Relative Export Prices 1972-2001

quality downgrading on China's part, as it could reflect changes in other countries relative quality *vis a vis* China.

A qualitatively similar result is found across one-digit SITC manufacturing industries using both PCGDP and skill abundance. Table 13 reports the results of estimating equation 4 by industry using PCGDP as an indicator of countries' relative skill and capital abundance. Across industries, the 1990s discount is greatest in Machinery and weakest in Chemicals.

Comparison of Chinese and OECD manufacturing export prices reveals that Chinese goods sell at a discount *vis a vis* the OECD. I compare Chinese and OECD export unit values according to log unit value ratios,

$$\ln(UVR_{tpc}) = \ln\left(\frac{u_{tp}^{OECD}}{u_{tp}^{CHINA}}\right), \quad (5)$$

where  $u_{tp}^{OECD}$  and  $u_{tp}^{CHINA}$  are the unit values of product  $p$  in year  $t$  for the OECD and China, respectively.

Figure 3 reports the mean log unit value ratio between the OECD and China by manufacturing industry between 1980 and 2001. Two features of the data are noteworthy. First, the fact that all ratios are greater than zero indicates that OECD exports generally sell for more than Chinese exports in all years. These price premia are greatest in Machinery and Manufactured Materials and lowest in Chemicals, perhaps because that manufacturing industry contains relatively more goods (chloroform, for example) that are commodities. OECD machinery varieties in 2001, for

	5-Chemicals	6-Manuf Materials	7-Machinery	8-Misc Manuf
	Log(uv <sub>pct</sub> )	Log(uv <sub>pct</sub> )	Log(uv <sub>pct</sub> )	Log(uv <sub>pct</sub> )
Log (Real PCGDP <sub>ct</sub> )	0.276 *** 0.073	0.339 *** 0.038	0.448 *** 0.082	0.443 *** 0.044
China 70s	0.241 0.185	0.471 *** 0.089	0.378 * 0.222	0.343 *** 0.085
China 80s	0.129 0.170	0.133 * 0.076	0.067 0.182	0.183 *** 0.062
China 90s	-0.251 ** 0.118	-0.318 *** 0.055	-1.045 *** 0.144	-0.261 *** 0.050
Constant	-0.686 *** 0.682	-1.523 *** 0.340	0.941 *** 0.772	-0.318 *** 0.367
Product-Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	336,271	993,060	592,531	1,064,696
R <sup>2</sup>	0.63	0.70	0.80	0.73

Notes: Table reports OLS regression results of country-product unit values by industry on country real per capita GDP from 1972 to 2001. Explanatory variables include an aggregate China dummy interacted with dummies for the 1970s (i.e., 1972-1979), 1980s (i.e., 1980-1989) and 1990s (i.e., 1990-2001). Robust standard errors adjusted for clustering at the country level reported below each coefficient. \*\*\* represent significance at the 1 percent level.

Table 13: China's Relative Export Prices 1972-2001, by Industry

example, command prices that are an average of 4 ( $e^{1.3}$ ) times higher than Chinese machinery varieties. T-tests of these log unit value ratios (not reported) indicate that virtually all are statistically significantly different from zero at the 10 percent level.

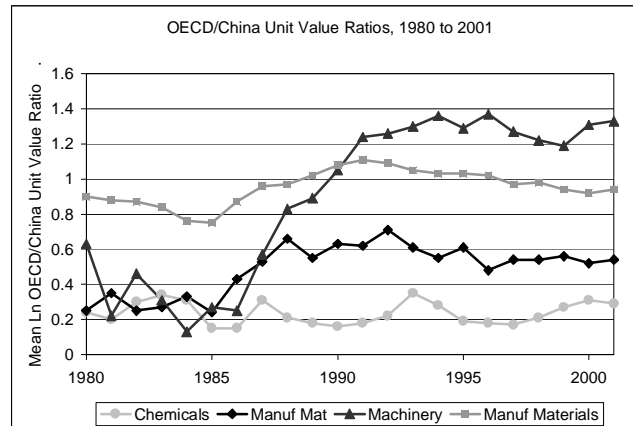
The second noteworthy feature of the results in Figure 3 is that the OECD price premium is either steady or increasing over time in all four industries. The relative Machinery price increases most substantially over time, particularly in the late 1980s. Relative Chemical prices appear to be the most steady.

#### 4. Discussion

This paper highlights two facts. First, China's export bundle increasingly overlaps with that of the world's most developed economies in a way that cannot be explained completely by its relative level of development and size. Second, within product markets, China's exports sell at a steady or increasing discount relative to the exports of the OECD.

The first fact implies that competition between the OECD and China is heating up, as China enters more and more product categories in which the OECD is present. On the other hand, the substantial price disparities between Chinese and OECD exports within product markets indicates that Chinese exports are of lower quality than OECD exports. To the extent that consumers view goods of low and high quality as poor substitutes, this fact suggests that competition between China and the OECD might be less extreme than their growing overlap in terms of export bundles suggests.

Furthermore, the increasing relative price of OECD varieties within product mar-



Note: Figure displays mean natural log OECD / China unit value ratio across products in noted industry, by year. Log unit values for each year and industry are significantly different from zero at the 1 percent level in almost all cases.

Figure 3: OECD/China Unit Value Ratios, 1980 to 2001

kets in some industries suggests that developed countries are moving out of low-quality varieties and into ever-more sophisticated varieties as developing countries like China expand their manufacturing. Such a reaction conforms with insights from international product cycle theory, which has developed countries inventing and exporting goods to developing countries until the latter figure out how to replicate them and enter the world market.<sup>15</sup> At that point, because of the low production costs implied by their labor abundance, developing countries drive developed countries out of the market and become the sole suppliers. A “quality ladder” variant of this model has developed and developing countries trading dominance over varieties of a particular good over time, as developed countries re-enter the market for an existing good by innovating and offering a more sophisticated version (Grossman and Helpman 1991).<sup>16</sup>

The product cycling suggested in the results of this paper is consistent with more direct evidence of quality upgrading by U.S. manufacturing firms. Bernard, Jensen and Schott (2006), for example, analyze the reaction of U.S. manufacturing plants to increased exposure to imports from low-wage countries like China as trade costs as-

<sup>15</sup>See, for example, Posner (1961) and Vernon (1966, 1979).

<sup>16</sup>Zhu and Treffer (2005), for example, examine a model in which countries’ comparative advantage is derived from differences in both productivity and factor-endowments. In the model, relatively fast productivity growth in developing countries allows them to catch up to developed countries. As a result of these gains, the least skill-intensive industries in the developed economies move to developing economies, where they are the most skill intensive. This movement raises the demand for skill in all countries, pushing up the skill premium and therefore income inequality. Productivity growth in developed economies also pushes up the skill premium via a more subtle channel: by raising the amount of output a given low-skilled worker can produce, relatively fast productivity growth in developing economies increase the world’s effective supply of unskilled labor.

sociated with accessing the U.S. market fell from 1972 to 1997. This exposure varied significantly across industries, with firms producing labor-intensive goods like apparel facing far greater exposure than firms manufacturing more sophisticated goods such as scientific equipment. Bernard et al. do indeed find that firms in industries experiencing greater exposure to low-wage country imports are more likely to shrink and die. This result suggests U.S. firms “move out” of products inconsistent with their comparative advantage once trade costs fall and low-wage country enter previously protected markets. But the authors’ also find that some U.S. firms “move up” in response to trade liberalization. First, they show that plants with higher exposure to countries like China are more likely to switch into industries that are more skill and capital intensive, and less exposed to low-wage country exports, than the industries left behind. Second, they report that within industries subject to the same level of low-wage country exposure, plants that are more capital intensive are more likely to survive and grow. To the extent that plants’ capital intensities within industries rises with the sophistication of the goods they produce in those industries, this finding implies U.S. firms adjust their product mix in line with comparative advantage. These adjustments induce a reallocation of economic resources within and across plants towards the manufacture of more sophisticated goods.

The existence of international product cycling offers important intuition for why trade with China will not eliminate manufacturing jobs in the OECD, as some critics claim. Even though increased trade with China may cause the OECD to abandon the production of its less-sophisticated goods, production of a more sophisticated set of goods (or services) is always waiting to take its place. The creative destruction associated with these reallocations should be encouraged: allowing countries to produce according to their comparative advantage enhances the efficiency of production and encourages the availability of a wider variety of products at lower prices to all consumers in all countries. Both of these outcomes raise standards of living.

All workers, of course, do not fare equally well under these changes. In developed countries, low-skill workers are disproportionately likely to be dislocated from their jobs, and they may also have the hardest time finding matches with new employers. Not every apparel worker that loses their job in Germany, for example, can find immediate employment with a pharmaceutical firm manufacturing the latest biotechnology drugs. A study of displaced workers in the United States by Kletzer (2001) estimates that manufacturing workers dislocated from their jobs by import competition on average accept a pay cut of 13% in moving to their next job. In her sample, while one third of displaced workers reported earning the same wage or more in their new job, one fourth reported earning at least 30 percent less.

It is precisely such losses among the least-skilled workers that should be the focus of public policy. Providing temporary relief by shielding certain jobs from import competition, however, is not the correct response. Such policies merely postpone an inevitable reallocation that becomes even more painful the longer it is delayed.

Instead, trade policy should focus on *workers* rather than *jobs*. Indeed, it should emphasize helping workers find new employment if their existing occupations disappear due to import competition. This goal can be achieved in part by providing workers with incentives to undergo any retraining necessary for securing employment in comparative-advantage industries. But it should also encompass broader support for the primary, secondary and tertiary educational institutions that provide workers with human capital before they even enter the workforce. It is only by maintaining their relative human capital abundance that developed economies will retain production of the world's most sophisticated goods.

Policy makers might also consider more innovative proposals to reduce labor market frictions during trade liberalization. Davidson and Matusz (2006) compare several such policies – including wage subsidies, employment subsidies, trade adjustment assistance, and training subsidies – in terms of their ability to transfer some of the aggregate gains from trade to those whose jobs are displaced by it. A well-designed wage insurance plan, for example, might give dislocated workers an incentive to accept a job where the wage is initially low but where the wage may increase with time, retraining and experience (Kletzer 2004). These policies may also reduce the time displaced workers spend unemployed. Though the cost of such assistance is not trivial, it, like social welfare programs more generally, are a perfectly acceptable means of transferring some of the overall gains from free trade from winners to losers, helping to ensure that all are better off as a result. They can also help garner support for trade liberalization at the outset: as reported by Scheve and Slaughter (2001), public opinion about free trade increases when it is linked to worker adjustment programs.

## 5. Caveats and Alternate Interpretations

The across- and within-product trends highlighted above are open to additional interpretations. I briefly discuss some of these interpretations in this section, with an eye towards how they might be pursued further in future research.

### 5.1. *Price=Quality?*

The within-product price disparities noted in this paper are taken as direct evidence in favor of vertical differentiation. As noted above, prices are a sufficient statistics for quality under the assumption that products possess only vertical attributes, that is, attributes for which all consumers agree to pay more. An alternate interpretation of the price differences discerned in this study is that they are due to variation in countries' production costs. That is, China's relatively high export prices *vis a vis* its per capita GDP in the 1970s and 1980s might reflect the inefficiency of Communist production, while the relatively low prices of the 1990s could be the result of a more efficient privatized economy taking full advantage of its relatively cheap labor force.

Under this interpretation, Chinese and OECD exports are very close – perhaps horizontal – substitutes, and it is only a matter of time before OECD goods with very high (quality-adjusted) prices are driven from the market entirely.

Proper assessment of this interpretation requires very detailed data about the hedonic attributes of goods produced and exported by China and developed economies. Though such data is not generally available, pilot studies for certain industries as well as efforts to identify product quality from publicly available unit value data are the subject of active research. Sutton (2005), for example, makes use of detailed investigations of manufacturing plants to summarize the evolution of product quality in the automobile-component and machine-tool industries in China and India. Hallak and Schott (2006) and Khandelwal (2006), on the other hand, take the opposite approach by proposing empirical techniques for estimating relative export quality from export prices and quantities in a way that controls for (unobservable) horizontal differentiation. Estimates from both Hallak and Schott and Khandelwal indicate that China's export quality is indeed inferior to that of the OECD.

### *5.2. Is China Really Just a Single Country?*

China's unprecedented increase in product penetration over the sample period is surprising and cannot fully be explained by either its size or level of development. On the other hand, though the Chinese economy is extremely labor abundant overall, relative factor endowments vary substantially across provinces. This heterogeneity can influence the range of goods China produces and exports, and therefore help explain the disproportionate similarity of China's export bundle with that of the OECD. Heterogeneity within China also has implications for how quickly some regions within China might catch up to the world's most developed nations.

There is no doubt that aggregate China is labor abundant. Tables 14 and 15 provide complementary views of this labor abundance relative to other countries in Asia, the Caribbean, Latin America and the OECD. Table 14 compares China's relative endowments to the mean relative endowments of other countries, by region. The first four columns summarize educational attainment as estimated by Barro and Lee (2000). They reveal that highly skilled workers – those with more than a secondary school education – are relatively scarce in Asia compared to Latin America, and scarcer still in China. While 13 percent of Latin America's population had attained a post-secondary education by 1999, the numbers are 8 percent and 3 percent for Asia and China, respectively. China also has a higher share of workers without any schooling than Latin America or the Caribbean: 21 percent of its population, versus 18 percent for both the Caribbean and Latin America, have never received formal schooling.

Table 15 reports the location of China in the distribution of other region's relative endowments. A value of 50 in this table, for example, indicates that China's relative

Region	No	Primary	Secondary	Post-	Arable Land	
	Schooling	Attainment	Attainment	Secondary	Per Person	Capital Per
	(%)	(%)	(%)	Attainment	(Hectares)	Capita (\$)
Asia	32	32	27	8	0.14	3,339
Caribbean	18	44	31	7	0.08	6,212
Latin America	18	49	20	13	0.25	5,590
OECD	5	34	40	21	0.38	67,688
China	21	42	36	3	0.10	2,274

Notes: Cells report mean (columns 2 through 5) or median (column 6) values across all countries by region for which data is available. Education measures are for 1999 and are from Barro and Lee (2000). Land abundance data are for 2000 and are from the World Bank's World Development Indicators database. Capital per population data is for 1990 and are from Nehru and Dhareshwar (1993). Per capita capital values are adjusted for purchasing power parity using World Bank PPP conversion factors; they are expressed in 1987 dollars.

Table 14: Relative Endowments by Region

endowments are equal to the median of the noted region. China's skill scarcity ranks the country below the median of the Asian, Latin American and Caribbean distributions. As indicated in Table 15, China's post-secondary education attainment places it in the 32nd percentile in Asia (behind Pakistan and India), in the 5th percentile of Latin America (just behind Guyana) and in the 33rd percentile of the Caribbean (between Haiti and Jamaica). It has relatively more unschooled citizens than 58 percent of Asian countries, 68 percent of Latin American countries and 67 percent of Caribbean countries.

Region	No	Primary	Secondary	Post-	Arable Land	
	Schooling	Attainment	Attainment	Secondary	Per Person	Capital Per
	(%)	(%)	(%)	Attainment	(Hectares)	Capita (\$)
Asia	58	84	68	32	52	27
Caribbean	67	50	50	33	75	20
Latin America	68	26	89	5	19	21
OECD	95	64	41	5	26	9

Notes: Cells report the percentile of each region's distribution that would be occupied by China if it were part of the region. See the notes to Table 1 for information on the source of each relative endowment variable.

Table 15: Where China Fits in Other Regions' Relative Endowments

In addition to being relatively skill scarce, China is relatively capital and land scarce. As of 2000, it has 0.10 hectares of arable land per person versus 0.25 hectares per person in Latin America, placing it in the 19th percentile of the Latin American distribution (between El Salvador and Venezuela). Its median (Nehru and Dhareshwar 1993) capital per capita in 1990 (the latest year available) of \$2,274 is also relatively low, placing it at the 21st percentile of the Latin American distribution (between Ecuador and Honduras).<sup>17</sup>

Though China as a whole is extremely labor abundant, its provinces vary substantially in terms of their levels of development. Coastal Shanghai's relative skill- and

<sup>17</sup>I compare regions' capital per capita in Tables 14 and 15 using the median rather than the mean because of significant outliers (for Mexico and Uruguay among others) in the Nehru and Dhareshwar (1993) dataset. More recent cross-national comparisons of capital abundance that include China as an observation are unavailable.

capital-abundance, for example, may place it in a different cone of diversification than the much more labor-abundant inland province of Guizhou. As indicated in Figure 1, if Shanghai inhabited the middle cone of diversification while Guizhou were in the lower cone, the two provinces would produce different sets of goods, and China as a whole might export a wider range of products. Such an outcome depends on factor immobility: if labor were freely mobile, workers in provinces with relatively low wages would have an incentive to move to provinces where wages are higher. These movements would lead to convergence in factor prices, relative endowments and product mix.

There is, of course, ample reason to believe that labor is not freely mobile within China. The Chinese government, for example, explicitly controls the ability of workers from the inland provinces to migrate and seek employment in coastal provinces, thereby preventing exactly the sort of factor price equalization just described.<sup>18</sup> As a result, the Chinese economy as a whole may be able to profitably produce a larger range of goods than would be expected of a country at a similar aggregate level of development but occupying just one cone of diversification.

Unfortunately, data comparable to that reported in Section 2 above on the distribution of factors within China is unavailable. In its place, Table 16 compares Chinese provinces, Autonomous Regions and Municipalities along two dimensions in 1999 using data on (non-PPP-adjusted) per capita GDP and illiteracy from the Chinese government quoted in OECD (2001). Regions in the table are sorted according to PCGDP, which ranges from \$3,275 (CNY 30,805) in Shanghai to \$299 (CNY 2475) in the inland province of Guizhou. To put this variation in perspective, note that comparable World Bank PCGDP figures for Korea, Mexico and Brazil are \$10,855, \$5,934 and \$3,538, respectively, and that China's aggregate PCGDP is \$856. The final column of Table 16 reports Chinese regional illiteracy rates.<sup>19</sup> These range from a high of 66 percent in Tibet to a low of 4 in Chongqing Municipality. By comparison, World Bank illiteracy rates in the over-15-year-old population in Mexico, Brazil and China as a whole are 9, 14 and 14 percent, respectively.

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<sup>18</sup>See Bannister (2005) for further discussion of the Chinese labor market.

<sup>19</sup>Intra-national PCGDP and illiteracy in China have a correlation of -0.33.

Province or Region	PCGDP (CNY mill)	Illiteracy (%)	Province or Region	PCGDP (CNY mill)	Illiteracy (%)
Shanghai Municipality	30,805	8.7	Hunan	5,105	11.1
Beijing Municipality	19,846	6.5	Henan	4,894	16.3
Tianjin Municipality	15,976	8.0	Chongqing Municipality	4,826	4.0
Zhejiang	12,037	15.7	Shanxi	4,727	9.1
Guangdong	11,728	9.2	Anhui	4,707	20.3
Fujian	10,797	18.5	Qinghai	4,662	30.5
Jiangsu	10,665	16.8	Jiangxi	4,661	13.2
Liaoning	10,086	7.2	Ningxia Hui AR	4,473	23.3
Shandong	8,673	20.2	Sichuan	4,452	24.3
Heilongjiang	7,660	9.8	Yunnan	4,452	16.8
Hebei	6,932	11.4	Xizang (Tibet) AR	4,262	66.2
Hubei	6,514	15.0	Guangxi Zhuang AR	4,148	12.4
Xinjiang Uygur AR	6,470	9.8	Shaanxi	4,101	18.3
Hainan	6,383	14.6	Gansu	3,668	25.6
Jilin	6,341	6.8	Guizhou	2,475	24.5
Neimongu (Mongolia) AR	5,350	16.4			

Notes: Source: China Statistical Yearbook, 2000. Quoted from OECD (2001). The official CNY per USD exchange rate for 1999 is 8.27. Using this exchange rate, PCGDP ranges from \$3725 to \$299. Regions are sorted according to PCGDP. AR=Autonomous Region

Table 16: Inter-Regional Relative Endowment Disparities within China

Though these comparisons are by no means rigorous, they do suggest that some regions of China may be able to produce products with skill and capital intensity approaching that of countries with much greater skill and capital abundance.

Heterogeneity in relative factor endowments across China, as well as differences in the rates of skill and capital deepening, may mean that some regions of the country will climb the quality ladder more quickly than others. Such variation is hard to discern in the international trade data used in this paper, which records the value-weighted average unit value of exports from all regions of the country. When data for Chinese exports by region become available, it would be useful to determine whether the exports of the more developed coastal provinces are closer substitutes for OECD exports than the exports of provinces in the interior.

### 5.3. Do the Chinese Manage Trade?

Export promotion on the part of the Chinese might play a role in its impressive record of product penetration. Obviously, policy instruments that support exporting can inflate the range of products Chinese firms export to the United States and thereby contribute to the trends observed above. These policies can be direct (e.g., export subsidies) or indirect, for example manipulation of the nominal exchange rate. Unfortunately, comprehensive data on these policies does not exist, so variation in their implementation across countries and time cannot at present be compared to gains in countries' product penetration.

### 5.4. Where Does China's Sophistication Originate?

In the theoretical models discussed above, countries' export sophistication is a function of their relative endowments in capital and skill. This line of thinking plays

down the potential importance of an otherwise labor-abundant country being an assembler of high-quality imported intermediate products, and it raises the question of why some countries are more attractive export platforms than others.<sup>20</sup> China, of course, is the recipient of a staggering level of foreign direct investment and it most certainly imports and assembles a large amount of intermediate inputs. Decomposing countries' export quality according to the relative contributions of its factor endowments and its imports would be a very valuable exercise, but it is hampered by the general unavailability of data, for example, detailed input-output tables that map countries' imports into their exports.

## 6. Conclusion

Though this paper provides valuable insight into the impact of globalization on developed economies, it also raises a number of questions.

The first set of questions relates to the ability of firms in developed economies to continue moving up the quality ladder. Khandelwal (2006), for example, finds that products vary widely in terms of the "length" of their quality ladders. As a result, firms in developed countries that produce in high-ladder industries may have more "room" to "move away" from competition from low-wage countries than firms in low-ladder industries. A better understanding of these dynamics requires further research: what firm, product and country characteristics determine the length of products' quality ladders and, perhaps more importantly, their growth over time?

A second question raised by the results of this paper concerns the substitutability of high- and low-end varieties within a product market. When specialization takes place across wholly different products, e.g., t-shirts and electron microscopes, it is relatively easy to be sanguine about the inability of declining t-shirt prices to influence the wages of electron-microscope manufacturers. One suspects that price-wage arbitrage is much more likely when developed and developing economies specialize in vertically differentiated varieties: price declines in conventional televisions may influence the price of high-end plasma displays. Though estimating such substitutability is beyond the scope of this paper, research by Khandelwal (2006) suggests that the within-product substitutability of imports is lower for products characterized by long quality ladders. Further research into this dimension of product cycling would be quite useful.

Third, to what extent is China's differentially large entry into U.S. product markets driven by intermediate rather than final goods trade? Is China's rapid product penetration merely a reflection of its being the preferred location for product assembly? Why is it preferred, and what are the implications of this preference for

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<sup>20</sup>Rodrik (2006), for example, examines the potential influence of China's export processing zones on the sophistication of its exports.

developed-country outcomes? Unfortunately, the data required to answer this question do not exist: world trade flows are not tracked in terms of value added, and detailed input-output tables by country generally are unavailable. Intermediate trade is also likely influential in determining exporters' sophistication. For example, will Chinese exports begin to look more sophisticated as Japanese outsourcing of assembly operations to the Mainland increases?

A final question for further research involves investigating the speed of product cycling. Is globalization hastening the migration of varieties from developed to developing economies? What are the implications of this acceleration?

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