Decomposing China-Japan-U.S. Trade: Vertical Specialization, Ownership, and Organizational Form

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Decomposing China-Japan-U.S. trade:

Vertical specialization, ownership, and organizational form

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ABSTRACT

We use the US International Trade Commission's uniquely detailed 1995–2007 Chinese Customs data to better understand the pattern of trade between China and its two largest trading partners, Japan and the United States. Our review finds that only a small share of these flows can be characterized as arm's length, one-way trade in final goods. Instead, we find extensive two-way trade, deep vertical specialization, concentration of trade in computer and communication devices, and a prominent role for foreign-invested enterprises. While these characteristics define both bilateral relationships, important differences between the two pairs do emerge, suggesting that trade costs influence the method by which multinationals choose to integrate their production with China. Consequently, we argue that dialogue on East Asian trade liberalization should include the possibility of significant production gains for the US from its inclusion in any regional agreements.

1. Introduction

China's ongoing transitions, from bureaucratic socialism to market economy and from a rural to an urban society, have transformed the country into a global economic power.[1] This transition has affected virtually every aspect of the world economy—which goods are made, what they cost, and the wages earned by those engaged in their production. The impact of China's economic emergence on its trading partners, however, goes well beyond the textbook treatment of liberalization of trade in final goods. Widely recognized is China's unique mode of

[1] Naughton (2007) emphasizes the dual nature of China's transition and its implications.

entry, characterized by unprecedented foreign direct investment inflows and heavy reliance on processing inputs as the fuel for explosive trade growth.[2]

These unique features of China's global engagement suggest that rather than simply changing *where* goods are made, China's opening permitted shifts in *how* goods are made. Trade theorists have emphasized two aspects of these shifts in the organization of production—the fragmentation of the production process and the internalization decisions of multinational firms. Fragmentation of production, sometimes referred to as "slicing of the value chain," is viewed as a consequence of trade liberalization in developing countries (e.g. Jones & Kierzkowski, 2001) as well as a determinant of the welfare effects of that liberalization on all partners (e.g. Deardorff, 2001, 2005). Similarly, the internalization decisions of multinationals, specifically the choice to produce inputs abroad through a foreign subsidiary versus purchasing inputs from an unaffiliated foreign subcontractor, not only arise from the liberalization of trade and investment policies, but also themselves shape the overall pattern of economic activity and its rewards.[3]

In this paper, we use uniquely detailed 1995-2007 China Customs data to better understand the pattern of trade between China and two of its largest and most advanced trading partners, the United States and Japan, emphasizing the distinct nature of these flows. The analysis reveals the extent to which bilateral trade is due to fragmented production and foreign-invested enterprises (FIEs), as well as the organizational form of China's processing trade relationships with Japan and the US. Using recent theoretical models as lenses through which we explore the bilateral trade flows, we uncover commonalities and differences in the production sharing strategies of American and Japanese firms, as evidenced in bilateral trade patterns.

Section 2 presents an overview of US-China and Japan-China bilateral trade. We quantify aspects of these trade flows that do not fit into neoclassical explanations, specifically the importance of processing trade and the significant role of FIEs. In section 3, we focus on trade in production "fragments," highlighting transport costs as a factor driving differences in the share of processing trade across the two bilateral relations. We also discuss new evidence on the vertical specialization of China's exports to the US and Japan. We turn then to exploring the role of foreign enterprises in China's bilateral trade flows in section 4. We ask if the trade data provide insight into how American and Japanese firms serve the local market and whether

[2] Dean, Fung, and Wang (2008) emphasize China's unique trade profile. They report that the current-dollar value of China's exports plus imports rose from $280.9 billion in 1995 to $1,760.4 billion in 2006, a growth of about 537%.

[3] Recent contributions to the literature are reviewed by Helpman (2006) and Antràs and Rossi-Hansberg (2008).

transport costs and product differentiation illuminate the differences. Finally, in section 5, we exploit a unique feature of the China Customs data to explore the organizational form of multinational firms engaged in processing trade, specifically comparing flows to the US with those to Japan. We conclude by summarizing our comparisons of the bilateral relationships and drawing implications for further research on the distributional gains from offshoring and for further dialogue on an East Asian regional trade and investment agreement.

2. Unique features of China-Japan-US trade

Commercials relations with China are important both to the United States and to Japan. By 2007, China was the third most important export destination and the top source of imports for the United States. Similarly, China was the second most important export destination and the top source of imports for Japan. Table 1 provides bilateral import and export values and growth rates over the 1996–2007 period. In current dollars, the value of China's exports to all destinations grew at an average annual growth rate of 20.9%. Exports to the United States grew somewhat faster, at an average annual growth rate of 21.7%, while exports to Japan grew more slowly, at an average annual rate of 11.5%. In comparison to the growth of exports to the European Union (24.5%) and ASEAN (22.3%), the growth of Chinese exports to Japan is relatively low.[4]

China's imports from all sources also grew at a rapid rate over the period, averaging growth in current dollars of 18.3%. Imports from both the United States and Japan grew more slowly, averaging 14.1% and 14.9%, respectively, only slightly below the growth of imports from the EU15. Over the same period, Chinese imports from ASEAN grew much more rapidly, at an annual average of 23.3%.

The relatively rapid growth of net exports to the United States is reflected in the US trade deficit with China, which grew at an average annual rate of 28.1% from 1996–2007. Over the same period, Japan saw rapid growth in its trade surplus with China, which changed from a small deficit in 1996 to a $31.9 billion surplus in 2007. As with Japan, China's trade with ASEAN grew rapidly, with ASEAN's small trade deficit in 1996 shifting to a surplus of $14.2 billion by 2007.

Japan and the United States are extremely important to China's trade growth over the past decade. As shown in Figure 1a, by 2007 the United States was the most important

[4] References to the EU refer specifically to the EU15 comprised of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

individual-country market for Chinese exports, moving up from the third largest destination in 1996. Hong Kong received the second largest share of exports by value, although some of these goods were re-exported.[5] Japan received the third largest share, importing more than twice as much as the next larger importer of Chinese goods, South Korea. There is some evidence of an East Asian supplier network even in these aggregate trade statistics. Japan, South Korea, and Taiwan are China's largest import sources, followed by the United States (Figure 1b). While these four countries were also the top four sources in 1996, the growth of imports from the three East Asian countries as a whole has been notably stronger than import growth from the US.

Processing trade, the import of goods for assembly and transformation in China and their subsequent re-exporting, lies behind much of the growth in China's imports and exports.[6] Processing trade comprises a large share of total bilateral trade with China for both developed partners. In 2007, 62.5% of China's exports to the US and 56.6% of those to Japan were processing exports.

Figures 2a and 2b illustrate the trend in processing and non-processing trade between China and the US and China and Japan. Figure 2a shows the dramatic take-off of US-Sino trade volumes in 2001, particularly with respect to processing trade. While there is a similar rise in China's exports to Japan, the increase is much smaller. There are several factors that account for this "takeoff" in 2001. With China's accession to the WTO, there was a sharp increase in FDI inflows from both the US and Japan. Between 2001 and 2002 alone, the flow of US and Japanese FDI projects grew by 29% and 35%, respectively.[7] As will be shown below, much of the increase in China's processing exports shown in figure 2a is due to rapid growth in exports from FIEs. China's WTO accession also meant the partial phase-out of textile and apparel restraints under the Agreement on Textiles and Clothing. This may account for part of the differential in growth of non-processing exports to the US relative to Japan, since Japan had no quantity restraints on these products.

Turning to Figure 2b, we see that the rise in Chinese processing exports to the US was not matched by a rise in processing imports from the US. Japan, rather than the US,

[5] Our Chinese dataset allows us to observe re-exports through Hong Kong and to identify and attribute them to their final destinations. However, the size of the share of exports with Hong Kong as their final destination suggests that some exports destined for other markets may still be included in these figures.

[6] Hammer (2006) provides greater detail on Chinese Customs classifications. Processing imports are generally exempt from customs tariffs.

[7] See 2006 Annual FDI data from the US and Japan, from the Chinese Ministry of Commerce http://www.fdi.gov.cn/pub/FDI_EN/Statistics/AnnualStatisticsData/default.jsp.

experienced a dramatic increase in its processing exports to China from 2001 onward. The rapid growth in non-processing imports from both countries is likely due in part to significant reductions in consumer goods prices with WTO accession (Ianchovichina and Martin, 2004). As will be discussed below, a large part of the growth in processing imports is again due to FIEs. But the differential growth of processing imports from Japan relative to the US suggests again that Japan may be a key source of inputs for China in the global supply chain.

Figure 3 provides China's top 10 exports to and imports from the United States and Japan, respectively. On first glance, the top 10 appear to be consistent with factor endowment similarities of the US and Japan: six of the top exports and six of the top imports are shared by the two bilateral flows. Particularly striking, however, is the importance of two-way trade between China and the US, and China and Japan, particularly in two product categories. In 2007, HS 85 (electrical machinery, sound, and television equipment) and HS 84 (nuclear reactor, boilers, machinery, and parts thereof) comprised 46.4% and 35.7% of China's exports to the US and Japan, respectively. These two categories also accounted for 33.5% and 50.2% of China's imports from the US and Japan, respectively. Deeper exploration into these categories reveals that trade in HS 84 is predominately trade in computers and computer parts, while HS 85 trade consists primarily of mobile phones and television parts. Thus, the bilateral commercial relations are dominated by two-way trade in a narrow set of products.

The Finger-Kreinen (1979) export similarity index is a method for observing changes in the similarity of exports from any two countries to a third country. In Table 2, we present this index for US and Japanese exports to China as well as for other country pairs. As seen in the row labeled "Japan/US," the similarity of exports from these two countries to China increased between 1996 and 2007, with the index value rising from 0.36 to 0.42. Thus, by 2007, 42% of exports from the US to China were "matched" by similar exports from Japan to China. Because these calculations have been made using disaggregated (HS8) data, they confirm a high degree of overlap in the compositions of exports from these two partners to China. Looking at other rows of Table 2, however, provides some perspective on these flows. US exports to China are more similar to those of the EU (with 48% of flows matched), a finding suggestive of a factor-proportions view of trade patterns. Contrary to that perspective, however, Japanese exports to China are significantly more similar to those of the Asian Tigers (with 52% of flows matched) than to those of the US. Further evidence of an East Asian supply network is the last row of Table 2, which shows a dramatic increase in the similarity between Japan and ASEAN exports to China during this period.

Trade mediated by FIEs operating in China, many in special economic zones, is significant for both Japan and the US. Figure 4 shows bilateral exports and imports by firm type. In 1996, exports to both the US and Japan were split fairly evenly between exports by state-owned enterprises (SOEs) and FIEs (Figures 4a and 4b). By 2007, however, FIEs controlled over 65% of exports from China to both countries, with SOEs providing a falling share. Since 2001, as private enterprises have been allowed to proliferate, the share of exports through these firms has grown, exceeding 10% of total exports to both the US and Japan by 2007. Many organizational forms are classified as private enterprises, including limited liability corporations, share-holding corporations, partnerships, and unincorporated businesses.

American and Japanese exports to China show somewhat different profiles. While more than half of exports from each country were destined for foreign-invested enterprises inside China by 2007, this form of trade was more dominant in the Japan-China relationship (Figures 4c and 4d). In 2007, 72% of China's imports from Japan went to FIEs, compared with 58% of China's imports from the US. As in the case of China's exports, SOEs play a declining role in import flows while private enterprises have increased in importance.

Overall, China's trade with the US and Japan looks very different from that based solely on comparative advantage. The largest share of trade is processing trade and it flows to and from foreign-invested enterprises operating in China. This trade is highly concentrated in just two HS chapters, which include computers and telecommunications devices. Thus, the picture that emerges is of bilateral flows dominated by trade in production "fragments," largely mediated by multinational enterprises.

Using neoclassical trade theory as a lens, observing relative factor endowments sheds little light on substantive differences between China's manufacturing trade with the United States and its trade with Japan. Both developed countries are abundantly endowed with capital, both physical and human, compared with China. In 2007, real GDP per capita in the United States and Japan was $38,338 and $40,656, respectively.[8] As of 2005, almost 60% of the American labor force had some form of tertiary education as did 40% of the Japanese labor force. In contrast, China's 2007 GDP per capita was $1,791, and only about 7% of its labor force had tertiary education in 2005. While the United States, with 0.6 hectares of arable land per person, is relatively well endowed with land compared with Japan (0.03 hectares per

[8] All data in this paragraph, with the exception of Chinese education data are from the World Bank's 2007 World Development Indicators and values are expressed in constant 2000 US dollars. The Chinese tertiary education data are from China's *Yearbook of Labour Statistics* for 2006.

person) and to China (0.11 hectares per person), this difference cannot explain variations in the manufacturing trade compositions of the two countries with China.

Reliance on theoretical guides other than neoclassical explanations is necessitated by the characteristics of bilateral trade flows we have highlighted in this section. While neoclassical models focus on trade in final goods, much of the actual flows are in intermediate goods. Equally important, neoclassical models do not explain the decision of firms to engage in foreign investment, exporting to and importing from the source country. To address these features of US-China and Japanese-China trade, we next consider models that seek to explain fragmentation of the production process into distinct vertically arranged tasks. We probe these explanations for clues to differences in the observed flows between the two trade pairs.

3. Production fragmentation and vertical specialization

Jones and Kierzkowski (2001) provide a useful definition of production fragmentation as the decomposition of production into separable component blocks connected by service links. In their discussion of the causes of fragmentation, they emphasize the importance of reductions in the costs of service links between fragments. Advances in telecommunications have reduced the costs of cross-border coordination, thereby encouraging the decomposition and offshoring of production blocks. Deardorff (2001) examines the link between the factor intensity of fragment production and factor prices in possible production locations (fragmentation across cones of diversification). Like Jones and Kierzkowski, Deardorff emphasizes the cost of fragmentation, noting that if coordination costs are large, offshoring of production fragments may not occur. Given the geographic proximity of Japan to China, we might anticipate that service links and production coordination are less costly for Japanese firms than for American firms. For both countries, however, China's trade liberalization, its encouragement of processing trade, and its incentives for foreign direct investment may all be viewed as policies that integrate China into both countries' supply chains.

We consider first the share of two-way trade in both the US-China and the Japan-China relationship, using the Grubel-Lloyd (1975) index of intra-industry trade (IIT). Two-way trade may be horizontal trade in similar goods, "vertical" trade in similar goods of different qualities, or vertical trade in intermediate goods, exported and imported as part of a sequential supply chain. Since the IIT index is calculated at a highly disaggregated level precisely to capture trade in similar products, it will include the first two types of two-way trade, but is likely to severely understate the third (trade in production fragments).[9] At the same time, horizontal trade in similar goods is also likely to be a relatively small share of two-way trade between partners of such vastly different income levels. Thus, the IIT index will give us only a crude preliminary look at the extent to which broadly defined industries are "integrated" with Chinese production.

Table 3 shows China's total exports and imports to Japan and the US, for the SITC 2-digit industries in which China has the largest global trade (exports plus imports). The IIT index is calculated at the SITC 5-digit level and aggregated up to the 2-digit industry level. Comparing the first two top panels, we see that Japan's trade with China is more heavily composed of IIT (27.6%) than is American trade with China (14.2%). Individual sectors also show large differences. In electrical machinery and equipment (SITC 76) 52% of trade between China and Japan is IIT, compared to 7.5% between China and the US. In office processing machines (SITC 75) the figures are 42.5% and 10.7%, respectively. Looking down the columns of Table 3, we see that in eight out of ten industries, IIT is a higher share of Japan-China trade than US-China trade. The only exceptions are professional instruments (SITC 87) and iron and steel (SITC 67). Xing (2007) finds similar patterns of high IIT for China's bilateral trade with Japan compared to the US, at both the aggregate and industry levels for the 1980 to 2004 period.

Both the pattern and magnitudes of China-Japan IIT across sectors are very similar to those for China-ASEAN IIT (bottom left panel of Table 3). For both bilateral pairs, half of the trade in telcommunciations, over 40% of trade in office equipment, and one-third of trade in electrical machinery and professional instruments is IIT. In contrast, the pattern and magnitudes of China-US and China-EU 15 IIT are highly correlated, and show little similarity to China's bilateral IIT with either Japan or ASEAN. With regard to the US and the EU 15, IIT with China is less than 20% in telecomms and in office equipment, while it exceeds 40% in general industrial machinery and is about 30% or more in professional instruments and electrical machinery. IIT is also larger in iron and steel for the US and EU 15, than for Japan and ASEAN. One possible explanation for these differences is that Japanese and ASEAN firms play different roles than American and EU firms in global supply chains. To the extent that the IIT index does reflect any trade in intermediate inputs, these differences could indicate that Japan and ASEAN are large suppliers of intermediates to China, while the US and EU are large buyers of the final processed goods from China. Dean, Fung, and Wang (2008) (DFW hereafter) find evidence that China's trade is shaped by such global supply chains. In 2002, China's exports were

[9] In the IIT literature, "vertical" IIT refers to differences in product quality, not to differences in stages of production (Greenaway, Hine and Milner, 1995). The SITC classifies products such that only a small number of 5-digit lines include products at different stages of production.

characterized by significant vertical specialization, with the foreign content of China's aggregate exports estimated to be between 25% and 46%. About 77% of China's imports in 2002 were processing or normal intermediate imports.[10] More than half of these imported intermediates were from Japan and the Four Tigers, while only about 18 % came from the US and the EU.

Several factors may explain China's reliance on other Asian countries as the source of intermediate inputs. An obvious factor is geographic location. Just as Mexico provides a nearby location for processing and assembly for American firms, China provides a nearby location for labor-intensive fragments of Japanese, Taiwanese, and Korean designed and marketed products. In a formal model, Yi (2003) shows that small differences in trade costs matter when production must be done sequentially. He considers a technology with three sequential stages, two of which may be produced offshore but the last must be produced close to firm headquarters. Because some trade costs have to be paid on gross value or weight rather than just that added at an individual stage, small differences in these costs can have large effects on fragmentation and trade volumes. Yi focuses on tariffs specifically, but tariffs are unlikely to drive China's processing trade because intermediates imported under the processing regime are tariff exempt. However, transportation costs play a similar role, as weight accumulates during a sequential production process.

Examining the data in detail, we find evidence consistent with an important role for transportation costs in shaping the roles played by Japan and the US in the global supply chains. China sources many intermediates from Asian countries, while exporting final goods and processed intermediates predominantly to the US, EU, and the rest of the world. Moreover, as Figure 1 indicates, China's imports from Japan are much larger than those from the US, and show much faster growth. China's exports to the US are much larger than to Japan and have grown more rapidly.

DFW (2008) provide a more detailed analysis of how China's trade is shaped by production fragmentation. They develop a method to identify imported intermediates using the Chinese Customs Regime Data and the UN Broad Economic Classification, as well as the 1997 and 2002 Chinese benchmark IO tables. They find that in 2002 Japan accounted for 19% of China's imported intermediates and 23% of China's imported processing intermediates. The figures for the US were only 7.6% and 6.3%, respectively. While Japan's share was roughly

[10] Dean, Fung, and Wang (2008) focus on trade in 2002 because that year matches the most recent benchmark input-output tables, which they use extensively in their analysis of the vertical specialization of China's trade.

stable between 1997 and 2002, the US share fell, with respect to both processing and normal intermediate imports during that time.

DFW use these data to determine the vertical specialization in Chinese exports for 1997 and 2002, using two methods. The first method combines the newly identified imported intermediates with the official Chinese benchmark input-output table. The second method goes one step further, and uses the Koopman, Wang, and Wei (2008) technique to split the official input-output table—allowing processing exports to be imported-input-intensive in production relative to normal exports and domestic sales. For 2002, DFW find a lower bound estimate of the foreign content of China's exports to the US and Japan of 28% and 25%, respectively; upper bound estimates are 55%, and 46%, respectively. These results suggest that China's exports to the US have a higher foreign content, on average, than those to Japan, though the difference is probably small.

From China's point of view, the US and Japan are sources for very different imports.[11] In 2002, the US accounted for more than half of Chinese imports of special industrial equipment, more than one-third of its imported fertilizers, more than one-quarter of its agricultural imports, and about 60% of its imported computers. Japan accounted for 45% of China's imported radio, TV, and communications equipment; about 30% of China's imports of special industrial equipment, electric machinery and equipment, parts and accessories for motor vehicles, and metal products; and more than one-quarter of China's metal working machinery imports.

Examining the 2002 bilateral trade data more closely we find that about 74% of China's imports from Japan were intermediate goods, while only 60% of China's imports from the US were intermediates. The bulk of the remaining 40% from the US were final goods. Nearly half of the intermediates imported from Japan came in under the processing regime, which indicates that they were re-exported after processing, while only about one-quarter of those from the US did. In contrast, nearly 68% of China's exports to the US were under the processing regime, while only 58% to Japan were processing exports.

The types of intermediates that China imports from the two countries show some similarities and some contrasts. In value terms, electronic elements and devices, leather, fur and down products, and chemicals dominate processing imports from the US, while agriculture, paper products, and chemical fertilizers dominate normal intermediate imports. From Japan, electronic elements and devices are important processing and normal intermediate imports,

[11] The data for this paragraph and the next two are from Dean, Fung, and Wang (2008). We thank them for giving us access to these data.

while cotton textiles and other electric machinery are key processing imports, and basic chemicals and steel pressing important normal intermediate imports.

In sum, we find evidence suggestive of global supply chains with Japan as a principal source for China's imported intermediates, and the US as a key destination for China's exports of products embodying imported intermediates. While the largest flows for both pairs occur in the electronics and machinery industries, there are substantive differences that emerge from the detailed data. China's processing trade with Japan is roughly balanced; three-quarters of its imports from Japan are intermediate goods; and its exports to Japan show a fairly high degree of vertical specialization. In comparison, China's processing trade with the US shows a large deficit; a smaller share of its imports from the US are intermediate goods; and its exports to the US show a somewhat higher level of vertical specialization.

4. Foreign invested enterprises

Evidence presented in the previous section attests to the importance of trade in intermediate goods to China's overall relationship with the US and Japan. An equally important aspect of China's trade is its reliance on foreign invested enterprises as the source of import demand and export supply. Fueled by reforms that legalized various types of non-state-owned enterprises but retained limitations on domestic credit, FIEs became the main vehicle for China's integration into the global economy. Currently, FIEs consist of fully-funded foreign enterprises (FFEs), Sino-foreign contractual joint ventures (CJVs) and Sino-foreign equity joint ventures (EJVs). American and Japanese firms have invested heavily in foreign affiliates in China, both to gain access to Chinese labor for processing and as a platform to serve the growing Chinese consumer market. From 1998 to 2007, American foreign direct investment in China averaged $3.9 billion per year. Over the same period, Japanese foreign direct investment in China averaged somewhat more, $4.3 billion per year. Though far outweighed by FDI from Hong Kong, these investments are large, persistent, and indicative of the rapid integration of production between China, Japan, and the US.

Why firms choose to operate foreign affiliates rather than service a market through exports from the home country is the subject of a large theoretical literature. Markusen (1984) introduced the proximity/concentration trade-off as an explanation for why firms choose a particular mode of entry into a foreign market. Serving a foreign market through a local affiliate replicates the home production process abroad but saves on transport costs. However, if there are economies of scale in production, exporting may be more profitable than serving the local market through FDI because production remains concentrated in a single location. This “horizontal” approach has been extended and tested by Brainard (1997), Markusen and Venables (1998, 2000), and Helpman, Melitz, and Yeaple (2004), among others. An alternative “vertical” approach follows the work of Helpman (1984), who shows that if there are increasing returns to scale in “headquarter services” and cross-country differences in factor prices, a firm may split the production of headquarter services and manufacturing across countries. Helpman’s model predicts that the extent of multinational activity will be increasing in relative factor endowment differences across countries. Empirical evidence on the vertical explanation for multinational activity is provided by Yeaple (2003a) and Hanson, Mataloni, and Slaughter (2005). Some empirical research, such as Yeaple (2003b), combines both the vertical and horizontal motive for foreign investment and attempts to capture complementarities between the two forms of activity.

Because this literature focuses on the mode of entry into a foreign market, empirical studies typically rely on detailed information on foreign affiliates sales to the host country domestic market. As noted by Greaney and Li (2009), there are significant differences in the extent to which American and Japanese firms use their Chinese subsidiaries to serve the local market. Their analysis reveals that in 2003 70% of sales by US majority-owned non-bank manufacturing affiliates in China were to the local market. Less than 8% of their sales were exports to the US. In contrast, in 2003 only 46% of sales by Japanese majority-owned non-bank manufacturing affiliates in China were to the local market, while 34% of sales were exports to Japan. These data are consistent with Markusen’s (1984) framework, in that transportation costs are larger for American firms than for Japanese firms and, thus, may be an explanation for the greater intensity with which American firms use local affiliates to serve the Chinese market rather than act as export platforms.

Foreign firms play an important role in China’s position in the global supply chain. Table 4 shows the share of China’s exports to various destinations that is classified as processing trade, the share carried out by FIEs, and the share of processing trade that is performed by FIEs. While Chinese exports to the US are somewhat more likely to be processing exports than are exports to Japan (62.5% versus 56.6%), we see that for both destinations, a remarkably high share of total exports is carried out by FIEs: 68.3% for exports to the US and 67.7% for exports to Japan in 2007. Secondly, and perhaps less surprisingly, the majority of processing trade is performed through FIEs, as 86.2% of processing exports come from FIEs to the US and 86.9% to Japan in 2007. Less obvious, however, is the extent to which total FIE trade is processing trade. Detailed examination of the data shows that, for many industries, FIEs do very little trade other than processing importing and exporting.

When we consider how transport costs might drive differences across industries, we note that Krugman (1980) identifies a "home-market effect" for industries producing differentiated products. While transport costs lead firms to locate production as close as possible to final consumers, fixed costs associated with differentiating products in response to consumer tastes encourage the concentration of production in a single location. In that case, there is a tendency for a differentiated-products industry to concentrate in the country with the larger market for home varieties, making the home country the net exporter of differentiated goods.

Hanson and Xiang (2004) test the home-market effect with international trade data organized into two groups of industries: those with high transport costs and more differentiated products and those with low transport costs and less differentiated products. In Table 5, we provide characteristics of Chinese imports from Japan and the US, for industries divided into the two groups identified by Hanson and Xiang. Because transport costs to China are much larger for American firms, we might expect to see the influence of firm-level fixed costs more clearly in Japan-China trade and thus, the influence of the home-market effect in these flows. The left panel provides the share of Chinese imports from Japan that are ordinary imports and the share that are processing imports, for the 3-digit SITC industries classified as having low transport cost/low differentiation (top panel) and high transport cost/high differentiation (bottom panel).[12] Interestingly, we see that China's imports from Japan of the highly differentiated products are much more likely to be ordinary trade, and less likely to be processing trade, than the low-differentiation products. This evidence suggests that, for Japan-Sino trade, the home market effect may indeed explain some of the differences in the ordinary trade shares across industries.

In contrast, the same comparison using US values in Table 5 shows very little difference between the two industry groups. China's imports from the US in both these categories are more likely to be ordinary trade, and less likely to be processing intermediates than are China's imports from Japan. Moreover, for imports from the US, the share of trade that is ordinary trade is nearly identical across the two industry groups. That no difference appears between high-differentiation and low-differentiation industries suggests that transport costs between the US and China dominate sourcing decisions.

Some caveats should be kept in mind. First, the differential results for the US and Japan across the product groups may reflect their different positions in the global supply chains.

[12] Using a concordance between SITC (Rev. 2) and HS codes, these shares were then averaged using trade volumes as weights.

Secondly, as emphasized by Ferrantino et al. (2008), there is considerable heterogeneity within these sectors and the Hanson and Xiang dichotomy may not reveal true differences in transportation costs across goods.

5. Contractual frictions and organizational form

While the importance of processing trade is evidence that firms have broken the production process into several fragments, some component production is done within the firm while some involves arm's length transactions. Recent theories of organization and trade, drawing upon models of contractual frictions, seek to understand which activities take place within the firm's boundaries. Thus, they address a narrower aspect of the data: whether production of intermediates takes place inside the firm (in-sourcing) or outside the firm (outsourcing). They presume that production is fragmented, rather than trying to explain how fragmented it is.

Simply observing the extent to which trade is mediated by foreign invested enterprises does not capture the extent to which an American or Japanese firm controls production decisions. However, some insight into firm boundaries can be obtained through recognition of a unique feature of Chinese Customs data. Processing imports are subdivided by Chinese customs into two categories: *process and assembly (P&A)*, which is conducted mostly by SOEs and FIEs; and *processing with imported materials (PWIM)*, which is largely conducted by FIEs. The key distinction between these two customs regimes is control over inputs: with P&A, the Chinese firm receives materials and processes them according to orders taken from the foreign firm, while with PWIM, the Chinese firm has full control of decisions related to input sourcing, production, trading, and financing. The Chinese firm involved in these relationships may be an SOE, an FIE, or a private domestic enterprise.

Use of this Chinese customs distinction to study firm boundaries was exploited by Feenstra and Hanson (2005), who develop their approach from recent advances in the study of imperfect contracts. Since production of final goods may require highly customized and specialized intermediate inputs to be produced by input suppliers, its quality may not be verifiable by a third party. In such a case, the final good producer and the input supplier may find it impossible to write a complete contract specifying the price-quality relationship. Moreover, even if such a contract could be written, it may not be enforced by the judicial system. Thus, the division of the economic surplus from production and use of the input may be subject to ex post bargaining between the final good producer and the input supplier/producer. This potentially results in what, in the literature, is called a "hold up" problem: distortions in the incentives for investment and effort in input production because the producer is able to get only a fraction of the returns to her investment or effort. If so, the input supplier will provide less investment or effort than is optimal for maximization of the joint production surplus. Such a situation may also characterize resources provided by the final good producer.

Helpman (2006) argues that "intermediate inputs under the direct control of the final good producer suffer less from agency problems than intermediate inputs that require the engagement of suppliers." Also, the effective bargaining power of the final good supplier is higher under integration than under outsourcing as under the former the final good supplier has some control over inputs and can recover some of its value if bargaining fails. This is good from the point of view of getting the resources provided by the final good producer as close to the optimum level (that which maximizes the joint surplus from production) as possible, but it adversely affects the level of activity of the input producer. Thus incentives are closer to optimal under integration when goods require intensive use of headquarter services (provided by the final good producer) in their production, while outsourcing is better when goods require intensive use of specialized inputs (provided by the intermediate good producer). If (1) headquarter services are capital intensive and input production is labor intensive, and if (2) the two have to be combined in the same country to produce a specific tradable intermediate input used in the production of a given nontradable final good (and there are many different intermediate and final goods), then we should see, *ceteris paribus*, a positive correlation between the share of intra-firm imports of a country and the capital abundance of the exporting country (Helpman, 2006; Antràs, 2003).

Note that intra-firm imports are correlated with vertical FDI while inter-firm imports are correlated with offshore outsourcing. With vertical FDI, inputs are being produced in the same multinational firm as the final output. This is not so with offshore outsourcing. Thus, according to this theory, in less capital-abundant countries such as China and India, we should see relatively more offshore outsourcing than offshoring through FDI. Of course, legal institutions are weaker in these countries than in the more capital-abundant countries, and that will be an offsetting force as it influences contract enforcement.

How well these theories fare with actual experience in China is the subject of Feenstra and Hanson's (2005) exploration of ownership and control in Chinese processing trade. They build a simple model of international outsourcing and apply it to China. They consider a multinational firm that has decided to set up an *export-processing* plant in a low-wage country. In this arrangement, the firm sends intermediate inputs to a processing factory, which converts the inputs into finished goods and then exports the final output. The decisions facing the multinational include who should own the processing factory and who should control input-purchase decisions the factory makes. They posit that parties use control rights over productive assets to ameliorate holdup problems created by incomplete contracts. Their model predicts that the joint surplus generated by the partnership depends on model parameters, including the specificity of investments and contracting costs, which they estimate.

Feenstra and Hanson do not observe the value of surplus from outsourcing activities directly. Rather, they use the share of processing trade accounted for by each contractual type to represent the probability that a particular contractual arrangement is chosen.[13] Comparing these shares in China's total processing exports over the period 1997–2002, they find that multinational firms tend to split factory ownership and input control with local managers. The most common form, as evidenced by trade shares, is to have foreign factory ownership but Chinese control over input purchases.

Following Feenstra and Hanson (2005), we calculate the shares of processing trade by contractual type for 1996 and 2007. In 1996, as shown in Table 6, multinationals engaged in export processing tend to split factory ownership and input control with local managers. A little over one-quarter of processing exports to the US come from Chinese owned factories operating under P&A arrangements (foreign control of inputs), while nearly two-thirds come from foreign owned factories operating under PWIM arrangements (local control of inputs). A similarly small share of processing exports to Japan (17.8%) come from Chinese owned factories operating under P&A arrangements, while the largest share (56.3%) come from foreign owned factories operating under PWIM arrangements. These results indicate similar patterns across the two bilateral relationships and are close to the results found by Feenstra and Hanson for all trade in the 1997–2002 period: 27% of processing exports produced in Chinese factories under P&A arrangements and 49.6% produced in Chinese factories under PWIM arrangements.

Looking at data from 2007 in Table 6, however, we do see some changes in contractual arrangements over the decade. The dominant form of processing trade continues to be foreign-owned factories with Chinese managers controlling input decisions. This type accounts for more than three-quarters of processing exports to the US and nearly as much to Japan. However, the second largest form—processing and assembly by Chinese firms—dwindles in share. Instead, there is a growing share of processing exports by foreign-owned firms with

[13] They assume that ownership and control are chosen to maximize joint surplus plus an i.i.d extreme value random error that varies across contractual types.

foreign control over inputs. This pattern appears with respect to both destination countries, but more dramatically with respect to the US.[14]

Further differences between the US and Japan emerge when we dig a bit deeper in the data and distinguish between foreign firms by type. As noted above, not all FIEs operate under the same organizational forms. In fully-funded enterprises, foreign control over production decision is complete. With an equity joint venture or contractual joint venture, control is shared between the foreign investor and the Chinese partner. In Table 7, we see that processing exports by foreign-owned firms destined for Japan are more likely to come from firms with foreign control over inputs than those destined for the US, regardless of firm type. But there is also variation across firm types. When the exporter is an FFE, so that the foreigner has complete ownership of the firm, the share of processing exports to the US under processing and assembly is 15% (8.9/59.7), in contrast to about 20% for exports to Japan. When foreign ownership is shared, as under an EJV, about 7% of processing exports to the US are from firms with foreign control over inputs, in contrast to 27% of exports to Japan. Finally when joint ownership is stipulated only contractually (CJV), the shares of processing exports to the US and to Japan under processing and assembly are 23% and 57%, respectively. This decomposition suggests that foreign firms undertaking processing exports to Japan are progressively more likely to retain control over inputs, as their control over the ownership of the firm declines.

6. Implications for regional integration

A detailed look at trade between China and two of its largest trading partners, the United States and Japan, finds that only a small share of these flows can be characterized as arm's length, one-way trade in final goods. Instead, we find extensive two-way trade, deep vertical specialization, concentration of trade in computer and communication devices, and a prominent role for foreign-invested enterprises. While these characteristics define both bilateral relationships, some important differences between the two pairs do emerge. China's imports from Japan are most likely destined for an FIE within China, and more likely to be processing than non-processing trade; its processing imports are roughly balanced with Chinese processing exports to Japan. In comparison, China's imports from the US are somewhat less likely to be destined for an FIE within China, and most likely to be non-processing trade; its processing imports are outsized by Chinese processing exports to the US. Even as both Japan

[14] Part of this dominance of foreign ownership and foreign control over inputs may be explained by the post-1996 ease in Chinese FDI restrictions, leading to a surge in the establishment of wholly-owned foreign subsidiaries (FFEs).

and the US experienced rapid growth in non-processing exports to China after 2001, Japan's processing exports to China increased apace while US processing exports grew far more slowly. The picture that emerges is one where China is in the midst of a global production chain, with Japan as a principal source of imported intermediates, and the US as a principal destination for exports embodying imported intermediates. This impression is reinforced by Wakasugi et al., (2008), who find a sharp decline in Japan's share of the world manufacturing value added between 1996 and 2004, a sharp increase for China and no change for the US.

While this evidence is often interpreted as support for the view that Japan is more deeply "integrated" with China, we stress that trade flows provide only a limited window into production fragmentation as they do not trace products through the production cycle. While it may certainly be the case that some Japanese firms are more likely to export components and parts to China for processing than are similar US firms, the evidence is also consistent with a relatively greater reliance by US-based firms on production of components within China, and thus relatively smaller flows of processing exports from the US to China. In other words, larger trade costs may lead US-based multinationals to choose direct investment over exporting relatively more often than do Japanese-based firms. Such a hypothesis cannot be tested with trade data; direct observation of the production structures chosen by Japanese and American multinationals is required.

Trade costs may also be an explanation for evidence of a "home-market effect" at work in the Japan-China relationship that we do not find in the US-China relationship. China's imports from Japan of highly differentiated products are much more likely to be ordinary trade than are less differentiated products, a difference not evident in US-China flows. Transport costs between the US and China may be large enough to outweigh the benefits of concentrating production within the US and serving China via exporting. For Japan, transportation costs are lower and thus serving the Chinese market through domestic production may more often be the profit maximizing strategy.

Although the US and Japan face different trade costs and, thus, appear to pursue somewhat different strategies for integrating with China, each will gain from shifting some fragments of production to a country where they can be produced at lower cost. Helpman and Rossi-Hansberg (2008) emphasize the productivity effect of offshoring and the possibility that these productivity gains raise wages for unskilled as well as skilled workers in the high-wage country. An important question is how the extent of this shift in response to differential transport costs affects the distribution of gains in the high-wage country. Does it matter for source country unskilled wages if more or less of the value chain is offshored?

Our findings also suggest a new perspective on the costs to the US of an East Asian free trade area that does not include the United States. There is an emerging consensus view of East Asia as a highly interdependent producer of final goods for North American consumption. Athukorala and Yamashita (2008) characterize the US-China trade imbalance as a structural phenomenon resulting from the emergence of China as a final assembly center for East Asian production networks, largely for North American consumption. Consequently, Athukorala (2005) argues that East Asian growth is increasingly reliant on extra-regional trade, mainly as a destination for its exports, strengthening the case for global, rather than regional, trade and investment policy making. Our findings add a somewhat different shading to these arguments, while retaining the case for global, over regional, liberalization. We have documented the many commonalities between China's bilateral trade with the US and that with Japan. While reliance on exports to Chinese processors may differ, production fragmentation and input processing are important for American producers as well as for Japanese producers. Thus, dialogue on regional trade liberalization should expand beyond a view of the US mainly as a final goods consumer; it should include discussion of gains for the US through greater production efficiency from production fragmentation and gains to East Asia through processing trade creation with the US.

References

Antràs, Pol (2003). Firms, contracts, and trade structure. *Quarterly Journal of Economics*, 118(4), 1375–1418.

Antràs, Pol, & Rossi-Hansberg, Esteban (2008). *Organizations and trade*. NBER Working Paper 14262. Cambridge, Massachusetts: National Bureau of Economic Research.

Athukorala, Prema-chandra (2005). Production fragmentation and trade patterns in East Asia. *Asian Economic Papers*, 4(3), 1–27.

Athukorala, Prema-chandra, & Yamashita, Nobuaki (2008). *Global production sharing and US-China trade relations*. Departmental Working Paper 2008-22 Canberra: Australian National University, Economics, RSPAS.

Brainard, S. Lael (1997). An empirical assessment of the proximity-concentration trade-off between multinational sales and trade. *American Economic Review*, 84, 520–544.

Dean, Judith, Fung, K.C., & Wang, Zhi (2008). *How vertically specialized is Chinese trade?* Office of Economics Working Paper 2008-09D. Washington: U.S. International Trade Commission.

Deardorff, Alan (2001). Fragmentation across cones. In S. Arndt & H. Kierzkowski (Eds.), *Fragmentation*. Oxford: Oxford University Press.

——— (2005). Gains from trade and fragmentation. Mimeo, University of Michigan, Ann Arbor.

Feenstra, Robert C., & Hanson, Gordon H. (2005). Ownership and control in outsourcing to China: Estimating the property rights theory of the firm. *Quarterly Journal of Economics*, 120(2), 729–762.

Ferrantino, Michael, Koopman, Robert, Wang, Zhi, & Yinug, Falan (2008). The nature of US-China Trade in advanced technology products. US International Trade Commission,

Washington, mimeo.
Finger, J. Michael, & Kreinin, M. (1979). A measure of 'export similarity' and its possible uses. *Economic Journal*, 89, 905–912.
Greenaway, David, Hine, Robert, & Milner, Chris (1995). Vertical and horizontal intra-industry trade: a cross industry analysis for the UK. *Economic Journal,* 105, 1505-1518.
Grubel, Herbert G., and Lloyd, Peter J. (1975). *Intra-industry trade: the theory and measurement of international trade in differentiated products.* New York: John Wiley.
Hammer, Alexander (2006). *The dynamic structure of US-China trade, 1995–2004*. Office of Economics Working Paper 2006-07A. Washington: U.S. International Trade Commission.
Hanson, Gordon H., Mataloni, Raymond J.. & Slaughter, Matthew J. (2005). Vertical production networks in multinational firms. Review of Economics and Statistics, 87(4), 664–678.
Hanson, Gordon H., & Xiang, Chong (2004). The home-market effect and bilateral trade patterns. *American Economic Review*, 94(4), 1108–1129.
Helpman, Elhanan (1984). A simple theory of international trade with multinational corporations. *Journal of Political Economy*, 92, 451–471.
——— (2006). Trade, FDI, and the organization of firms. *Journal of Economic Literature*, 44, 589–630.
Helpman, Elhanan, Melitz, Marc J., & Yeaple, Stephen R. (2004). Export versus FDI with heterogeneous firms. *American Economic Review*, 94, 300–316.
Helpman, Elhanan, and Rossi-Hansberg, Esteban (2008). Trading tasks: A simple theory of offshoring. *American Economic Review*, 98(5), 1978–1997.
Ianchovichina, Elena, and Martin, Will (2004). Economic impacts of China's accession to the WTO. In D. Bhattasali, S. Li, and W. Martin (Eds.), *China and the WTO*. Washington: World Bank and Oxford University Press.
Jones, Ronald W., and Kierzkowski, Henry (2001). A framework for fragmentation. In S. Arndt and H. Kierzkowski (Eds.), *Fragmentation*. Oxford: Oxford University Press.
Koopman, Robert, Wei, Shang-Jin, & Wang, Zhi (2008). *How much of Chinese exports are really made in China?* NBER Working Paper 14109. Cambridge, Massachusetts: National Bureau of Economic Research.
Krugman, Paul (1980). Scale economies, product differentiation, and the pattern of trade. *American Economic Review*, 70(5), 950–959.
Markusen, James R. (1984). Multinationals, multi-plant economies, and the gains from trade. *Journal of International Economics,* 16, 205–226.
Markusen, James R., and Venables, Anthony J. (1998). Multinational firms and the new trade theory. *Journal of International Economics*, 46, 183–203.
——— (2000). The theory of endowment, intra-industry and multi-national trade. *Journal of International Economics*, 52, 209–234.
Naughton, Barry (2007). *The Chinese economy: Transitions and growth*. Cambridge, Massachusetts: MIT Press.
Wakasugi, Ryuhei, Ito, Banri & Tomiura, Eiichi (2008). Offshoring and trade in East Asia: a statistical analysis. *Asian Economic Papers*, 7, 101-124.
Yeaple, Stephen R. (2003a). The role of skill endowments in the structure of US outward FDI. *The Review of Economics and Statistics*, 85, 726–734.
——— (2003b). The complex integration strategies of multinationals and cross country dependencies in the structure of FDI. *Journal of International Economics*, 60, 293–314.
Yi, Kei-Mu (2003). Can vertical specialization explain the growth of world trade? *Journal of Political Economy*, 111(1), 52–102.
Xing, Yuqing (2007). Foreign direct investment and China's bilateral intra-industry trade with Japan and the US. *Journal of Asian Economics,* 18, 685-700.

Table 1

China-Japan-US exports, imports, and trade balance, billions of current US dollars

China's Exports By Destination

Country	1996	2007	AAGR
US	26.7	232.7	21.7
Japan	30.9	102.1	11.5
ASEAN	10.3	94.2	22.3
EU15	19.8	221.3	24.5
ROW	63.4	567.7	22.0
World	151.2	1,217.9	20.9

China's Imports By Origin

Country	1996	2007	AAGR
US	16.2	69.5	14.1
Japan	29.2	134.1	14.9
ASEAN	10.9	108.4	23.3
EU15	19.9	106.1	16.4
ROW	60.4	452.4	20.1
World	136.5	870.1	18.3

China's Trade Balance

Country	1996	2007
US	10.5	163.3
Japan	1.7	-31.9
ASEAN	-0.6	-14.2
EU15	0.0	115.3
ROW	3.0	115.3
World	14.7	347.8

AAGR= average annual growth rate

a) For exports (imports), country refers to the final destination (original source) country where goods are consumed (produced). For example, exports passing though Hong Kong but destined for the US are entered as exports to the US (not Honk Kong).

b) ASEAN includes Brunei, Indonesia, Cambodia, Laos PDR, Malaysia, Myanmar,Philippines, Singapore, Thailand, Vietnam

Source: Authors' calculations using official Chinese customs data

Table 2
Export similarity indices, various country pairs

	Similarity of Exports to China[1]	
	1996	**2007**
Japan/US	0.36	0.42
EU/US	0.44	0.48
EU/Japan	0.41	0.44
Tigers/Japan	0.56	0.52
Tigers/US	0.32	0.34
ASEAN[2]/Japan	0.20	0.30
ASEAN[2]/US	0.18	0.25

[1]Finger and Kreinen (1979) export similarity index, calculated using the HS 8-digit Chinese mirror import data.
[2]ASEAN excluding Singapore, and including East Timor.

Table 3

China's exports and imports by country (USD, mn) and intra-industry trade (IIT) index (%) in 2007

		Japan				US			
SITC	Description	Exports	Imports	Balance	**IIT Index**	Exports	Imports	Balance	**IIT Index**
77	Electrical machinery	11,666	37,027	(25,362)	**32.2%**	19,054	10,836	8,218	**28.1%**
76	Telecommunications and sound recording	7,762	5,581	2,182	**52.2%**	36,847	1,435	35,412	**7.5%**
75	Office and processing machines	10,085	3,911	6,173	**42.5%**	38,165	2,152	36,013	**10.7%**
84	Articles of apparel and clothing	16,499	128	16,371	**1.4%**	18,737	20	18,717	**0.2%**
87	Professional instruments	2,122	7,884	(5,762)	**35.3%**	3,664	3,591	73	**45.0%**
74	General industrial machinery	3,896	5,896	(2,000)	**48.2%**	8,718	3,517	5,201	**41.9%**
89	Miscellaneous manufactured articles, n.e.s.	4,401	1,915	2,486	**25.9%**	21,610	1,175	20,435	**5.3%**
67	Iron and steel	2,122	7,702	(5,580)	**13.5%**	4,454	754	3,700	**16.5%**
28	Metalliferous ores and metal scrap	115	1,974	(1,859)	**1.7%**	6	3,156	(3,150)	**0.2%**
65	Textile yarn and related products	3,152	3,154	(2)	**21.6%**	6,075	547	5,528	**9.9%**
Subtotal		61,819	75,171	(13,352)		157,329	27,182	130,147	
Total Trade		101,379	133,777	(32,398)	**27.6%**	232,570	69,267	163,302	**14.2%**

		ASEAN				EU15			
SITC	Description	Exports	Imports	Balance	**IIT Index**	Exports	Imports	Balance	**IIT Index**
77	Electrical machinery	12,473	42,520	(30,047)	**32.9%**	21,044	14,246	6,798	**35.9%**
76	Telecommunications and sound recording	9,796	3,699	6,098	**48.3%**	29,646	2,786	26,860	**17.1%**
75	Office and processing machines	8,678	14,019	(5,342)	**47.9%**	39,165	1,485	37,679	**7.3%**
84	Articles of apparel and clothing	5,032	98	4,935	**3.1%**	19,954	333	19,622	**3.3%**
87	Professional instruments	2,405	867	1,538	**29.8%**	3,241	4,566	(1,325)	**29.5%**
74	General industrial machinery	4,080	1,858	2,222	**38.9%**	9,064	12,526	(3,462)	**45.7%**
89	Miscellaneous manufactured articles, n.e.s.	2,381	1,890	491	**33.9%**	13,095	1,195	11,901	**11.9%**
67	Iron and steel	7,964	231	7,732	**4.7%**	9,039	3,706	5,333	**26.7%**
28	Metalliferous ores and metal scrap	5	4,537	(4,532)	**0.2%**	451	3,679	(3,227)	**0.4%**
65	Textile yarn and related products	5,839	703	5,136	**18.3%**	6,348	1,075	5,273	**19.3%**
Subtotal		58,653	70,421	(11,768)		151,049	45,597	105,451	
Total Trade		94,066	108,223	(14,158)	**30.1%**	221,263	105,955	115,308	**22.1%**

Source: Authors' calculations using official Chinese customs data, and HS 2007 to SITC Rev. 4 concordance from WITS. Excludes HS 98 and HS 99.
a) The intra-industry trade index is the Grubel and Lloyd index (1975), calculated at the SITC 5-digit level and aggregated to SITC 2-digit.
b) Top ten Industries based on size of Chinese global trade flows (imports + exports), excluding petroleum, in descending order.

Table 4
China's exports, by destination and type, 1996 and 2007

Country	Year	Processing Exports/Total Exports (%)	FIE Exports/Total Exports (%)	FIE Processing Exports/Total Processing Exports (%)
World	1996	55.8	40.7	62.9
	2007	50.7	57.1	84.4
US	1996	72.0	50.6	64.0
	2007	62.5	68.3	86.2
Japan	1996	55.8	48.2	69.6
	2007	56.6	67.7	86.9
ASEAN	1996	41.3	30.4	59.1
	2007	42.7	49.6	81.7
EU15	1996	49.9	35.4	60.4
	2007	51.9	58.3	84.4
ROW	1996	53.2	36.2	60.1
	2007	45.7	51.4	83.3

Source: Authors' calculations using official Chinese customs data
a) Processing exports are made up of process & assemble and process with imported material.
b) FIE exports are made up of Sino-foreign contractual joint venture, Sino-foreign equity joint venture, and

Table 5

Characteristics of Chinese imports, by origin and type, 2007, industries identified by Hanson and Xiang (2004)

		Japan (as share of total trade)		US (as share of total trade)	
SITC	Industry	Ordinary Trade	Processing Trade	Ordinary Trade	Processing Trade
Industries with low trasport costs and low production differentiation					
514	Nitrogen Compounds	62.9	31.8	69.6	13.6
541	Pharmaceuticals	85.0	6.7	77.5	6.1
726	Printing Machinery	66.1	1.8	58.9	0.7
751	Office Machines	69.1	3.6	74.7	0.2
752	Computers	36.7	41.2	81.7	3.2
759	Computer Parts	6.6	74.6	15.3	60.4
761	Televisions	70.1	10.4	75.9	8.2
762	Radios	77.5	9.1	2.7	1.2
764	Audio Speakers	18.0	60.0	43.4	42.2
881	Cameras	14.9	34.8	66.4	7.1
882	Camera Supplies	37.8	50.4	60.2	33.8
884	Optical Lenses	25.0	71.1	47.3	37.9
885	Watches and Clocks	8.6	84.3	24.8	69.4
	Weighted Average	25.9	55.3	63.9	19.1
Industries with high transport costs and high product differentiation					
621	Rubber and Plastics	43.5	50.7	63.6	27.6
625	Tires	89.3	4.8	69.4	3.9
634	Wood Panels	54.6	44.9	32.7	64.6
635	Wood Manufacturing	38.2	48.3	68.4	23.1
641	Paper and Paperboard	44.1	47.6	69.8	26.4
642	Paper Products	29.3	60.5	34.8	57.1
661	Cement	92.8	6.8	96.3	2.4
662	Clay	69.9	24.1	81.1	1.5
663	Mineral Manufacturing	43.5	48.9	43.5	30.2
665	Glassware	12.8	84.4	45.7	33.4
666	Pottery	45.5	49.0	36.6	17.5
671	Pig Iron	19.6	80.4	99.6	0.4
672	Iron Ingots	64.2	33.6	91.9	1.0
673	Iron Bars	43.0	52.6	31.9	59.1
674	Iron Sheets	38.4	57.5	61.4	33.8
676	Steel Rails	60.1	35.0	0.2	98.2
677	Iron Wire	50.8	43.0	46.9	47.7
678	Iron Tubes	69.9	16.4	82.5	9.6
679	Iron Castings	40.3	55.6	13.9	79.0
812	Sanitary and Plumbing	39.9	40.7	74.8	9.9
821	Furniture	91.8	4.7	51.9	25.6
	Weighted Average	45.0	49.8	65.1	25.9

Source: Authors' calculations using official Chinese customs data

Table 6
Processing exports by input control and factory ownership (% of total processing exports)

		Ownership of Factory			
		1996		2007	
Country	Control over Inputs	Foreign	Chinese	Foreign	Chinese
US	***Foreign (processing & assembling)***	3.3	26.5	10.4	8.3
	Chinese (process with imp materials)	60.7	9.5	75.9	5.4
Japan	***Foreign (processing & assembling)***	13.3	17.8	15.9	8.0
	Chinese (process with imp materials)	56.3	12.6	71.1	5.0

Source: Authors' calculations using official Chinese customs data
a) Total processing exports are made up of Process & assemble, and process with imported material.
b) Foreign ownership is made up of Sino-foreign contractual joint ventures, Sino-foreign equity joint ventures, and foreign-invested enterprises. Chinese ownership is made up of state-owned enterprises, collective enterprises, private enterprises, individual-owned industrial or commercial firms, customs broking enterprises, and other.

Table 7
Processing exports by input control and foreign ownership type
(% of total processing exports)

		Foreign Ownership Type 2007		
Country	Control over Inputs	FFE	CJV	EJV
US	***Foreign (processing & assembling)***	8.9	0.3	1.0
	Chinese (process with imp materials)	59.7	1.3	15.1
Japan	***Foreign (processing & assembling)***	10.4	0.8	4.7
	Chinese (process with imp materials)	52.1	1.4	17.4

Source: See Table 6.

Figure 1a: China's Export Market, By Country (1996 & 2007)
(in millions of US dollars)

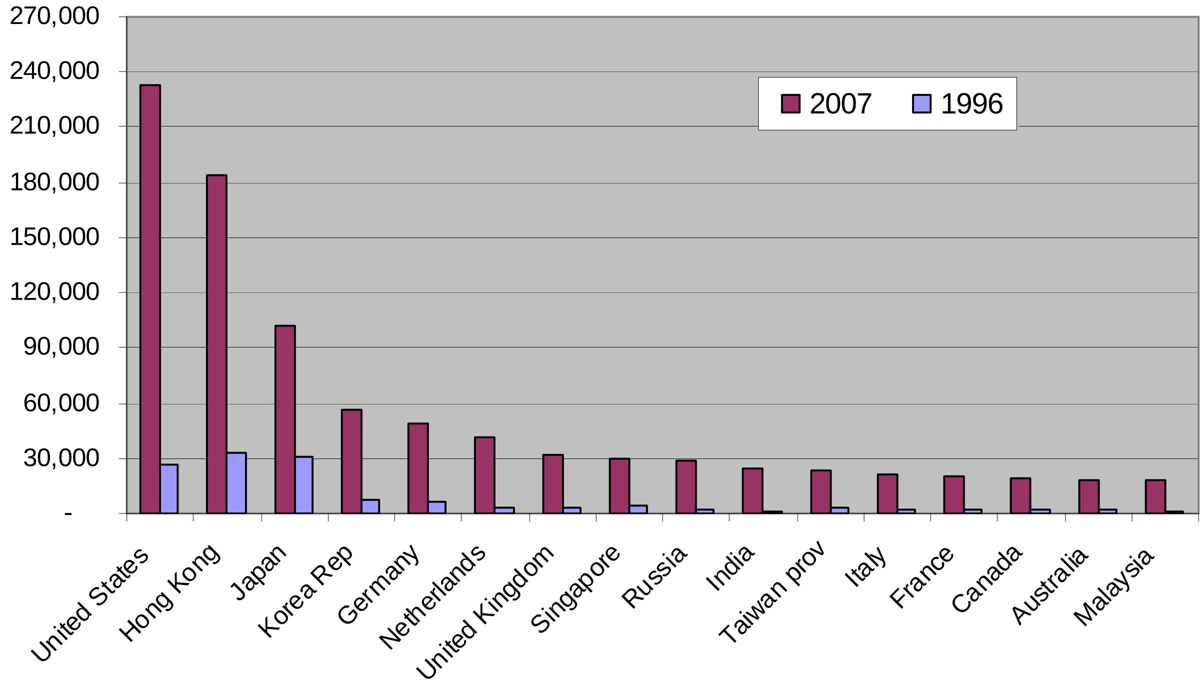


Figure 1b: China's Import Market, By Country (1996 & 2007)
(in millions of US dollars)

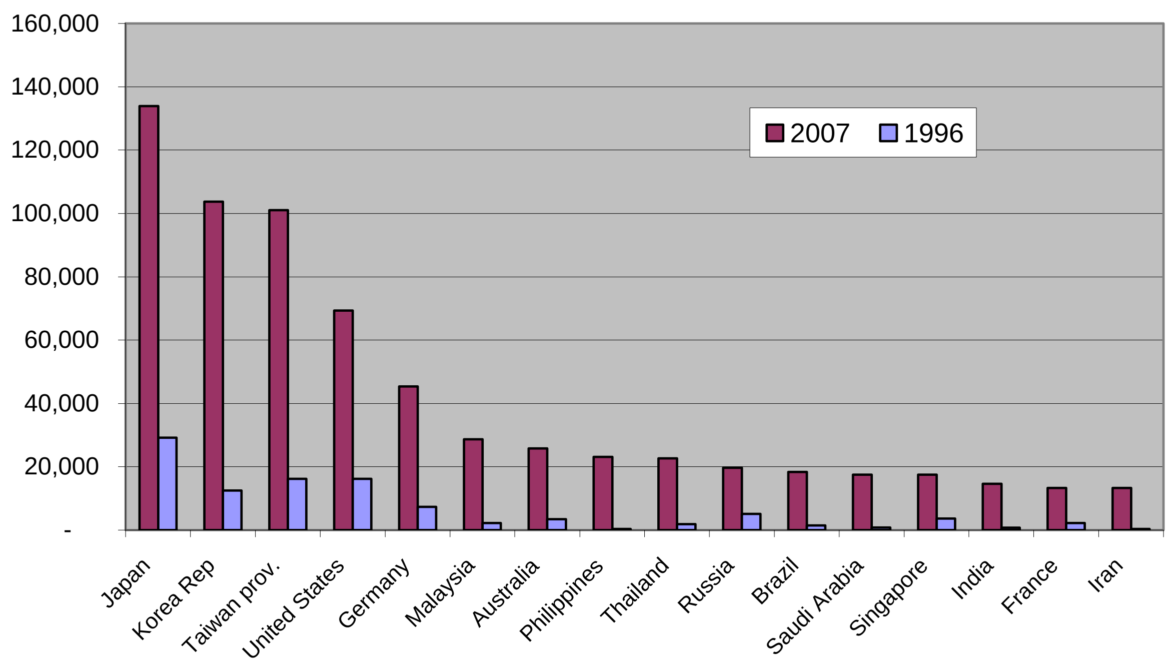


Figure 2a: China's Processing (P) and Non-Processing (NP) Exports (By destination, USD billions)

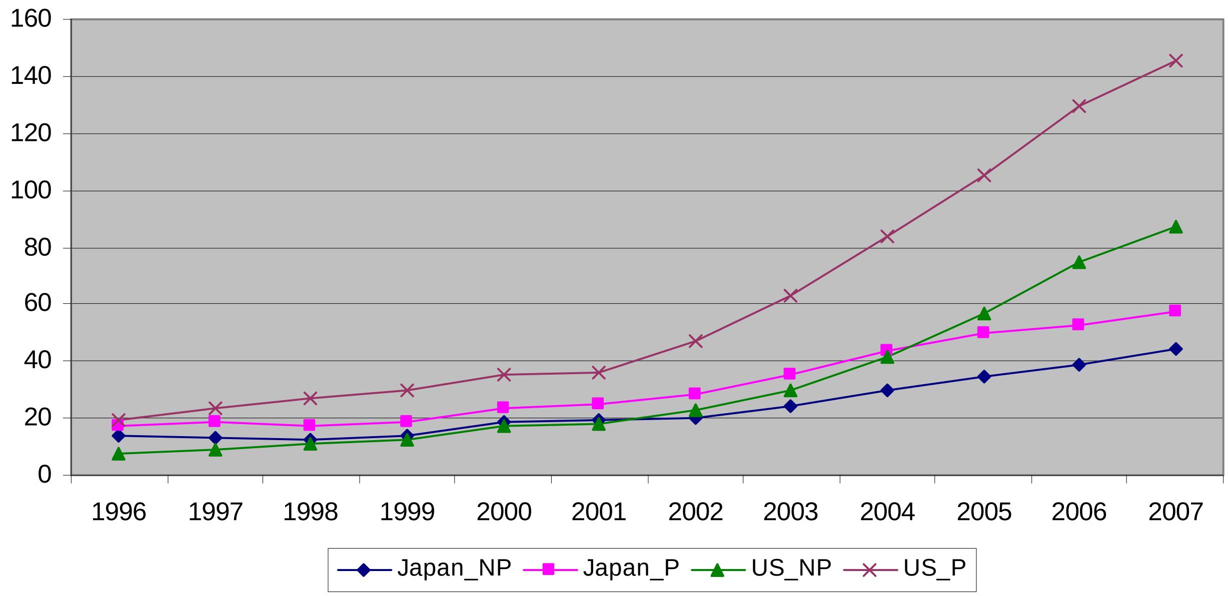


Figure 2b: China's Processing (P) and Non-Processing (NP) Imports (By source, USD billions)

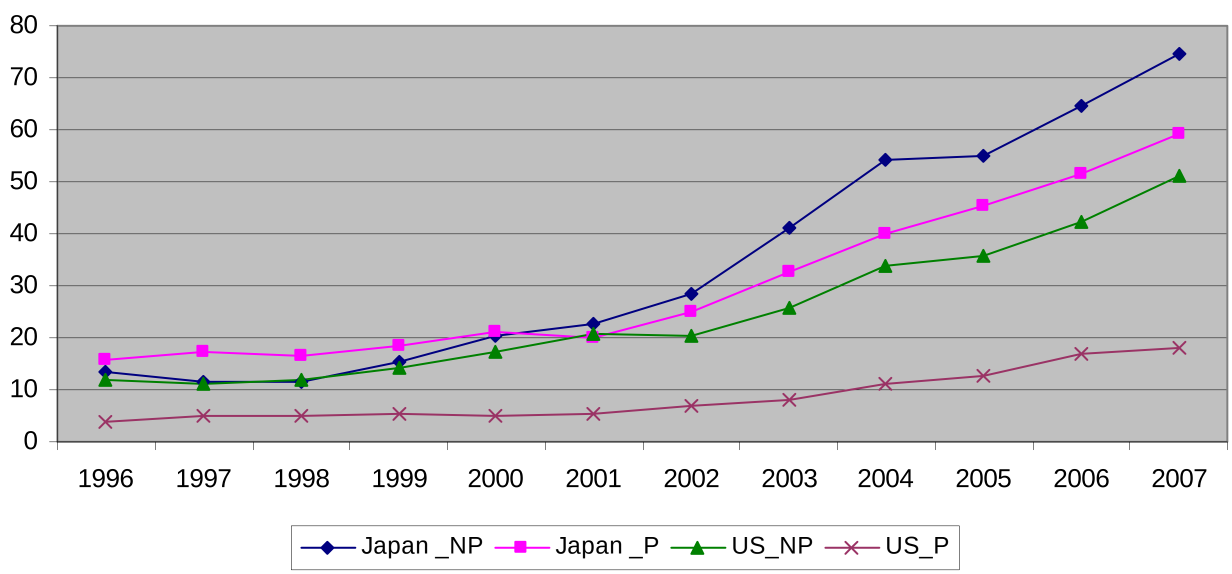


Figure 3a: China's Top Ten Exports in 2007, by Country

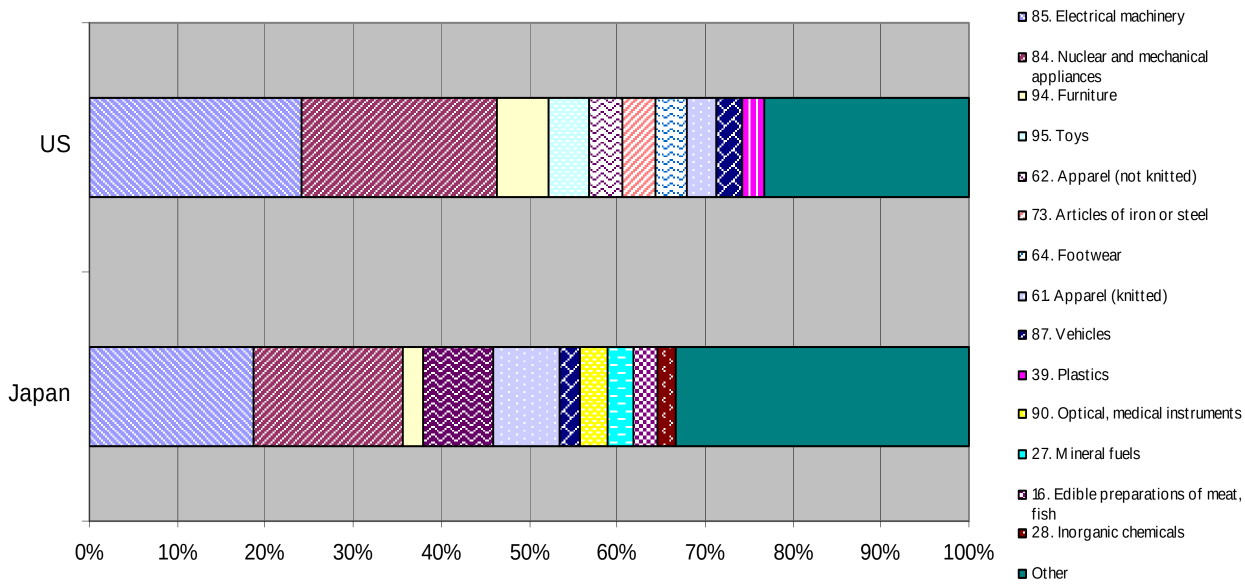
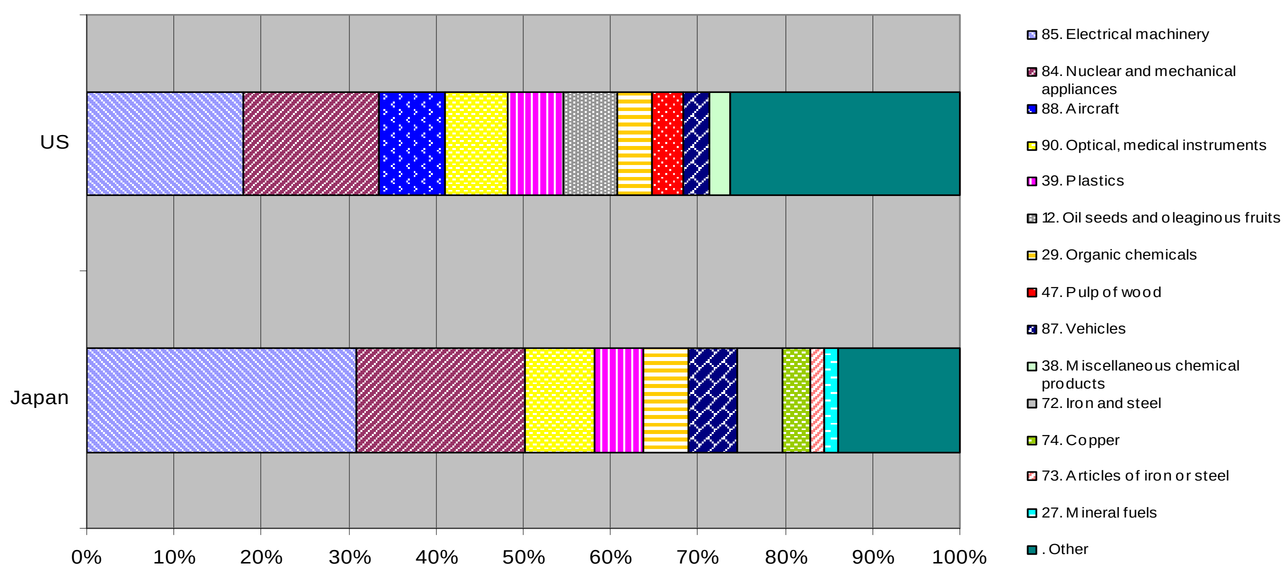


Figure 3b: China's Top Ten Imports in 2007, by Country



Source: Author's calculations using official Chinese Customs data.

Figure 4a: China's Exports to the US (by type)

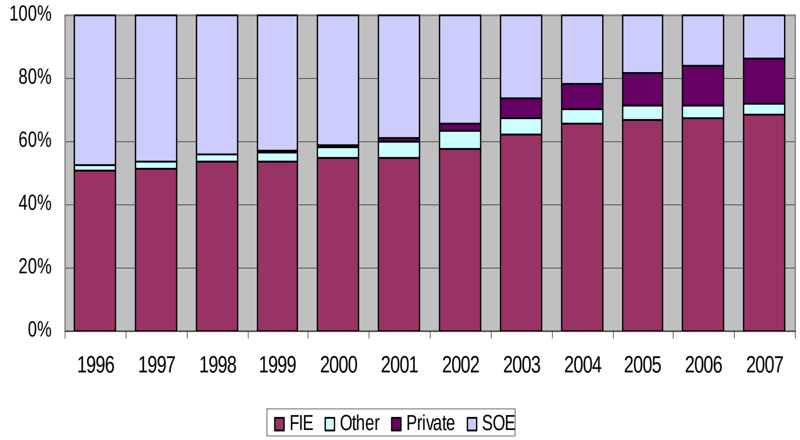


Figure 4b: China's Exports to Japan (by type)

Figure 4c: China's Imports from the US (by type)

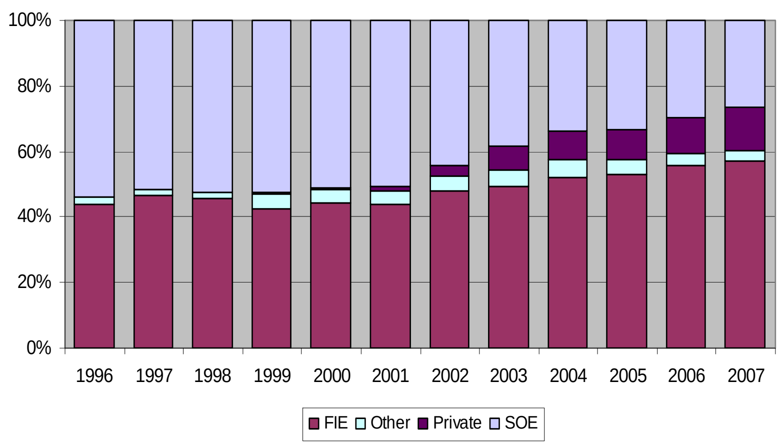


Figure 4d: China's Imports from Japan (by type)