June 14, 2012

Testimony before the U.S.-China Economic and Security Review Commission
Hearing on "The Evolving U.S.-China Trade and Investment Relationship"

Judith M. Dean
Professor of International Economics
Brandeis University

I. Introduction

If you bought an Apple iPod in 2005, it would likely have been imported from China. But China would have contributed less than 3% of the value in that iPod. Most of its value would have been produced in Japan and the United States (Linden, Dedrick and Kraemer, 2009). This is because the iPod is produced in a global supply chain. While most of the R&D and design is done in the United States, firms in many other countries are involved in different stages of the production of the iPod. Among those countries are Japan, Thailand, Taiwan, Korea, Philippines, Singapore, and China (Linden, et al, 2009). This is not unique to the iPod. Dean, Fung and Wang (2011), for example, estimate that foreign content accounted for between 63% and 95% of the value of China's IT-related exports in 2002.

Such "global supply chain" production is becoming increasingly prominent. "Instead of carrying out everything from …R&D to delivery and retail within a single country, many industries are slicing up this process into stages or tasks (or "fragments") that are then undertaken in many countries" (USITC, 2011a). The ability to split the production process into tasks that can be done in different locations implies a change in the nature of specialization. Firms in different countries are now able to specialize in stages or tasks *within* the production of a good, based on comparative advantage. This strengthens all countries' gains from trade, since goods can be produced more efficiently than if the entire process had to take place in a single location. This also changes the pattern of trade. Trade flows will increasingly be comprised of trade in intermediate goods, and reflect the sequential nature of these production chains. The volume of trade between industrial and developing countries is also likely to grow, since global supply chains make use of *differences* in comparative advantage when allocating tasks (Arndt and Kierzkowski, 2001).

The international fragmentation of production is particularly important for understanding China's trade. Chinese Official Customs data records its supply chain trade—known as "processing trade" –separately from its normal trade. Based on these data, about half of China's remarkable trade growth between 1995 and 2008 is attributable to processing trade (Dean, et al., 2011). On average, about 85% of this global supply chain manufacturing has been done through foreign multinational subsidiaries or joint ventures (Dean, Lovely, and Mora, 2009). Recent work by U.S. and Chinese researchers provides evidence that China is typically at the "end of the value chain," engaged in low-skilled labor intensive activities in high-tech industries, such as pharmaceuticals and electronics (USITC, 2011b).

Because of the importance of these global supply chain relationships in China's trade, conventional trade statistics will misattribute much of the value of a product to China, which is in fact produced elsewhere. Conventional trade statistics will also mask the interdependence between countries in carrying out global production. In contrast, value added (VA) trade measures can contribute greatly to a clearer understanding of global supply chain trade. In this testimony, I focus on two such contributions. VA trade measures can: (1) provide a more accurate view of the flow of value-added between countries; (2) reveal the interdependence of countries involved in global production processes. I then illustrate how these two insights can help contribute to sound trade policy.

II. What are VA trade measures?

How much of the value of a product is actually made in each country that participates in a global chain? Hummels, Ishii, and Yi (2001) took a step toward answering this question by linking a country's input-output table to its trade data, to measure the foreign content in a country's exports.[1] Hummels, et al., measured not only the imported inputs used directly in producing an export, but also the indirect use of imported inputs in domestic intermediate goods used to produce that export. A high foreign content indicated that imported intermediate goods made up a large proportion of the value of a country's exports. This potentially indicated that a country was involved in global production chains, and likely at the "end of the chain."

VA trade measures are much more extensive. Instead of focusing on a single country, they use global input-output data to map the sources and destination of value contributed by each country to a finished product. Thus they reveal how much of the value of a good originates in a particular country and is exported to another country, either directly, or indirectly through one or more additional countries. VA trade thus captures the complexity of today's supply chains, in which intermediate goods can cross borders multiple times before being exported as a final good by the country at the end of the chain. VA trade measures also reveal how much of a country's own value-added is reimported indirectly—embodied in imported intermediates or finished goods (Koopman, Powers, Wang and Wei, 2010; Johnson and Noguera, 2011).

III. What are the benefits of VA trade measures?

A. A more accurate view of the pattern of trade

Estimates of the foreign content in China's exports reveal the importance of global supply chains in China's trade. Dean, Fung and Wang (2011)[2] found evidence of an extensive Asian network of input suppliers to China. In 2002, for example, Japan and the Tigers accounted for half of China's directly imported intermediates, with an additional 10% from other East and Southeast Asian countries. A similar pattern emerged for processing intermediate imports, with nearly 80% of directly imported intermediates coming from this Asian network.[3] Using both the official Chinese input-output table, and separate input-output tables for processing and normal exports (developed by Koopman, Wang and Wei, 2012), Dean, et al, calculated the total foreign content in Chinese exports by destination and by industry.[4] They found that foreign content accounted for as much as 42% of China's 2002 global exports, and as much as 54% of China's exports to the United States.

Recent estimates of value-added trade provide a much fuller picture, allowing us to trace values flowing directly between trading partners, and indirectly through additional countries. Koopman, Powers, Wang, and Wei (2010) find that in 2004, about 35.7% of the value of China's global exports was of foreign origin. They, too, find China involved in an Asian production network, with Japan accounting for about 22% of this foreign value-added and the Four Tigers accounting for another 28%. However, their work also shows that the United States and the EU-15 accounted for 10% and 11%, respectively, of the foreign value in China's exports. Thus the United States and EU-15 share of foreign value-added embodied in China's exports was about the same as that of South Korea and Taiwan.

---

[1] The share of foreign content is also referred to as "vertical specialization (VS) share."

[2] Dean, Fung and Wang (2011) build on Hummels, et al. They developed an improved method of identifying intermediates using both Chinese processing trade data and the UN Broad Economic Classification.

[3] Dean, Lovely and Mora (2009) describe in more detail the types of imported intermediates sourced from different supplier countries.

[4] The splitting of the input-output table into separate tables for processing and for normal exports allows for the relatively high imported intermediate intensity of processing exports compared to normal exports or domestic sales.

Together, these findings suggest that Japan, the United States, Europe and the Four Tigers export intermediates to China either directly or indirectly, for further processing. These goods then are exported by China, largely to final consumers.

Table 1 reproduces the USITC (2011a) estimates of 2004 U.S. imports, measured by conventional trade statistics and by value-added. Here we see that conventional trade statistics overstate U.S. imports from China. Using VA estimates, China accounts for only 7.7% of U.S. imports rather than 11.1% using conventional statistics. The roles of Mexico and Canada in U.S. imports are also overstated, though the differences between the two measures are smaller than for China. This overstatement occurs because these countries are more likely to be in the middle or end of global production chains, so their exports have a high foreign content. In contrast, conventional trade statistics understate the role of Europe and Japan in U.S. imports. This is because 17.6% of European and 26% of Japanese exports to the United States are exported indirectly, through at least one other country before reaching the United States. VA estimates also reveal that 8.3% of U.S. imports is actually U.S. value-added that is reimported indirectly through third countries.

In contrast, the USITC (2011a) reports that 87% of the value of U.S. exports is produced in the United States. To the extent that U.S. exports are produced in global chains, this suggests that the largest proportion of value-added is created in the United States, and that the United States is likely to be at the beginning of such chains. Of the remaining 13% of value-added, the largest contributors are Europe (3.3%) and Canada (1.7%). Only 0.8% of the value of U.S. exports originates in China.

B. A clearer view of the interdependence of nations

Estimates of foreign content in Chinese exports are helpful in assessing China's role in global production. Dean, et al. (2011) find wide variation in foreign content of Chinese exports across industries (figure 1). Using separate input-output tables, for example, they find foreign content of over 90% for computers and telecommunications equipment—suggesting that China was at the end of the value chain in IT-related sectors. In contrast, foreign content in Chinese metal products, general industrial machinery, and paper (more capital-intensive sectors) was about 40-50%, and in textile production (a relatively labor-intensive sector) was only about 25%. These results correspond to China's comparative advantage, based on its relative scarcity of high-skilled labor and capital equipment, and its relative abundance of less-skilled labor, compared to industrial countries.[5]

VA exports from Koopman, et al. (2010) give further insight into China and many other countries' positions in global supply chains. They decompose the domestic value-added in a country's exports into four types: (1) final goods; (2) intermediate goods used by the direct importer to produce final goods for its own consumption; (3) intermediates that are further processed by the direct importer into final goods for export; (4) intermediate goods that are further processed by the direct importer for export. About 58% of China's VA exports are final goods. Only 23% are intermediates used in final goods by the direct importer, and about 19% are intermediates further processed by the direct importer and then exported. These results suggest that China is indeed near the end of many global supply chains. In contrast, only about 42% of Mexico's VA exports are final goods. Intermediates consumed by the direct importer

[5] Property rights also impact the extent and manner of involvement in global supply chains. Research by Antras (2005), Feenstra and Hanson (2005) and others suggests that if a product embodies extensive R&D or intellectual property, and is new, firms may be less likely to offshore tasks, or only do so through foreign affiliates. This is because of the risk of poor quality control and/or lack of contract enforcement. Dean and Fung (2009) find evidence of a negative correlation between R&D-intensity and Chinese processing activity in an industry. Processing exports in R&D intensive sectors also show high foreign content, suggesting that most of the value was created elsewhere. But the ability to produce with a foreign affiliate does increase processing exports in R&D-intensive industries.

constitute another 40%, and the remaining 18% are further processed by the direct importer for export. This suggests that Mexico may be more involved in middle stages of global supply chains.

USITC (2011a) estimates of 2004 VA trade by product help to reveal the variation in roles of many countries in producing U.S. imports and exports (tables 2 and 3). These tables show sectors in which global production chains play a significant role. In table 2, China accounts for 7.7% of overall U.S. VA imports. However, China accounts for lower shares of VA imports in products like chemicals, motor vehicles, and business services, and higher shares in apparel, electronic equipment, and machinery and equipment. In electronic equipment, the Asian network is evident. Nearly 30% of U.S. VA imports in this sector are from East Asia, with another 19% from Japan and 14% from China. In contrast, China has little role in motor vehicles and parts. Japan and the EU-15 each account for 23% of U.S. VA imports in this sector, and Canada 16%. U.S. value-added reimported accounts for another 19%.

Table 3 shows that on average the United States accounts for 87% of U.S. VA exports. With the exception of the electronic equipment sector, U.S. value-added was close to this average in all sectors listed, except electronic equipment (77%) and business services (95%). This suggests that the United States creates most of the value-added in its exports in these sectors. Unlike China, the United States has very little foreign content in its exports. Across the sectors, the largest contributor of foreign value-added to U.S. exports is actually Europe.

IV. How can VA trade measures contribute to sound trade policy?

During the last decade, international controversy and protectionist sentiment has arisen regarding U.S.-China trade. Two issues have been prominenet in this controversy: (1) the idea that the U.S. bilateral trade deficit with China is disproportionately large; (2) the idea that China is suddenly competing directly with the United States and other industrial countries in high-tech, sophisticated exports. VA trade measures help shed light on both these issues, by providing a more accurate assessment of the U.S.-China bilateral trade balance, and by showing that China's export sophistication is a reflection of global supply chain trade.

As the evidence above shows, a significant share of the value of China's exports to the world, and to the United States, is produced in other countries. China is near the end of global production chains, with most of its VA exports being final goods. In contrast, U.S. exports have very low foreign content. Most of their value originates in the United States, suggesting that the United States is at the beginning of many global chains. This implies that conventional trade statistics significantly overstate the value-added actually exported by China to the United States, while only marginally overstating the value-added exported by the United States to China.

Thus, VA trade measures reveal a much smaller U.S.-China trade deficit than do conventional trade statistics. According to USITC (2011a) estimates (figure 2), the U.S. bilateral trade deficit with China is roughly 40% smaller using VA trade measures than using conventional trade statistics. The U.S. bilateral deficits are also smaller with Canada and Mexico. Because the exports of all three of these countries to the United States contain much value produced in other countries, the actual values imported from these countries are much smaller than conventional statistics would suggest. In contrast, VA trade measures reveal larger U.S. bilateral deficits with Europe and Japan than conventional statistics do. This is because a substantial amount of value produced by these countries is exported to the U.S. indirectly, through third countries.

Research by Rodrik (2006) and Schott (2008) suggested that the bundle of goods exported by China to the United States closely resembled the export bundles of higher income, OECD countries and not developing countries at similar income levels. This raised the concern that China had somehow leapfrogged over its traditional comparative advantage. But Dean, et al. (2011) and Koopman, et al.

(2012) found that Chinese exports to richer countries had a higher foreign content than Chinese exports to poorer countries. In addition, they found that a large share of Chinese imported inputs were sourced from Japan, with additional smaller shares sourced from the EU and the United States. Thus, Chinese exports to the United States might resemble those of other OECD countries because much of their value originated in the OECD.

Examining exports to nearly 200 destinations in 1997 and 2002, Dean, et al. (2011), found that Chinese and OECD exports differed dramatically *across* destinations. Where Chinese exports were similar to those of the OECD, they had high foreign content (figure 3). Econometric testing revealed that a higher share of foreign content in Chinese exports had a significant, positive impact on the similarity between Chinese and OECD exports. The VA trade estimates from Koopman, et al. (2010) also suggests that much of the foreign value-added in Chinese exports is from Japan, the United States, and the EU-15, and that China is likely to be near the end of many global chains. Thus, China's export "sophistication" is likely to arise from its participation in global supply chain trade.

VA trade measures help us see the sources of value flowing between countries, particularly in goods produced in global supply chains. Here they helped reveal that the U.S.-China trade deficit is much smaller than it is thought to be, and that we mistakenly classify much European and Japanese value-added, as well as some U.S. value-added as coming from China. VA trade measures also help us to see why U.S.-China trade would grow so rapidly in higher-tech products. The answer is that these higher tech products actually embody mostly value-added from other industrial nations, and from the United States itself. Many nations are interconnected today, in their joint efforts to produce goods more efficiently for consumption in all nations. These insights underscore the importance of keeping markets open, so that intermediate goods can continue to move freely between countries, as they are processed into final goods. Doing so will allow the United States to continue to benefit from global supply chain trade, both as a producer and as a consumer.

References

Antras, P., 2005. "Incomplete Contracts and the Product Cycle," *American Economic Review* 95: 1054-1073.

Arndt, Sven. and Henryk Kierzkowski, eds., 2001. *Fragmentation*. Oxford: Oxford University Press.

Dean, Judith M., K. C. Fung, and Zhi Wang, 2011. "Measuring Vertical Specialization: the Case of China," *Review of International Economics*, 19:609-25.

Dean, Judith M., Mary E. Lovely, and Jesse Mora, 2009. "Decomposing China–Japan–U.S. Trade: Vertical Specialization, Ownership, and Organizational Form." *Journal of Asian Economics* 20: 596-610.

Dean, Judith M. and K.C. Fung, 2009. "Explaining China's Position in the Global Supply Chain," prepared for the Joint Symposium on U.S.-China Advanced Technology Trade and Industrial Development October 23-24, 2009, Tsinghua University (manuscript).

Feenstra, Robert and Gordon Hanson, 2005. "Ownership and Control in Outsourcing to China: Estimating the Property-Rights Theory of the Firm," *Quarterly Journal of Economics*, May: 729-61.

Hummels, David, Jun Ishii and Kei-mu Yi, 2011. "The Nature and Growth of Vertical Specialization in World Trade," *Journal of International Economics*, 54 (2001):75-96.

Johnson, Robert, and Guillermo Noguera, 2011. "Accounting for Intermediates: Production Sharing and Trade in Value Added", Unpublished Manuscript, Dartmouth College.

Koopman, Robert, Zhi Wang, and Shang-Jin Wei, 2012. "Estimating Domestic Content in Exports When Processing Trade is Pervasive," *Journal of Development Economics*, 99: 179-189.

Koopman, Robert, William Powers, Zhi Wang, and Shang-Jin Wei, 2010. "Give Credit Where Credit is Due: Tracing Value-Added in Global Production Chains, " NBER Working Paper No. 16426.

Linden, Greg, Kenneth Kraemer, and Jason Dedrick, 2009. "Who Captures Value in a Global Innovation Network? The Case of Apple's iPod," *Communications of the ACM*, 52: 140-44.

Rodrik, Dani, 2006. "What's So Special About China's Exports?" *China and the World Economy*, 14 :1-19.

Schott, Peter, 2008. "The Relative Sophistication of Chinese Exports," *Economic Policy*, 53:5-40.

USITC, 2011a. *The Economic Effects of Significant U.S. Import Restraints, Seventh Update* 2011. Washington, DC: USITC.

USITC, 2011b. "Proceedings of the Joint Symposium on U.S.-China Advanced Technology Trade and Industrial Development," *Journal of International Commerce and Economics*, 3:1-239.

Table 1. U.S. Imports and Value-Added Shares in U.S. Imports, 2004, by Source

Region	Total imports	Share of general imports	Share of value-added imports	Share of value added passing through a third country before entering the United States
	Millions of $	Percent		
Europe	393,301	24.7	26.1	17.6
Canada	242,170	15.2	11.0	3.2
Japan	138,417	8.7	10.4	26.0
United States	—	0.0	8.3	100.0
China	176,879	11.1	7.7	14.8
Mexico	154,571	9.7	4.9	4.0
Rest of Americas[a]	76,183	4.8	4.7	13.2
Developing East Asia	79,250	5.0	4.5	32.4
Taiwan, Singapore, Hong Kong	73,066	4.6	4.3	36.7
Korea	51,707	3.3	3.3	31.8
Brazil	23,662	1.5	1.6	20.3
Australia and New Zealand	15,717	1.0	1.3	33.6
Russia	12,003	0.8	1.3	46.4
India	17,486	1.1	1.1	22.0
South Asia	9,557	0.6	0.5	10.2
Rest of world	120,320	7.6	8.5	23.5
Total	1,590,124	100.0	100.0	25.8[b]

Source: Commission estimates.

[a]Including South American, Central American, and Caribbean countries other than Mexico and Brazil.
[b]U.S. average, weighted by U.S. imports from all sources.

Source: USITC (2011a)

Table 2. Country or Regional Sources of Value Added in U.S. Imports, selected sectors, 2004 (%)

Sector	U.S returned	China	Japan	East Asia	Canada	Mexico	Latin America	Europe	Others	Total
Total	8.3	7.7	10.4	12.0	11.0	4.9	6.3	26.1	13.2	100.0
Selected Sectors										
Apparel	11.0	11.2	2.4	27.8	2.4	2.0	10.4	11.4	21.4	100.0
Chemicals, rubber and plastics	6.3	5.0	9.7	8.7	12.0	2.5	3.6	42.8	9.4	100.0
Motor vehicles and parts	19.1	2.5	23.0	7.2	16.0	3.8	1.9	23.1	3.4	100.0
Electronic equipment	8.6	14.4	19.0	29.6	2.4	9.3	1.3	11.4	3.9	100.0
Machinery and equipment	11.3	10.1	17.2	9.7	6.9	4.7	2.9	32.1	5.1	100.0
Business services	1.5	1.3	6.2	12.7	8.8	0.2	2.7	55.5	11.3	100.0

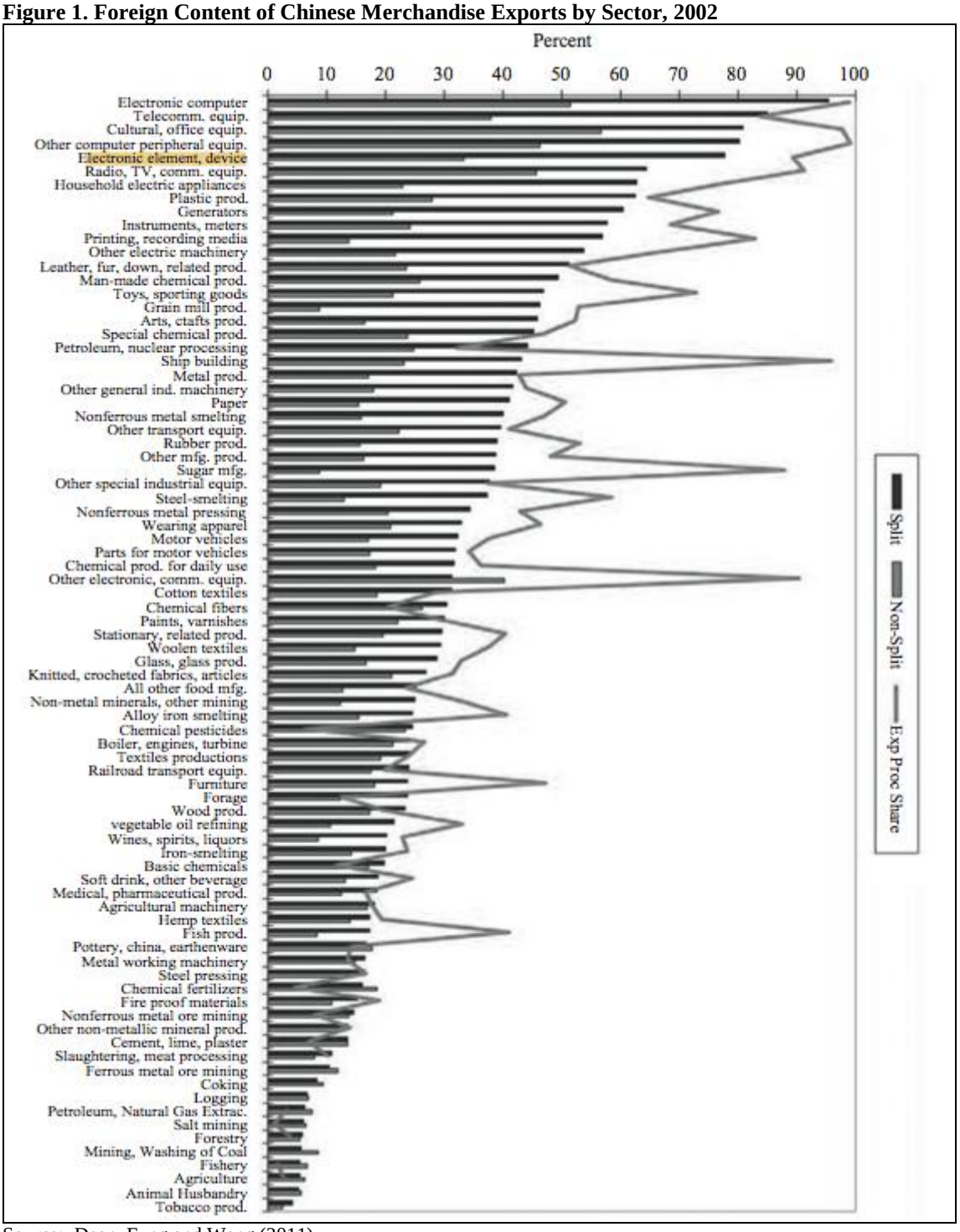
Source: Commission estimates.
Source: USITC (2011a)

Table 3. Country or Regional Sources of Value Added in U.S. Exports, selected sectors, 2004 (%)

Sector	U.S.	China	Japan	East Asia	Canada	Mexico	Latin America	Europe	Others	Total
Total	87.1	0.8	1.3	1.5	1.7	0.9	1.1	3.3	2.1	100.0
Selected sectors										
Apparel	88.5	0.7	0.8	1.5	1.3	0.6	0.7	3.3	2.5	100.0
Chemicals, rubber and plastics	85.5	0.5	1.0	1.1	2.2	0.7	1.5	4.4	3.0	100.0
Motor vehicles and parts	81.5	1.3	3.0	1.9	3.0	1.3	1.3	4.7	2.0	100.0
Electronic equipment	76.9	2.7	3.7	5.1	1.6	2.2	1.0	4.7	2.0	100.0
Machinery and equipment	89.4	1.0	1.2	1.3	1.3	0.8	0.8	2.8	1.4	100.0
Business services	95.6	0.2	0.6	0.7	0.5	0.2	0.2	1.4	0.6	100.0

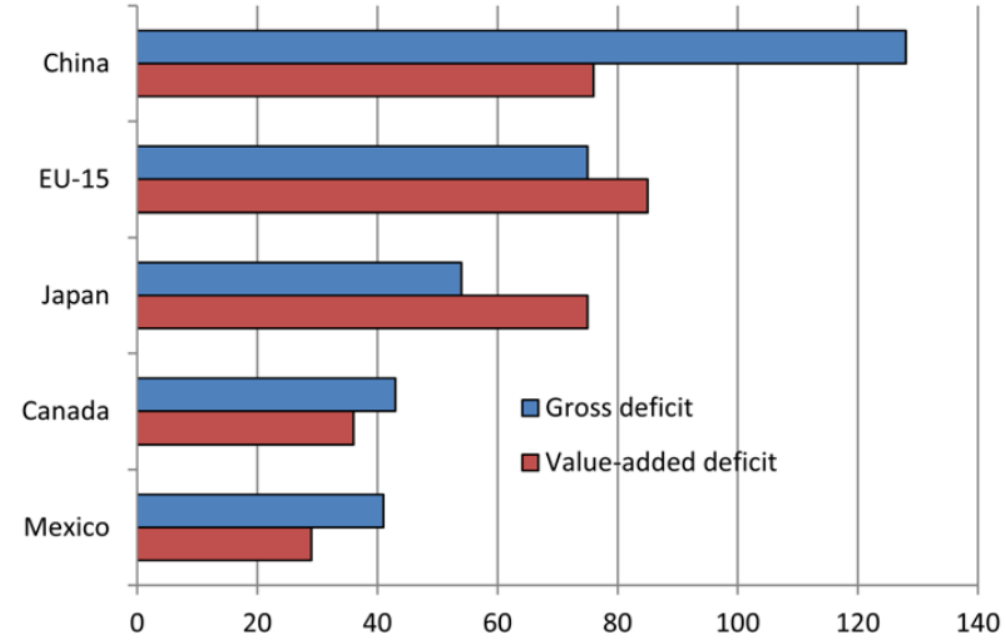
Source: Commission estimates.
Source: USITC (2011a)

Figure 1. Foreign Content of Chinese Merchandise Exports by Sector, 2002



Source: Dean, Fung and Wang (2011)

Figure 2. US Bilateral Trade Deficits with Major Trading Partners (billions of dollars)



Source: Commission estimates.

Source: USITC (2011a)

Figure 3. Export Similarity and Foreign Content: 1997 and 2002

Source: Dean, Fung and Wang 2011