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The Sophistication of East Asian Exports

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Abstract: Hausmann, Hwang, and Rodrik (2007) found that countries that export more sophisticated products tend to subsequently grow more rapidly. We examine the sophistication of Asia's exports using Hausmann et al.'s and Kwan's (2002) measures. Japan remains the technology leader in Asia, but not in the world. In 2012, Japan's exports competed with those of South Korea and Taiwan and were complementary with those of China and the Association of Southeast Asian Nations (ASEAN). South Korea and Taiwan competed intensely with each other but less so with China and ASEAN, while ASEAN countries competed extensively with each other. Given the high levels of competition and cooperation among East Asian countries, greater exchange rate stability in the region would reduce export volatility among competitors and facilitate trade among comrades.

JEL classification: F14, F10

***Keywords*:** Exports; Technology; East Asia

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1. Introduction

A number of studies have indicated that the sophistication level of a country's exports matters. For instance, Hausmann, Hwang, and Rodrik (2007) found that countries that export what rich countries export tend to subsequently grow more rapidly than other countries. They reported that this is true controlling for initial per capita income, human capital levels, and country-specific characteristics. Jarreau and Poncet (2012), using a similar specification, found that provinces in China that export more sophisticated products tend to grow more rapidly than other provinces.

One mechanism driving this faster growth is that firms that start producing sophisticated goods can converge to the quality frontier in these goods (see Hwang, 2007). Another is that an entrepreneur pioneering a region's foray into a sophisticated product engages in a cost discovery process, and if successful generates positive externalities for other entrepreneurs who learn that they too can profitably produce this good (Hausmann and Rodrik, 2003). A third is that exporting sophisticated products can lead to a more rapid diffusion of technology (Lall, Weiss, and Zhang, 2006).

How has the technology level of East Asian exports evolved? Is Japan still the leader? How does China's export basket compare with those of richer Asian countries such as South Korea and Taiwan and with those of emerging economies such as Thailand? Which Asian countries compete in exporting to third markets, and which countries have complementary export structures.

This paper addresses these questions. To do this, it builds product sophistication indices (PSI) and country sophistication indices (CSI) that reflect the PSIs of the goods that the countries export.

Kwan (2002) pioneered the use of these indices. Hausmann, Hwang, and Rodrik (2007) constructed related measures. These indices assume that products exported by richer countries tend to be more technologically sophisticated. The logic behind this is that goods exported by wealthy counties have higher labor costs. To compete in world markets, they need to be produced using more sophisticated technological processes (see Lall et al., 2006).

This paper uses Kwan's (2002) method and the method of Hausmann et al. (2007) to calculate sophistication indices. The results indicate that Japan was producing at the technology frontier in the 1980s and early 1990s, but has since fallen behind. It now produces capital intensive goods that are on average less sophisticated than the goods produced by countries such as Switzerland.

Japan's export basket nevertheless remains more sophisticated than those of South Korea and Taiwan. This largely reflects Japan's advantage in producing capital and equipment good. The exports of Korea and Taiwan are in turn more sophisticated than those of China, Malaysia, the Philippines, and Thailand. The export baskets of these middle income countries are then more advanced by every measure than those of Indonesia, Vietnam, Cambodia, and Laos.

Consistent with these results, evidence from the UNCTAD Merchandise Trade Correlation Index indicates that, in 2012, Japan's exports competed with those of South Korea and Taiwan and were complimentary with those of China and ASEAN. Korea and Taiwan competed intensely with each other and less so with China and ASEAN. ASEAN countries also competed extensively with each other.

These findings have several policy implications. Given the high degree of competition in third markets, greater exchange rate stability in East Asia could prevent large swings in exports from countries like Korea and Japan. Exchange rate stability would also facilitate the flow of goods between countries that are in complementary relationships within regional production networks (see Hayakawa and Kimura, 2009). In addition, the evidence indicates that policy makers in Asia should not be complacent about the sophistication of their countries' exports but should focus on improving human capital and making technological progress.

The next section presents the data and methodology we employed. Section 3 contains the results. Section 4 draws policy implications and concludes.

2. Data and Methodology

To measure export sophistication, Kwan (2002) assumed that countries with higher incomes will export higher value added products. He constructed a PSI for each export category by calculating a weighted average of the per capita GDPs of the product's exporters, using the countries' shares of global exports as weights. For example, if semiconductors were only exported by country A, country B, and country C, and if their respective shares of the global export market were 70%, 20% and 10% and their respective per capita GDP values were $40,000, $10,000, and $1,000, then the PSI for semiconductors would be $40,000*70% + $10,000*20% + $1,000*10% = $30,100.

Formally, the product sophistication index for a product k can be represented as:

$$PSI(k) = \frac{\sum_j x(jk)Y(j)}{X(k)}, \qquad (1)$$

where PSI(k) is the product sophistication index for product k, x(jk) are exports of product k by country j, Y(j) is per capita gross domestic product in country j, and X(k) are total world exports of product k. Equation (1) is thus a weighted average of the per capita GDPs of product k's exporters, using the countries' shares of global exports of k as weights.

To understand this index it is helpful to consider a couple of examples. Table 1 presents the leading exporters of special purpose machinery (ISIC 2929). This category includes sophisticated products such as industrial robots and semiconductor manufacturing machinery. Table 2 presents the leading exporters of carpets and rugs (ISIC 1722). This category includes textile, needle loom floor coverings, and other lower technology goods. For special purpose machinery, apart from China all of the leading exporters are high income countries. For carpets and rugs, on the other hand, many of the leading exporters are developing and emerging economies. The value of the PSI for special purpose machinery is thus high ($32,706) while the value of the PSI for carpets and rugs is lower ($21,744).

To calculate the sophistication of a country's exports, Kwan (2002) posited that the larger the share of sophisticated products in a country's exports, the more advanced its export structure is. For example, assume that the product sophistication index is $30,500 for medical equipment, $27,300 for automobiles, and $10,100 for furniture and that a country's export basket is composed of 50% medical equipment, 30% automobiles, and 20% furniture. Then the country's sophistication index (CSI) would be $30,500*50% + $27,300 *30% + $10,100*20% = $25,460. A country that has a larger share of low-tech products in its export structure will thus have a lower CSI.

Formally, the sophistication index for country j can be calculated using the formula:

$$CSI(j) = \frac{\sum_k x(jk)PSI(k)}{X(j)}, \qquad (2)$$

where CSI(j) is the country sophistication index for country j, x(jk) are exports of product k by country j, PSI(k) is the product sophistication index for product k, and X(j) are total exports of country j to the world. Equation (2) is thus a weighted average of the product sophistication indexes of the goods that country j exports, using the percentage of country j's total exports in each good as weights.

Hausmann et al. (2007) argued that the weighting scheme in equation (1) gives too much weight to large countries. For example, they noted that the value of US exports of men's blazers in 1995 equaled $28,800,000 while the value of Bangladeshi exports of men's blazers equaled $19,400,000. For the US, this equaled 0.005 percent of total exports while for Bangladesh this equaled 0.6 percent of total exports. Even though blazer exports are more important to Bangladesh than to the US, equation (1) would weigh US income more heavily than Bangladeshi income in calculating the sophistication of blazers.

Hausmann et al. (2007) thus proposed a different weighting scheme. In equation (1), they recommended weighting per capita GDP by each country's revealed comparative advantage in product k. They call the resulting measure the productivity level of product k:

$$PRODY(k) = \sum_j \frac{\left(\frac{x(jk)}{X(j)}\right)}{\sum_j \left(\frac{x(jk)}{X(j)}\right)} Y(j), \qquad (3)$$

where PRODY(k) is the productivity level of good k, x(jk)/X(j) is the share of commodity k in the country's overall export basket, and $\sum_j(x(jk)/X(j))$ is the sum of the value shares across all countries j exporting product k, and Y(j) is per capita GDP in country j. Equation (3) thus weighs a country's per capita GDPs by the country's revealed comparative advantage in product k.

Hausmann et al. (2007) then used PRODY to calculate each country's sophistication index. They called this measure the productivity level associated with a country's export basket (EXPY):

$$EXPY(j) = \frac{\sum_k x(jk)PRODY(k)}{X(j)}, \quad (4)$$

where EXPY(j) is the productivity level associated with country j's export basket, PRODY(k) is the productivity level of good k, and the other variables are defined after equation (2).

We measure the sophistication of individual exports and of a country's export basket using both Kwan's (2002) method (equations (1) and (2)) and Hausmann et al's (2007) method (equations (3) and (4)). We employ each country's exports to the world disaggregated to the four-digit ISIC level. The data are measured in U.S. dollars and obtained from the CEPII-CHELEM database. We measure per capita GDP both in constant US dollars and in PPP. These data are also obtained from the CEPII-CHELEM database.[1]

It is possible that firms are capable of exporting more sophisticated products but choose to export less sophisticated products to emerging economies because consumers there are less wealthy. To test for this, we also investigate each country's exports to the U.S. instead of to the world. The results, available on request, are similar to those reported below.

3. Results

Table 3 presents the Country Sophistication Index for the world's two leading countries and for East Asian and Southeast Asian economies. The first two columns present results for the CSI calculated using Kwan's (2002) method and real per capita GDP, the next two columns with the CSI calculated using Hausmann et al.'s (2007) method and real per capita GDP, and the final

[1] In the database, Cambodia and Laos are aggregated together.

two columns with the CSI calculated using Kwan's method and per capita PPP GDP. The results are similar for the three methods.

In all three cases Switzerland and Ireland are the leading countries, and their values for the CSI are close. In all three cases Japan is the leading Asian economy, and its CSI value is 10 to 20 percent below the value for the leading economy. Next come South Korea and Taiwan. Their values for the CSI are close to each other in all three cases and between 5 and 12 percent below the CSI value for Japan. They are followed by Thailand, the Philippines, China, and Malaysia. The order of these four countries changes, but they are always between 8 and 15 percent below the values for South Korea and Taiwan. Indonesia comes next in all three specifications, followed by Vietnam and then Laos and Cambodia. Since the results are similar in the three specifications, in the discussion that follows we focus on the findings using Kwan's (2002) method and real per capita GDP.

3.1 Comparing Japan with the World's Leaders

Figure 1 shows the percentage of the total value of Swiss and Japanese exports in 2011 as a function of the PSI of the goods. In the products with the highest values, Switzerland is ahead. This is driven by three categories. 26 percent of Switzerland's exports are in the category pharmaceutical products, which has a PSI of $35,700, as compared to 1 percent for Japan. 10 percent of Switzerland's exports are in the category of watches and clocks, which has a PSI of $38,700, as compared to 0.2 percent for Japan. 4 percent of Switzerland's exports are in the category medical equipment, which has a PSI of $33,900, as compared to 1 percent for Japan.

Figure 1 shows that the mode of Japan's exports falls in the third highest range (the $25,000 to $30,000 category). 42 percent of Japan's exports are in this category.

Figure 2 graphs the shortfall of Japan's CSI relative to the world leader between 1967 and 2011. In 1967 Japan's CSI was 16 percent below the highest CSI. At that time many of Japan's exports were labor intensive goods such as textiles, wearing apparel, and furniture. Japan then rapidly reached the technological frontier. According to Figure 2, its CSI climbed to within 2 percent of the world leader between 1982 and 1992. After this, however, Japan's country sophistication index has been falling rapidly relative to the world leader. Data on the rankings and the CSI values for the top ten countries between 1967 and 2011 are presented in Appendix A.

Another way to see how the sophistication of Japan's exports has fallen relative to the leader is to look at the share of Japan's exports that can be classified as high-technology goods compared to the country with the highest CSI. For every year in our sample the country with the highest CSI is Switzerland. The classification of goods into the high-technology category was performed by the OECD and obtained from the CEPII-CHELEM database. Goods are classified as high-tech based on the ratio of R&D spending to value-added (see, e.g., Hatzichronoglou, 1997).

Figure 3 shows that Japan's share of high-tech goods exports was as low as 13 percent in the early 1970s. In then rose to above 30 percent in the 1980s. By the early 1980s Japan's share had surpassed the world's leader. In the 1990s, though, Japan's share fell below the leader's share and by 2011 it had fallen to less than 20 percent as compared with 47 percent for Switzerland. Between 2000 and 2011 Japan's share of high-tech exports fell from 33 percent to below 20 percent. Over these 11 years Japan's share of medium low-tech exports increased from 14 percent to 23 percent. Japan's share of medium low-tech exports has thus become higher than its share of high tech exports.

While Switzerland's and Ireland's CSIs were well ahead of Japan's in 2011, Germany's was only 2 percent ahead of Japan's. As Table A1 in Appendix A shows, Germany's CSI was the third highest in 2011. Germany is also noteworthy because, like Japan, it is a large economy and a major exporter. Thus, while Japan's technological sophistication has fallen relative to the world leaders, it is still well positioned relative to most countries.

3.2 Comparing South Korea and Taiwan with Japan

Figure 4 shows the percentage of the total value of Japanese, South Korean, and Taiwanese exports in 2011 as a function of the PSI of the goods. In the products with the highest PSI values ($25,000 and above), Japan is clearly the leader.

Table 4 shows the product categories that make up at least one percent of the exports of these three countries. The three highest categories (pharmaceutical products, medical equipment, and aeronautics) each make up one percent of Japan's total exports but zero percent of the total exports of the other countries.

The table also indicates that Japan has a clear lead in the ISIC 29 category, machinery and equipment. This category is composed of machine tools, machinery for mining and textiles, pumps, gears, engines, turbines, and similar products. For values of the product sophistication index above $25,000, 16 percent of Japan's exports are in this ISIC category as compared with 8 percent for Korea and 7 percent for Japan.

In every year between 1967 and 2011, Japan has been the leading supplier of these goods to East Asia. 30 percent of the region's imports of these goods come from Japan. For the most sophisticated subcategory (ISIC 2929), which includes semiconductor making machinery, industrial robots, and other advanced capital goods, 35 percent of Asia's imports come from

Japan. The value of Japan's exports of these goods to the region is almost three times as large as the next leading exporter (Germany) and twice as large as exports from all other East Asian countries combined. Thus Japan remains the most important source of sophisticated capital goods for the region.

On the other hand, Figure 5 indicates that both South Korea and Taiwan now export more goods in ISIC category 32 to the world than Japan does. These goods include flat-screen televisions, smart phones and other mobile devices, semiconductors and integrated circuits. Recently Samsung and LG have taken the lead in exporting these products. Samsung was rated as the second most innovative firm in the world in 2013 by the Boston Consulting Group, and LG was rated as the 25th most innovative firm.[2] Japanese electronics firms are thus facing intense competition in electronics exports from high-tech firms in Korea and Taiwan.

3.3 Other Comparisons across the Region

Figure 6 compares PSIs across a range of countries in the region. The figure includes Japan, Korea, China, and Vietnam. For clarity's sake, it does not include Taiwan, Thailand, Malaysia, or the Philippines. Table 3 indicates that Taiwan's CSI is similar to Korea's and that the ASEAN countries' CSIs are close to China's. Figure 6 makes clear that 1) Japan's exports are more sophisticated than Korea's (and by extension Taiwan's), 2) Korea's are more sophisticated than China's (and by extension Malaysia's, the Philippines', and Thailand's), and 3) China's are more sophisticated than Vietnam's (and by extension Cambodia's and Laos's). The figure also indicates that there is a lot of overlap in export categories between Japan and Korea, between Korea and China, and between China and Vietnam. However, there is little overlap between Japan and Korea on the one hand and Vietnam on the other.

[2] See www.bcg.com.

Figure 7 compares Thailand and Indonesia. The figure indicates that Thailand's export basket is diversified, with about 30 percent each in the third, fourth, and fifth highest ranges ($25,000 to $30,000, $20,000 to $25,000, and $15,000 to $20,000). A further analysis confirms this. The eight largest export categories for Thailand in 2011 are wearing apparel (10 percent), computers (10 percent), rubber products (6 percent), motor vehicles (6 percent), electronic components (6 percent), refined petroleum (4 percent), primary plastic (4 percent) and TV and radio transmitters (4 percent). By contrast, the 8 largest export categories for Indonesia are petroleum and natural gas (15 percent), hard coal (13 percent), vegetable and animal oils (10 percent), non-ferrous metal (5 percent), rubber products (5 percent), non-ferrous ores (5 percent), basic chemicals (3 percent), and refined petroleum (3 percent). Thailand thus exports a wide variety of manufactured products while Indonesia focuses on primary commodities. As Dervis (2013) noted, countries with diversified export baskets tend to experience more robust growth than primary goods exporters.

Figure 8 compares PSIs for China versus Cambodia and Laos. Like Thailand, China exports a diversified basket across a wide range of PSI values. By contrast, Cambodia and Laos's exports are very concentrated in the low category with PSI's between $10,000 and 15,000. The spike in Cambodia and Laos's exports in this category is driven primarily by wearing apparel (36 percent), knitwear (19 percent), and footwear (7 percent). Thus Cambodia and Laos are focused on exporting lower value added labor-intensive goods while China exports both lower value added and higher value added goods.

3.4 Comrades and Competitors

The results above indicate that Japan, South Korea, and Taiwan are at one end of the technology spectrum and that Vietnam and Cambodia are at the other end. We would thus expect the exports of advanced Asian economies to compete with each other and the exports of developing Asian economies to compete with each other. We would also expect more of a cooperative relationship between advanced Asia and developing Asia.

To examine this issue we use the UNCTAD merchandise trade correlation index (TCI). The TCI examines the similarity between two countries' export baskets to determine the extent that they compete or cooperate with each other. To construct the TCI, UNCTAD first determines a country's trade specialization at the three-digit SITC level. Trade specialization for each good is calculated by dividing the net flow of goods (exports minus imports) to the total flow of goods (exports plus imports). The higher the value of this normalized trade balance for a particular product, the more competitive the country is in this product compared to other countries. The TCI is then the simple correlation coefficient between two economies trade specialization values across all products. The correlation coefficient varies from -1 to +1. TCI values greater than 0 imply that the two countries' export structures are competitive, and values less than 0 imply that they are complementary. The closer the trade correlation index between two countries is to +1 (-1), the more the countries' exports are competitive (complementary).[3]

Table 5 reports the results. For Japan, we find a high correlation (0.466) with Korea and a moderately high (0.302) correlation with Taiwan. Japan's TCI with every other country in the table is negative. Thus Japan competes extensively with Korea in exports and competes somewhat with Taiwan. It also has a complementary export structure with China and ASEAN.

Turning to Korea, the highest correlation in the whole table (0.546) is between Korea and Taiwan. Thus Korea and Taiwan have similar export baskets. The TCI between Korea and

[3] TCI data and a more detailed discussion of how these were constructed are available at www.unctad.org.

China equals 0.193 and the TCI between Korea and Thailand equals 0.162. This indicates that there is some competition between these countries in exports to third markets. Korea's TCI with Cambodia, Indonesia, the Philippines, and Vietnam are negative. Thus Korea's export basket is complementary to those of the ASEAN countries.

For Taiwan, apart from positive TCIs with Japan and Korea it also has a TCI of 0.261 with China. The values of its TCI with other countries in the region tend to be small.

China's highest TCI is with Vietnam (0.362). This makes sense since Figure 6 indicates that there is a lot of product overlap between China and Vietnam in lower end products. China's next highest TCI is with Thailand (0.270).

ASEAN countries compete extensively among themselves. Vietnam had a TCI of 0.470 with Indonesia, 0.347 with Cambodia, and 0.33 with the Philippines and Thailand. Indonesia has a TCI of 0.39 with Malaysia and 0.328 with the Philippines.

These results using the UNCTAD methodology and three-digit SITC data are very similar to the results reported above obtained using Kwan's (2002) methodology and four-digit ISIC data. They indicate that advanced Asian countries tend to export similar products and that emerging Asian countries do also but that there is little overlap between what advanced Asian countries and emerging Asian countries export. The fact that two different data sets and two different methodologies yield similar conclusions lends credence to these findings.

4. Conclusion

This paper has investigated the sophistication of East Asian exports. To do this it has constructed product sophistication indices and country sophistication indices following the work of Kwan (2002) and Hausmann, Hwang, and Rodrik (2007).

The results indicate that Japan was producing at the technology frontier in the early 1990s, but has since slipped. It now produces capital intensive goods that are on average less sophisticated than the goods produced by countries such as Switzerland. Japan's export basket is nevertheless more sophisticated than those of South Korea and Taiwan, whose exports are in turn more advanced than those of China, Malaysia, the Philippines, and Thailand. These middle income countries then export goods that tend to be more sophisticated than the products exported by Indonesia, Vietnam, Cambodia, and Laos.

Consistent with these finding, the Merchandise Trade Correlation Index indicates that Japan's exports in 2012 competed with those of South Korea and Taiwan and were complimentary with those of China and ASEAN. Korea and Taiwan competed intensely with each other and less so with China and ASEAN. China competed with Vietnam and less so with Indonesia. ASEAN countries also competed extensively with each other.

The results presented here indicate that policymakers in East Asia should not be complacent about the sophistication of their countries' exports. They need to improve their countries' human capital to foster innovation and climb the technological ladder. For Japan, Sawa (2013) recommended nurturing creativity and logical thinking by returning to the type of well-rounded education that engineering students and others in Japan received until the mid-1970s. For China, Rozelle (2010) recommended addressing problems such as anemia, vitamin deficiencies, and lack of eyeglasses that afflict rural students and also focusing on math, science, Chinese, English, and computers. For ASEAN, Thorbecke, Lamberte and Komoto (2013) advocated providing children with adequate nutrition, healthcare, and primary education; providing high school students with a high quality education in science and math; and providing university students with scientific and engineering training. Heckman (2005) also noted that

early childhood input is important for development and recommended that mothers spend time with their young children.

The evidence reported here that there is a complimentary relationship between Japan's and China's export baskets suggests that the concerns of Chinese officials about the yen depreciation that began in November 2012 are not well placed. The depreciation of the yen will enable more firms in China and the rest of Asia to purchase sophisticated capital goods from Japan. Lee and Wie (2013) found that importing sophisticated capital goods promotes skill-biased technological change and development in emerging Asia.

The intense competition between Japan and Korea indicates that the concerns of Korean officials about the weaker yen are well founded. Figure 9 shows the yen/won rate between 2000 and 2013. The won appreciated 40 percent between the end of 2003 and the middle of 2007. It then depreciated by 70 percent by the beginning of 2009 and appreciated again by 35 percent by September 2013. These volatile exchange rates contributed to large swings in exports from the two countries. Greater exchange rate stability would reduce the volatility of exports for both countries.

The evidence also indicates that Thailand and China have diversified export baskets. These tend to be more robust to changes in consumer demand, the terms of trade, and other variables. On the other hand, Indonesia's export basket is very concentrated in primary products and Cambodia's and Laos's baskets are very concentrated in textiles and other lower end products. These countries should seek to diversify the products that they export.

The results here also indicate that there is a complementary relationship between developed and emerging Asia. A lot of their trade takes place within regional production networks. Parts and components flow back and forth across East Asia and ASEAN for final

assembly in China and re-export to the world. Several researchers have reported that greater exchange rate stability would facilitate the flow of parts and components within the region (see, e.g., Hayakawa and Kimura, 2009). More stability not only between the yen and the won but between other currencies in the region would thus facilitate production fragmentation.

Countries in the region should continue climbing the ladder of comparative advantage and exporting more sophisticated products. Investing in human capital would help countries to reach this goal. Maintaining a measure of exchange rate stability in the region would reduce volatile swings in exports and help to maintain the flow of parts and components. For developing and emerging countries in Asia, investing in human capital and maintaining stable exchange rates would also attract investments from multinational corporations. In addition, resisting corruption, providing consistent and coherent enforcement of laws and regulations at all governmental levels and maintaining stable macroeconomic fundamentals would attract FDI. Investments from multinationals can lead to the formation of industrial clusters and abundant opportunities for local firms to take part in sophisticated production networks. Through a process of learning by doing, local engineers and workers can then acquire new skills and local firms can graduate to producing higher value added, knowledge-based goods.

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Table 1. Leading Exporters of Special Purpose Machinery

Country	Share of World Exports
Japan	19.78
Germany	16.71
United States	10.42
China, People's Rep.	6.73
Italy	6.48
Netherlands	5.86
South Korea	4.95
Switzerland	3.83
Austria	2.38
Taiwan	2.28
France	2.08
United Kingdom	1.95
Canada	1.56
Singapore	1.26
Sweden	1.11
Finland	1.05
Belgium	1.03
Hong Kong	0.98
Spain	0.78

Note: Special Purpose Machinery Come from ISIC Category 2929.
Source: CEPII-CHELEM database.

Table 2. Leading Exporters of Carpets and Rugs

Country	Share of World Exports
Belgium	17.96
China, People's Rep.	14.53
India	11.04
Turkey	9.48
Netherlands	8.12
United States	6.78
Germany	5.02
Egypt	2.71
United Kingdom	2.26
France	1.66
Denmark	1.50
Austria	1.23
Pakistan	1.22
Italy	1.21
Thailand	1.17
Poland	1.15
Saudi Arabia	0.93
Canada	0.79
Switzerland	0.74

Note: Carpets and Rugs come from ISIC Category 2929.
Source: CEPII-CHELEM database.

Table 3. Country Sophistication Index (CSI) for the Two Leading Countries and for East and Southeast Asian Economies.

CSI Calculated using Kwan's Method and Real Per Capita GDP		CSI Calculated using Hausmann et al.'s Method and Real Per Capita GDP		CSI Calculated using Kwan's Method and Per Capita PPP GDP	
Country	Country Sophistication Index	Country	Country Sophistication Index	Country	Country Sophistication Index
Switzerland	30070	Switzerland	25338	Ireland	28897
Ireland	29944	Ireland	24492	Switzerland	28571
Japan	25726	Japan	20635	Japan	26525
South Korea	23397	Taiwan	18832	Taiwan	25243
Taiwan	22839	South Korea	18694	South Korea	25224
Thailand	20917	China, People's Rep.	16746	Philippines	23349
Philippines	19906	Thailand	16599	Thailand	23145
China, People's Rep.	19622	Philippines	16143	Malaysia	22602
Malaysia	19495	Malaysia	15342	China, People's Rep.	21700
Indonesia	18026	Indonesia	12530	Indonesia	20473
Viet Nam	16170	Viet Nam	12316	Viet Nam	19173
Cambodia, Lao PDR	14826	Cambodia, Lao PDR	7587	Cambodia, Lao PDR	17396

Source: Calculations by the authors.

Table 4. Percent of Japan's, South Korea's, and Taiwan's Exports by Product Category in 2011.

Product Category (Four-digit ISIC Classification)	Product Sophistication Index	Percent of Country's Exports in the Product Category			Technological Intensity of Export Category
		Japan	South Korea	Taiwan	
Pharmaceutical products (2423)	35683	1	0	0	High
Medical equipment (3311)	33896	1	0	0	High
Aeronautics (3530)	33699	1	0	0	High
Other special purpose machinery (2929)	32706	5	2	2	Medium High
Engines Turbines (2911)	32364	1	0	0	Medium High
Paints Ink (2422)	31145	1	0	0	Medium High
Chemical products (2429)	31010	3	1	4	Medium High
Measuring instruments (3312)	30928	2	1	1	High
Machinery for mining (2924)	29947	2	2	0	Medium High
Machine tools (2922)	29043	2	1	2	Medium High
Motor vehicles (3410)	28883	14	9	0	Medium High
Pumps (2912)	28540	2	1	1	Medium High
Gears (2913)	28303	2	0	1	Medium High
Parts for vehicles (3430)	27597	6	4	1	Medium High
Primary plastic (2413)	27450	2	4	5	Medium High
Electrical distribution & control devices (3120)	26500	2	1	1	Medium High
General purpose machinery (2919)	26279	1	1	1	Medium High
Basic chemicals except fertilizer (2411)	26259	4	5	5	Medium High
Machinery for textiles (2926)	26089	1	1	0	Medium High
Plastic products (2520)	25795	2	1	2	Medium Low

Cutlery Tools (2893)	24964	1	0	1	Medium Low
Glass and glass products (2610)	24323	1	0	1	Medium Low
Precious and Nonferrous metals (2720)	23900	4	3	3	Medium Low
Fabricated metal products (2899)	23697	1	1	3	Medium Low
Textiles (1729)	23580	0	0	1	Low
Basic iron and steel (2710)	23357	6	6	5	Medium Low
Electric motors (3110)	23059	1	1	1	Medium High
Optics & photographic equipment (3320)	22570	3	6	7	High
Structural metal products (2811)	22282	0	1	0	Medium Low
Accumulators & batteries (3140)	21512	1	1	0	Medium High
Electronic components (3210)	21361	7	9	23	High
Tires (2511)	20851	1	1	0	Medium Low
Refined petroleum (2320)	20730	2	9	6	Medium Low
Electrical equipment (3190)	20728	2	2	2	Medium High
Ships (3511)	20406	3	9	0	Medium Low
Motorcycles (3591)	20390	1	0	0	Medium High
Manmade fibers (2430)	20179	0	1	1	Medium High
Preserved fish (1512)	18014	0	0	1	Low
Furniture (3610)	17950	0	0	1	Medium Low
Domestic. appliances (2930)	16790	0	1	0	Medium High
Rubber products (2519)	16701	1	0	0	Medium Low
Computer equipment (3000)	16391	3	2	4	High
TV & radio transmitters (3220)	16276	2	4	5	High
TV & radio receivers (3230)	14390	1	3	1	High

Textile fiber & fabrics (1711)	14027	0	1	1	Low

Note: The product sophistication index (PSI) is calculated using the method of Kwan (2002). The higher the value of the PSI, the more sophisticated the product.
Source: CEPII-CHELEM database and calculations by the authors.

Table 5. UNCTAD Merchandise Trade Correlation Index for 2012

	Cam-bodia	China	Taiwan	Indo-nesia	Japan	Korea	Malay-sia	Phili-ppines	Thai-land	Viet Nam
Cambodia	..	-0.006	-0.158	0.218	-0.280	-0.252	-0.009	0.224	0.195	0.347
China	-0.006	..	0.267	0.090	-0.089	0.193	0.145	0.081	0.270	0.362
Taiwan	-0.158	0.267	..	-0.050	0.302	0.546	0.0955	0.0425	0.129	0.006
Indonesia	0.218	0.090	-0.050	..	-0.362	-0.157	0.393	0.328	0.226	0.470
Japan	-0.280	-0.089	0.302	-0.362	..	0.466	-0.254	-0.085	-0.202	-0.396
Korea	-0.252	0.193	0.546	-0.157	0.466	..	0.010	-0.075	0.162	-0.209
Malaysia	-0.009	0.145	0.0955	0.393	-0.254	0.010	..	0.124	0.263	0.147
Philippines	0.224	0.081	0.0425	0.328	-0.085	-0.075	0.124	..	0.121	0.331
Thailand	0.195	0.270	0.129	0.226	-0.202	0.162	0.263	0.121	..	0.332
Viet Nam	0.347	0.362	0.006	0.470	-0.396	-0.209	0.147	0.331	0.332	..

Note: The merchandise trade correlation index (TCI) is constructed based on a country's trade specialization as determined at the three-digit SITC level. The TCI is the simple correlation coefficient between two economies trade specialization values across all products. The correlation coefficient varies from -1 to +1. TCI values greater than 0 imply that the two countries' export structures are competitive, and values less than 0 imply that they are complementary. The closer the trade correlation index between two countries is to +1 (-1), the more the countries' exports are competitive (complementary).
Source: www.unctad.org .

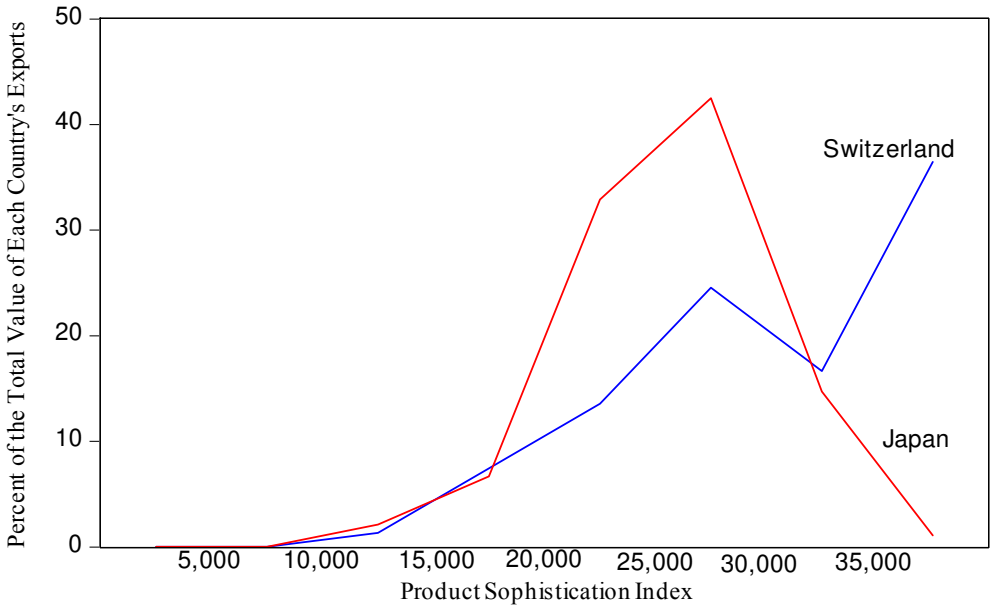

Figure 1. The Frequency of Japanese and Swiss Exports based on the Sophistication of the Products Exported

Note: The figure represents the share of each country's exports at different levels of product sophistication. Product sophistication is calculated using the method of Kwan (2002).

Source: CEPII-CHELEM database and calculations by the authors.

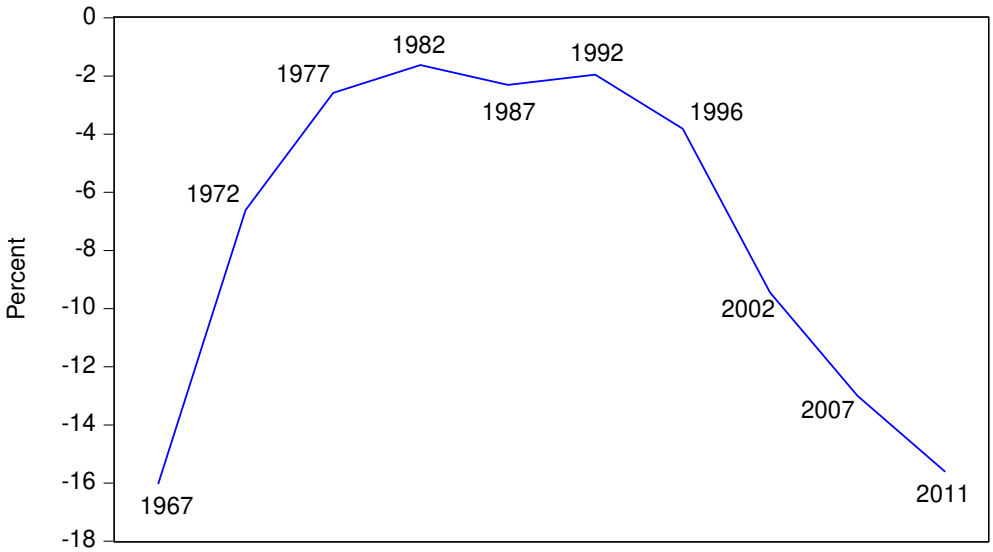

Figure 2. The Percent Shortfall of Japan's Country Sophistication Index from the World Leader's Country Sophistication Index

Note: The Country Sophistication Index is calculated using the method of Kwan (2002).

Source: CEPII-CHELEM database and calculations by the authors.

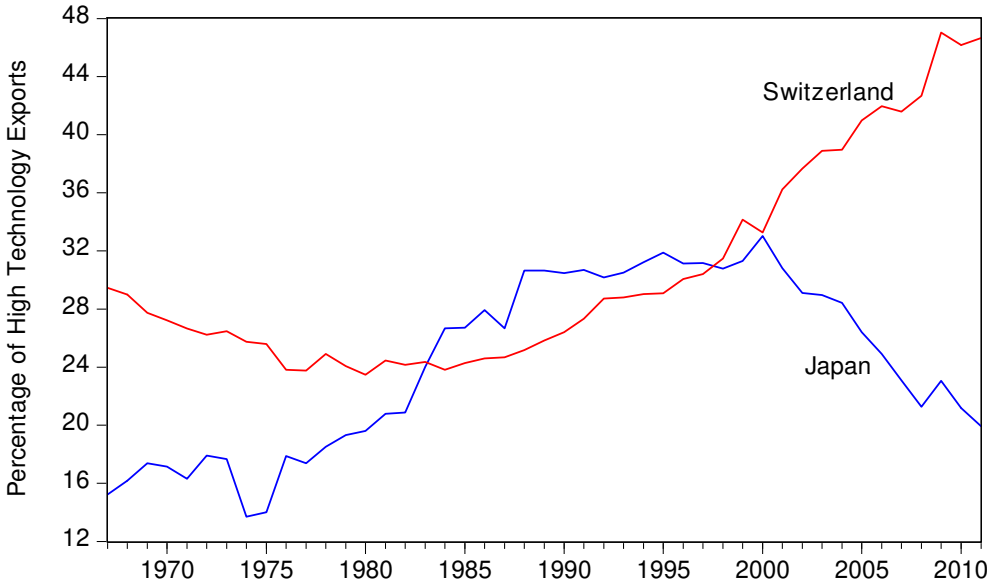

Figure 3. The Percentage of High Technology Exports in Japan's and Switzerland's Total Manufactured Exports.

Note: Goods are classified as high-tech based on the ratio of R&D spending to value-added (see, e.g., Hatzichronoglou, 1997).
Source: CEPII-CHELEM database.

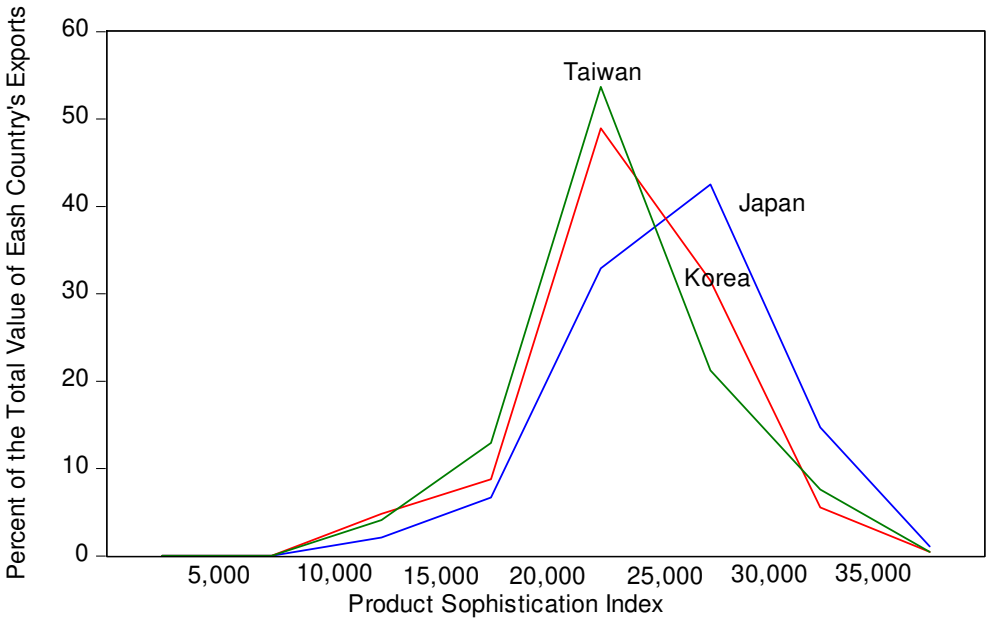

Figure 4. The Frequency of Japanese Korean, and Taiwanese Exports based on the Sophistication of the Products Exported

Note: The figure represents the share of each country's exports at different levels of product sophistication. Product sophistication is calculated using the method of Kwan (2002).

Source: CEPII-CHELEM database and calculations by the authors.

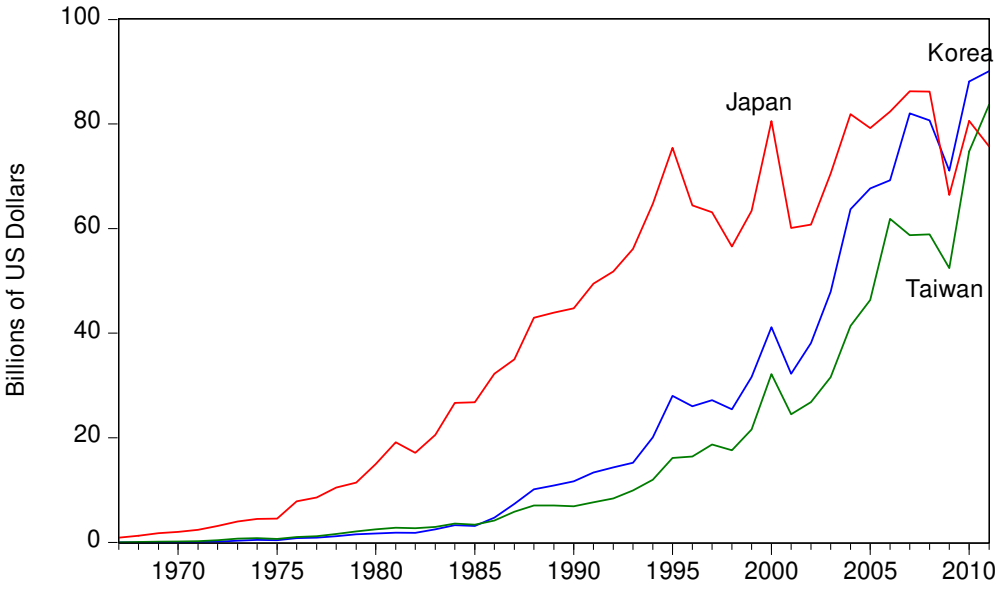

Figure 5. The Value of Exports of Televisions, Radios, and Communication Equipment from Japan, South Korea, and Taiwan.

Note: The data are for ISIC code 32 and include flat-screen televisions, smart phones and other mobile devices, semiconductors and integrated circuits.

Source: CEPII-CHELEM database.

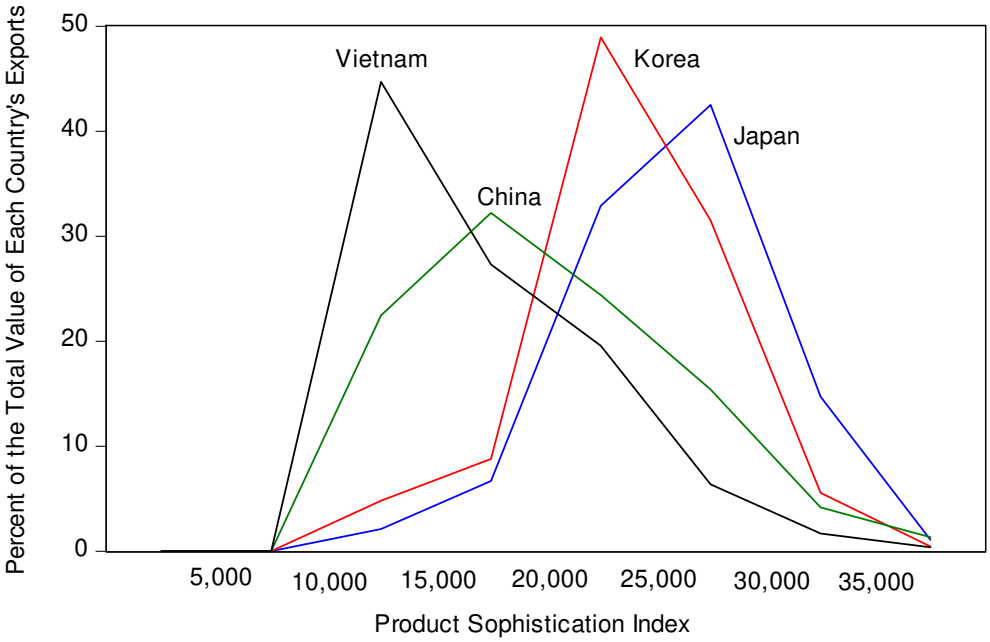

Figure 6. The Frequency of Japanese, Korean, Chinese, and Vietnamese Exports based on the Sophistication of the Products Exported.

Note: The figure represents the share of each country's exports at different levels of product sophistication.
Product sophistication is calculated using the method of Kwan (2002).
Source: CEPII-CHELEM database and calculations by the authors.

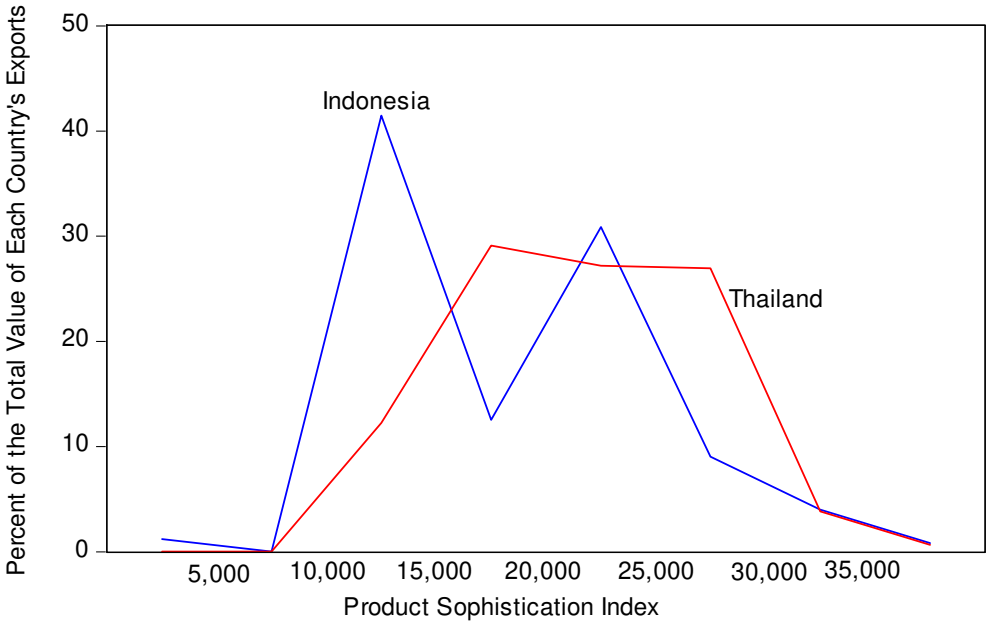

Figure 7. The Frequency of Thai and Indonesian Exports based on the Sophistication of the Products Exported.

Note: The figure represents the share of each country's exports at different levels of product sophistication.
Product sophistication is calculated using the method of Kwan (2002).
Source: CEPII-CHELEM database and calculations by the authors.

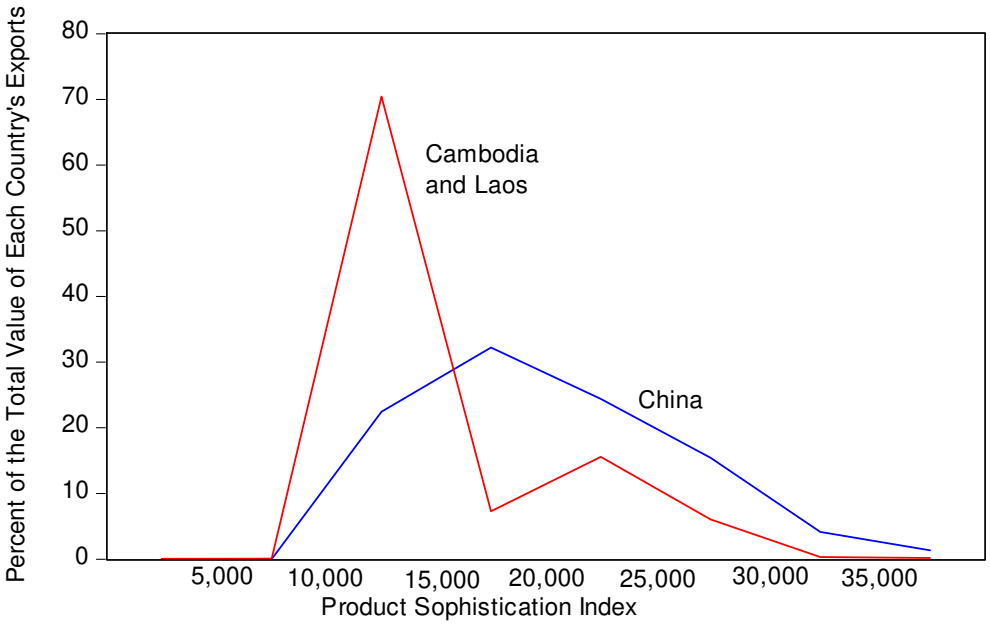

Figure 8. The Frequency of Chinese, Cambodian and Laotian Exports based on the Sophistication of the Products Exported.

Note: The figure represents the share of each country's exports at different levels of product sophistication. Product sophistication is calculated using the method of Kwan (2002).

Source: CEPII-CHELEM database and calculations by the authors.

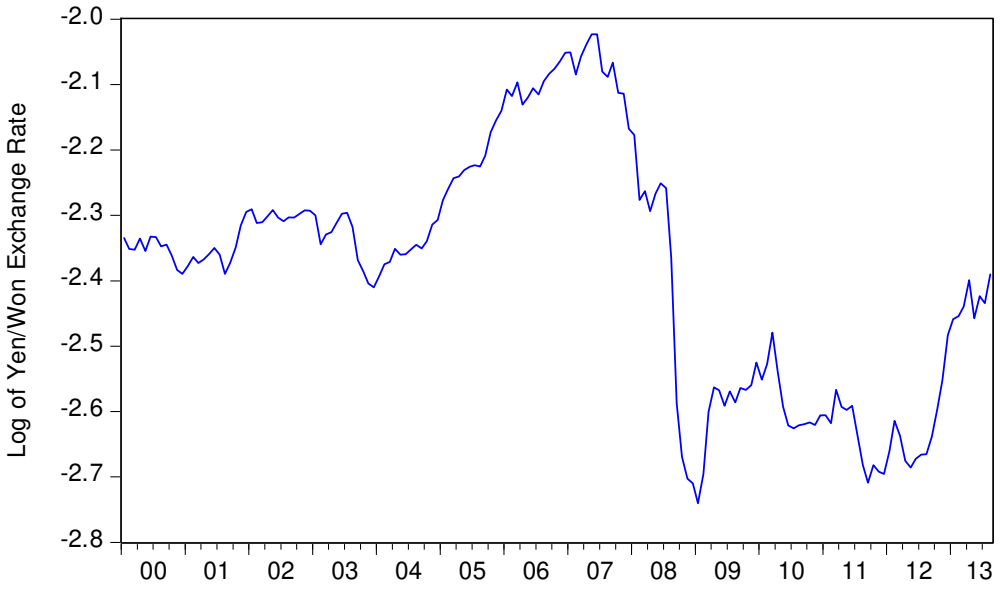

Figure 9. The Log of the Yen/Won Exchange Rate.
Source: Federal Reserve Bank of St. Louis FRED database and calculations by the authors.

Appendix A

Table A1. Country Sophistication Index (CSI) for the Ten Leading Countries, 1967-2011.

Rank in 1967	Country	Country Sophist. Index	Rank in 1972	Country	Country Sophist. Index	Rank in 1977	Country	Country Sophist. Index
1	Switzerland	16105.74	1	Switzerland	18150.29	1	Switzerland	19572.18
2	Germany	14520.39	2	Germany	17429.33	2	Germany	19084.75
3	United Kingdom	14278.03	3	United Kingdom	17081.99	3	Japan	19073.42
4	Finland	14179.21	4	Japan	16988.72	4	Sweden	18989.38
5	Sweden	14103.96	5	Sweden	16958.59	5	Finland	18442.95
6	Japan	13722.2	6	Finland	16751.24	6	Luxembourg	18359.34
7	Austria	13542.17	7	Luxembourg	16669.45	7	United Kingdom	18332.17
8	Luxembourg	13401.08	8	Austria	16496.02	8	Austria	18275.43
9	Denmark	13244.92	9	Belgium	15970	9	Ireland	18088.58
10	Norway	13232.53	10	Norway	15879.52	10	France	17887.65
Rank in 1982	Country	Country Sophist. Index	Rank in 1987	Country	Country Sophist. Index	Rank in 1992	Country	Country Sophist. Index
1	Switzerland	20733.33	1	Switzerland	23784.33	1	Switzerland	26085
2	Japan	20397.46	2	Japan	23241.51	2	Japan	25579.13
3	Germany	20077.71	3	Sweden	23094.45	3	Sweden	25299.87
4	Sweden	19948.46	4	Germany	23027.02	4	Germany	25216.21
5	Ireland	19642.52	5	Finland	22664.42	5	Ireland	25064.42
6	Luxembourg	19446.36	6	Luxembourg	22550.34	6	Finland	24812.57
7	Finland	19442.11	7	Ireland	22513.32	7	United Kingdom	24404.33
8	Austria	19418.1	8	Austria	22168.15	8	Austria	24401.76
9	Czech Republic	19185.56	9	Czech Republic	22092.03	9	Luxembourg	24319.33
10	Slovenia	18846.62	10	United Kingdom	21468.29	10	France	23878.71

Table A1. Country Sophistication Index (CSI) for the Ten Leading Countries, 1967-2011 (continued).

Rank in 1996	Country	Country Sophist. Index	Rank in 2002	Country	Country Sophist. Index	Rank in 2007	Country	Country Sophist. Index
1	Switzerland	26753.16	1	Switzerland	29679.47	1	Switzerland	31396.38
2	Germany	25839.65	2	Ireland	28600.51	2	Ireland	29904.79
3	Ireland	25838.12	3	Germany	27787.93	3	United States	28571.88
4	Japan	25751.01	4	United States	27695.36	4	France	28474.39
5	Sweden	25635.27	5	France	27629.72	5	Germany	28283.24
6	United States	25520.7		Sweden	27585.2	6	Sweden	27671.6
7	Finland	25316.17	7	Austria	27223.08	7	Austria	27661.12
8	France	25221.57	8	Finland	27068.44	8	Japan	27568.25
9	Austria	25075.05	9	Japan	27003.81	9	New Zealand	27560.57
10	United Kingdom	24811.4	10	Belgium	26708.57	10	Belgium	27389.87
Rank in 2011	Country	Country Sophist. Index						
1	Switzerland	30069.61						
2	Ireland	29943.93						
3	Germany	26309.51						
4	France	25993.56						
5	Finland	25898.51						
6	Austria	25739.53						
7	Japan	25726.33						
8	Sweden	25561.8						
9	New Zealand	25475.66						
10	United Kingdom	25328.09						

Note: The Country Sophistication Index is calculated using the method of Kwan (2002). The higher the value of CSI, the more sophisticated the country's export basket is.
Source: Calculations by the authors.