RIETI Discussion Paper Series 13-E-094

Industry-Level Competitiveness, Productivity, and Effective Exchange Rates in East Asia

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http://www.rieti.go.jp/en/

RIETI Discussion Paper Series 13-E-094

November 2013

Industry-Level Competitiveness, Productivity, and Effective Exchange Rates in East Asia*

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Abstract

In this paper, we investigate export competitiveness based on unit labor costs (ULCs) and nominal effective exchange rates (NEERs) for Japan, China, and Korea for the 12 two-digit manufacturing industries for the period 2001-2009. Japan's ULCs either are relatively stable or declining in most industries, while that of Korea shows an upward trend in many industries, with the electrical and optical equipment industry being a major exception. China's ULCs are declining in most industries. Evaluating ULCs on a foreign currency basis, Japan's ULCs increased rapidly during the period of yen appreciation, suggesting that its cost reduction efforts were more than offset by the appreciation of the yen.

The results of our empirical analysis suggest that both increases in ULCs and appreciation of the home currency reduce exports by raising the home country's relative prices. The negative impact of ULCs is largest for China, while it is negligible for Japan. However, the negative impact of NEERs is largest for Japan. Moreover, the negative impact of ULCs tends to be larger for machinery-related industries, suggesting that cost competitiveness is particularly important in these industries.

JEL Classification: F14, F23, F31

Keywords: Competitiveness, Productivity, Industry-specific effective exchange rates, Unit labor costs, Unit multifactor costs

* This study is conducted as a part of the Project "Research on Currency Baskets" undertaken at Research Institute of Economy, Trade and Industry (RIETI). The authors are grateful for helpful comments and suggestions by Eiji Ogawa, Kiyotaka Sato, William Thorbecke, and Discussion Paper seminar participants at RIETI. We gratefully acknowledge financial support from Japan Society for the Promotion of Science in the form of Grants-in-Aid for Scientific Research (No. 24330101 and No. 23243050).

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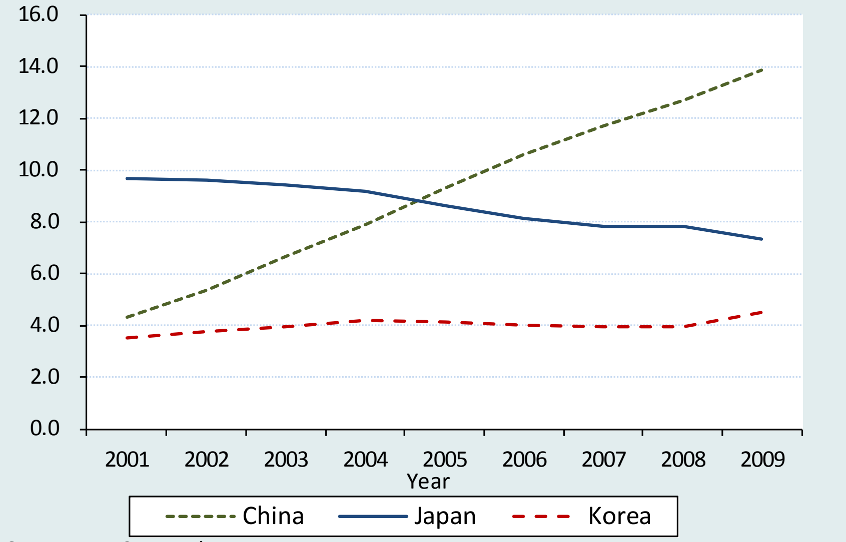
1. Introduction

China’s emergence as a top manufacturing exporter has been attracting considerable attention around the world, and the trade patterns of China and other East Asian countries have been examined intensively in the field of international economics. Numerous empirical studies show that East Asian countries are engaged in the international division of labor, with capital- and labor-intensive products and processes located in different countries. These patterns of division of labor, called “production fragmentation” in the literature, have changed the relative international competitiveness of East Asian countries. At the same time, a number of Asian countries, particularly Korea and Taiwan, have successfully developed their technological capabilities and gained substantial global market shares in certain industries such as the electrical machinery industry. Last but not least, another important factor likely to have shaped trade patterns in East Asia is developments in exchange rates. The yen appreciation after the Plaza Accord in 1985 accelerated overseas production by Japanese firms, contributing to the advance of production fragmentation in East Asia. Moreover, the different exchange rate regimes adopted by countries across the region are likely to have affected the prices of their exports in world markets and hence their export competitiveness.

As a result of these developments, Japan’s presence in global export markets has been waning relative to its East Asian neighbors, China and Korea. Let us look at each country’s global export share, which is often considered as a measure of international competitiveness. As indicated in Figure 1, Japan’s export share was almost 10% and the largest among the three Asian countries in 2001, but since then, China’s export share has steadily increased, rising from 4.3% in 2001 to 13.8% in 2009, resulting in the top share among these three countries. Korea’s global export share also slightly increased, from 3.5% in 2001 to 4.5% in 2009; on the other hand, Japan’s export gradually declined, falling from 9.7% in 2001 to 7.3% in 2009.

Figure 1. Global Export Share of Manufactured Goods (%)



Source: UN Comtrade.
Note: Authors' calculation. The export shares of manufactured goods are calculated using SITC Codes 6 (manufactured goods classified chiefly by materials) and 7 (machinery and transport equipment).

Of course, there are a variety of factors underlying these changes in global export shares. In the literature, relative prices in world markets are considered to be an important factor determining competitiveness, although non-price factors may also matter in some cases. Price competitiveness reflects production costs, the nominal exchange rate, and markups.

Therefore, many preceding studies use the real exchange rate, i.e., the nominal exchange rate adjusted by the prices of domestic products relative to prices of products overseas as a measure of relative prices in world markets in order to examine the determinants of international competitiveness, assuming that goods prices reflect production costs and markups. However, measuring real exchange rates is not straightforward. Mainly due to data constraints, real exchange rates are calculated at the macro level, using in many cases the consumer price index (CPI) to gauge the relative prices of domestic and foreign products. This is obviously problematic, because the CPI includes the prices of many non-tradable goods and services.[1] Although the real

[1] Bayoumi, Harmsen, and Turunen (2011) show that CPI-based relative effective exchange rate measures are not good indicators of price competitiveness. Moreover, the CPI includes imported final consumption products, which is not appropriate for assessing the price competitiveness of exported goods. On the other hand, it could be argued that the CPI might be useful because it includes non-tradable goods and services which are embodied in exported goods. However, in the case of Japan, the weight of non-tradable services in the calculation of the CPI is approximately 60%, while the share of services inputs (intermediate inputs from all the tertiary sectors, including construction and utilities) in manufacturing sector production is

exchange rate can be calculated using other price measures such as the producer price index (PPI) excluding non-tradable goods and services, the export or import price index, or unit labor costs (ULCs), such price indices are not readily available for most developing countries. It is even more difficult to reliably measure real exchange rates at a more disaggregated level, i.e., the industry-level, due to the lack of data for such price measures. Thus, although there are a growing number of studies that examine the relationship between export performance and price competitiveness using a variety of real exchange rate measures, most studies have focused on the exports of developed countries only (e.g., Chinn (2006) for the United States, Bayoumi, Harmsen, amd Turunen (2011) for the Euro Area). Moreover, even for developed countries, analyses at the disaggregated industry level are still scarce. A few studies using relatively disaggregated data indicate that the impact of real exchange rates differs depending on the sector (Lewney et al. 2012) or the type of products – e.g., consumption goods or other types of goods – considered (Thorbecke and Kato 2012a, 2012b).

As mentioned above, CPI-based real exchange rates are problematic, while PPI-based or export price index-based real exchange rates also have their shortcomings. Specifically, prices include markups, so that, as we will explain later in this paper, we cannot distinguish between changes in markups and changes in production costs.

Against this background, the aim of this paper is to examine industry-level export competitiveness based on ULCs and nominal effective exchange rates (NEERs) for Japan, China, and Korea. This paper contributes to the literature in the following three respects. First, we construct ULC indexes at the 12 two-digit manufacturing industry-level for the three East Asian countries and use these for industry-level cross-country comparisons. Such comparisons are still very scarce for these countries and the relationship among export competitiveness, exchange rates, and cost competitiveness has not yet been adequately examined at the industry level.[2] Second,

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approximately 30% (according to the explanation on the CPI and the Input-Output Tables published by the Statistics Bureau of Japan). These figures suggest that the CPI to a large extent reflects the prices of non-tradable services and that using the CPI as a measure of prices of exported goods is not appropriate.

[2] Although there are some studies on ULCs for Japan and China, the relationship between exports and cost competitiveness at the disaggregated industry level has not yet been adequately investigated for these three countries. For example, Ceglowski and Golub (2011) analyze China's ULCs relative to those of the United States, but they measure ULCs for the manufacturing sector as a whole without looking at a more detailed industry level. On the other hand, while Inklaar, Wu, and van Ark (2003) compare Japan's ULC levels with those of the United States at the two-digit manufacturing industry level, they do not compare these with other East Asian countries such as Korea and China. Meanwhile, Dekle and Fukao (2009), focusing on unit multifactor costs, conduct a comparison between Japan and the United States,

we use industry-specific effective exchange rates, not market exchange rates, for the currencies of the three countries we focus on. Although market exchange rates can be used for the analysis of bilateral trade, it is more appropriate to employ effective exchange rates for examining global export competitiveness. Moreover, using industry-specific effective exchange rates is particularly appropriate if the composition of export destinations differs across industries. Third, using such industry-level data for the three countries, we try to disentangle the complex effects of nominal exchange rates and cost competitiveness on export competitiveness, assuming that these effects likely differ across countries and industries.

The rest of the paper is constructed as follows. Section 2 provides an overview of nominal effective exchange rate and ULC trends for the three countries both at the aggregated level and the two-digit industry level. The section further presents a brief description of the ULC measure and the data used for constructing our measure. Section 3 explains the model we use for estimating relative prices and competitiveness, while Section 4 presents the empirical analysis using industry-level data for Japan, China, and Korea. Section 5 concludes.

2. An Overview of Factors Explaining Countries' International Competitiveness

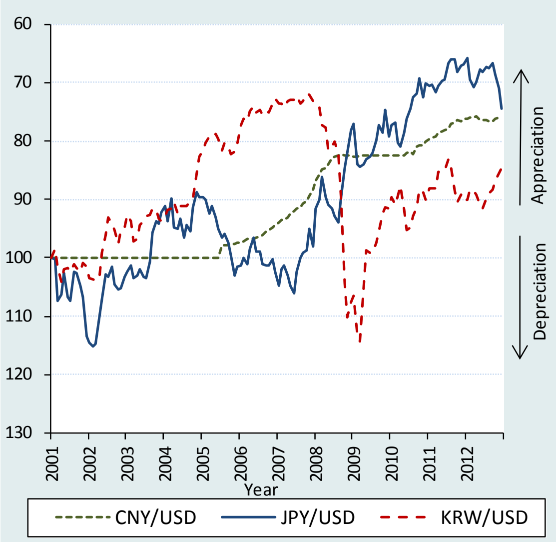
2.1 Effective exchange rates (EER) for China, Japan, and Korea

As described in the previous section, there are various factors explaining the international competitiveness of countries and industries. One of these factors is foreign exchange rates, which have experienced considerable fluctuations not only in the case of the major currencies, but also the currencies of developing countries. In the last decade, one of the most volatile movements was observed in the exchange rate between the Japanese yen and the Korean won. Figure 2 shows the exchange rates of the Japanese, Korean, and Chinese currencies vis-à-vis the U.S. dollar from January 2001 to the end of 2012. The Chinese RMB, which was pegged to the U.S. dollar until July 2005, has gradually appreciated since then. Following the collapse of Lehman Brothers in September 2008, the RMB was temporarily pegged to the dollar again, but has been allowed to appreciate since September 2010 and reached a record high in 2012. In contrast with the gradual and controlled appreciation of the RMB, the Japanese yen and

but again do not compare Japan with other Asian countries.

the Korean won experienced volatile and asymmetric movements over the last ten years. For example, the yen appreciated sharply vis-à-vis most currencies following the collapse of Lehman Brothers, including the U.S. dollar, while the Korean won depreciated sharply. In terms of exports, these developments mean that Japan's price competitiveness deteriorated substantially, while Korea's improved considerably, particularly against Japan.

Figure 2. Nominal Exchange Rate vis-à-vis the U.S. Dollar (2001/1=100)



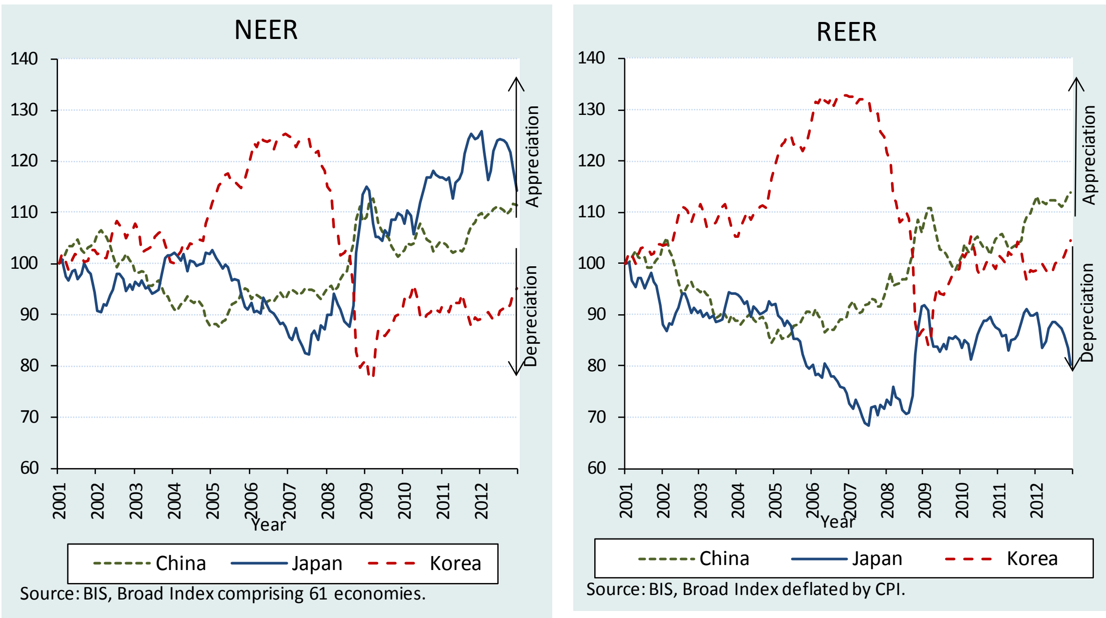
Source: Authors' calculation. Exchange rate data are from Datastream.

However, when considering the impact of exchange rate changes on export performance, it is not the bilateral nominal exchange rate but the effective exchange rate that provides a better measure of exporting firms' price competitiveness in the global market. The Bank for International Settlements (BIS) publishes both the nominal and real effective exchange rates of Japan, Korea, and China, which are shown in Figure 3.[3] The figure indicates that while the NEER of the yen and the RMB exhibit a clear upward trend since the middle of 2008, the NEER of the won experienced a large and sharp decline in 2008 and has remained below the value of the beginning of our observation period in 2001. Looking at the real effective exchange rates (REERs), the trends for the yen and the won are very similar to the NEER, but more extreme, for the period 2001-2008, but after that, they are very different from the NEERs. The first

[3] Bank for International Settlements (BIS) effective exchange rate indices (broad indices) comprising 61 economies and deflated by the CPI (http://www.bis.org/statistics/eer/index.htm).

problem with the REERs in Figure 3 is that the REERs provided by the BIS are calculated based on CPIs and, as explained in the previous section, therefore are not appropriate for measuring the international competitiveness of traded goods. Second, the BIS's REERs are at the macro level and do not provide any information on industry-level differences. However, REER changes likely differ markedly across industries, reflecting large differences in changes in prices and production costs across industries.

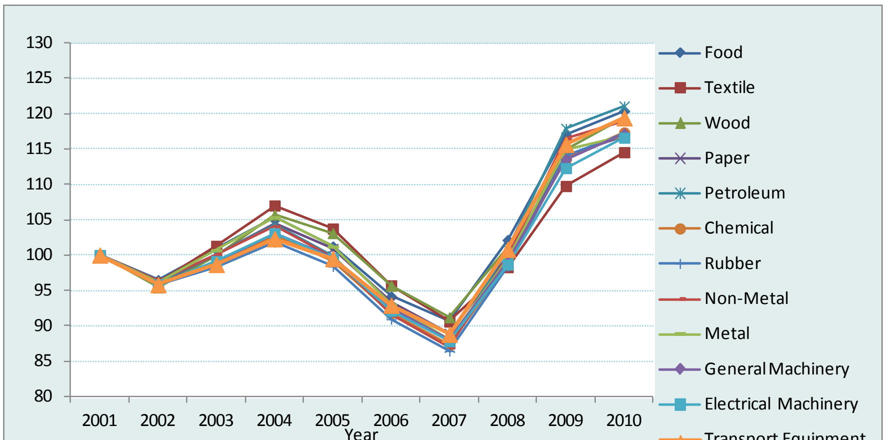
Figure 3. Nominal and Real Effective Exchange Rates Calculated by the BIS (2001/1=100)



As discussed above, the BIS effective exchange rates do not provide a satisfactory measure for examining price competitiveness across industries. Even though all industries in a country face the same nominal exchange rate, the effective rate can differ across industries: each industry faces its own specific competitive environment that differs from other industries, since the relative movements of domestic industry-specific prices to the corresponding foreign prices are likely to differ. To empirically examine the role of the exchange rate for exporters' price competitiveness in specific industries, Sato et al. (2012a, 2012b) constructed a new dataset of industry-specific EERs for Japan and found that the importance of the exchange rate differed across industries. In a follow-up study, Sato et al. (2013) further constructed industry-specific EERs for China and Korea in order to provide a better explanation for industry-specific export price competitiveness among the three countries.[4] Decomposing industry-specific REERs into various factors, Sato et al. (2013) showed that Korean firms' export competitiveness relative to that of their Japanese counterparts during the period of won appreciation was boosted by a substantial fall in domestic producer prices, especially in the electrical machinery industry. Figure 4, taken from Sato et al. (2013), presents industry-specific NEERs (2001=100) for Japan, China, and Korea.[5] Although the overall trend was similar to that indicated by the BIS NEER data (shown in Figure 3), the figure shows that there were some differences in the level of NEERs across industries.[6]

Figure 4. Industry-Specific NEERs (2001=100)

(a) Japan



Source: Sato et al. (2012b, 2013), The data are taken from the RIETI website.

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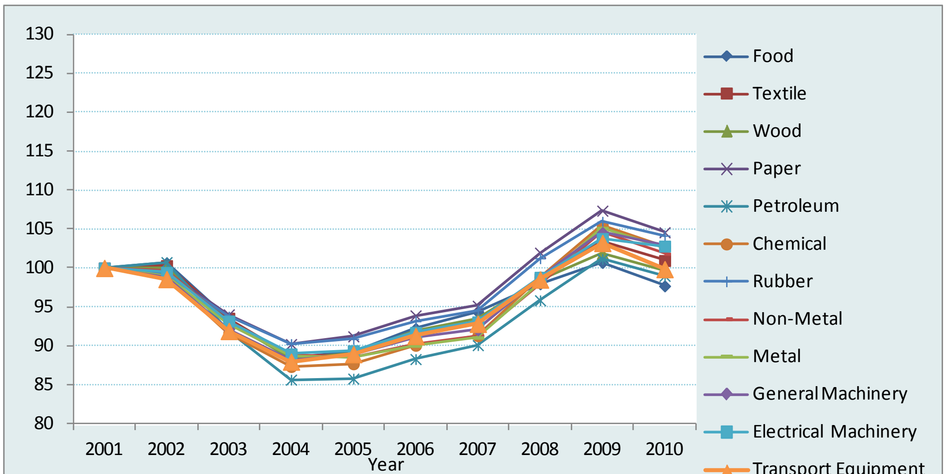
[4] Daily series of industry specific NEERs and REERs for Japan, China, and Korea from January 2005 are available on the website of the Research Institute of Economy, Trade and Industry (RIETI) (http://www.rieti.go.jp/users/eeri/en/index.html).

[5] Details on the NEER calculation are provided in Appendix 1.

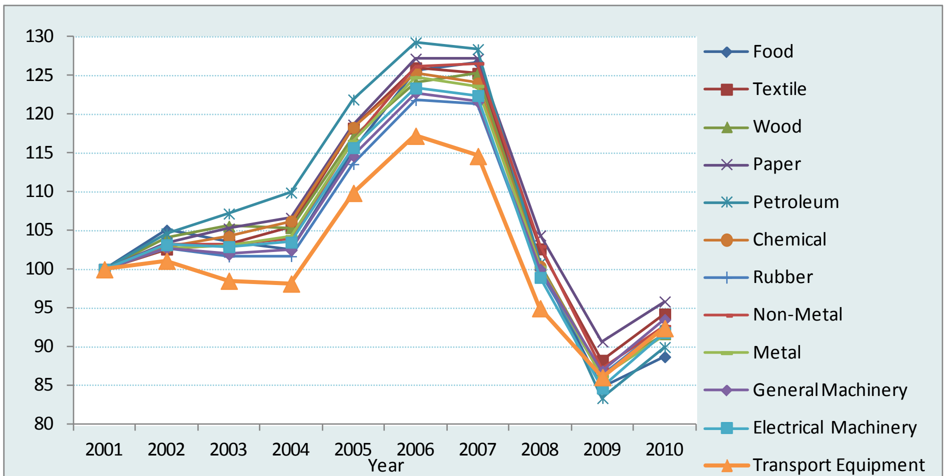
[6] There are a number of studies that analyze the effective exchange rate at an industry level. Goldberg (2004), for example, constructs real effective exchange rates (REERs) by industry for the United States and applies these for a simple regression model to test the influence of exchange rates on profits. She finds that while the industry-specific exchange rates are all statistically significant, the broad exchange rate measure is statistically insignificant.

(b) China



Source: Sato et al. (2012b, 2013), The data are taken from the RIETI website.

(c) Korea



Source: Sato et al. (2012b, 2013), The data are taken from the RIETI website.

Figure 4 indicates that, over time, gaps in the NEERs across industries of 5-10 percentage points have opened up. Moreover, it seems that industry differences in NEERs tend to be larger in periods of drastic appreciation, which suggests that the composition of export destinations across industries varies and that it may be easier for some industries than others to adjust the composition of export destinations.

2.2 Unit Labor Costs (ULCs) for the Manufacturing Sector in China, Japan, and Korea

Apart from exchange rates, another factor affecting international competiveness is productivity by changing production costs and hence price levels. A widely used measure of such cost competitiveness is ULCs. ULCs are defined as total labor costs per unit of output and are usually calculated as the ratio of total labor compensation in nominal terms to real output. As shown in the following equation (1), ULCs also equal to the ratio of compensation per worker to labor productivity (*Y/L* in the equation):

$$ULC = \frac{w_n L}{Y} = \frac{w_n}{\frac{Y}{L}} \quad (1)$$

where w_n denotes nominal labor compensation per worker, Y denotes real output, and L is the number of workers. Therefore, under the standard interpretation of ULCs, the reason for an increase (decrease) in ULCs is that workers' nominal compensation grew faster (slower) than labor productivity.[7]

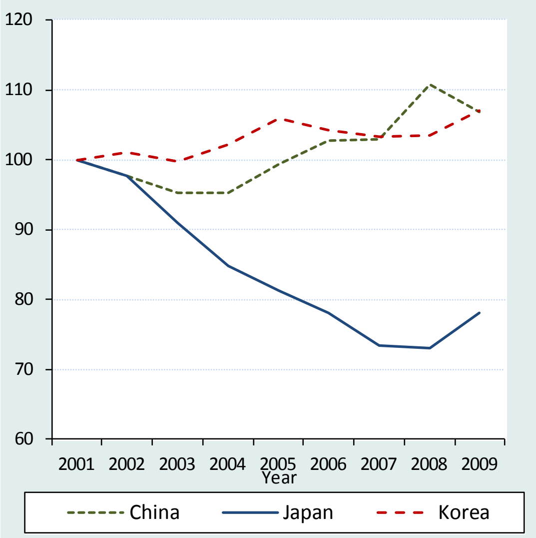
Figure 5 illustrates the developments in ULCs for the manufacturing sector in local currency terms for the three countries we focus on.[8] The figure shows that Japanese manufacturing ULCs have declined greatly compared to the other two countries. This decline in ULCs mainly reflects productivity improvements in Japan's manufacturing sectors, although slow wage growth due to prolonged deflation also plays a role.[9] The sharp decline in Japan's ULCs suggests that Japanese manufacturing firms have been making great efforts at reducing production costs in the face of severe export competition from neighboring emerging countries. Such cost reductions also imply that without any change in the nominal exchange rate Japan's real effective exchange rate would have declined (i.e., Japan would have been gaining international competitiveness by reducing production costs).

[7] Although labor productivity is also related to cost competitiveness, unit labor costs are considered to be a better measure of production costs than labor productivity. When wages increase along with productivity increases, looking at labor productivity does not allow us to tell whether per-unit production costs are reduced or not. Unit labor costs can measure changes in production costs taking productivity improvements into account.

[8] The ULCs in Figure 5 are calculated as the ratio of nominal total labor compensation to real value added for the manufacturing sector. Japanese and Korean ULC data are taken from OECD statistics and Chinese ULCs are calculated by the authors using data from the World Input-Output Database (WIOD) and the World Bank's World Development Indicators. For China, labor compensation in nominal local currency for the manufacturing sector is taken from the WIOD and value added in constant local currency for the manufacturing sector is taken from the World Development Indicators.

[9] According to the JIP (Japan Industry Productivity) database provided by the Research Institute of Economy, Trade and Industry (RIETI), the growth rate of labor productivity (real gross output per worker) in the manufacturing sector was much larger than the growth rate of nominal labor compensation per worker during the period 2001 to 2009. From 2001 to 2008, labor productivity grew by 27%, while nominal labor compensation per worker grew by 8.5%. From 2001 to 2009, the former grew by 10%, while the latter decreased by 0.1%.

Figure 5. Unit Labor Costs, Manufacturing (2001=100)



Source: OECD Stat for Japan and Korea. For China, authors' calculation using the WIOD and World Bank data.

The figures for NEERs and ULCs for the manufacturing sector presented above suggest that Japan's efforts at cost reduction were offset by the deterioration in the exchange rate during periods of yen appreciation, but boosted export competitiveness during periods of yen depreciation. On the other hand, ULCs in China and Korea increased for most of the period from 2001 to 2009, suggesting that their cost competitiveness deteriorated relative to Japan's.

However, developments in ULCs are likely to have been very different across industries, given that the speed of technological development greatly differs across industries. Therefore, in this subsection, we examine ULCs for the three countries by industry. Utilizing industry-level data taken from the WIOD, we construct annual series of ULCs for the 12 manufacturing sectors for the period 2001-2009.[10] More specifically, we use the data on labor compensation in nominal local currency and real output, calculating ULCs as the ratio of the former to the latter.[11] Although ULC indexes

[10] Although the WIOD provides data from 1995 to 2009, we restrict our analysis to the period from 2001 to 2009. The reason is that the industry-level NEER data, which we use for our econometric analysis below, are only available from 2001 onward. On the other hand, while the NEER data are available until 2012, the sample period for our analysis ends in 2009 due to the lack of data on industry-level costs and output for years after 2009.

[11] While the manufacturing sector ULCs in Figure 5 are calculated using manufacturing real value added as the denominator, in this section, we calculate industry-level ULCs using industry-level real output as the denominator. We use labor compensation in nominal local currency by industry and volume indices of gross output by industry to calculate the ULC indexes, and these industry-level data are taken from the WIOD.

(2001=100) by industry are calculated annually, in Table 1 we only show the index values for 2005 and 2009 for each industry and country for brevity. Developments in ULC indexes for the entire observation period are shown in Appendix Figure 1.

Table 1. Unit Labor Costs by Industry (2001=100, calculated based on local currency)

Industry Classification	China		Japan		Korea	
	2005	2009	2005	2009	2005	2009
Food, beverages and tobacco	102.2	112.0	107.6	109.4	116.0	133.9
Textiles	79.4	71.1	99.1	114.0	91.3	102.5
Wood and cork	78.9	74.7	96.2	97.7	124.3	149.6
Pulp, paper, printing and publishing	68.1	57.1	88.1	94.8	121.8	154.5
Coke, refined petroleum and nuclear fuel	135.1	146.6	93.5	104.4	161.5	120.6
Chemicals	99.2	90.4	92.2	103.0	110.9	121.3
Rubber and plastics	84.6	74.3	100.5	83.6	119.3	126.4
Other non-metallic minerals	83.3	65.0	89.2	75.3	111.7	144.1
Basic metals and fabricated metal	83.8	67.9	93.4	91.3	120.9	136.8
General machinery	70.1	61.0	79.2	67.6	99.0	107.5
Electrical and optical equipment	66.1	53.9	65.4	47.3	69.7	63.2
Transport equipment	74.8	67.4	87.1	82.7	98.0	126.2

Source: Authors' calculation based on data taken from the WIOD.

Table 1 and Appendix Figure 1 show, first, that developments in ULCs greatly differ not only across countries but also across industries. Second, Japan's ULCs were relatively stable or declined in most industries, while Korea's ULCs tend to show an upward trend in many industries. As for China, ULCs declined in most industries until 2007, after which they remained more or less stable, which suggests that wage rates started to rise faster than labor productivity. Third, Korea's ULCs show the largest increase among the three countries in a majority of industries. A notable exception is the electrical and optical equipment industry, which is one of the few industries where Korea's ULCs were declining, but then ULCs in the electrical and optical equipment industry showed a drastic decline in all three countries.

2.3 Industry-Level ULCs in Foreign Currency Terms

The analysis above showed that the NEER for Japan fluctuated considerably during our observation period, while that for China remained relatively stable. Moreover, the cost competitiveness of Japan and China increased in many industries through a reduction in ULCs, while Korea's ULCs declined only in the electrical and optical equipment industry. These observations suggest that Japan's cost advantage was offset when Japan faced a large appreciation of the home currency while Korea's cost *dis*advantage was offset when Korea experienced a large depreciation of the home currency.

In fact, Japan suffered a large decline in exports following the collapse of Lehman Brothers in 2008, while Korea's did so only to a much lesser extent, suggesting that nominal exchange rate movements had a large impact on the two countries' relative export competitiveness.[12] To examine the effect of nominal exchange rates on cost competitiveness, we evaluate the ULCs in foreign currencies using the industry-specific NEER and show the results in Figure 6.[13]

Looking at Figure 6, China's ULCs remained relatively low in most industries in most years owing to the nominal exchange rate, which was relatively stable and did not appreciate much during the observation period. On the other hand, although Korea's ULCs increased considerably during the period of won appreciation (mid-2000s), they then declined sharply in 2008 and 2009 thanks to the rapid depreciation of the won. In contrast, Japan's ULCs increased sharply in 2008 and 2009 due to the appreciation of the yen, suggesting that Japan's efforts at cost reduction were more than offset by the yen appreciation.

To compare the ULCs based on local currency (Table 1 and Appendix Figure 1) and those based on foreign currency (Figure 6), let us look at Japan's and Korea's electrical and optical equipment and transport equipment industries as examples. Compared to the 2001 ULC level, by 2009, Japan had achieved a 53% ULC reduction in the electrical and optical equipment industry in local currency terms, while Korea achieved a 37% reduction. Meanwhile, in the transport equipment industry, Japan achieved a 17% ULC reduction, while Korea's ULCs increased by 26%. However, looking at the foreign currency-based ULCs in 2009, the differences in ULCs for the two countries were less than 2 percentage points in the case of the electrical and optical equipment industry and 13 percentage points in the case of the transport equipment

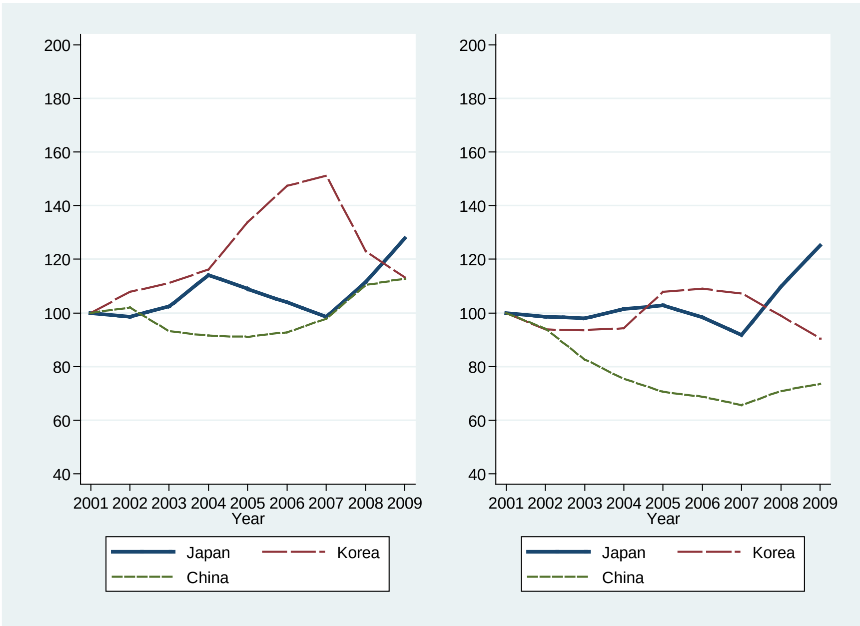
[12] Deckle and Fukao (2009) argue that many Japanese industries managed to lower production costs by improving productivity, while their U.S. counterparts did not. However, the cost competitiveness of Japanese industries was eroded by the appreciation of the nominal exchange rate of the yen.

[13] We construct the ULC indexes based on foreign currencies as follows. First, we calculate labor compensation per unit of output in terms of local currency, which is also used for constructing the local currency-based ULC indexes shown in Table 1. Then, labor compensation in local currency per unit of output is converted to foreign currency-based values using the industry-specific NEER. Finally, labor compensation in foreign currency per unit of output is converted to an index set to 100 for 2001.

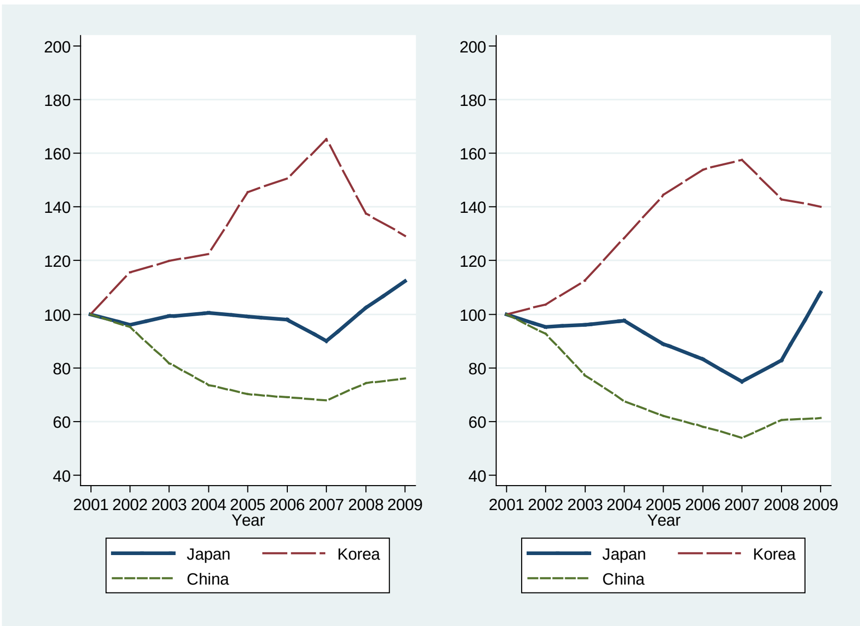
industry. These figures indicate how large the impact of exchange rate fluctuations on cost competitiveness is.

Figure 6. Unit Labor Costs by Industry (2001=100, calculated based on foreign currency using the nominal effective exchange rate)

(a) Food, beverages and tobacco (b) Textiles

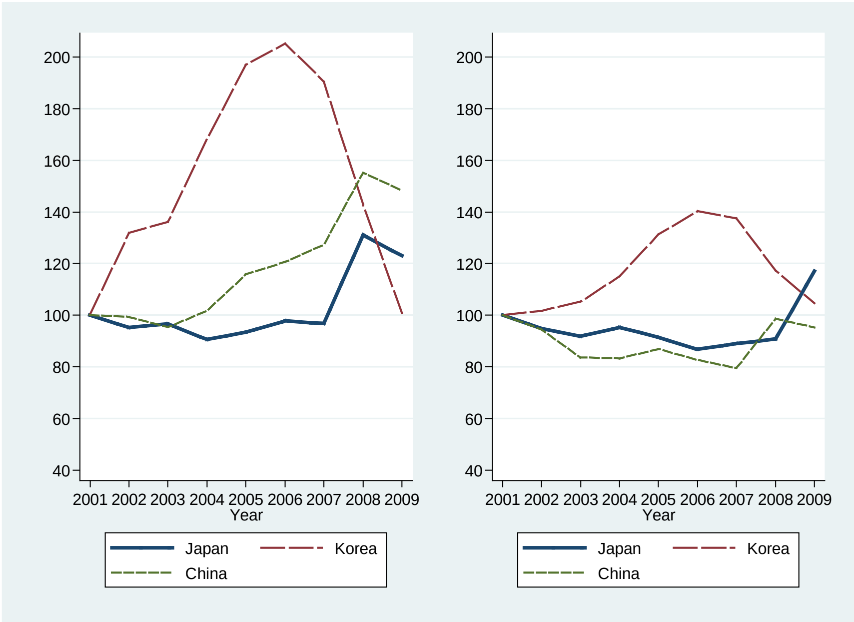


(c) Wood and cork (d) Pulp, paper, printing and publishing



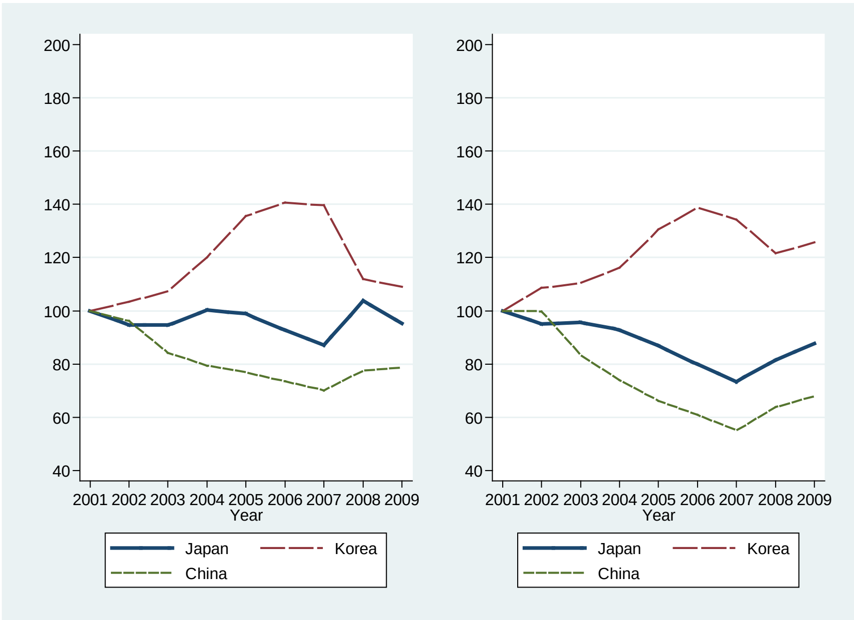
(e) Coke, refined petroleum and Nuclear fuel

(f) Chemicals

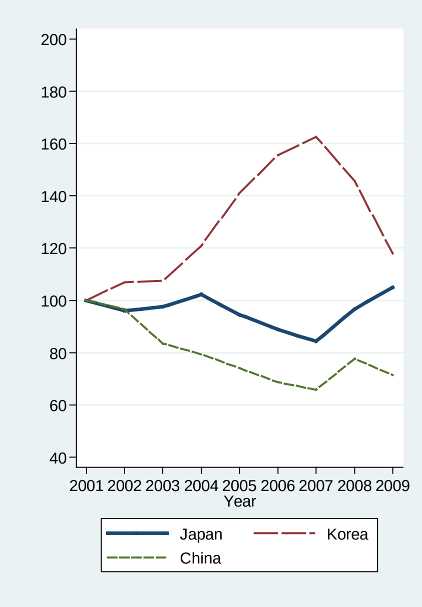


(g) Rubber and plastics

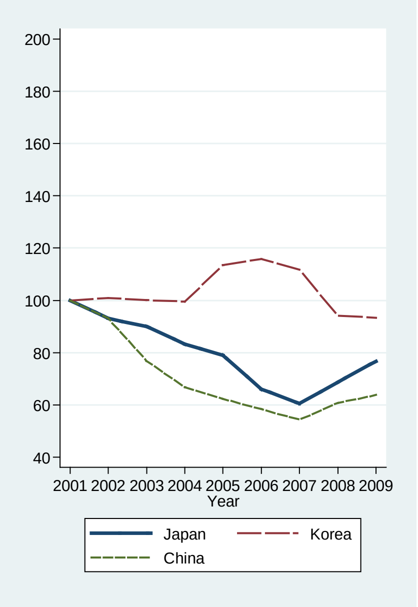
(h) Other non-metallic minerals



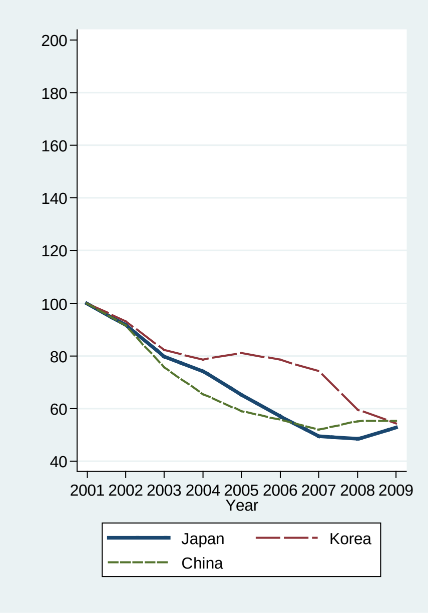
(i) Basic metals and fabricated metal



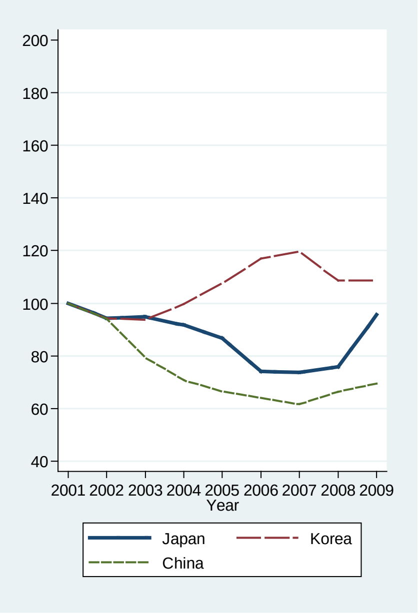
(j) General machinery



(k) Electrical and optical equipment



(l) Transport equipment



Source: Authors' calculation based on data taken from the WIOD.

3. Model for Relative Prices and Competitiveness

Following Chinn (2006), we explain the relationship between factors which affect international competitiveness. Specifically, we focus on relative prices, nominal exchange rates, and unit labor costs at home and abroad. The logarithm of the real exchange rate at time t (q_t) is defined as

$$q_t \equiv s_t - p_t + p_t^* \qquad (2)$$

where s is the log of the nominal exchange rate defined in units of home currency per unit of foreign currency and p stands for the log of price levels. * denotes the foreign country.

Suppose the price index is a geometric average of traded (denoted by superscript T) and non-traded (denoted by superscript N) goods prices:

$$\begin{aligned} p_t &= \alpha p_t^N + (1-\alpha) p_t^T \\ p_t^* &= \alpha^* p_t^{N*} + (1-\alpha^*) p_t^{T*} \end{aligned} \qquad (3)$$

Then substituting (3) into (2) and re-arranging yields

$$q_t \equiv (s_t - p_t^T + p_t^{T*}) - \alpha(p_t^N - p_t^T) + \alpha^*(p_t^{N*} - p_t^{T*}) \qquad (4)$$

Equation (4) indicates that the real exchange rate can be expressed as the sum of three components: (i) the relative price of tradable goods, (ii) the relative price of non-tradables in terms of tradables in the home country, and (iii) the corresponding relative price in the foreign country.

As the purpose of our study is to examine the export competitiveness of manufacturing industries in the three countries, we focus on the first component, the relative price of tradable goods, since we regard relative prices in global markets as a critical determinant of export competiveness. Consequently, we disregard the effects of the relative price of non-tradables in terms of tradables in the home and the foreign country, so that the real exchange rate may be adequately represented by:

$$q_t^2 = q_t^T \equiv (s_t - p_t^T + p_t^{T*}) \qquad (5)$$

This definition is most appropriate when considering the relative price that achieves external balance in trade in goods and services.

A related concept is cost competitiveness (Marsh and Tokarick, 1996). To see how cost competitiveness is related to export competitiveness, consider the following markup model of pricing:

$$p_t^T = \log\left[(1+\mu_t)\left(\frac{W_t}{A_t}\right)\right] \qquad (6)$$

where μ is the percentage markup, W is the nominal wage rate, and A is labor productivity per hour. *W/A* is therefore ULC. Re-expressing (5) using equation (6), and assuming that markups are constant ($\mu_t = \mu$) yields:

$$q_t^3 = \left[s_t - (w_t - a_t) + (w_t^* - a_t^*)\right] - \ln(1+\mu) + \ln(1+\mu^*) \qquad (7)$$

where *w* and *a* denote the log of the nominal wage rate and the log of labor productivity, respectively. The last two terms are constant. In this case, the real exchange rate is the nominal rate adjusted by wages and productivity levels in the home country, and by wages and productivity levels in the foreign country. It shows that changes in relative prices can be determined by changes in the nominal exchange rate, in ULCs in the home country, and ULCs in the foreign county.

4. Empirical Analysis

4.1 Empirical Framework

International competitiveness, namely, the price competitiveness of exported goods, can be captured by the "relative prices" of a country's exported goods vis-à-vis goods exported from foreign countries. As discussed in Section 3, changes in relative prices can be determined by changes in the nominal exchange rate, ULCs in the home country, and ULCs in the foreign country. We therefore assume that a country's export volume is determined by foreign demand, the nominal effective exchange rate, ULCs at home, and ULCs abroad:

$$lnEXP_{ijt} = \theta_1 lnEXPRoW_{ijt} + \theta_2 lnNEER_{ijt} + \theta_3 lnULC_{ijt} + \theta_4 lnFULC_{ijt} + \mu_{ij} + \tau_t + \epsilon_{ijt} \qquad (8)$$

where $lnEXP_{ijt}$ denotes the real export value in local currency in logarithm for country *i* and industry *j* in year *t*.[14] *lnEXPRoWijt* is the logarithm of total exports from the rest of the world (exports from all countries except country *i*) in nominal U.S. dollars and is a proxy for foreign demand. $lnNEER_{ijt}$ is the nominal effective exchange rate index (relative to 2001=100) in logarithm, and $lnULC_{ijt}$ is the ULC index (relative to 2001=100, calculated based on the local currency) in logarithm for country *i*, industry *j*, and year *t*. $lnFULC_{ijt}$ is the ULC index for foreign countries in logarithm. Although $lnFULC_{ijt}$ should be calculated using the ULCs of all countries exporting products in

[14] Trends of real exports for each industry for each country are shown in Appendix Figure 3.

industry *j*, the variable is constructed using the unit labor costs of the 40 countries included in the WIOD, i.e., the 27 EU countries and 13 other major countries. Although the WIOD covers major emerging economies such as Brazil, Russia, India, and China, it does not cover Southeast Asian countries except Indonesia. For Asia, the WIOD covers only China, Japan, Korea, Taiwan, and Indonesia, which is a weakness of the WIOD. Nevertheless, our $lnFULC_{ijt}$ variable is constructed using consistent industry-level data including as many countries as possible. In this paper, the *lnFULC* variable is calculated as follows. For example, in the case where the home country is Japan, the ULC index for foreign countries (*FULC)* is the weighted average of the ULC indexes (ULC based on local currency*)* for all other 39 countries except Japan, using each country's nominal exports to the rest of the world in U.S. dollars as weights. The *lnFULC* variable is the logarithm of *FULC*. The *lnFULC* variable for China and Korea is calculated in the same manner. μ_{ij} and τ_t capture country-industry specific effects and year specific effects, respectively. ε_{ijt} is an error term. The construction of the ULC and the NEER variables was already explained in Section 2, and other industry-level data are taken from the WIOD.[15]

In order to eliminate country-industry fixed effects, we take the first difference for all variables except the year dummies. The equation is estimated using OLS and we examine how changes in the exchange rates and ULCs affect a country's exports. Moreover, in order to check whether the effects of ULCs or nominal effective exchange rates differ across countries or industries, we include cross-terms of a country or industry dummy and the first difference of the *lnULC*, *lnFULC*, and *lnNEER* variables. Therefore, the basic specification we estimate is the following equation (9), and we also estimate equations including various cross terms:

$$\Delta lnEXP_{ijt} = \theta_1 \Delta lnEXPRoW_{ijt} + \theta_2 \Delta lnNEER_{ijt} + \theta_3 \Delta lnULC_{ijt} + \theta_4 \Delta lnFULC_{ijt} + \tau_t + \epsilon_{ijt} \quad (9)$$

In equation (9), we expect the coefficient on $lnEXPRoW_{ijt}$ (θ_1) to be positive, since an increase in foreign demand is likely to have a positive impact on exports from the home country. Based on the relationship shown by equation (7), we expect negative coefficients for $lnNEER_{ijt}$ and $lnULC_{ijt}$ (θ_2 and θ_3), while we expect a positive coefficient for $lnFULC_{ijt}$ (θ_4). Whereas the nominal exchange rate (s_t) in equation (7) is

[15] The data on world exports at the WIOD industry level were provided by Johannes Pöschl at the Vienna Institute for International Economic Studies. We thank him for providing the data.

defined as units of home currency per unit of foreign currency and a larger value corresponds to a depreciation of the home currency, the variable we use for our statistical analysis ($lnNEER_{ijt}$) is an index where a larger value corresponds to an appreciation of the home currency. Therefore, we expect a negative relationship between the NEER and exports from the home country. As for ULCs, an increase in ULCs in the home country is likely to weaken price competitiveness and is expected to have a negative impact on exports from the home country. On the other hand, an increase in ULCs in foreign countries is expected to have a positive impact on exports from the home country.

As for differences across industries, we include cross-terms for the three machinery-related industries: general machinery, electrical and optical equipment, and transport equipment. We choose these three industries for the following reasons. First, these machinery products are highly differentiated, and the degree of product differentiation may affect the relative importance of price competitiveness and non-price competitiveness.[16] Second, fragmentation of production in East Asia is most pronounced in these machinery-related industries. In production fragmentation, production costs strongly matter for the decision of production location. Therefore, the effects of unit costs and nominal exchange rates in these industries may differ from those in other industries. Third, products in these machinery-related sectors are important export goods for the three Asian countries we focus on. For example, the share of these three industries in the total exports of goods for Japan is approximately 70% on average for the period 2001-2009. The corresponding shares for Korea and China are 63% and 51%, respectively.[17] Moreover, as the technological capabilities of local manufacturers in Korea and China develop, the three countries are increasingly competing in the global market for some machinery-related products. Therefore, price competitiveness may be more important in the machinery-related industries than in other industries.

In our analysis, in addition to ULCs, we also use unit multifactor costs (UMFCs) as a measure of cost competitiveness. Although ULCs are widely used as a measure of cost competitiveness, they do not capture costs for other production factors such as capital and intermediate inputs. Increases or decreases in UCLs can be driven by

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[16] Rauch (1999) identifies differentiated products at the three- and four-digit SITC levels and concludes that barriers for matching international buyers and sellers are higher for differentiated than for homogeneous products. According to Rauch (1999), most differentiated products fall into machinery-related sectors.

[17] These figures are calculated in terms of local currency and based on the WIOD industry-level export data.

either changes in production efficiency or substitution between labor input and other factor inputs. Therefore, by using UMFCs instead of ULCs we take not only labor costs but also the cost of capital and intermediate inputs into account.[18]

However, we mainly focus on ULCs in this paper despite the above-mentioned limitation of ULCs. The reason is that the relative costs of non-tradable inputs, i.e., labor, matter more for export competitiveness than the costs of tradable inputs such as capital and intermediate inputs, which tend to be equalized internationally. In addition, although the WIOD provides industry-level capital compensation data for less-developed countries, data on capital costs are often less reliable than data on labor compensation, especially for less-developed countries such as China. Therefore, we mainly use ULCs as our measure of cost competitiveness in the estimation, but also use UMFCs instead of ULCs to check the robustness of our results.

4.2 Estimation Results

The estimation results using ULCs as a cost measure are shown in Table 2. As mentioned above, we estimate the same model using UMFCs instead of ULCs as a robustness check and the results are shown in Appendix Table 1.[19] *JP* and *KR* denote Japan and Korea dummies, respectively, while *GM*, *EL*, and *TR* are dummies for the general machinery, electrical and optical equipment, and transportation equipment industries, respectively. In both Table 2 and Appendix Table 1, the columns labeled (1) – (3) show the results using observations for the period 2001-2009 while columns (4) – (6) show the results using observations for the period 2001-2008. The reason for running estimations excluding observations for 2009 is that the large fluctuations in the exchange rates of the major currencies and the severe global economic downturn following the collapse of Lehman Brothers may have had exceptional effects on exports. Excluding the 2009 observations thus helps us to check the robustness of our estimation results. As will be seen, the estimation results in columns (4) – (6) are very similar to those in columns (1) – (3), suggesting that our results are not driven by the large economic shock following the 2008 financial crisis.[20]

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[18] Unit multifactor costs are defined as the ratio of total factor costs in nominal terms (labor compensation, intermediate inputs, and capital compensation) to real output, and are calculated using the industry-level data taken from the WIOD. The calculated UMFCs based on local currency are shown in Appendix Figure 2.

[19] Summary statistics of variables used in the estimation are shown in Appendix Table 2.

[20] In Appendix Table 1, although the estimated coefficients on the cost variables (*D.lnUMFC*

As shown in Table 2, the coefficients on *D.lnEXPRoW* and *D.lnULC* are statistically significant and have the expected sign in all columns. Looking at the magnitudes, the estimated coefficients suggest that, on average, a 10% increase in foreign demand increases home country exports by approximately 3-5%, while a 10% increase in the ULC index decreases home country exports by 5-6% (equations (1) and (4)).

The results indicate that, as predicted by the model outlined in Section 4.1, an increase in labor costs reduces exports by raising home country prices relative to prices elsewhere. In particular, as shown in columns (3) and (6) in Table 2, all three cross-terms of *D.lnULC* and the industry dummies have a negative and significant coefficient, suggesting that the negative impact of higher ULCs is larger for these machinery-related industries than other manufacturing industries. This larger negative impact implies that cost competitiveness is particularly important in these machinery industries, probably because production processes can easily be relocated within the production networks spanning East Asia in response to an increase in labor costs. However, looking at differences in the impact of ULCs across countries (columns (2) and (5)), the negative impact on exports of an increase in ULCs is largest in the case of China, while it is smaller in the case of Korea (the coefficient on *KR*D.lnULC* is positive, but the sum of the coefficients on *D.lnULC* and *KR*D.lnULC* is still negative.). In the case of China, a 10% increase in the ULC index decreases exports by 12%, while in the case of Korea, the same increase lowers exports by only 4.8% (column (5)). On the other hand, in the case of Japan, adding up the two coefficients even yields a slightly positive value, suggesting that labor costs do not matter much for Japanese exports.

As for the nominal effective exchange rate, the estimated coefficient on *D.lnNEER* is negative and significant in all cases except columns (2) and (5). These results indicate that for Japan, China, and Korea together an appreciation of the home currency has a negative effect on home exports, as theory would lead one to expect; however, this result is mainly driven by the negative impact in the case of Japan. In column (2), the impact of the NEER is not statistically significant for Korea and China, and in column (5) it is even positive. Further, columns (3) and (6) suggest that the negative impact of an increase in the NEER is larger for the transportation equipment industry than the other two machinery industries and non-machinery industries. This large negative impact implies that the exchange rate tends to affect exports in the

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and its interaction terms) are not statistically significant in many cases, the coefficient on *D.lnUMFC* tends to be negative, which is consistent with the results in Table 2. As for the nominal effective exchange rate and other explanatory variables, the results in Appendix Table 1 are largely consistent with those in Table 2.

transportation equipment industry more strongly than those in other industries.

As for foreign ULCs (*lnFULC*), the estimated coefficient is not statistically significant in most cases, and the impact of *lnFULC* is not very clear. While the estimated coefficient is as expected positive in columns (2) and (5), the cross-terms of *lnFULC* and *JP* and *KR* have a negative coefficient. Therefore, the results suggest that an increase in production costs in foreign countries has a positive impact on home exports only in the case of China and that China's exports are sensitive to relative production costs at home and abroad. On the other hand, in the case of Korea and Japan, an increase in production costs in foreign countries leads a reduction in home exports. This relationship suggests that home exports and foreign exports are complementary and a cost increase in foreign countries negatively affects home country exports by raising the cost of imported intermediate goods.

Table 2. Estimation Results: Unit Labor Costs Used as Cost Variable

Dependent variable: D.ln(real export value in local currency)

	(1)	(2)	(3)	(4)	(5)	(6)
D.lnEXPRoW	0.386***	0.498***	0.310***	0.284**	0.554***	0.244*
	(0.104)	(0.100)	(0.108)	(0.124)	(0.114)	(0.125)
D.lnNEER	-0.413***	0.013	-0.343***	-0.402***	0.924**	-0.401***
	(0.095)	(0.374)	(0.105)	(0.114)	(0.382)	(0.127)
D.lnULC	-0.512***	-1.235***	-0.278**	-0.647***	-1.883***	-0.399**
	(0.120)	(0.199)	(0.137)	(0.142)	(0.221)	(0.167)
D.lnFULC	-0.121	0.470*	0.019	-0.036	0.548**	0.047
	(0.176)	(0.247)	(0.184)	(0.189)	(0.246)	(0.193)
JP*D.lnNEER		-0.848**			-2.521***	
		(0.406)			(0.477)	
KR*D.lnNEER		-0.256			-0.844*	
		(0.451)			(0.442)	
JP*D.lnULC		1.248***			2.096***	
		(0.257)			(0.301)	
KR*D.lnULC		0.758***			1.095***	
		(0.288)			(0.313)	
JP*D.lnFULC		-0.842**			-0.868***	
		(0.335)			(0.334)	
KR*D.lnFULC		-1.140***			-1.131***	
		(0.357)			(0.352)	
GM*D.lnNEER			-0.111			0.437
			(0.359)			(0.441)
EL*D.lnNEER			-0.304			-0.028
			(0.372)			(0.441)
TR*D.lnNEER			-0.685*			-0.526
			(0.390)			(0.461)
GM*D.lnULC			-0.798*			-1.396**
			(0.452)			(0.587)
EL*D.lnULC			-0.826**			-0.736*
			(0.383)			(0.423)
TR*D.lnULC			-1.078**			-0.997*
			(0.460)			(0.520)
GM*D.lnFULC			-0.627			1.625
			(0.633)			(1.754)
EL*D.lnFULC			-0.091			-0.076
			(0.749)			(0.880)
TR*D.lnFULC			0.100			-0.624
			(0.655)			(1.191)
Observations	312	312	312	273	273	273
F-statistic	20.549	18.151	12.319	5.507	9.915	3.574
R-squared	0.430	0.512	0.458	0.174	0.383	0.212

Standard errors in parentheses.
* p<0.10, ** p<0.05, *** p<0.01
Year dummies are included.

5. Summary and Concluding Remarks

In this paper, we examined the industry-level export competitiveness of manufacturing industries in China, Japan, and Korea. One of the determinants of export competitiveness is relative prices in the global market and relative prices are considered to reflect production costs and nominal exchange rates. Therefore, production costs and nominal exchange rates affect a country's competitiveness in the global market. However, the effects of exchange rate movements and cost reductions on export competitiveness are likely to differ not only across countries but also across industries, and such effects can sometimes be very complex as a result of factors such as the increasingly intricate supply chains linking economies in East Asia, technological progress in emerging economies in the region, and different exchange rate regimes across countries. This means that the impact of production costs and exchange rates on export competitiveness differs depending on whether an industry is in a complementary or competitive relationship with neighboring countries. To address such industry-level variations, this paper closely examined changes in exchange rates and unit labor costs (ULCs) by industry for each of the three East Asian countries and investigated how and to what extent these changes affect industry-level export volumes of these countries.

We found that ULCs were declining or relatively stable in most industries for Japan and China, while those of Korea tended to show an upward trend in many industries, with the electrical and optical equipment industry being a major exception. On the other hand, while China's NEER was relatively stable, those of Japan and Korea fluctuated substantially. Moreover, the Japanese yen and the Korean won tended to move in opposite directions, meaning that Korean exporters enjoyed a depreciation of the won when Japanese exporters were struggling with an appreciation of the yen and vice versa. In fact, measuring ULCs in foreign currency, we found that Japan's efforts at cost reduction were offset by the appreciation of the yen, while Korea's ULCs declined thanks to the depreciation of the won. Particularly in the cases of the electrical and optical equipment industry and the transportation equipment industry, exchange rate fluctuations had a large impact on the cost competitiveness of Japan and Korea.

In our empirical analysis, we found that ULCs tend to have a negative impact on exports and that the negative impact is largest for China, while it is much smaller for Korea. In contrast, ULCs do not appear to matter much for Japanese exports. On the other hand, an increase in the NEER does have a strong negative impact on exports for Japan, whereas the effect is not significant for Korea and China. We further found that the negative effect of a NEER increase in the case of Japan was not simply the result of the rapid yen appreciation following the 2008 financial crisis, but also operated before the crisis. These results suggest that labor costs are important determinants of export competitiveness in the case of China, while exchange rates are important determinants of export competitiveness in the case of Japan.

Looking at different industries, we found that in increase in ULCs had a larger negative impact in machinery-related industries than in other manufacturing industries, indicating that in these industries cost competitiveness is particularly important. The reason likely is that production can easily be relocated across East Asian countries through production networks in response to an increase in labor costs.

Overall, the analysis in this study empirically confirmed that, as predicted by theory, both ULCs and NEERs affect export competitiveness, but the effects greatly differ across countries and industries. In particular for China and Japan, the effects are notably different and indicate that for China cost reductions are important for maintaining competitiveness, while for Japan, exchange rate management is important. Thus, by eliciting such differential effects, this paper provides empirical evidence relevant to the design of policies to enhance industrial competitiveness and coordination in foreign exchange markets. Specifically, in the case of Japan, for example, our results suggest that policies for cost reduction may not be very effective in enhancing export competitiveness and that instead policies to achieve greater exchange rate stability may be more effective.

To conclude, we would like to highlight several issues for future research. The first of these concerns taking the type of product into account. Our results suggest that the factors determining export competitiveness differ across industries, but such differences may be more pronounced if we take product characteristics into account. For example, final goods and intermediate goods are likely to have different price elasticities, and final goods production may be easier to relocate to low-cost countries than certain types of intermediate goods. Second, exchange rate pass-through is likely to differ across countries and industries (and types of goods) depending on market power and non-price competitiveness. Relating our results to the effects of exchange rate pass-through could help to disentangle the complex effects of the exchange rate and cost competitiveness on export competitiveness. Third, countries' exports may be becoming more and more complementary as a result of advancing production fragmentation. Further investigation taking account of product types and intra-firm trade, etc., therefore could offer further insights, provided detailed data are available. We believe that all of these extensions would provide further evidence for gaining a better understanding of competitiveness in international markets.

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Appendix 1: Construction of Industry-Specific Effective Exchange Rates

Following Sato et al. (2012a, 2012b), we use the following formula to construct effective exchange rates (*EER*):

$$EER_{it} = \prod_{j=1}^{n} \left(ER_{it}^{j} \right)^{\alpha_i^j}, \tag{A1}$$

where *ER* denotes the bilateral nominal or real exchange rate of country *j*'s currency vis-à-vis the home currency (say, Japanese yen), and α_i^j is the share of home country (Japanese) exports in industry *i* to country *j* in total home country (Japanese) exports. The bilateral nominal (real) exchange rate is used for *ER* when constructing industry-specific nominal (real) effective exchange rates.

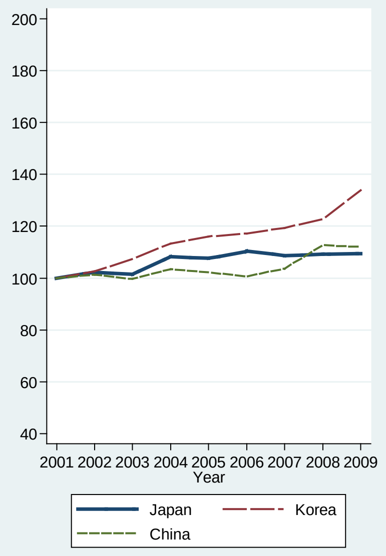
In calculating effective exchange rates, we use one home country and 26 trading partner (export destination) countries. For the industry classification, we use the 2-digit International Standard Industrial Classification (ISIC) Rev.3. We aggregate the 22 ISIC manufacturing industries into 12 industries following Sato et al. (2012a, 2012b), where further details can be found.

To calculate trade weights for constructing industry-specific EERs for Japan, China, or Korea, we employ the following two-step procedure. First, we compute the country's total amount of exports to the 26 partner countries ("26-total" exports). We then calculate the trade weight of each destination country for each industry by dividing the exports to each destination by the 26-total. Second, when calculating the EER series, we use the 3-year average of the trade share for each year to smooth out annual changes in trade shares. The export data are obtained from the UN Comtrade Database.

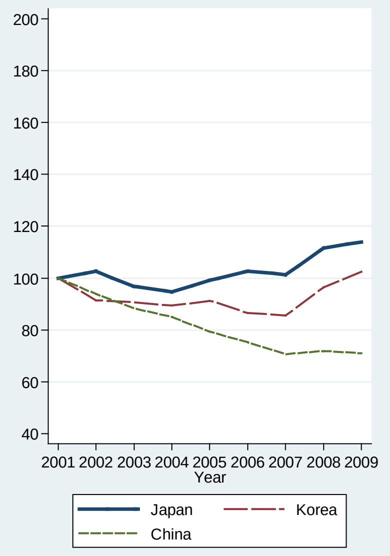
For the weighting scheme, we use the simple export weight of direct bilateral trade to calculate the effective exchange rate.

Appendix Figure 1: Unit Labor Costs by Industry (2001=100, calculated based on local currency)

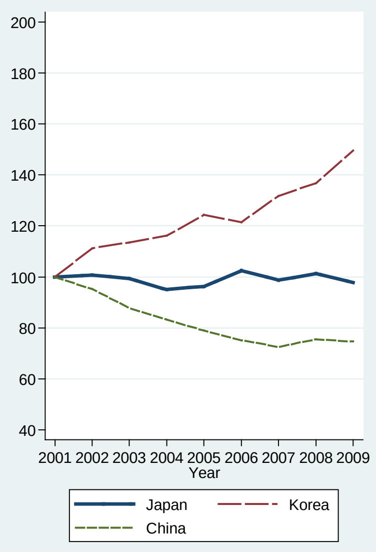
(a) Food, beverages and tobacco



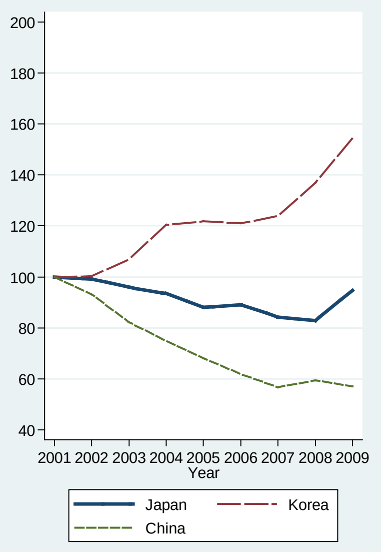
(b) Textiles



(c) Wood and cork

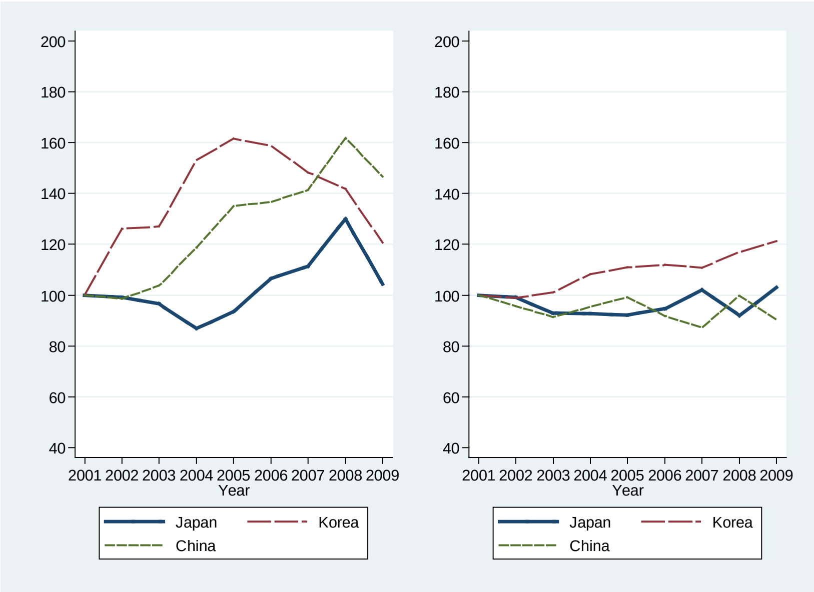


(d) Pulp, paper, printing and publishing



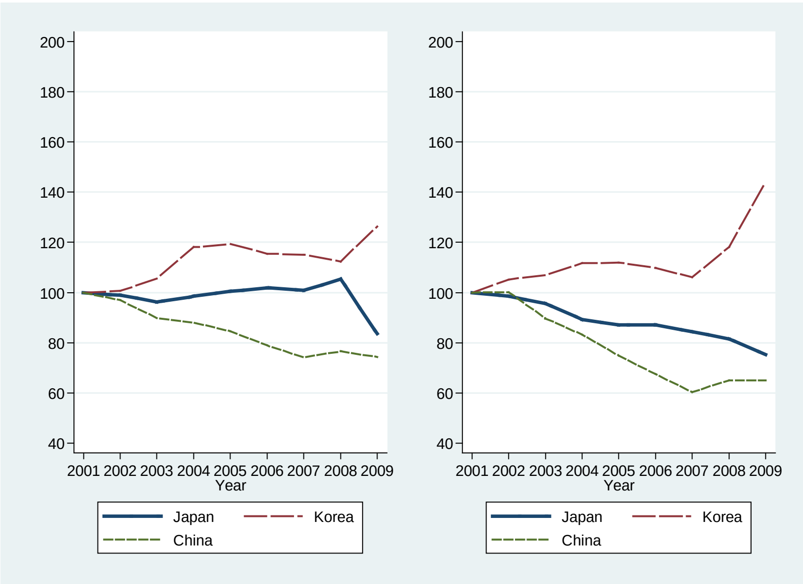
(e) Coke, refined petroleum and nuclear fuel

(f) Chemicals



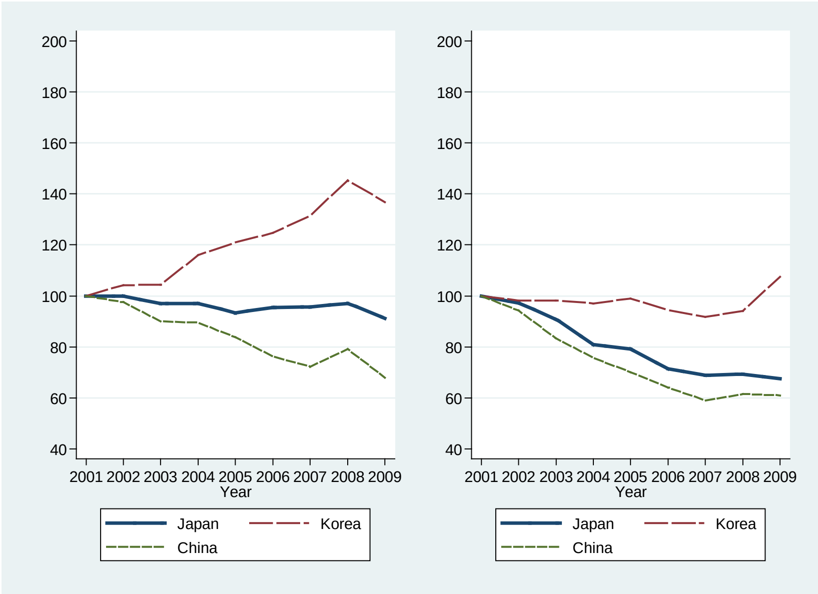
(g) Rubber and plastics

(h) Other non-metallic minerals



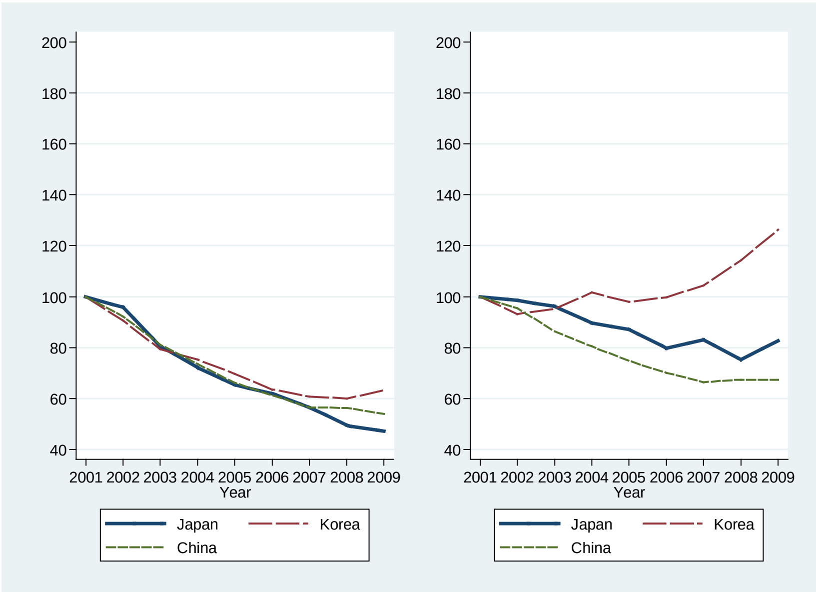
(i) Basic metals and fabricated metal

(j) Machinery



(k) Electrical and optical equipment

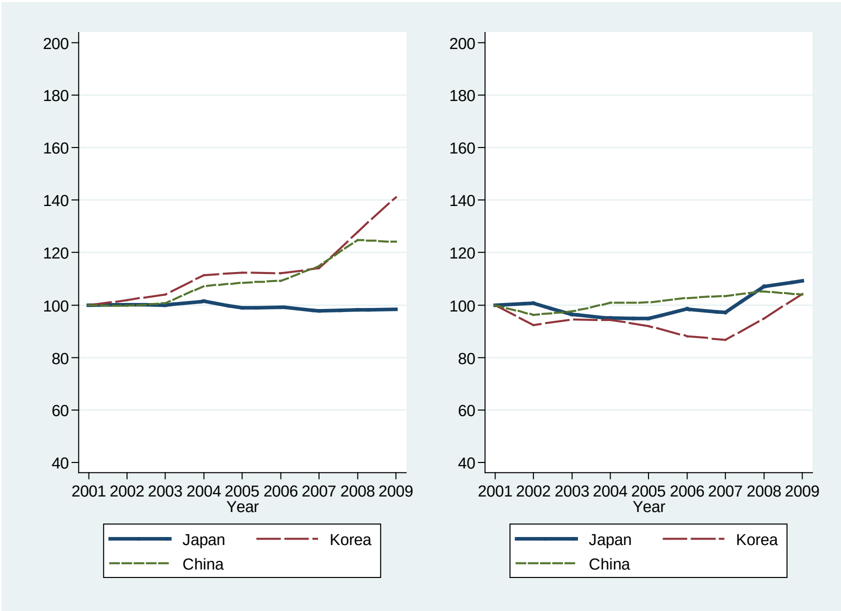
(l) Transport equipment



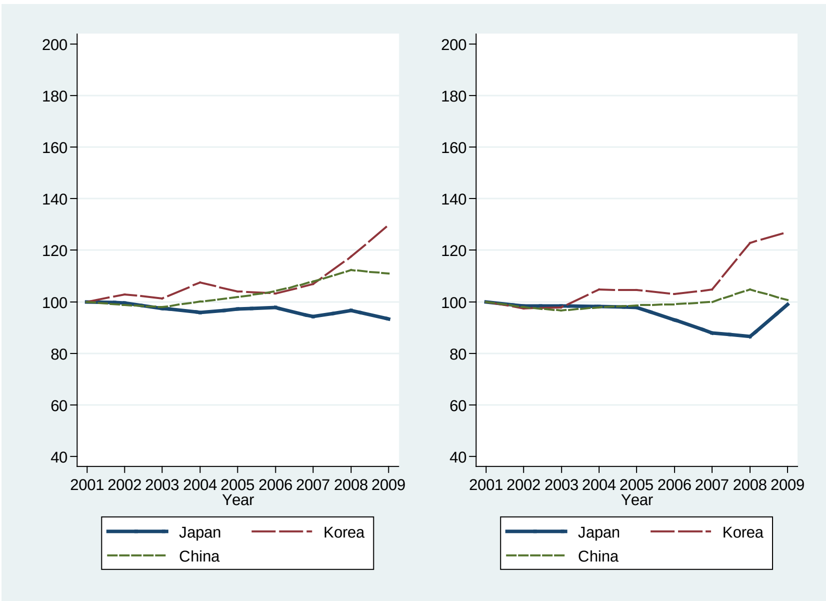
Source: Authors' calculation based on data taken from the WIOD.

Appendix Figure 2. Unit Multifactor Costs by Industry (2001=100, calculated based on local currency)

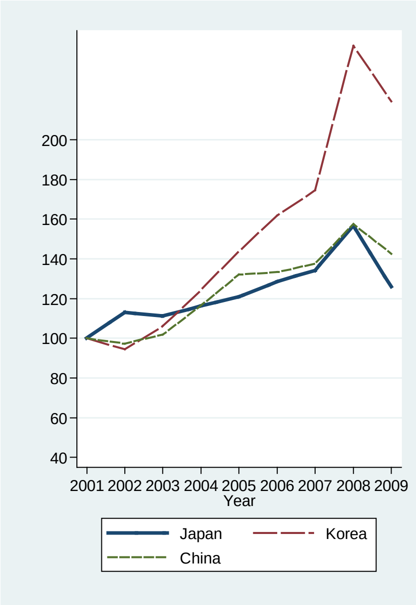
(a) Food, beverages and tobacco (b) Textiles



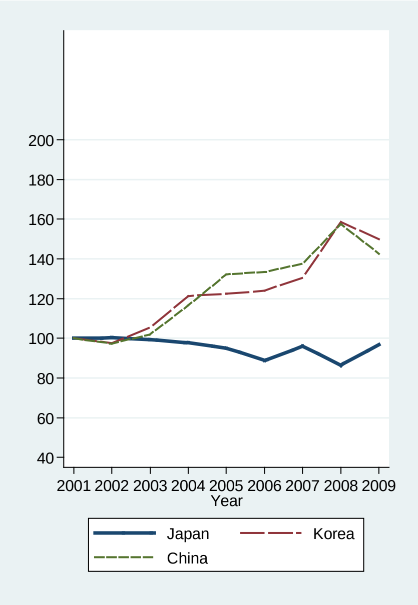
(c) Wood and cork (d) Pulp, paper, printing and publishing



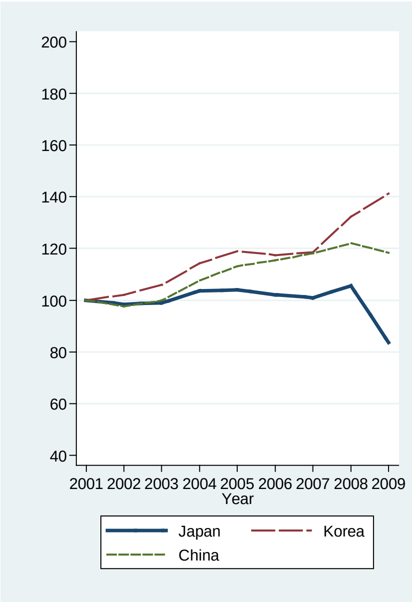
(e) Coke, refined petroleum and nuclear fuel



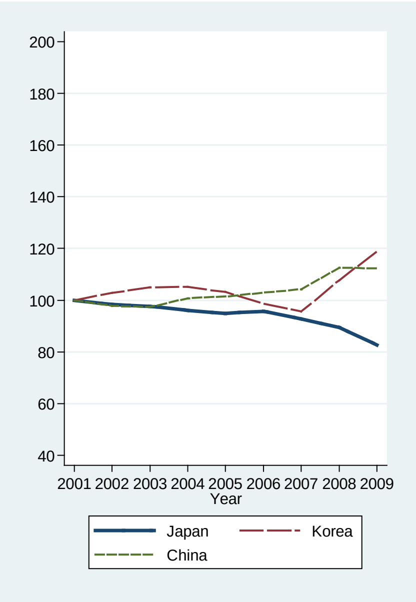
(f) Chemicals



(g) Rubber and plastics

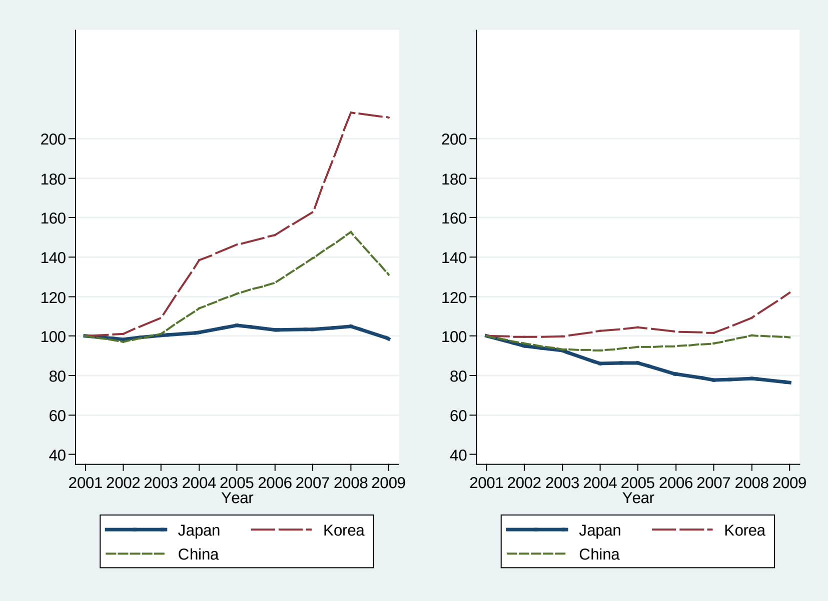


(h) Other non-metallic minerals



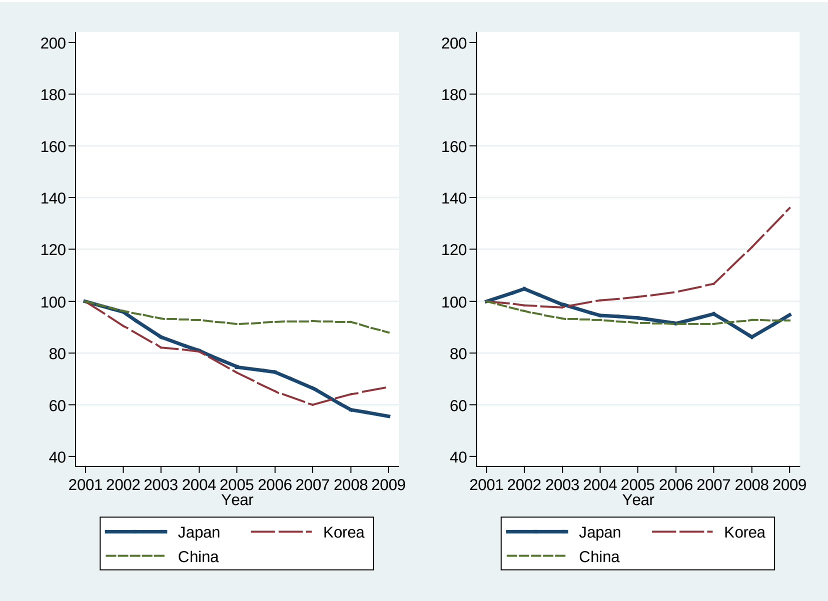
(i) Basic metals and fabricated metal

(j) Machinery



(k) Electrical and optical equipment

(l) Transport equipment



Source: Authors' calculation based on data taken from the WIOD.

Appendix Table 1. Estimation Results: Unit Multifactor Costs Used as Cost Variable

Dependent variable: D.ln(real export value in local currency)

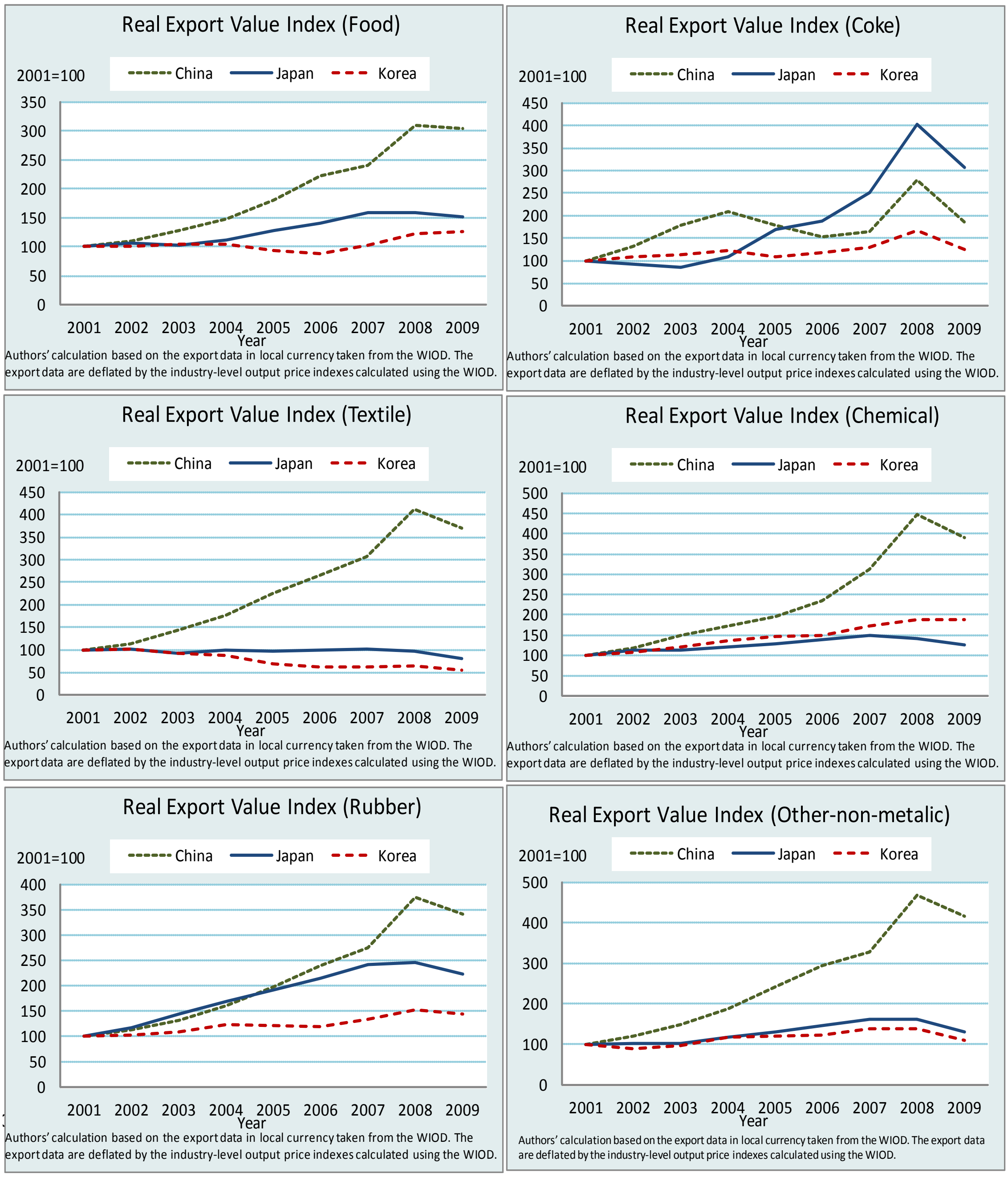
	(1)	(2)	(3)	(4)	(5)	(6)
D.lnEXPRoW	0.479***	0.554***	0.459***	0.386**	0.514***	0.239
	(0.143)	(0.139)	(0.148)	(0.185)	(0.179)	(0.193)
D.lnNEER	-0.379***	0.099	-0.314***	-0.417***	0.257	-0.400***
	(0.106)	(0.373)	(0.116)	(0.128)	(0.400)	(0.140)
D.lnUMFC	-0.150	0.025	-0.068	-0.163	-0.227	-0.039
	(0.158)	(0.407)	(0.174)	(0.191)	(0.489)	(0.216)
D.lnFUMFC	-0.405*	0.047	-0.281	-0.363	0.084	-0.040
	(0.238)	(0.354)	(0.241)	(0.283)	(0.401)	(0.291)
JP*D.lnNEER		-0.860**			-1.276***	
		(0.383)			(0.482)	
KR*D.lnNEER		-0.360			-0.648	
		(0.484)			(0.506)	
JP*D.lnUMFC		0.092			0.732	
		(0.459)			(0.585)	
KR*D.lnUMFC		-0.263			-0.174	
		(0.505)			(0.566)	
JP*D.lnFUMFC		-0.577			-0.551	
		(0.397)			(0.439)	
KR*D.lnFUMFC		-1.166**			-1.188**	
		(0.501)			(0.528)	
GM*D.lnNEER			-0.089			0.164
			(0.384)			(0.445)
EL*D.lnNEER			0.412			0.751
			(0.470)			(0.550)
TR*D.lnNEER			-0.955**			-0.520
			(0.456)			(0.558)
GM*D.lnUMFC			-0.034			0.034
			(0.720)			(0.847)
EL*D.lnUMFC			0.853			0.973
			(0.655)			(0.701)
TR*D.lnUMFC			-1.097*			-0.489
			(0.663)			(0.840)
GM*D.lnFUMFC			0.694			2.890*
			(1.308)			(1.653)
EL*D.lnFUMFC			-7.107***			-7.980***
			(2.079)			(2.190)
TR*D.lnFUMFC			3.305**			4.739**
			(1.637)			(2.115)
Observations	312	312	312	273	273	273
F-statistic	18.337	14.606	11.388	3.444	4.427	3.031
R-squared	0.402	0.458	0.439	0.116	0.217	0.185

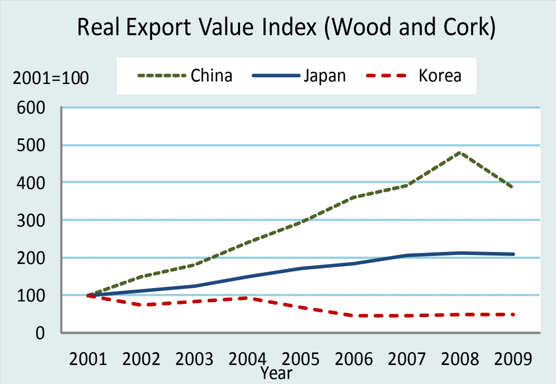
Standard errors in brackets.
* $p<0.10$, ** $p<0.05$, *** $p<0.01$
Year dummies are included.

Appendix Table 2. Summary Statistics of Variables Used in the Estimation

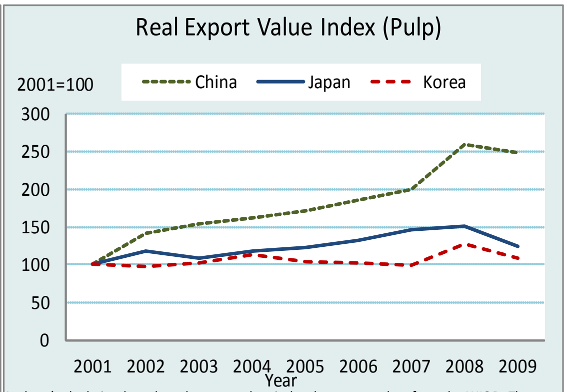
Variable	Obs.	Mean	Std. Dev.	Min.	Max.
D.lnEXP	312	0.08069	0.16601	-0.48586	0.52671
D.lnEXPRoW	312	0.07761	0.14731	-0.47801	0.38429
D.lnNEER	312	0.00107	0.07857	-0.24188	0.15631
D.lnULC	312	-0.00970	0.06765	-0.23192	0.23179
D.lnFULC	312	0.02270	0.04990	-0.07856	0.29838
JP*D.lnNEER	312	0.00549	0.04435	-0.08453	0.15631
KR*D.lnNEER	312	-0.00597	0.05922	-0.24188	0.11730
JP*D.lnULC	312	-0.00594	0.03840	-0.23192	0.15474
KR*D.lnULC	312	0.00759	0.03879	-0.16163	0.23179
JP*D.lnFULC	312	0.00701	0.03029	-0.07856	0.29252
KR*D.lnFULC	312	0.00643	0.03025	-0.07696	0.29302
GM*D.lnNEER	312	0.00010	0.02109	-0.19579	0.13602
EL*D.lnNEER	312	-0.00003	0.02091	-0.20660	0.13108
TR*D.lnNEER	312	0.00009	0.01993	-0.18801	0.13732
GM*D.lnULC	312	-0.00261	0.01817	-0.12174	0.13324
EL*D.lnULC	312	-0.00585	0.02413	-0.17224	0.05043
TR*D.lnULC	312	-0.00113	0.01747	-0.10024	0.09892
GM*D.lnFULC	312	0.00062	0.01299	-0.03949	0.12871
EL*D.lnFULC	312	-0.00098	0.01176	-0.07856	0.05990
TR*D.lnFULC	312	0.00109	0.01227	-0.04029	0.11168
D.lnUMFC	312	0.01232	0.06510	-0.23192	0.34810
D.lnFUMFC	312	0.02784	0.05145	-0.15903	0.31962
JP*D.lnUMFC	312	-0.00414	0.03451	-0.23192	0.15474
KR*D.lnUMFC	312	0.01170	0.04713	-0.12041	0.34810
JP*D.lnFUMFC	312	0.00934	0.03229	-0.15219	0.31287
KR*D.lnFUMFC	312	0.00886	0.03233	-0.15903	0.31962
GM*D.lnUMFC	312	-0.00024	0.01127	-0.07505	0.11150
EL*D.lnUMFC	312	-0.00359	0.01871	-0.13480	0.06577
TR*D.lnUMFC	312	0.00056	0.01420	-0.09754	0.12417
GM*D.lnFUMFC	312	0.00140	0.00584	0.00000	0.03885
EL*D.lnFUMFC	312	-0.00115	0.00515	-0.03374	0.00978
TR*D.lnFUMFC	312	0.00110	0.00527	-0.00718	0.04311

Appendix Figure 3. Real Export Value Indexes (2001=100)





Authors' calculation based on the export data in local currency taken from the WIOD. The export data
are deflated by the industry-level output price indexes calculated using the WIOD.



Authors' calculation based on the export data in local currency taken from the WIOD. The
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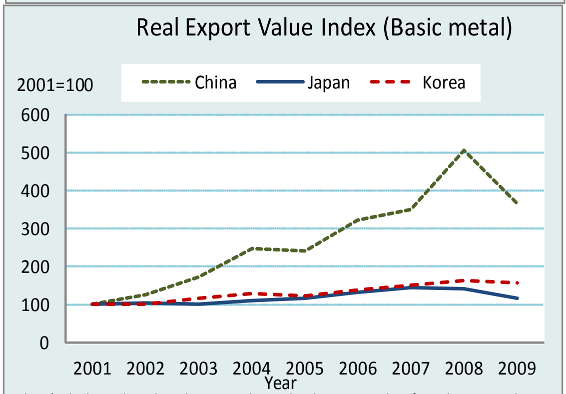
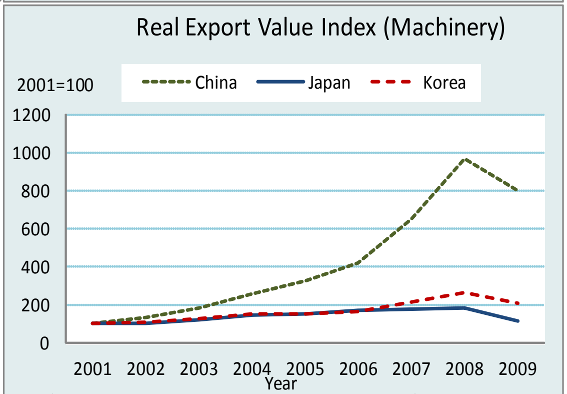
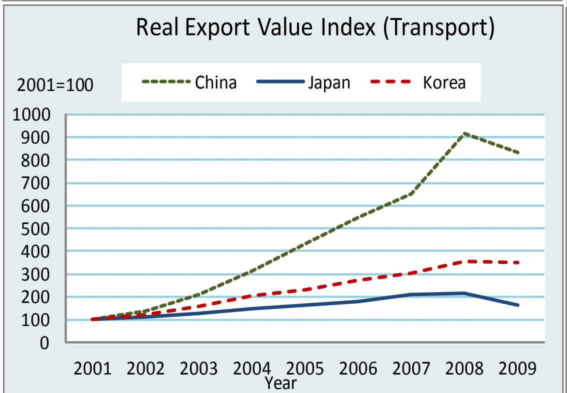


Authors' calculation based on the export data in local currency taken from the WIOD. The
export data are deflated by the industry-level output price indexes calculated using the WIOD.



Authors' calculation based on the export data in local currency taken from the WIOD. The
export data are deflated by the industry-level output price indexes calculated using the WIOD.



Authors' calculation based on the export data in local currency taken from the WIOD. The
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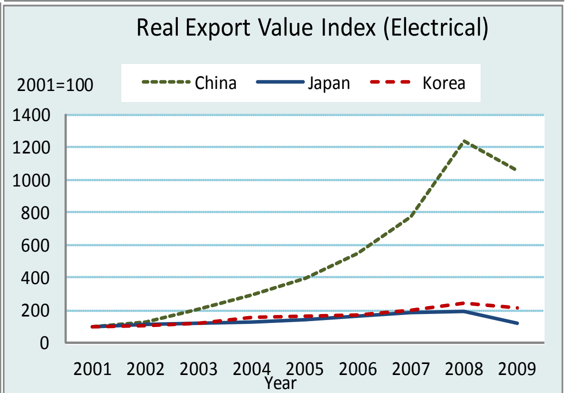

Authors' calculation based on the export data in local currency taken from the WIOD. The
export data are deflated by the industry-level output price indexes calculated using the WIOD.