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SATO Kiyotaka
Yokohama National University

SHIMIZU Junko
Gakushuin University

Nagendra SHRESTHA
Yokohama National University

Shajuan ZHANG
Yokohama National University

RIETI
Research Institute of Economy, Trade & Industry, IAA

The Research Institute of Economy, Trade and Industry
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SATO Kiyotaka[†]
SHIMIZU Junko[‡]
Nagendra SHRESTHA[§]
Shajuan ZHANG[♣]

Abstract

In this paper, we construct the daily nominal effective exchange rate (NEER) of the Japanese yen for eight major manufacturing industries, which provides a better indicator to reflect differences in international competitiveness across industries compared with the conventional NEER. By applying these datasets on stock return and pass-through by industry, we confirm that there are different effects by industry. As the Japanese yen appreciated substantially against the U.S. dollar and other major currencies following the Lehman Brothers collapse in September 2008, it has become increasingly important to watch the daily fluctuations of the Japanese yen, not only at the effective base but also by industry. The daily industry-specific NEER could be reflected in the formulation of policies and can determine which industries should be prioritized in emergency measures against a rising yen.

JEL Classification: F31, F33, F15
Keywords: Effective exchange rate; Industry-specific, Competitiveness, Trade-weight

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[†] Department of Economics, Yokohama National University
[‡] Corresponding author: Faculty of Economics, Gakushuin University (junko.shimizu@gakushuin.ac.jp)
[§] Center for Economic and Social Studies in Asia (CESSA), Department of Economics, Yokohama National University
[♣] International Graduate School of Social Sciences, Yokohama National University

1. Introduction

Although the foreign exchange intervention by Bank of Japan is carried out since the yen strengthened to a postwar record of 75.95 in New York in August 2011, it is unlikely to weaken the currency further. On the other hand, European Union's sovereign-debt crisis due to Greece financial problem has pushed down the euro in the 100 level against the yen for the first time in almost ten years after euro introduction. Such a strong yen might delay the Japan's post tsunami economic recovery.

It is always said that the strong yen makes Japanese exports less competitive and has a harmful effect on Japanese economy. However, it is rash to judge a phenomenon of the strong yen only from the market exchange rate against the US dollar. Comparing with the previous decades, most countries now engage with more international trade with many partners. While bilateral exchange rate involves a currency pair, an effective exchange rate is a weighted average of a basket of foreign currencies, and it can be viewed as an overall measure of the country's external competitiveness. Recently, not only BIS, but also many central banks publish their own currencies' effective exchange rates. While these indices include the movement of all trading partners' currencies, they are disadvantageous in that they are constructed by aggregate based export weights. For example, Goldberg (2004) argues the effectiveness of industry-specific indices and shows that use of aggregate indices misses the empirical importance of the exchange rate on producer profits in specific industries. They constructs three industry-specific real exchange rate indexes for the United States and find the advantage of using industry-specific is appropriate for understanding the effects of exchange rate fluctuations on specific U.S. industries. For analyzing European countries, Alexandre, et al. (2009) constructs the aggregate and sector-specific exchange rate indexes for the Portuguese economy and finds the sector-specific exchange rates are more informative than aggregate exchange rates in explaining changes in employment.

In this paper, we construct the daily nominal effective exchange rates (NEER) of the Japanese yen for each of eight major manufacturing industries[2]. The industry-specific NEER that we construct is designed to be a measure that captures the industry-specific evolution in the exchange value of a currency relative to all other currencies reflected each industry-specific importance. As Bank of Japan (BOJ) noted, there are various kinds of weighted value of trade, such as export or import value, or the total value of exports and imports. BIS adopts more complicated way, named the double-weighting scheme, which reflect import competition, direct export competition and third-market export competition.[3] In this paper, we use the weighted value of Japan's exports to the individual countries and regions for the purpose of measuring the "competitiveness of Japan's exports" as BOJ used to do. Using an industry-specific NEER, we

[2] The database of daily industry-specific NEER have been published on the website of RIETI since June 2011 (http://www.rieti.go.jp/users/eeri/en/index.html/).

[3] See Klau and Fung (2006) for the methodologies of calculating effective exchange rate by other central banks.

confirm that NEER fluctuates differently across industries and provide a better indicator to reflect differences in international competitiveness across industries compared with the conventional NEER that offers no industry breakdown. The differences in the levels of yen appreciation between industries can be compared and examined by referring to these rates. Accordingly, these data could be reflected in the formulation of policies and can determine which industries should be prioritized in emergency measures against a rising yen. In addition, they can be utilized in the typical micro and macro-economic analysis, which might bring more specific results than using aggregated data.

The reminder of this paper is organized as follows. Section 2 explains the details of our calculation method of effective exchange rate by industry. In Section 3, new evidence and characteristics of the Japanese yen's industry-specific NEER are presented, and apply these daily data on some simple regressions. Section 4 apply the industry-specific NEER to investigate the exchange rate pass-through to Japanese export price. Finally, Section 5 concludes.

2. Calculation method of the NEER by industry

It is obvious to note that overall and industry-specific trading partners of a country differ significantly. The industry-specific NEER based on the overall export weight will remarkably affect the result. The NEERs by industry released by RIETI, which are the weighted average of NEERs (100 = January 3, 2000) in relation to the trade volume with “major exporting partners” in each industry, can examine the yen’s competitiveness by industry. In this section, we demonstrate how to construct the industry-specific NEER in detail.

2-1. Trading partner countries

First, we figure out major trading partner countries that account for one percent or more of Japan's total exports at least once during the period from 1997 to 2009[4]. We use 37 export destination countries and are listed in Table 1. It must be noted that the number of trading partner countries, and hence the export weights differ across industries.

Table 1 Major Trading Partner Countries

[4] The BIS calculates the EERs of the Japanese yen against 59 countries (44 currencies) for the "broad-based" rates and 25 countries (15 currencies) for the "narrow-based" rates as of December 2011. Comparing with these numbers, our choice of trading partner countries are almost middle of broad and narrow based.

1.	Australia	14.	Iran	27.	Singapore
2.	Belgium	15.	Ireland	28.	South Africa
3.	Brazil	16.	Italy	29.	Spain
4.	Canada	17.	Korea	30.	Switzerland
5.	Chile	18.	Malaysia	31.	Taiwan
6.	China	19.	Mexico	32.	Thailand
7.	Colombia	20.	Netherlands	33.	UAE
8.	Egypt	21.	Norway	34.	UK
9.	France	22.	Oman	35.	USA
10.	Germany	23.	Philippines	36.	Venezuela
11.	Hong Kong	24.	Puerto Rico (USA)	37.	Viet Nam
12.	India	25.	Russia		
13.	Indonesia	26.	Saudi Arabia		

Note: Major trading partner countries are chosen if the account for one percent or more of Japan's total export at least once from 1997 to 2009.

2-2. Industrial Classifications and Weighting Scheme

Second, we collect 1,932 export commodities at the HS9-digit level from 2007 for each destinations and then these commodities are reclassified into eight industries, such as "Textile", "Chemicals", "Metal and Metal Products", "General Machinery", "Electrical Machinery", "Transport Equipment", "Precision Instruments", and "Other Products" (Table 2), based on the Basis Classification Index for the Summary Report on Trade of Japan.[5]

Table 2 Industrial Classification

1.	Textile
2.	Chemicals
3.	Metal and Metal Products
4.	General Machinery
5.	Electrical Machinery
6.	Transport Equipment
7.	Precision Instruments
8.	Other Products

Third, we compute the industry-specific export share of each major trading partner country for each year, assuming that the sum of exports to major trading partner countries is equal to Japan's total exports. It is again important to mention that the industry-specific export share for the partners accounting less than one percent are excluded as partner while calculating NEER for that particular industry. Then, we calculate the export weights as the previous three-year average of the export shares. Table 3 shows an example of the three-year average of export share from 2007 to 2009 by industry and by destination country that correspond to the export weight in 2010. It indicates that there are considerable differences of country weight by

[5] Since the number of export commodities at the HS9-digit level published by Ministry of Finance is 1,932, we use all of them.

industry. For example, the weight of USA is 42.4 % in Transport Equipment, but 20.0 % in Electrical Machinery and 8.5 % in Textile. By contrast, the weight of China is 44.6 % in Textile, but 8.0 % in Transport Equipment. From the standpoint of concentration, while more than 40 % of Transport Equipment export heads in USA, the exports of General Machinery and Electrical Machinery disperse widely across the world.

Table 3 Export weights in 2010 for Selected Partner Countries

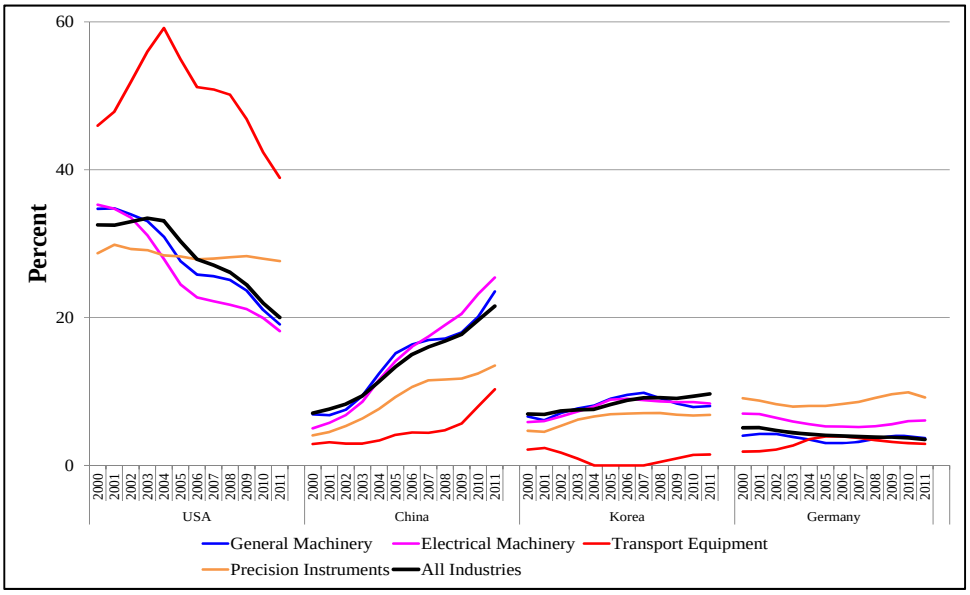
	USA	China	Hong Kong	Korea	Taiwan	Germany	Holland	Thailand	Malaysia	Philippines
Textile	8.5	**44.6**	**10.0**	5.6	3.1	2.2	0.0	3.7	1.5	1.4
Chemicals	**12.3**	**26.6**	5.3	**15.5**	**12.4**	2.8	2.6	5.0	1.9	1.3
Metal and Metal products	7.0	**25.7**	4.3	**18.3**	9.3	0.4	0.0	8.7	4.7	2.1
General Machinery	**21.0**	**20.1**	3.0	7.9	6.3	3.9	2.6	6.5	2.1	0.9
Electrical Machinery	**20.0**	**23.2**	**10.5**	8.6	7.9	6.0	2.9	4.4	3.8	2.8
Transport Equipment	**42.4**	8.0	0.0	1.4	1.0	3.0	2.2	2.2	0.5	0.0
Precision Instruments	**28.0**	**12.4**	**13.0**	6.7	3.9	9.9	5.7	3.2	0.0	0.0
Other Products	**13.1**	**22.1**	6.6	**15.4**	**10.1**	3.5	2.4	3.2	1.5	1.9

Note: Export weights are calculated as average of export share in previous three years.
Source: Authors' calculation from Trade Statistics of Japan, Ministry of Finance.

Figure 1 shows the change in Japanese export weights (calculated as previous three years average) since 2000 for selected partners and industries. The figure indicates significant difference in industry-specific export weights and overall export weight referring to all industries. Especially, Figure 1 demonstrates remarkable annual change, specifically for two primary partners, USA and China, in Japanese export weights. Chinese weights in Japan's export exhibit upward trend, whereas the US has opposite trend. China has become the Japan's most important export destination (21.5%) for all industries leaving the US behind with 20.0% in 2011. However, the US share for Japanese transport equipment still enjoys unchallenged top position with just below 40% share in 2011, although it declined significantly since attaining its peak (about 60 percent) in 2004. Such differences in industry-specific characteristics advocate our policy to use corresponding weights to calculate the industry-specific NEER. Therefore, our approach to revise export weights every year has distinct advantage compared to the use of base year weights while calculating effective exchange rates[6]. Export weights are scheduled to revise every year once the latest data becomes available.

Figure 1 Change in Trade for Selected Partners and Industries

[6] The BIS calculates the weights of the EERs every three years after the corresponding period ends, using the three-year average of the total value of trade.



Note: Export weights are calculated as previous three years average of export share.
Source: Authors' calculation from Trade Statistics of Japan, Ministry of Finance.

2-3. Calculation of the NEER

Following the calculation methodology of the Bank of Japan, we construct the NEERs as chain-linked indices for each industry. The NEER of industry j in m^{th}-day of year t ($NEERj,t,m$) is represented as follows:

$$NEER_{j,t,m} = E^{2000}_{j,2001,1} * E^{2001}_{j,2002,1} * \cdots * E^{t-1}_{j,t,1} * E^{t}_{j,t,m},$$

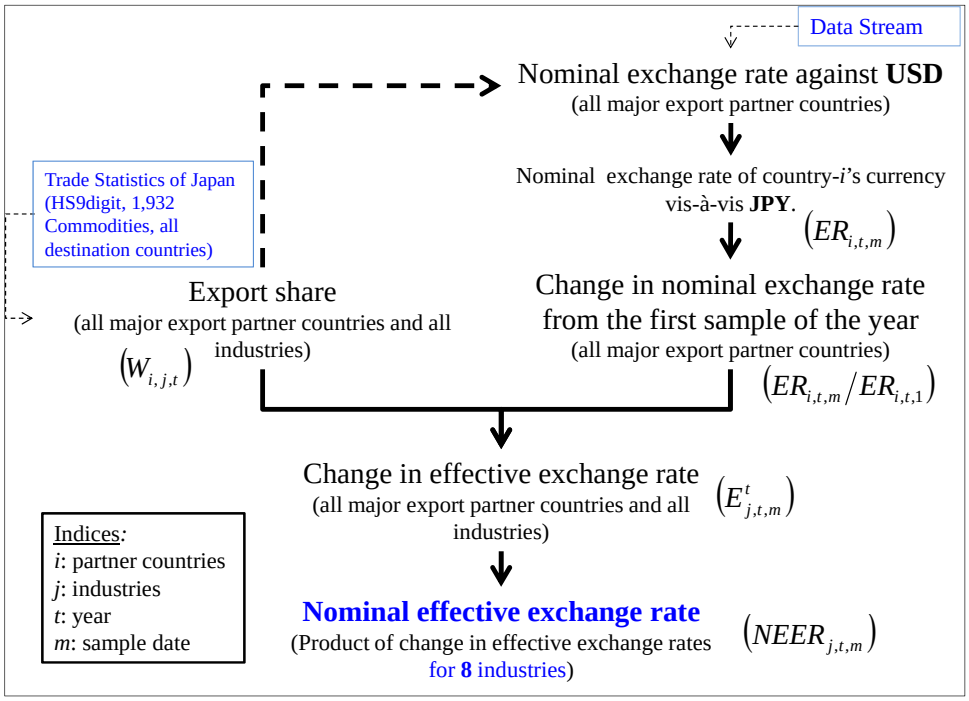
where $E^{t-1}_{j,t,1}$ represents the rate of change in the effective exchange rate of industry j from the first sample of year t-1 to the first sample of year t, which is computed by using the export weights of year t. $E^{t}_{j,t,m}$ is the rate of change in the effective exchange rate of industry j from the first sample of year t to the m^{th}-day of year t, which is calculated by using the export weights of the year t. Thus, the formula for $E^{t}_{j,t,m}$ is given by the following geometric mean:

$$E^{t}_{j,t,m} = \prod_{i} \left(\frac{ER_{i,t,m}}{ER_{i,t,1}} \right)^{W_{i,j,t}},$$

where $ER_{i,t,m}$ is the nominal exchange rate of country i vis-à-vis the Japanese yen in m^{th}-day of year t. $W_{i,j,t}$ is the industry j's weight of exports to country i in year t.

The benchmark period of the NEER is the first day of January 2000 (i.e., January 4, 2000 = 100). For calculating daily NEER, we use the daily exchange rate downloaded from Datastream[7]. The chart below shows the flow of calculating the Japanese NEER by industry.

[7] We use daily exchange rate at NY closing time.



3. New evidence of the Japanese yen's industry-specific nominal effective exchange rate

In this section, we show the characteristics of daily industry-specific NEER at first. Second, we investigate the relationship between industry-specific NEER and the exchange rate of major currencies. Third, we investigate the effect of the industry-specific NEERs on the stock index returns by industry.

3-1. The Characteristics of Daily Industry-Specific NEER

First, we see the characteristics of the data of NEER by industry. Table 4 shows the descriptive statistics of daily data of NEER by industry between January 4, 2000 and October 31, 2011. Among eight industries, the mean and the maximum of precision instruments was the lowest, which indicates that the competitiveness of precision instruments was kept comparing with other industries. By contrast, the mean and the maximum of metal and metal products was the highest, which suggests that metal and metal products lost their competitiveness compared with other industries. From the standpoint of the volatilities, the NEERs of transport equipment were the most volatile, while those of textile were the most stable.

Table 4. Descriptive Statistics of Daily Industry-Specific NEER (1/3/2000-10/31/2011)

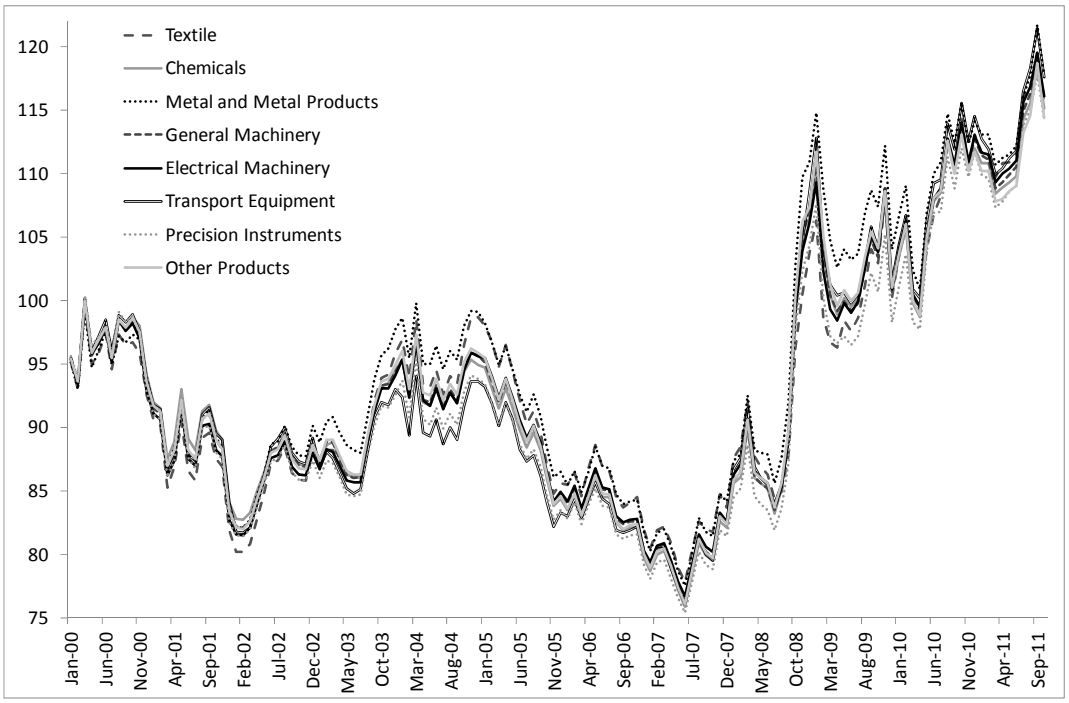
	Textile	Chemicals	Metal and Metal Products	General Machinery	Electrical Machinery	Transport Equipment	Precision Instruments	Other Products
Mean	93.29	93.08	94.96	93.19	93.12	93.01	91.87	93.22
Maximum	119.50	120.30	123.30	120.90	120.90	122.80	119.00	120.10
Minimum	77.40	75.70	77.20	76.00	76.40	75.90	75.10	75.90
Std. Dev.	9.35	9.66	10.16	9.71	9.74	10.32	9.51	9.62

Note: All Industry-Specific NEERs are January 3, 2000=100.

Figure 2 shows the movement of industry-specific NEER in monthly basis from January 2000 to October 2011. Although their moving trends were nearly the same, there are apparent differences in level between industries as the descriptive statistics indicate above. While the NEER of precision instrument located in the lower side, the NEER of metal and metal products located in the upper side. In May 2009, the difference between the NEER of precision instrument and metal and metal products widened almost 7 points.

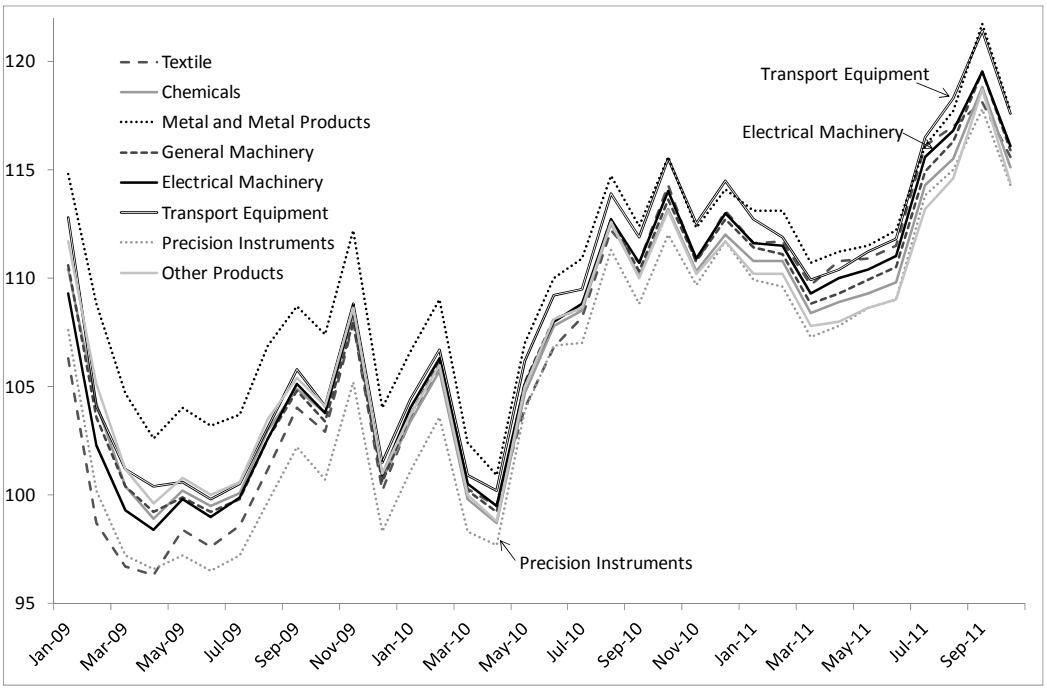
Figure 3 focuses on the movement of the latest three years and we can see the differences more clearly. Although the effect of the yen's appreciation on Japanese exporting companies was often measured in the fiercely competitive areas of transportation equipment, electrical machinery, and general machinery against their rival countries, we found that the effect on each industry was different. Among them, the NEER of transport equipment located in the upper side, which means that transport equipment suffered more serious damage by yen's appreciation than other industries. While the NEER of electrical machinery and general machinery located in the middle, the NEER of precision instrument located in the lowest.

Figure 2. The Movement of Industry-Specific NEER (in monthly basis, Jan 2000-Oct 2011)



（Note: Monthly data is the average of daily Industry-Specific NEER (1/3/2000＝100）

Figure 3. The Movement of Industry-Specific NEER (in monthly basis, Jan 2009-Oct 2011)



（Note: Monthly data is the average of daily Industry-Specific NEER (1/3/2000＝100）

3-2. The Relationship between Industry-Specific NEER and the Major Currencies

Next, we investigate the relationship between industry-specific NEER and the exchange rate of major currencies, such as the US dollar/yen and the euro/yen by adopting the equation introduced by Frankel and Wei (1994) as follows;

$$\Delta \log\left(NEER_{industry,t}\right) = c + \alpha_0 \cdot \Delta \log\left(\frac{USdollar}{Yen}_t\right) + \alpha_1 \cdot \Delta \log\left(\frac{Euro}{Yen}_t\right) + u_t. \qquad (1)$$

We estimate the above equation on a daily basis in the whole sample period between 4 January 2000 and 31 October 2011, and the sub-sample period before and after the Lehman Brothers collapse in September 2008. Table 5 summarizes the results. Basically, most industry-specific NEERs are strongly related with the movement of US dollar/yen exchange rates and their correlations are almost 90 percent, which is far larger than the trade share with US. It is because many of Japanese trading partner countries in Asia adopted US dollar peg or pro-US dollar peg currency regime in this sample period. Among eight industries, the relationship between the US dollar/yen is the strongest in Textile, while it is the weakest in precision instrument. On the other hand, the relationships between the euro/yen are less than 20 percent in average. Comparing these relationships between before and after the Lehman Brothers collapse, the relationships with both the US dollar/yen and the euro/yen became stronger than before. That happened because the Japanese yen appreciated against most currencies due to the unwinding of

so-called carry trade in that period, and the industry-specific NEERs appreciated reflecting the sudden appreciation of the Japanese yen against both the US dollar and the euro. Such a strong relationship between the industry-specific NEERs and nominal exchange rate of the Japanese yen against the US dollar suggests that BOJ's frequent interventions to stabilize interbank yen-dollar exchange rates are also effective to stabilize the yen in the effective exchange rate base.

Table 5. The Relationship between Industry-Specific NEER and US$/Yen, Euro/Yen

Sample Period	1/4/2000-10/31/2011		1/4/2000-8/31/2008		10/1/2008-10/31/2011	
Coefficinet on	US$/Yen	Euro/Yen	US$/Yen	Euro/Yen	US$/Yen	Euro/Yen
Chemicals	0.8739 ***	0.1443 ***	0.8428 ***	0.1217 ***	0.9181 ***	0.1659 ***
Electrical Machinery	0.8739 ***	0.1465 ***	0.8418 ***	0.1313 ***	0.9217 ***	0.1596 ***
Metal and Metal Products	0.9294 ***	0.0951 ***	0.9023 ***	0.0475 ***	0.9648 ***	0.1441 ***
Precision Instruments	0.8397 ***	0.1926 ***	0.8237 ***	0.1667 ***	0.8591 ***	0.2213 ***
Textile	0.9320 ***	0.0713 ***	0.9174 ***	0.0570 ***	0.9536 ***	0.0857 ***
General Machinery	0.8733 ***	0.1551 ***	0.8478 ***	0.1236 ***	0.9088 ***	0.1867 ***
Transport Equipment	0.8816 ***	0.1709 ***	0.8633 ***	0.1272 ***	0.9061 ***	0.2153 ***
Other Products	0.8862 ***	0.1486 ***	0.8575 ***	0.1166 ***	0.9264 ***	0.1802 ***

Note: Authors' calculation. *10%, **5% and 1% significance level.

3-3. The Relationship between the Industry-Specific NEER and Stock Index

It is frequently seen in Japanese stock market that yen's appreciation makes Japanese stock index decline. However, the degree of negative impact of the strong yen on each stock might be different across industries. Then, we investigate the effect of the industry-specific NEERs on the stock index returns by industry. Following Adler and Dumas (1983) and Jorion (1991), which examine the pricing of exchange rate risk in the U.S. stock market, using two-factor and multi-factor arbitrage pricing models, we estimate foreign exchange rate impact on underlying stock return using the following time-series regression model:

$$\Delta \log\left(Stock\ Index_{industry,t}\right) - \Delta \log(Topix_t) = \mathrm{c} + \alpha \cdot \Delta \log\left(NEER_{industry,t}\right) + u_t, \quad (2)$$

where Stock Index$_{industry}$ is the stock price index by industry (TOPIX-17 series); TOPIX is the representative market portfolio in the first section of Tokyo Stock Market, and NEER$_{industry}$ is the industry-specific nominal effective exchange rate. In equation (2), the coefficient of NEER, α, measures exchange rate impact of an underlying industry-specific stock index. Our novelty is using industry-specific data both in stock index and foreign exchange rate and we can compare the impact of exchange rate on stock by industry. We estimate the above equation on a daily basis in the whole sample period between 4 January 2000 and 31 October 2011, and the

sub-sample period before and after the Lehman Brothers collapse in September 2008.[8]

Table 6. Impact of Industry-Specific NEER on Stock Index Returns by Industry (Daily basis)

Sample Period	1/4/2000-10/31/2011 (Daily)			
Dependent Variable: △log(Stock Indexi)-△log(TOPIX)	△log(NEERi) Coefficinet	t-stats.	R-squared	D.W.
Chemicals	-0.0166	(-0.9586)	0.0000	1.9093
Electrical Machinery	-0.1171 ***	(-5.3881)	0.0090	1.7767
Metal and Metal Products	0.0268	(1.0512)	0.0000	1.9542
Precision Instruments	-0.1199 ***	(-4.6685)	0.0067	2.0059
Textile	-0.0069	(-0.2773)	-0.0003	1.9502
General Machinery	-0.1668 ***	(-8.1060)	0.0206	1.8670
Transport Equipment	-0.1511 ***	(-5.6670)	0.0100	1.8390
Other Products	-0.1013 ***	(-3.5209)	0.0037	1.8435

Sample Period	1/4/2000-8/31/2008 (Daily)			
Dependent Variable: △log(Stock Indexi)-△log(TOPIX)	△log(NEERi) Coefficinet	t-stats.	R-squared	D.W.
Chemicals	-0.0384	(-1.5847)	0.0007	1.7940
Electrical Machinery	0.0173	(0.5875)	-0.0003	1.6943
Metal and Metal Products	0.0298	(0.8083)	-0.0002	1.8642
Precision Instruments	-0.0696 **	(-2.0364)	0.0014	1.9885
Textile	0.0142	(0.4354)	-0.0004	1.8783
General Machinery	-0.0735 ***	(-2.7797)	0.0030	1.9047
Transport Equipment	-0.0986 ***	(-2.8401)	0.0031	1.7848
Other Products	-0.0791 **	(-2.0854)	0.0015	1.8701

Sample Period	10/1/2008-10/31/2011 (Daily)			
Dependent Variable: △log(Stock Indexi)-△log(TOPIX)	△log(NEERi) Coefficinet	t-stats.	R-squared	D.W.
Chemicals	-0.0118	(-0.4885)	-0.0010	2.2224
Electrical Machinery	-0.2849 ***	(-8.7099)	0.0855	2.0218
Metal and Metal Products	0.0139	(0.4209)	-0.0010	2.3039
Precision Instruments	-0.2129 ***	(-5.2483)	0.0321	2.0277
Textile	-0.0425	(-1.1079)	0.0003	2.1980
General Machinery	-0.2590 ***	(-7.4597)	0.0639	1.8099
Transport Equipment	-0.2263 ***	(-5.0532)	0.0297	1.9453
Other Products	-0.1343 *	(-2.8116)	0.0085	1.7962

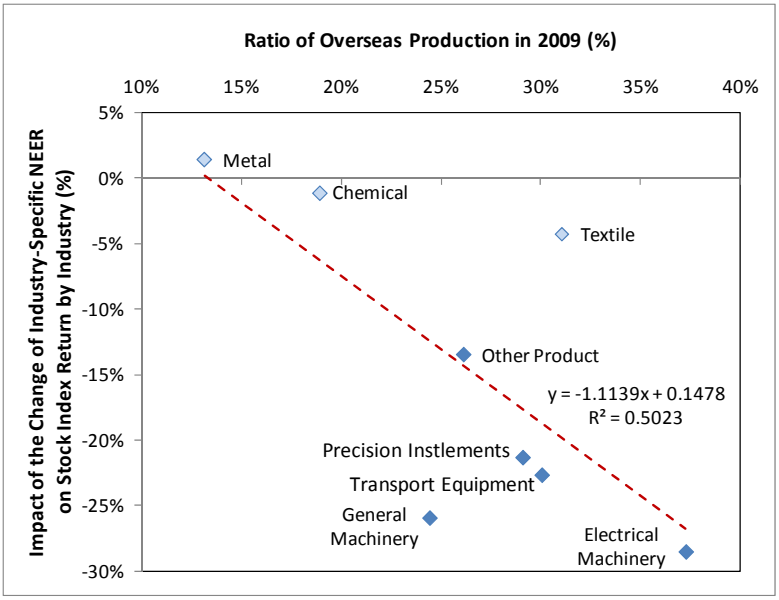
Note: Authors' calculation. Standard errors are shown in parentheses. *10%, **5% and ***1% significance level.

Table 6 reports the regression results. The coefficients on industry-specific NEERs are negative as expected and significant for Japanese representative manufacturing industries, such as electrical machinery, general machinery, precision instrument, and transport equipment in the whole sample period, which confirms that the Japanese manufacturing industry-specific stock index returns are adversely affected by industry-specific NEER's appreciation. Among eight industries, transport equipment and general machinery have stronger exchange rate impact than

[8] Appendix shows the estimated results of the equation (2) by applying three different exchange rate variable to investigate how these industry-specific NEER can provide a better indicator to reflect differences in international competitiveness across industries compared with the bilateral nominal exchange rate (US dollar-Yen) and the conventional aggregate NEER calculated by BIS in a monthly basis.

other industries. Comparing these impacts between before and after the Lehman Brothers collapse, most industries' exchange rate impacts on their stock became larger than before. These results suggest that the negative impact of each NEER's appreciation on each stock index became more serious after yen's appreciation trend became clearer. For example, the exchange rate impact of electrical machinery was insignificant before the Lehman Brothers collapse, however it became 28.5 percent, which was significant and the strongest among eight industries except for other products after the Lehman Brothers collapse. One possible explanation to answer the serious damage of electrical machinery's stock return by NEER's appreciation is that these industries has high share of overseas sales and are deeply expose to the foreign exchange rate risk. Recently, it is said that Japanese exporters revenue is damaged by yen's appreciation not only from a fall of export payment in terms of the Japanese yen, but also a decline of Japanese exporters repatriation profits earned overseas subsidiaries and a decline of consolidated sales. Figure 4 shows the relationship between the estimated impact of industry-specific NEER on industry-specific stock index in the lower column in Table 6 (10/1/2008-10/31/2011) and foreign production ratio by industry reported in the fiscal year of 2009. It clearly indicates that higher foreign production ratio has bigger negative impact of exchange rate on stock index. These results suggest that even if Japanese exporters expand their foreign production network to reduce the foreign exchange exposure, they cannot get away from the another type of foreign exchange rate risk.

Figure 4. The Relationship between Impact of Industry-specific NEER on Stock Index and Foreign Production Ratio by industry



Note: Each impact of the change of industry-specific NEER on stock index return by industry is the estimated coefficient in the lower column of Table 6 (10/1/2008/10-31-2011). All estimated coefficients except for Metal, Chemical and Textile are statistically significant under the significance level of 10%. Ratio of Overseas Production is from "Annual Survey of Corporate Behavior in FY2009" by Economic and Social Research Institute, Cabinet Office.

4. An Application of Industry-Specific NEER on Export Pricing

In this section, we investigate the relationship between the industry-specific NEER and the export price indexes for Japanese manufacturing industries. There are extensive researches about the exchange rate pass-through in Japanese industries. For example, Otani, et al. (2005) empirically examines the movement of the exchange rate pass-through to the aggregate import prices in Japan. They found that the exchange rate pass-through to Japan's import prices declined in the 1990s, which supports Campa and Goldberg's (2005) conclusion that the import price pass-through declined in major industrial countries. Parsons and Sato (2008) investigate the pass-through of Japanese export by using highly disaggregated commodity data to evaluate the pass-through by commodity and by destination.[9] Ceglowski (2010) investigates the exchange rate response of Japanese export prices using sector-specific measures of the yen's value relative to invoicing currencies. They found the increases in the exchange rate response of two key export sectors, transport equipment and electrical machinery, which suggest the changes in export pricing behavior. As previous studies indicate, there are differences in the degree of exchange rate pass-through to the export prices across manufacturing industries. However, most studies used aggregated NEER in their empirical analysis. Our novelty is to investigate which industry adjusts its export price to dampen or amplify the effect of its own NEER fluctuation on its export price.

In accordance with Ceglowski (2010) and Mahdavi (2002) that examine the relationship between the dollar's NEER and the export price indexes by US manufacturing industry, we estimate the following regression equation:

$$\ln(EXPI_{i,t}) = \beta_{0i} + \beta_{1i} \cdot \ln(NEER_{i,t}) + \beta_{2i} \cdot \ln(CGPI_{i,t}) + \beta_{3i} \cdot \ln(PPI_{world,t}) + u_{i,t}, \quad (3)$$

where *EXPI* is an export price index (denominated in the Japanese yen) of industry *i*, *NEER* is an industry *i*'s specific nominal effective exchange rate, *CGPI* is a corporate goods price index of industry *i* which is a proxy for the industry *i*'s production cost, and *PPI* is a trade-weight average of the producer (or wholesale) price index of Japanese major export markets (a proxy for foreign competitors' price index), and *u* is an error-term. ln denotes the natural logarithm of the values of the variables, and the subscripts *i* (i=1,...,8) and *t* index the sort of industry and time, respectively. All data are available in monthly basis.

Before using the level regression of equation (3), we have checked the stationarity of variables by unit-root test and confirmed that most variables are non-stationary in levels but stationary in first-difference. Thus, the first-difference of the variables is used to ensure the stationarity and the following equation is estimated:

[9] Persons and Sato (2008) suggest the difference of pricing-to-market (PTM) by destination. They found that the most PTM occurs in Japanese exports to the US market, but less PTM in Europe, and no PTM in East Asia.

$$\Delta \ln(EXPI_{i,t}) = \beta_{0i} + \beta_{1i} \cdot \Delta \ln(NEER_{i,t}) + \beta_{2i} \cdot \Delta \ln(CGPI_{i,t}) + \beta_{3i} \cdot \Delta \ln(PPI_{world,t}) + u_{i,t}, \quad (4)$$

where β_{1i} is the exchange rate sensitivity of export prices denominated in the Japanese yen, and β_{2i} and β_{3i} capture the sensitivity of export prices to shifts in Japanese domestic price level and foreign competitors' price level, respectively. The empirical analysis is based on the monthly data from January 2000 to October 2011. Separate estimations were performed for each export price index of eight manufacturing industries, which is consistent with industry-specific NEER. All data for these sector-specific export price index and corporate goods price index are from the Bank of Japan. The data of producer price index of Japanese major exporting countries are from CEIC. In order to allow for the possibility of gradual adjustment of export price to exchange rates, the current and six lagged values of NEER, corporate goods price index, and producer price index are included[10]. Thus, the following empirical form for estimation is employed:

$$\Delta \ln(EXPI_{i,t}) = \beta_{0i} + \sum_{j=0}^{6} \beta_{1i,j} \cdot \Delta \ln(NEER_{i,t-j}) + \sum_{j=0}^{6} \beta_{2i,j} \cdot \Delta \ln(CGPI_{i,t-j}) + \sum_{j=0}^{6} \beta_{3i,j} \cdot \Delta \ln(PPI_{world,t-j}) + u_{i,t}, \quad (5)$$

In equation (5), we focus on the short-run relationship between exchange rates and the export prices of industry *i*, which is given by the estimated coefficient $\beta_{1i,0}$ and the long-run elasticity is given by the sum of the coefficients $\sum_{j=0}^{6} \beta_{1i,j}$, which shows the cumulative effect of a change in the industry-specific NEER on industry-specific export prices 6 months after the change. β_{1i} can be interpreted as follows. Since we use the export price index denominated in terms of the Japanese yen and NEER, which indicates higher value means an appreciation of the Japanese yen, a value of β_{1i} close to zero implies that the export price does not respond to fluctuations in NEER. In other words, the changes in NEER are passed through to importers. By contrast, negative and significant value of β_{1i} indicates that the exporters lower their yen denominated export price according to yen's appreciation, which means that Japanese exporters tend to stabilize the export price in terms of the importer's currency (pricing-to-market).

Table 8 presents the estimates of exchange rate pass-through into export prices for eight manufacturing industries. All of the short-run NEER coefficients are negative and statistically significant. Most of the summed NEER coefficients are negative, statistically significant except for chemical, and the size of coefficients ranges from 0.2163 (general machinery) to 0.3956 (electrical machinery). Among eight industries, the coefficient of general machinery is the smallest both in the short-run and the long-run. It suggests that general machinery tends to keep their export price in spite of the appreciation of the Japanese yen compared with other industries. This result appears to be reasonable since general machinery includes some very competitive industries, such as machine tool industries and semiconductor production equipment.

[10] The data of industry-specific CGPI are seasonally adjusted.

The coefficients of CGPI are positive and significant for chemical in both the short and the long-run and electrical machinery in the short-run. The coefficients of world PPI are positive for chemical in the short-run and for metal and metal products, textile, and other products both in the short and the long-run. These domestic and world price effects on export prices are larger than the NEER effects on them. For example, the decline of electrical machinery's export price is affected partially by the appreciation of its NEER and largely by the decline of its CGPI in the short-run. By contrast, the increase of export price of metal and metal products, textile, and other products are largely affected by foreign competitors' price both in the short and the long-run. Compared with the previous studies, our estimated coefficients of the exchange rate on the export price are smaller than the results of Ceglowski (2010), which investigated the monthly data of Japanese export price index by industry.[11] It might suggest that the exchange rate pass-through in Japanese manufacturing industries were declining. One possible explanation is that our sample period includes the sudden and large appreciation of the Japanese yen after the Lehman Brothers collapse and that the exporters could only partially change their export prices in response to the sudden yen's appreciation, while Ceglowski (2010) estimated the longer period from January 1980 to May 2007. However, more detailed analyses are necessary to investigate the factors in such differences.

Table 8. The response of Export Price Index by industry (January 2000 to October 2011)

Estimated Coefficient		Chemicals	Electrical Machinery	Metal and Metal Products	Precision Instruments	Textile	General Machinery	Transport Equipment	Other Products
Short run	$NEER_{industry}$	-0.2722*** (0.0592)	-0.2129*** (0.0300)	-0.2440*** (0.0602)	-0.2424*** (0.0325)	-0.2900*** (0.0430)	-0.1777*** (0.0240)	-0.2748*** (0.0411)	-0.2343*** (0.0358)
	$CGPI_{industry}$	0.5254*** (0.2215)	0.6713*** (0.2737)	-0.4711 (0.3844)	-0.2139 (0.4637)	0.0431 (0.1765)	-0.2116 (0.3936)	-0.5395 (0.3686)	-0.2129 (0.3359)
	PPI_{world}	1.0096*** (0.2581)	-0.0324 (0.1048)	0.9022*** (0.2364)	-0.0452 (0.1125)	0.2653** (0.1469)	0.0272 (0.0852)	-0.1061 (0.1454)	0.3020*** (0.1266)
Long run	$NEER_{industry}$	-0.0095 (0.1986)	-0.3956*** (0.0915)	-0.2858* (0.1842)	-0.3683*** (0.1023)	-0.3631*** (0.1352)	-0.2163*** (0.0766)	-0.3339*** (0.1332)	-0.3386*** (0.1149)
	$CGPI_{industry}$	1.3456** (0.7802)	0.4013 (0.6349)	-0.9017 (0.9693)	0.2521 (1.5204)	-0.0189 (0.8522)	0.8193 (0.9481)	-0.8342 (0.8099)	1.0515 (0.8966)
	PPI_{world}	-0.2695 (0.8709)	-0.1211 (0.2234)	2.80131*** (0.5747)	-0.0357 (0.2384)	0.6818** (0.3620)	-0.0906 (0.2069)	-0.3626 (0.3149)	0.6183** (0.3144)
Adjusted R^2		0.5251	0.3304	0.3378	0.3509	0.3429	0.3845	0.3392	0.3621
F-statistics		25.5127 (0.0000)	11.9376 (0.0000)	12.3099 (0.0000)	12.9851 (0.0000)	12.5659 (0.0000)	14.8475 (0.0000)	10.7514 (0.0000)	13.5840 (0.0000)

Note: Authors' calculation. Standard errors are shown in parentheses. *10%, **5% and ***1% significance level.

[11] In Ceglowski (2010), the estimated coefficient on the exchange rate ranged from a low of 0.55 for metals to a high of 0.73 for general machinery, except for the highest of 0.94 for precision instrument. Note that their coefficients were positive since their exchange rates were defined as units of domestic currency per unit of foreign currency.

5. Conclusion

The effect of the yen appreciation in 2011 on Japanese exporting companies is often measured in the fiercely competitive areas of transportation equipment, electrical products, and machinery against their Korean rivals as the Korean won depreciated to 15.32 won per yen at the end of September 2011. As such, we construct effective exchange rates by industry, noting that examining the yen's competitiveness by industry is a novel approach. The differences in the levels of yen appreciation between industries can be compared and examined by referring to these rates. As a results, according to the data for 2008 and after, the yen appreciated most significantly in the metal and copper product areas, with differences of as much as five points or more at certain times compared with the precision equipment area. The latest movements indicate that the yen appreciated the most in transportation equipment among the eight industries in 2011. Such data could be reflected in the formulation of policies and can determine which industries should be prioritized in emergency measures against a rising yen for helping maintain their competitiveness.

By applying daily industry-specific NEER data on the equation introduced by Frankel and Wei (1994), which examines the relationship between NEER and the exchange rate of major currencies, we confirm that most industry-specific NEERs are strongly related with the movement of US dollar/yen exchange rates. Next, we investigate the effect of the industry-specific NEERs on the stock index returns by industry, and confirm that the Japanese manufacturing industry-specific stock index returns are adversely affected by industry-specific NEER's appreciation. Among eight industries, transport equipment and general machinery have stronger exchange rate impact than other industries. Comparing these impacts between before and after the Lehman Brothers collapse, most industries' exchange rate impacts on their stock became larger than before. These results suggest that the negative impact of each NEER's appreciation on each stock index became more serious after yen's appreciation trend became clearer. We also confirm that higher foreign production ratio has bigger negative impact of exchange rate on stock index, which suggests that Japanese exporters manufacturing revenue is damaged by yen's appreciation by the decrease of Japanese exporters repatriation profits earned overseas subsidiaries.

At last, by using the monthly data of industry-specific NEER, we investigate the relationship between industry-specific NEER and the export price indexes for Japanese manufacturing industries. As a result, we confirm significant response of each industry's export prices to each NEER both in the short and the long-run. Among eight industries, the response of general machinery is the smallest, which suggests that general machinery tends to keep their export price in spite of the appreciation of the Japanese yen due to their strong competitiveness compared with other industries.

While this study just conducts the simple empirical analysis by using constructed industry-specific NEER, we need more detailed procedures to investigate the factors causing the different results by industry. These remain for our future studies.

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Appendix: The Comparison between Industry-Specific NEER, US dollar-Yen exchange rate, and BIS NEER

As section 3 indicates, the differences between aggregate effective exchange rates and industry-specific effective exchange rates arise because industries have different trading partners. Then, we investigate how these industry-specific NEER can provide a better indicator to reflect differences in international competitiveness across industries compared with the bilateral nominal exchange rate (US dollar-Yen) and the conventional aggregate NEER calculated by BIS. We estimate the equation (2) in section 3 by applying three different exchange rate variables in a monthly basis. We estimate in the whole sample period between January 2000 and October 2011, and the sub-sample period after the Lehman Brothers collapse, between October 2008 and October 2011.

Tale A1 and A2 summarizes the results. We confirm significant and larger impacts of industry specific NEER on stock returns than BIS-NEER in general machinery and other products for the whole sample period, and in transport equipment, electric appliances, precision instrument, general machinery, and other products for the sample period after the Lehman Brothers collapse. The size of adjusted R-squared also is larger in the case of applying industry specific NEER than others. These results suggest the importance of using industry-specific NEER especially for the industries which are facing severe price competition.

Table A1. The Impact of Nominal Exchange rates on Stock Returns by Industry

Industry	Exchange rates	Coefficient		t-stats	R-squared	D.W.
Transport	Sample Period: 2000/1-2011/10					
	USDYEN	0.5702	***	(4.5353)	0.1226	2.1308
	BIS_NEER	-0.5781	***	(-3.5334)	0.0758	2.1259
	NEER_Transport	-0.5007	***	(-3.9304)	0.0935	2.1478
	Sample Period: 2008/10-2011/10					
	USDYEN	0.8934	***	(3.7129)	0.2676	2.2048
	BIS_NEER	-0.6135	*	(-1.9190)	0.0712	2.4168
	NEER_Transport	-0.6939	***	(-3.0169)	0.1880	2.3128
Electric Machinery	Sample Period: 2000/1-2011/10					
	USDYEN	0.3252	***	3.1498	0.0599	2.0671
	BIS_NEER	-0.4561	***	-3.5126	0.0749	2.1888
	NEER_Electoric Appliances	-0.4374	***	-4.1504	0.1039	2.1271
	Sample Period: 2008/10-2011/10					
	USDYEN	0.5926	***	3.8565	0.2839	1.8925
	BIS_NEER	-0.6981	***	-3.8472	0.2828	2.6076
	NEER_Electoric Appliances	-0.7320	***	-5.7646	0.4794	2.0647
Precision Instrument	Sample Period: 2000/1-2011/10					
	USDYEN	0.3811	***	3.1192	0.0587	2.0585
	BIS_NEER	-0.5483	***	-3.5746	0.0776	2.1306
	NEER_P. Instrument	-0.4411	***	-3.5121	0.0749	2.1088
	Sample Period: 2008/10-2011/10					
	USDYEN	0.7539	***	3.3187	0.2225	2.3983
	BIS_NEER	-0.6657	***	-2.3237	0.1117	2.4496
	NEER_P. Instrument	-0.8310	***	-4.1007	0.3112	2.4342
General Machinery	Sample Period: 2000/1-2011/10					
	USDYEN	0.2244	**	2.2798	0.0291	1.9003
	BIS_NEER	-0.3400	***	-2.7464	0.0446	1.9573
	NEER_Machinery	-0.3497	***	-3.5203	0.0753	1.9385
	Sample Period: 2008/10-2011/10					
	USDYEN	0.4778	**	2.4898	0.1293	2.0564
	BIS_NEER	-0.6247	***	-2.8180	0.1655	2.4507
	NEER_Machinery	-0.6437	***	-3.9391	0.2932	2.2623

Notes: Dependent variable is the excess return of industry-specific stock index (return of industry-specific stock index - return of TOPIX).

* Significant at 10% level, ** Significant at 5% level, *** Significant at 1% level.

Table A2. The Impact of Nominal Exchange rates on Stock Returns by Industry

Industry	Exchange rates	Coefficient	t-stats	R-squared	D.W.
Metal		Sample Period: 2000/1-2011/10			
	USDYEN	-0.1481	(-1.2212)	0.0035	2.1176
	BIS_NEER	0.2637 *	(1.7237)	0.0139	2.1305
	NEER_Metal	0.2390 *	(1.9501)	0.0196	2.1074
		Sample Period: 2008/10-2011/10			
	USDYEN	-0.0066	(-0.0370)	-0.0294	2.1102
	BIS_NEER	0.3919 ***	(1.9476)	0.1655	2.4507
	NEER_Metal	0.0913	(0.5488)	-0.0204	2.1734
Chemical		Sample Period: 2000/1-2011/10			
	USDYEN	0.0123	(0.1874)	-0.0069	1.9634
	BIS_NEER	0.0040	(0.0478)	-0.0072	1.9589
	NEER_Chemical	-0.0066	(-0.0969)	-0.0071	1.9606
		Sample Period: 2008/10-2011/10			
	USDYEN	-0.0670	(-0.7427)	-0.0130	2.3947
	BIS_NEER	0.0791 ***	(0.7433)	-0.0130	2.4178
	NEER_Chemical	0.0483	(0.5615)	-0.0200	2.4291
Textile		Sample Period: 2000/1-2011/10			
	USDYEN	-0.1559	(-1.4767)	0.0084	1.9751
	BIS_NEER	0.2618 *	(1.9677)	0.0201	2.0039
	NEER_Textile	0.1988 *	(1.8084)	0.0160	1.9814
		Sample Period: 2008/10-2011/10			
	USDYEN	-0.0467	(-0.2960)	-0.0268	2.4281
	BIS_NEER	0.0028	(0.0150)	-0.0294	2.3857
	NEER_Textile	0.0490	(0.3087)	-0.0265	2.4232
Other products		Sample Period: 2000/1-2011/10			
	USDYEN	0.2985 **	2.2398	0.0279	2.3028
	BIS_NEER	-0.2887 *	-1.6951	0.0132	2.2963
	NEER_Others	-0.3497 **	-2.5697	0.0385	2.2873
		Sample Period: 2008/10-2011/10			
	USDYEN	0.3711	1.5043	0.0348	2.6678
	BIS_NEER	-0.1300	-0.4338	-0.0237	2.5458
	NEER_Others	-0.3570 ***	-1.5532	0.0388	2.5912

Notes: Dependent variable is the excess return of industry-specific stock index (return of industry-specific stock index - return of TOPIX).

* Significant at 10% level, ** Significant at 5% level, *** Significant at 1% level.