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The Contribution of the Yen Appreciation since 2007 to the Japanese Economic Debacle

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THE CONTRIBUTION OF THE YEN APPRECIATION SINCE 2007 TO THE JAPANESE ECONOMIC DEBACLE

Willem Thorbecke[1]

NON-TECHNICAL SUMMARY

The Japanese yen has appreciated by more than 25 percent since June 2007. Japanese exports, industrial production, and stock prices crashed between June 2007 and March 2009 and have yet to regain their pre-Crisis values. This paper investigates how the strong yen has contributed to this debacle?

There are several channels through which an appreciation of the yen could affect Japanese firms. It could cause exports to fall because Japanese firms lose their price competitiveness. It could harm Japanese enterprises if they are unable to pass-through exchange rate changes into foreign currency prices. It could reduce the profitability of Japanese companies that are exposed to exchange rate changes. This paper investigates these channels.

The results indicate that the appreciation of the yen caused exports to fall significantly, especially for the automobile sector. The findings also imply that the appreciation of the yen caused yen export prices to fall much more than yen costs in the automobile and electronics sectors. Finally, the evidence indicates that the appreciation of the yen caused stock prices in these same two industries to plummet.

The automobile and electronics industries have long been the flagships of the Japanese economy. Mitigating the damage caused by the *endaka* is thus of particular moment. To cope with the dislocation, Japanese firms should focus on innovating rather than on competing based on price in commoditized industries.

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ABSTRACT

The Japanese yen in 2012 remains 25 percent above its value in 2007. Exports, industrial production, and stock prices crashed after 2007 and have yet to regain their pre-crash values. This paper investigates the contribution of the yen appreciation to this economic disaster. Evidence from Johansen maximum likelihood and dynamic ordinary least squares (DOLS) estimation indicates that a 25 percent appreciation reduces long run exports by 8 – 18 percent. Panel DOLS evidence reveals that the appreciation especially depressed exports in the automobile sector. Regression evidence implies that the yen appreciation caused yen export prices to fall 29 percent in the automobile sector and 22 percent in the electrical and electronics sector. Finally, evidence from estimating exchange rate exposures indicates that the yen appreciation has reduced profitability significantly in the automobile and electronics sectors. Japanese firms could mitigate some of these harmful effects by focusing on innovating rather than competing based on price in commoditized industries.

JEL classification: F10, F40

Keywords: Exchange rate elasticities; Exchange rate pass-through; Japan

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CENTRE D'ÉTUDES PROSPECTIVES ET D'INFORMATIONS INTERNATIONALES

COMMENT L'APPRÉCIATION DU YEN DEPUIS 2007 A CONTRIBUÉ À LA DÉBÂCLE DE L'ÉCONOMIE JAPONAISE

Willem Thorbecke

RÉSUMÉ NON TECHNIQUE

Le yen japonais s'est apprécié de plus de 25 % depuis juin 2007 en termes effectifs réels. Les exportations japonaises, la production industrielle et les cours de Bourse se sont effondrés entre juin 2007 et mars 2009 et n'ont pas, depuis, retrouvé leurs niveaux d'avant-crise. Cet article examine comment la force du yen a contribué à cette débâcle.

L'appréciation du yen peut affecter les entreprises japonaises de plusieurs façons : la perte de compétitivité-prix peut faire chuter leurs exportations ; les entreprises peuvent être dans l'incapacité de transmettre la variation du taux de change aux prix en monnaies étrangères ; les rendements des sociétés japonaises sensibles aux variations de change peuvent diminuer. Cet article examine ces différents canaux.

Les résultats indiquent que l'appréciation du yen a fait baisser les exportations de manière significative, en particulier celles du secteur automobile. Ils signalent aussi que, les prix à l'exportation, en yens, ont baissé beaucoup plus que les coûts dans les secteurs de l'automobile et de l'électronique. Enfin, dans ces deux industries, l'appréciation du yen a fait chuter les cours des actions.

Les industries de l'automobile et de l'électronique ont longtemps été les fleurons de l'économie japonaise. Comment peuvent-elles réagir aux dommages causés par cette nouvelle *endaka* ? Plutôt que de tenter de se battre sur les prix de produits banalisés, la voie la plus prometteuse pour les entreprises japonaises consisterait à concentrer leurs efforts sur l'innovation.

RÉSUMÉ COURT

En 2012, le yen japonais est, en termes effectifs réels, encore 25 % au-dessus de son niveau de 2007. Après leur effondrement, la reprise des exportations, de la production industrielle et la remontée des cours boursiers n'ont pas permis de retrouver les valeurs d'avant-crise. Cet article examine la façon dont l'appréciation du yen a contribué à ce désastre économique. Nos estimations économétriques indiquent qu'une appréciation du yen de 25 % réduit à long terme les exportations de 8 % à 18 %. L'estimation d'un modèle dynamique DOLS sur données de panel révèle que l'impact de l'appréciation est particulièrement fort sur les exportations automobiles. L'appréciation du yen a fait chuter de 29 % les prix à l'exportation en yens dans le secteur de l'automobile et de 22 % dans les secteurs électrique et électronique. Enfin, les résultats de l'estimation de l'exposition au taux de change indiquent que l'appréciation du yen a réduit de manière significative les profits dans les secteurs automobile et électronique. Plutôt que de se battre sur le terrain de la compétitivité-prix sur des produits banalisés, les entreprises japonaises pourraient réagir en renforçant leurs capacités d'innovation.

Classification JEL : F 10, F 40
Mots-clefs : Elasticité des taux de change; Exchange rate pass-through; Japon

THE CONTRIBUTION OF THE YEN APPRECIATION SINCE 2007 TO THE JAPANESE ECONOMIC DEBACLE

Willem Thorbecke

1. INTRODUCTION

The Japanese real effective exchange rate appreciated 30 percent between June 2007 and March 2009. Japanese real exports fell 40 percent over this period, industrial production dropped 35 percent, and the Nikkei index lost more than 80 percent of its value. Five years later the yen remains strong and exports, industrial production and stock prices have yet to regain their pre-Crisis values. How has the strong yen contributed to this debacle?

There are several channels through which an appreciation of the yen could affect Japanese firms. It could cause exports to fall because Japanese firms lose their price competitiveness. It could harm Japanese enterprises if they are unable to pass-through exchange rate changes into foreign currency prices. It could reduce the profitability of Japanese companies that are exposed to exchange rate changes. It could cause Japanese multinational companies to move production overseas.

This paper investigates the first three channels.[2] To examine how the strong yen has affected Japanese exports, Johansen maximum likelihood estimation and dynamic ordinary least squares (DOLS) techniques are used. The results indicate that there are cointegrating relationships between Japanese aggregate exports, the real effective exchange rate, and real income in importing countries. The evidence indicates that a ten percent appreciation of the yen in the long run is associated with a steady state decrease in exports of between three and seven percent. The findings also indicate that the gap between actual and long run exports closes at a rate of about 30 percent per quarter. From this perspective, the 50 percent drop in exports between 2008:III and 2009:II can be viewed as an overshooting relative to fundamentals and the 40 percent rebound between 2009:II and 2011:IV as a return to equilibrium. The fact that the volume of exports in 2011:IV remained 10 percent below the volume in 2008:III reflects the fact that the yen has remained strong.

Figure 1 shows that the drop in Japanese exports across sectors has been uneven. The value of chemical exports did not fall between 2008 and 2009, while the value of machinery exports fell 40 percent and the value of vehicle exports fell 63 percent. Exports for all the sectors in Figure 1 except vehicles rebounded in 2010. For vehicles, exports in 2010 remained 32 percent below their 2008 values. To help understand these patterns, panel data sets including Japanese exports by industry are employed. Results from panel DOLS estimation indicate

[2] For evidence on the fourth channel, see Thorbecke (2008) and Thorbecke and Salike (2011).

that exchange rate elasticities are zero for chemical exports and are large for vehicle exports. In general, industries with larger exchange rate elasticities experienced greater drops in exports during the crisis.

Figure 2 shows the evolution of yen prices and yen costs for Japanese exports since 2005. Yen costs are proxied by the domestic corporate goods price index. The figure shows that yen export prices increased relative to yen costs until June 2007. After this, the yen began a sustained appreciation and yen export prices tumbled. Between June 2007 and May 2012, yen export prices fell 28 percent more than yen costs. This has squeezed profit margins for Japanese firms. This paper presents evidence on the fall in yen export prices relative to yen costs for individual sectors between June 2007 and May 2012 and also between January 2005 and May 2012. The second period includes the time before the crisis when yen prices were increasing relative to yen costs. In principle Japanese firms could have saved during this period to be prepared for losses if the yen appreciated in the future and yen prices fell.

As documented below, yen prices after June 2007 fell more than yen costs for all of the industries examined. The drop was especially pronounced, though, for automobiles and for electric and electronic products. Over the January 2005 to June 2012 period, however, the drop in yen prices relative to yen costs was small for general machinery and chemicals. On the other hand, the drop exceeded 14 percent for automobiles and 40 percent for electric and electronic products. For all goods, yen export prices fell 22 percent more than yen costs over the 2005-2012 period.

To understand the causes of the fall in export prices, yen export prices are regressed on current and lagged values of changes in exchange rates, production costs, and other variables. The results indicate that export prices in the short run are very sensitive to exchange rates changes. The evidence implies that the 40 percent appreciation of the yen nominal effective exchange rate between June 2007 and the May 2012 caused yen export prices to fall 22 percent for electrical and electronic machinery, 29 percent for automobiles, and 24 percent for all goods.

To measure the effect of exchange rate changes on industry profitability, industry stock indices are regressed on exchange rates changes. The results indicate that the automobile industry and the electronics industry are especially exposed to exchange rate appreciations. At the other end of the spectrum, there is no evidence that the chemical industry and the telecommunications equipment industries are affected by the value of the yen.

The results thus indicate that the harmful effects of the strong yen have fallen disproportionately on the automobile and electronics sectors. Exports in the automobile sector and profitability in both the automobile and electronics sectors plummeted due to the appreciation of the yen. Since Japan has long had a comparative advantage in these technologically sophisticated industries, mitigating the damage caused by the *endaka* is of particular moment for the Japanese economy.

The next section presents evidence concerning how exchange rate changes affect aggregate exports. Section 3 investigates the effect of exchange rate changes on exports disaggregated by industry. Section 4 examines the effect of exchange rate changes on yen export prices. Section 5 estimates industry exposure to exchange rate changes. Section 6 concludes.

2. THE RESPONSE OF AGGREGATE EXPORTS TO EXCHANGE RATE CHANGES

2.1 Data and Methodology

According to the imperfect substitutes model of Goldstein and Khan (1985), exports can be represented as:

$$ex_t = \alpha_1 + \alpha_2 rer_t + \alpha_3 y_t^* + \varepsilon_t \tag{1}$$

where ex_t represents aggregate real exports from Japan to the world, rer_t represents the Japanese real effective exchange rate, y_t^* represents real income in the rest of the world, and all variables are measured in natural logs.

Equation (1) can be written in vector error correction form as:

$$\Delta ex_t = \beta_{10} + \varphi_1(ex_{t-1} - \alpha_1 - \alpha_2 rer_{t-1} - \alpha_3 y_{t-1}^*) + \beta_{11}(L)\Delta ex_{t-1} + \beta_{12}(L)\Delta rer_{t-1} + \beta_{13}(L)\Delta y_{t-1}^* + \nu_{1t} \tag{2a}$$

$$\Delta rer_t = \beta_{20} + \varphi_2(ex_{t-1} - \alpha_1 - \alpha_2 rer_{t-1} - \alpha_3 y_{t-1}^*) + \beta_{21}(L)\Delta ex_{t-1} + \beta_{22}(L)\Delta rer_{t-1} + \beta_{23}(L)\Delta y_{t-1}^* + \nu_{2t} \tag{2b}$$

$$\Delta y_t^* = \beta_{30} + \varphi_3(ex_{t-1} - \alpha_1 - \alpha_2 rer_{t-1} - \alpha_3 y_{t-1}^*) + \beta_{31}(L)\Delta ex_{t-1} + \beta_{32}(L)\Delta rer_{t-1} + B_{33}(L)\Delta y_{t-1}^* + \nu_{3t} \tag{2c}$$

where the φ's are the error correction coefficients, the L's represent polynomials in the lag operator, and the other variables are defined above. The coefficient φ_1 measures how quickly exports respond to disequilibria. If exports move towards their equilibrium values, then φ_1 will be negative.

Another way to estimate equation (1) is to employ dynamic ordinary least squares estimation (see Stock and Watson, 1993). DOLS involves regressing the dependent variable on the independent variables and on lags and leads of the first differences of the independent variables. If there is a cointegrating relationship among the variables, DOLS provides consistent and efficient estimates of the long run parameters. The estimated equation has the form:

$$ex_t = \alpha_1 + \alpha_1 rer_t + \alpha_2 y_t * + \sum_{k=-K}^{K} \beta_{1,k} \Delta rer_{t+k} + \sum_{k=-K}^{K} \beta_{2,k} \Delta y_{t+k} * + \varepsilon_t \tag{3}$$

where K represents the number of leads and lags of the first differenced variables and the other variables are defined above.

Before estimating the model, augmented Dickey-Fuller tests are used to test whether each series is integrated of order one. The Schwarz criterion is then employed to determine how many lags to use in equation (2) and whether to include a time trend in the cointegrating equation. The trace statistic and the maximum eigenvalue statistic are used to test the null of no cointegrating relations against the alternative of one cointegrating relation.

Quarterly data on Japanese aggregate exports to the world, the Japanese real effective exchange rate, and income in the rest of the world are obtained from the IMF's International Financial Statistics (IFS). Exports are deflated using Japanese export prices from IFS. To calculate rest of the world income ($y_t *$), a weighted index of income changes in Japan's top ten export destinations is constructed using the following formula:

$$y_t * = y_{t-1} * \prod_{i=1}^{10} (y_{i,t} / y_{i,t-1})^{w_{i,t}} \tag{4}$$

where the subscript i indexes the 10 largest importing countries, y_i is income in importing country i, and w_i is the share of Japanese exports going to country i relative to Japanese exports going to the ten largest export markets[3]. The weights are calculated using annual data from the CEPII-CHELEM database and converted to quarterly data using linear interpolation. The index is set equal to 100 in 1981q1. All of the data used in this paper are described in more detail in the data appendix.

2.2 Results

Table 1 presents the results for Japan's exports. The first row presents results using the 1982:III – 2010:IV sample period, the second row using the 1990:I – 2010:IV sample period, and the third row using the 1990:I – 2008:II sample period. Both the trace and the maximum

[3] One could use more than 10 countries to calculate y^*. In 2010, 2% of Japan's exports went to the 11th leading importer. For a country with a 2% weight in equation (4), even a 5% quarterly change in income would only change y^* by 0.1%. Since a one standard deviation shock to y^* would change it by 2.2%, including more than 10 countries in equation (4) would only have a minuscule effect on y^*.

eigenvalue statistics indicate the presence of one cointegrating relation for the results in the first and second rows (but not for the third row).

In the results for the entire sample period in the first row, the exchange rate elasticity equals –0.26 and is statistically significant at the 1 percent level. This implies that a 10 percent appreciation of the real effective exchange rate would reduce exports by 2.6 percent. The income elasticity equals 1.07 and is also statistically significant at the 1 percent level. This implies that a 10 percent increase in income in the importing countries would increase exports by 10.7 percent.

The sample in the second row employs only more recent data to control for possible changes in the structure of the Japanese economy during the 1980s. The exchange rate elasticity now equals –0.67 and remains statistically significant at the 1 percent level. This implies that a 10 percent appreciation of the real effective exchange rate would reduce exports by 6.7 percent. The income elasticity is again close to unity and statistically significant at the 1 percent level.

The sample in the third row ends in 2008:II to see whether the findings are affected by the Global Financial Crisis that began in 2008:III. The exchange rate elasticity now equals 0.44 and is statistically significant at the 1 percent level. The income elasticity now equals exactly 1 and is statistically significant at the 1 percent level.

Table 2 presents dynamic ordinary least squares estimates over the three sample periods. The results are similar to those in Table 1. The trade elasticities are statistically significant at the 1 percent level in every case. The exchange rate elasticities equal -0.27 in the first period, -0.57 in the second period, and -0.61 in the third period. In Table 1 these values were -0.26 in the first period, -0.67 in the second period, and -0.44 in the third period. The income elasticities are again close to one for every sample period.

The results in Tables 1 and 2 for the 1982–2010 period are close to those reported by other authors for similar sample periods. For instance Crane, Crowley, and Quayyum (2007), employing Johansen maximum likelihood estimation over the 1981Q1 – 2006Q4 period, found that a 10 percent appreciation in the Japanese real effective exchange rate would reduce Japanese exports by 3.4 percent.

In Table 1 the error correction coefficient φ_1 is negative and statistically significant in every case, implying that exports move towards their equilibrium values. The results in the first row indicate that the gap between the actual and the long run values closes at a rate of 32 percent per quarter; the results in the second row indicate that the gap closes at a rate of 24 percent per quarter; the results in the third row indicate that the gap closes at a rate of 20 percent per quarter.

Figure 3 presents residuals from the vector error correction estimates for Japanese exports over the entire sample period. The figure indicates that exports rose above their equilibrium values just before the Global Financial Crisis began in 2008:III. They then fell far below their equilibrium value during the Crisis. By the end of the sample period, they appear to be returning to their equilibrium values. Thus one reason why the volume of exports at the beginning of 2012 remained 10 percent below the volume in 2008:II is because the real effective exchange rate in 2012 remains 25 percent above the value it had when it began appreciating.

3. THE RESPONSE OF SECTORAL EXPORTS TO EXCHANGE RATE CHANGES

3.1 Data and Methodology

According to the CEPII-CHELEM database, 80 percent of Japan's exports in 2010 came from the following chains: machinery, vehicles, electronics, chemicals, and electrical goods. This section investigates exports from these sectors.

To do this panel data sets are constructed for each sector including Japanese exports to major importing countries over the 1993-2010 period. Panel DOLS techniques are then used to obtain trade elasticities. The estimated model takes the form:

$$ex_{i,j,t} = \beta_0 + \beta_1 rer_{j,t} + \beta_2 y_{j,t}^{*} + \sum_{k=-p}^{p} \alpha_{1,k} \Delta rer_{j,t-k} + \sum_{k=-p}^{p} \alpha_{2,k} \Delta y_{j,t-k}^{*} \qquad (5)$$

$$+\mu_j + \mu_t + u_{i,j,t},$$

$$t = 1, \cdots, T; \qquad j = 1, \cdots, N.$$

Here $ex_{i,j,t}$ represents real exports of sector *i* from Japan to major importing country *j*, $rer_{j,t}$ represents the bilateral real exchange rate between Japan and importing country *j*, $y_{j,t}^{*}$ equals real income in country *j*, μ_j is a country *j* fixed effect, and μ_t is a time fixed effect.

Data on exports, the real exchange rate, and real income in the importing countries are obtained from the CEPII-CHELEM database. Exports are disaggregated into the main sectors listed above and are measured in U.S. dollars. They are deflated using export price data for the relevant sectors obtained from the Bank of Japan. The export prices are measured in yen, and converted into dollars using the nominal yen/dollar exchange rate. The CEPII real exchange rate between Japan and country *j* is calculated by first dividing gross domestic product in US dollars for Japan by gross domestic product in purchasing power parity for Japan and doing the same for country *j*. The resulting ratio for Japan is then divided by the ratio for country *j*. This variable measures the units of consumer goods in Japan needed to buy a unit of consumer goods in country *j*.

It is desirable to exclude countries that were minor importers over part of the sample period since these countries can have very large percentage changes in imports from year to year due to idiosyncratic factors rather than due to the macroeconomic variables in equation (5).

Including these countries can distort the estimated coefficients. Table 3 lists the major importing countries for each sector.

Results from a battery of panel unit root tests, available on request, indicate that in most cases the variables are integrated of order one (I(1)). Residual cointegration tests, developed by Kao (1999), are then performed for the variables in equation (5). The null hypothesis of no cointegration can be rejected in most cases. For the electronics industries, the p-value equals 0.057 and for the chemical industy the p-value equals 0.128. For the machinery sector, there is only evidence of cointegration if the Great Trade Collapse of 2009 is excluded. Over the 1993-2008 period, the null hypothesis of no cointegration can be rejected for the machinery sector at the 8% level.

3.2 Results

Table 4a presents the results from estimating equation (5) over the 1993-2010 period. The results in column (1) are for all exports and the results in column (2) are for all exports except parts and components. Previous authors have found that estimating exchange rate elasticities for parts and components can prove tricky, since an exchange rate depreciation in the importing country that increases that country's exports can also increase its imports of parts and components (see Kamada and Takagawa, 2005).

The exchange rate elasticities for all goods in columns (1) and (2) equal –0.32 and -0.26. These are at the low end (in absolute values) of the elasticites reported in Tables 1 and 2. The income elasticities in columns (1) and (2) equal 0.89 and 0.86. These are slightly less than the values of about unity reported in Tables 1 and 2.

Columns (3) through (7) report results for the key industrial sectors. There is no evidence that exchange rates affect exports in the chemical and electrical sectors. For exports of electronics goods excluding parts and components, the exchange rate elasticity equals -0.38 and is significant at the 10 percent level. For machinery and for vehicles excluding parts and components, the exchange rate elasticities equal -0.51 and -1.26 and are significant at the 1 percent level. The income elasticity is significant at the 1 percent level for the chemical, electrical, electronic, and machine sectors and is not significant for the vehicle sector. For the first three of these sectors the income elasticity equals or exceeds unity and for the fourth sector it equals 0.5.

To test whether these results are sensitive to the trade collapse of 2009, Table 4b presents the results with the sample period truncated at 2008. The results are similar to those reported in Table 4a for all of the sectors except electronics and automobiles. For electronics, the exchange rate elasticity is smaller and not statistically significant. For automobiles, the exchange rate remains statistically significant at the 1 percent level and now equals -0.66. The income elasticity for automobiles now equals 1.14 and is significant at the 1 percent level. Taken together, the evidence in Tables 4a and b thus indicates that machines and automobiles are sensitive to exchange rate changes. The evidence that exchange rates affect electronics exports is more tenuous[4]. Perhaps if sector specific exchange rates were available on a bilateral basis for this sector, the results would have been more conclusive.

4. THE PASS-THROUGH OF EXCHANGE RATE CHANGES TO EXPORT PRICES

4.1 Data and Methodology

Export prices can be modeled as a product of marginal costs and firms' markup (see Campa and Goldberg, 2005). In this framework, Ceglowski (2010) represents the first difference of Japanese export prices as a function of current and lagged values of the first difference of the exchange rate, foreign prices, domestic costs, and economic activity in the destination market:

$$\Delta p_{jt}^{x} = \beta_0 + \sum_{i=0}^{p} \beta_{1i}\, \Delta e_{jt-i} + \sum_{i=0}^{p} \beta_{2i}\, \Delta p_{t-i}^{f} + \sum_{i=0}^{p} \beta_{3i}\, \Delta c_{jt-i} + \sum_{i=0}^{q} \beta_{4i}\, \Delta y_{t-i}^{f} + u_t, \quad (6)$$

where p_j^x is the yen price of exports in industry *j*, e_j is the exchange rate, p^f measures foreign prices, c_j represents costs for industry *j* , and y^f represents economic activity in the export market.

The yen price of exports by industry (p_j^x) is available from the Bank of Japan (BoJ), the yen nominal effective exchange rate (e_j) or alternatively the yen/dollar nominal exchange rate are also available from BoJ. The foreign price measure (p^f) is calculated by multiplying the BoJ real effective exchange rate series by the product of the nominal effective exchange rate and the Japanese corporate goods price index. Costs (c_j) are represented by the producer price index in industry *j*. Economic activity in export markets (y^f) is measured by the IMF measure for industrial production in industrialized countries.

This paper investigates the following sectors: chemicals, electrical and electronic machinery, general machinery, and transportation[5]. Consistent time series for the variables in equation (6) are available starting in January 2005. The sample period for the estimation thus extends from January 2005 to March 2012. Following Ceglowski (2010), the estimation begins with

[4] Thorbecke (2012) examined only key parts of the electronics sector (consumer electronics, computre equipment, and telecommunications equipment) and reported robust evidence of exchange rate elasticities of about unity for exports from these industries.

[5] In the case of electrical and electronic machinery, there was not an exact correspondence between the yen export price series and the corporate goods price index. The corporate goods price index for electrical machinery and equipment was employed.

six lags of e_j, p^f, and c_j and three lags of y^f. To avoid overfitting the lag length is then progressively reduced by one down to a minimum of two lags and the Schwarz Criterion is used to choose between the models.

4.2 Results

Column (1) of Table 5 reports the sum of the coefficients on the contemporaneous first difference of the nominal effective exchange rate (ΔNEER) and lagged first differences of the NEER. Results for the coefficients on the other variables in equation (6) are available on request. Column (2) of Table 5 reports the results from a separate regression of the sum of the coefficients on the contemporaneous first difference of the nominal yen/dollar exchange rate (ΔYen$) and lagged first differences of the yen/dollar rate. Again results for the coefficients on the other variables are available on request.

Columns (3) – (5) then focus on the period beginning in June 2007 when the yen started appreciating until May 2012 and Columns (6) – (8) cover the whole period from January 2005 until May 2012. Columns (3) and (6) report the drop in yen export prices over these respective periods; Columns (4) and (7) report the drop in yen export prices relative to the drop in yen costs (as proxied by the domestic corporate goods price index for the relevant industry); and Columns (5) and (8) report the drop in yen export prices over the period in question explained by the change in the NEER.

The first row of Table 5 reports the results for all goods. The coefficient on NEER equals -0.62 and the coefficient on Yen$ equals 0.52. In both cases the coefficients are statistically significant at the 1 percent level. These results indicate that a 10 percent appreciation of the NEER would decrease yen export prices for all goods by 6 percent and a 10 percent appreciation of Yen$ would decrease them by 5 percent. Columns (3) and (4) indicate that the *endaka* period after June 2007 was especially difficult for Japanese exporters, with yen export prices falling by 27 percent and yen export prices relative to yen costs falling by 28 percent. Column (5) indicates that 24 percent of the drop in yen export prices between June 2007 and May 2012 can be explained by the yen appreciation. Over the entire January 2005 to May 2012 period, yen export prices fell by 16 percent and by 22 percent more than yen costs. 11 out of the 16 percent fall in yen export prices over this period can be explained by the appreciation of the NEER.

The second row of Table 5 reports results for the chemical industry. The coefficients on the exchange rates are large (-1.14 for NEER and 0.51 for Yen$) and statistically significant at the 1 percent level. However, the results in columns (6) and (7) indicate that yen export prices and also yen export prices relative to yen costs over the January 2005 to May 2012 sample period only fell by 3 percent. Thus profitability in the chemical industry does not appear to have been affected much by changes in export prices.

The third row reports the results for the electrical and electronics industries. The coefficient on NEER equals -0.58 and the coefficient on Yen$ equals 0.59. Both coefficients are statistically significant at the 1 percent level. These results indicate that a 10 percent yen appreciation would decrease yen export prices for electrical and electronics goods by 6 percent. Columns (3) and (4) indicate that after June 2007 yen export prices fell 49 percent and yen export prices relative to yen costs fell 37 percent. Column (5) reports that 22 percent of the drop in yen export prices between June 2007 and May 2012 can be explained by the yen appreciation. Over the entire January 2005 to May 2012 period, yen export prices fell by 55 percent and by 40 percent more than yen costs. 10 out of the 55 percent fall in yen export prices over this period can be explained by the appreciation of the NEER.

Thorbecke (2012) examined exchange rate pass-through for subsectors of the electrical and electronics industries. He reported that the effect of exchange rate changes on export prices is smallest for differentiated products (electronic computers and electromedical equipment) and largest for commoditized industries (color TV receivers, display devices, integrated circuits, and silicon wafers). These results support Katz's (2012) observation that Japanese electronics firms tend to compete with foreign firms based on price in commoditized industries. They thus have to allow yen prices to adjust more for these items in order to keep foreign currency prices competitive.

The fourth row of Table 5 reports results for general machinery. The coefficient on NEER equals -0.50 and the coefficient on Yen$ equals 0.46. Both coefficients are statistically significant at the 1 percent level. These results indicate that a 10 percent yen appreciation would decrease yen export prices for electrical and electronics goods by 5 percent. The results in columns (6) and (7) indicate that yen export prices and also yen export prices relative to yen costs over the January 2005 to May 2012 sample period only fell by 6 percent. Thus profitability in the general machinery industry does not appear to have been affected much by changes in export prices.

The fifth row of Table 6 reports results for transportation equipment. The coefficient on NEER equals -0.73 and the coefficient on Yen$ equals 0.71. Both coefficients are again statistically significant at the 1 percent level. These results indicate that a 10 percent yen appreciation would decrease yen export prices for transportation equipment by 7 percent. The results in columns (3) and (4) indicate that yen export prices fell by 24 percent and that yen export prices relative to yen costs fell by 26 percent over the June 2007 to May 2012 period. The appreciation of the yen caused yen export prices to fall by 29 percent, more than the entire 24 percent fall in export prices over this period. For the entire January 2005 to May 2012 period, yen export prices fell by 14 percent more than yen costs and the appreciation of the yen alone caused yen export prices to fall by 13 percent. Thus the yen appreciation, by significantly lowering yen export prices relative to yen costs, has significantly reduced profit margins for Japanese automakers in recent years.

5. THE EXCHANGE RATE EXPOSURE OF SECTORAL STOCK RETURNS

5.1 Data and Methodology

Many authors have investigated the effects of exchange rate changes on industry profitability by estimating exchange rate exposures (see, e.g., Chamberlain, Howe, and Popper, 1997, Dominguez and Tesar, 2006, or Jayasinghe and Tsui, 2008). Industry stock returns ($\Delta R_{i,t}$) are typically regressed on exchange rate changes (Δe_t) and changes in the aggregate stock market ($\Delta R_{M,t}$):

$$\Delta R_{i,t} = \alpha_i + \beta_{i,e} \Delta e_t + \beta_{i,M} \Delta R_{M,t} + \varepsilon_{i,t} \quad . \qquad (7)$$

This paper estimates equation (7) for key industries.

Stock return data are obtained from the Datastream database. Industry stock returns for key industries are calculated as the daily change in the natural log of the industry stock index. The following industries are examined: automobiles and parts, chemicals, computer hardware, electrical components and equipment, electronic equipment, electronic office equipment, industrial machinery, semiconductors, technology hardware and equipment, and telecommunications.

The daily change in the exchange rate is calculated as the daily change in the natural log of the Japanese nominal effective exchange rate and the nominal yen/dollar exchange rate. Daily Japanese nominal effective exchange rate data are obtained from the Bank of England. One problem with these data is that the market close in England is several hours after the market close in Japan. Jayasinge and Tsai (2008) thus used the exchange rate change lagged one day. Dominguez and Telsar (2006) reported that many firms in Japan are exposed to the dollar/yen exchange rate. Chamberlain, Howe, and Popper (1997) used the yen/dollar rate to estimate exposures. To obviate timing problems, this paper also uses the yen/dollar Tokyo closing rate obtained from the Bank of Japan.

The variable ΔR_M is measured as the daily change in the natural log of a value-weighted aggregate index of Japanese stocks. These data are obtained from Datastream.

While the yen was appreciating after June 2007, the Korean won was depreciating. Between June 2007 and March 2009, the won depreciated by more than 50 percent. Japanese firms state that this has made it hard to compete with firms in Korea (see METI, 2010, and JETRO, 2010). The daily won/dollar exchange rate (ΔR_W), obtained from the Bank of Korea, is also included as an additional explanatory variable to test for this effect.

To facilitate comparison with the results in the previous section, the estimation begins in January 2005. The sample extends to June 2012.

5.2 Results

Column (1) of Table 6 reports the sectoral exposures to the yen/dollar exchange rate. Column (2) reports the sectoral exposures to the won/dollar exchange rate. Column (3) reports the sectoral exposures to the market index. Column (4) reports the adjusted R-squared. Column (5) reports the change in sectoral stock returns between the day when the yen began its appreciation trend (22 June 2007) and 27 June 2012. Column (6) reports the change in sectoral stock returns over the entire sample period (1 January 2005 and 27 June 2012).

Column (5) indicates that sectoral stock returns have fallen logarithmically by between 50 and 145 percent since the yen began appreciating in June 2007. This period has thus been difficult for Japanese industries. Column (6) indicates that the best performers over the 1 January 2005 to 27 June 2012 period are industrial machinery (+21 percent), electronic equipment (-20 percent), and automobiles (-26 percent). While the 20 percent drop in electronics equipment stocks and the 26 percent drop in auto stocks over the last 7 years may not seem large, it is important to remember that on average stocks should earn positive returns over time. If one approximates this average return with a linear trend term over the 1979 to 2012 period, stock prices for autos are now 51 percent below their predicted value and stock prices for electronics equipment are 62 percent below their predicted value. The last 7 years have thus been a bad period for Japanese stocks. The fact that the values in Column (6) are smaller in absolute value than the values in Column (5) imply that stock prices rose between January 2005 and June 2007, when the yen was depreciating. The only exception is the telecommunications sector, where stock prices fell 52 percent between January 2005 and June 2007.

The sectors in Table 6 are ordered by their exposures to the yen/dollar exchange rate. These exposures are of the expected sign and statistically significant at the 1 percent level for all sectors except chemicals and telecommunications. The first sector in Table 6 is electronic office equipment, with an exchange rate exposure of 0.40. This value implies that a 10 percent appreciation of the yen against the dollar would lead to a 4 percent decrease in stock returns for companies making electronic office equipment. The second sector is automobiles and parts, with an exchange rate exposure of 0.32. The next four sectors are all part of the electronics industry (technology hardware and equipment, semiconductors, computer hardware, and electronic equipment). For technology hardware, the exposure exceeds 0.30 and for semiconductors and computer hardware the exposures exceed 0.20. The last two sectors with statistically significant exchange rate exposures are the electrical equipment and industrial machinery sectors. These sectors have much smaller exchange rate exposures (0.11 and 0.10) than the automobile sector and most of the electronics sector.

For the chemical and the telecommunications sectors, the exchange rate exposures are not statistically significant. As discussed above, returns in the telecommunications sector were already collapsing before the yen began appreciating in June 2007.

The Korean won exposures are of the expected sign and statistically significant at the 1 percent level for all sectors except computer hardware and telecommunications. The most exposed sectors are electronic office equipment and semiconductors. Both sectors have exchange rate exposures of -0.23. These values imply that a 10 percent depreciation of the won against the dollar would lead to a 2.3 percent decrease in stock returns for Japanese companies making electronic office equipment and semiconductors. Other electronic sectors (e.g., technology hardware and electrical components) are also exposed to the won exchange rate. While the Japanese automobile sector had the second highest exposure to the yen, it has a somewhat lower exposure (-0.12) to the won. The chemical sector, although not exposed to the yen, is exposed to the value of the won. Overall these results indicate that there was extensive competition between Japanese and Korean firms over the sample period, especially in the electronics sector.

The yen exposures reported here seem large compared with those in previous studies. For instance, the highest exposure reported by Jayasinghe and Tsui (2008) for Japanese industries over the 1992-2000 period is less than 0.176, and the exposure for automobiles and parts is 0.175. The high exposures reported here perhaps reflect the damage that exchange rate changes have inflicted on Japanese industries since 2007.

6. Conclusion

The period after the yen began appreciating in June 2007 has been especially difficult for the Japanese economy. Exports fell 50 percent between 2008:III and 2009:II, vehicle exports fell 64 percent between 2008 and 2009, yen export prices fell 27 percent more than yen costs between June 2007 and May 2012, and the return on the overall Japanese stock market fell 86 percent during this time. This paper investigates the contribution of the strong yen to this economic disaster.

To understand the behavior of yen exports, this paper uses Johansen maximum likelihood estimation and dynamic ordinary least squares techniques to estimate trade elasticities. For aggregate exports, exchange rate elasticities range from 0.3 and 0.7. A sustained 25 percent appreciation of the yen would thus reduce Japanese exports by between 8 and 18 percent. The 50 percent drop in exports between 2008:III and 2009:II thus probably reflects an overshooting relative to fundamentals and the 40 percent rebound between 2009:II and 2011:IV represents a return to equilibrium. The fact that the volume of exports in 2012 remains 10 percent below the volume in 2008:III reflects the fact that the yen has remained strong.

The drop in exports in 2009 was especially severe for the electronics, machinery, and automobile industries. Vehicle exports were also the slowest to rebound, with the value of exports in 2010 remaining 32 percent below the value in 2008. Exchange rate elasticities reported here are also the largest for the vehicle industry, varying (in absolute value) between 0.7 and 1.3. A 25 percent sustained appreciation of the yen, as occurred between 2007 and

2012, would thus contribute in the long run to a decrease in automobile exports of between 18 and 33 percent.

One can gauge the effect of exchange rate changes on profit margins by examining changes in yen export prices relative to yen costs. For the chemical and machinery industries, yen export prices fell respectively by only 3 and 6 percent more than yen costs between January 2005 and May 2012. For the electrical & electronic (E&E) sector and the transportation sector, on the other hand, the fall in yen prices relative to yen costs was substantial. Between June 2007 and May 2012, for instance, yen prices for E&E exports fell 37 percent more than yen costs and yen prices for transportation exports fell 26 percent more than yen costs. Regression evidence indicates that 22 of the 37 percent fall for the E&E sector can be explained by the appreciation of the yen and 29 of the 26 percent fall for the transportation sector can be explained by the yen appreciation.

One can also investigate the effect of exchange rates on industry profitability by estimating the exposure on industry stock returns to exchange rate changes. Evidence presented here indicates that the largest exposures are found in the following industries: electronic office equipment, automobiles and parts, technology and hardware, semiconductors, and computer hardware. The exposure of industrial machinery to exchange rate changes is only one-fourth as large as the exposure for electronic office equipment and one-third as large as the exposure for automobiles and parts. The exposure of the chemical industry to exchange rate changes is not statistically different from zero.

The evidence reported in this paper thus implies that the automobile and electronics sectors were especially harmed by the appreciation of the yen since 2007. Exports in the automobile sector and profitability in both sectors tumbled because of the strong yen. These two industries have long been the flagships of the Japanese economy.

How can Japan cope with this dislocation caused by the appreciation of the yen? As Katz (2012) noted, competing based on price in commoditized industries is a bad strategy for Japanese companies now. Instead, they should innovate and seek to produce high quality goods that have lower price elasticities.

They should also seek new markets for their goods. Results reported here indicate that Japanese exports are sensitive to income in importing countries. Since growth is sputtering in the West, Japanese firms should pursue other markets. Asian markets are especially promising in this regard. Efforts to promote free trade, infrastructure connectivity, and development in the region would thus benefit not only emerging and developing Asia but also Japan.

The appreciation of the yen since 2007 has been trying for Japanese firms. Japan, however, has a long history of responding successfully to oil crises, earthquakes, previous *endaka* episodes, and other adversities. Part of the response this time should involve the sometimes contradictory goals of producing high quality goods and of producing goods tailored to the needs of consumers in less wealthy Asian countries.

APPENDIX

Data Definition and Sources

Section 2:

Exports are quarterly Japanese aggregate exports to the world, deflated using Japanese export prices. (Data source: IMF IFS)

The Japanese real effective exchange rate (reer) is the quarterly CPI-deflated reer. (Data source: IMF IFS)

Rest of the world income is calculated as a geometric average of quarterly income in the 10 leading importing countries. These countries are China, Germany, Hong Kong, Malaysia, Singapore, South Korea, Taiwan, Thailand, the United Kingdom and the United States. For every quarter, each country's income is weighted based on the share of Japanese exports going to the country relative to Japanese exports going to the ten countries together (Data source: CEPII-CHELEM and IMF IFS)

The number of observations and the sample periods for each specification are listed in Tables 1 and 2.

Section 3:

Exports are bilateral annual exports between Japan and the major importing countries. They are disaggregated into the following chains: machinery, vehicles, electronics, chemicals, and electrical goods. They are deflated using yen export price data for the relevant sector converted to U.S. dollars using the nominal yen/dollar exchange rate. The major importing countries for each sector are listed in Table 3. (Data sources: CEPII-CHELEM and Bank of Japan)

Exchange rates are bilateral annual real exchange rates between Japan and country *j*. They measure the units of consumer goods in Japan needed to buy a unit of consumer goods in country *j*. (Data source: CEPII-CHELEM)

Income represents real GDP in the importing country. (Data source: CEPII-CHELEM)

The number of importing countries for each sector, the number of observations, and the sample period are listed in Table 4.

Section 4:

Export prices are the monthly yen price of exports by industry. The following industries are examined: chemicals, electrical and electronic machinery, general machinery, and transportation. (Data source: Bank of Japan)

Costs for each industry are represented by the monthly industry PPI. (Data source: Bank of Japan)

Exchange rates are the monthly yen nominal effective exchange rate or the yen/dollar nominal exchange rate. (Data source: Bank of Japan)

Foreign prices are monthly data calculated by multiplying the Bank of Japan real effective exchange rate series by the product of the nominal effective exchange rate and the Japanese corporate goods price index. (Data source: Bank of Japan)

Economic activity in export markets is measured by the IMF monthly series on industrial production in industrialized countries. (Data source: IMF IFS)

The number of observations and the sample period are listed in Table 5.

Section 5:

Industry stock returns are daily changes in the natural log of the industry stock index. The following industries are employed: automobiles and parts, chemicals, computer hardware, electrical components and equipment, electronic equipment, electronic office equipment, industrial machinery, semiconductors, technology hardware and equipment, and telecommunications. (Data source: Datastream)

The Japanese exchange rates are daily changes in the natural log of the Japanese nominal effective exchange rate and the nominal yen/dollar exchange rate. (Data sources: Bank of England and Bank of Japan)

Market return data are daily changes in the natural log of a value-weighted aggregate index of Japanese stocks. (Data source: Datastream)

The Korean exchange rates are daily change in the natural log of the nominal won/dollar exchange rate. (Data sources: Bank of Korea)

The number of observations and the sample period are listed in Table 6.

Figure 1. The Value of Japanese Exports Disaggregated by Sector.
Source: CEPII-CHELEM database.

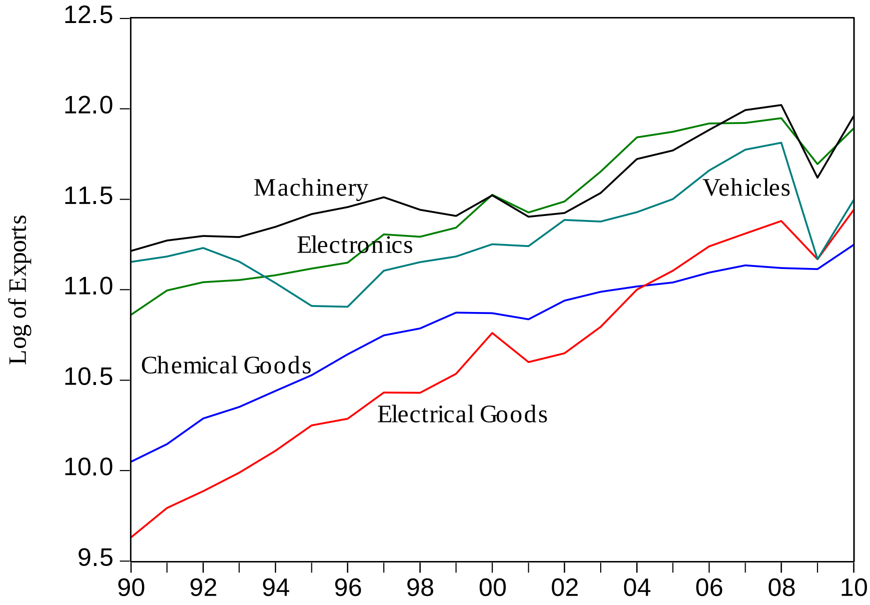

Figure 2. Aggregate Yen Corporate Goods Price Index and Aggregate Yen Export Price Index.
Source: Bank of Japan.

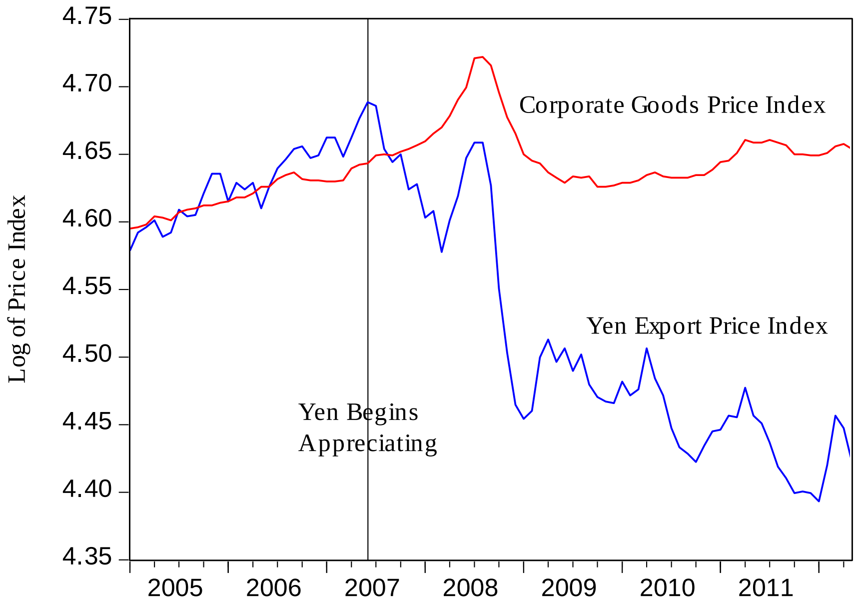

Figure 3. Residuals from Vector Error Correction Estimates of Japanese Exports over the 1982 – 2010 Period.

Source: Calculations by the author.

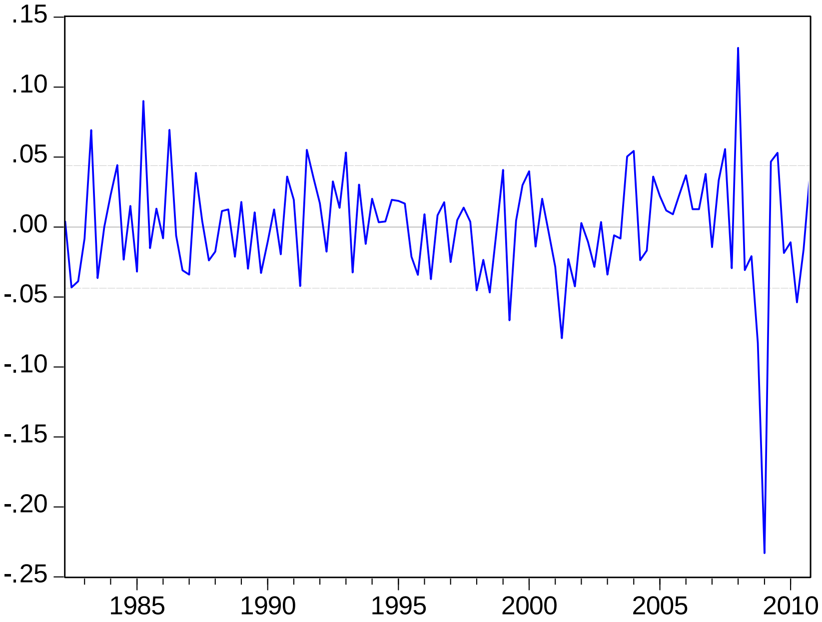

Table 1. Johansen MLE Estimates for Japanese Exports to the World[1]

	Number of Cointegrating Vectors	Number of Observations	Yen REER Elasticity	Income Elasticity	Error Correction Coefficients		
					Exports	Yen REER	Income
<u>Japan's Exports</u> (Lags: 4; Sample: 1982:III-2010:IV; No trend; Seasonal dummies for the first, second, and third quarters included)	1,1	114	-0.26*** (0.08)	1.07*** (0.03)	-0.32*** (0.10)	0.03 (0.10)	-0.02 (0.02)
<u>Japan's Exports</u> (Lags: 3; Sample: 1990:I-2010:IV; No trend; Seasonal dummies for the first, second, and third quarters included)	1,1	84	-0.67*** (0.10)	0.95*** (0.04)	-0.24** (0.08)	-0.18** (0.08)	0.03 (0.02)
<u>Japan's Exports</u> (Lags: 0; Sample: 1990:I-2008:II; No trend; Seasonal dummies for the first, second, and third quarters included)	0,0	74	-0.44*** (0.16)	1.00*** (0.13)	-0.20*** (0.06)	-0.02 (0.08)	0.01 (0.10)

[1]Number of Cointegrating Vectors indicates the number of cointegrating relations according to the trace and maximum eigenvalue test using 5% asymptotic critical values.
*** (**) denotes significance at the 1% (5%) level.

Table 2. Dynamic OLS Estimates for Japanese Exports to the World

	(1)	(2)	(3)
Yen REER Elasticity	-0.27***	-0.57***	-0.61***
	(0.04)	(0.08)	(0.06)
Income Elasticity	1.06***	1.00***	1.04***
	(0.02)	(0.03)	(0.03)
No. of Lags and Leads	2	5	5
Adjusted R-squared	0.98	0.99	0.99
No. of observations	117	81	74
Sample Period	1981:4-2010:4	1990:1-2010:1	1990:1-2008:2

Notes: DOLS estimates. Heteroskedasticity-consistent standard errors are in parentheses. The number of lags are determined by the Schwarz Criterion. *** denotes significance at the 1% level.

Table 3. Major Importing Countries for Japan's Exports

IMPORTING COUNTRIES	EXPORTING SECTOR					
	ALL	CHEMICAL	ELECTRICAL	ELECTRONIC	MACHINERY	VEHICLES
AUSTRALIA	X	X		X	X	X
BELGIUM-LUXEMBOURG	X					X
CANADA	X			X	X	X
CHINA	X	X	X	X	X	X
FRANCE	X	X		X	X	X
GERMANY	X	X	X	X	X	X
HONG KONG	X	X	X	X	X	
INDONESIA	X	X	X		X	
ITALY						X
MALAYSIA	X	X	X	X	X	
NETHERLANDS	X			X		X
NEW ZEALAND						X
PHILIPPINES			X			
SAUDI ARABIA						X
SINGAPORE	X	X	X	X	X	X
SOUTH KOREA	X	X	X	X	X	
SWITZERLAND						X
TAIWAN	X	X	X	X	X	
THAILAND	X	X	X	X	X	
UNITED KINGDOM	X	X	X	X	X	X
UNITED STATES	X	X	X	X	X	X

Source: CEPII-CHELEM database.

Table 4a. Panel Dynamic OLS Estimates of Japanese Sectoral Exports to Major Trading Partners over the 1993-2010 Period

	Sector						
	(1) All	(2) All w/o parts & components	(3) Chemicals	(4) Electrical	(5) Electronics w/o parts and components	(6) Machinery	(7) Vehicles w/o parts and components
Bilateral RER (CEPII)	-0.32***	-0.26***	-0.06	0.01	-0.38*	-0.51***	-1.26***
	(0.09)	(0.05)	(0.08)	(0.07)	(0.23)	(0.08)	(0.23)
Real GDP	0.89***	0.86***	1.00***	1.44***	1.29***	0.50***	0.32
	(0.05)	(0.06)	(0.04)	(0.09)	(0.06)	(0.09)	(0.43)
Adjusted R^2	0.97	0.97	0.97	0.92	0.95	0.95	0.93
Sample Period	1993-2010	1993-2010	1993-2010	1993-2010	1993-2010	1993-2010	1993-2010
No. of Importing Countries	16	16	13	12	14	14	13
No. of Observations	288	288	234	216	252	252	234

Notes: The sectors in the table represent chains as defined by the CEPII-CHELEM database. The data are measured in U.S. dollars, and are deflated using export price data for the relevant sector obtained from the Bank of Japan and converted to dollars using the nominal yen/dollar exchange rate.

*** (**) [*] denotes significance at the 1% (5%) [10%] level.

Table 4b. Panel Dynamic OLS Estimates of Japanese Sectoral Exports to Major Trading Partners over the 1993-2008 Period

	Sector						
	(1) All	(2) All w/o parts & components	(3) Chemicals	(4) Electrical	(5) Electronics w/o parts and components	(6) Machinery	(7) Vehicles w/o parts and components
Bilateral RER (CEPII)	-0.31*** (0.08)	-0.30*** (0.05)	-0.16 (0.10)	0.08 (0.07)	-0.06 (0.23)	-0.58*** (0.07)	-0.66*** (0.26)
Real GDP	0.89*** (0.06)	0.85*** (0.05)	1.01*** (0.06)	1.58*** (0.09)	1.36*** (0.10)	0.39*** (0.09)	1.14*** (0.22)
Adjusted R^2	0.97	0.97	0.96	0.93	0.96	0.96	0.94
Sample Period	1993-2008	1993-2008	1993-2008	1993-2008	1993-2008	1993-2008	1993-2008
No. of Importing Countries	16	16	13	12	14	14	13
No. of Observations	256	256	208	192	224	224	208

Notes: The sectors in the table represent chains as defined by the CEPII-CHELEM database. The data are measured in U.S. dollars, and are deflated using export price data for the relevant sector obtained from the Bank of Japan and converted to dollars using the nominal yen/dollar exchange rate.
*** denotes significance at the 1% .

Table 5. The Effect of Exchange Rate Changes on Yen Export Prices for Various Sectors

	Exchange Rate Variable		June 2007 to May 2012			January 2005 to May 2012		
Sector	(1) Nominal Effective Exchange Rate (NEER)	(2) Yen/dollar Nominal Exchange Rate (Yen$)	(3) Δ ln(Yen Export Price)	(4) Δ ln (Yen Export Price) - Δln (Yen Costs)	(5) Δln(Yen Export Price) explained by Δln(NEER)	(6) Δ ln (Yen Export Price)	(7) Δln (Yen Export Price) - Δln (Yen Costs)	(8) Δ ln(Yen Export Price) explained by Δ ln(NEER)
All	-0.62*** (0.04)	0.52*** (0.05)	-0.266	-0.277	-0.242	-0.156	-0.215	-0.106
Chemical	-1.14*** (0.12)	0.51*** (0.15)	-0.213	-0.194	-0.446	-0.034	-0.031	-0.196
Electrical & Electronic	-0.58*** (0.05)	0.59*** (0.04)	-0.489	-0.373	-0.223	-0.549	-0.402	-0.098
General Machinery	-0.50*** (0.04)	0.46*** (0.06)	-0.159	-0.154	-0.195	-0.062	-0.058	-0.085
Transportation	-0.73*** (0.06)	0.71*** (0.11)	-0.240	-0.259	-0.287	-0.129	-0.144	-0.126

Notes: The values in the table are the sum of the coefficients on the contemporaneous first difference of the exchange rate (Δe_j) and lagged first differences of the exchange rate. The number of lags is determined by the Schwarz criterion. Yen costs are proxied by the domestic corporate goods price index for the relevant industry. Data on yen export prices and yen costs come from the Bank of Japan. The sample period for the estimation extends from January 2005 to March 2012. There are 84 observations. Heteroskedasticity-consistent standard errors are in parentheses.

*** denotes significance at the 1% level.

Table 6. Exchange Rate Exposure of Japanese Industries

	Exposure to Yen/$ Exchange Rate	Exposure to Won/$ Exchange Rate	Exposure to Market Index		Δ ln (Sectoral Stock Index)	
Sector	(1) Coefficient (Standard Error)	(2) Coefficient (Standard Error)	(3) Coefficient (Standard Error)	(4) Adjusted R- squared	(5) June 22, 2007- June 27, 2012	(6) Jan. 1, 2005- June 27, 2012
Electronic Office Equipment	0.43*** (0.06)	-0.23*** (0.06)	0.99*** (0.04)	0.70	-1.00	-0.38
Automobiles and Parts	0.33*** (0.05)	-0.12*** (0.05)	1.07*** (0.03)	0.79	-0.74	-0.26
Technology Hardware and Equipment	0.33*** (0.04)	-0.19*** (0.05)	1.05*** (0.03)	0.82	-1.13	-0.74
Semiconductors	0.31*** (0.05)	-0.23*** (0.05)	1.10*** (0.03)	0.72	-1.45	-1.09
Computer Hardware	0.20*** (0.05)	-0.07 (0.06)	1.10*** (0.03)	0.73	-1.13	-0.98
Electronic Equipment	0.15*** (0.04)	-0.12*** (0.03)	1.00*** (0.03)	0.81	-0.57	-0.20
Electrical Components and Equipment	0.14*** (0.03)	-0.16*** (0.04)	1.14*** (0.02)	0.84	-0.96	-0.48
Industrial Machinery	0.14*** (0.03)	-0.18*** (0.04)	1.18*** (0.03)	0.85	-0.63	0.21
Chemicals	0.04 (0.03)	-0.10*** (0.04)	1.08*** (0.03)	0.86	-0.82	-0.30
Telecommunications	-0.07 (0.06)	0.02 (0.06)	0.98*** (0.04)	0.55	-0.50	-1.03

Notes: The coefficients in the table come from a regression of daily sectoral stock returns on the daily yen/dollar nominal exchange rate, the daily won/dollar nominal exchange rate, and the daily total market return index. Stock return data are from Datastream, the yen/dollar exchange rate data are from the Bank of Japan, and the won/dollar exchange rate data are from the Bank of Korea. The sample period for the estimation extends from 1/05/2005 to 6/27/2012. There are 1747 observations. Heteroroskedasticity-consistent standard errors are in parentheses.
*** denotes significance at the 1% level.

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