Exchange Rates and Profit Margins: The Case of Japanese Exporters

Thomas Klitgaard

Exporters must make a pricing decision whenever exchange rates change. A rise in the yen's value, for example, forces Japanese exporting firms to decide how much to alter the prices seen by their foreign customers. At one extreme, they could lower the yen price of their exports so that the dollar price of their sales to the United States would remain unaffected. The yen's rise would then have no impact on the price and volume of U.S. imports from Japan, but it would have adverse consequences for Japanese profit margins. At the other extreme, Japanese firms could keep the yen price of their exports unchanged so that the yen's rise would be completely passed through to U.S. consumers in the form of higher prices in dollar terms. The profit margins of Japanese exporters would then remain unchanged, but the volume of sales would drop, leading to a lower *level* of profits.

This article examines how Japanese exporters are responding to the conflicting objectives of maintaining stable profit margins and stable export sales when the value of the yen fluctuates. We find that Japanese firms tend to strike a balance between these goals. The firms' foreign customers do see exchange-rate-driven changes in prices, but the firms moderate the extent of these changes by altering their profit margins. For Japanese exporters producing industrial machinery, electrical machinery, and transportation equipment, our analysis suggests that a 10 percent rise in the yen leads to a roughly 4 percent decline in export margins (relative to the margins on goods sold in Japan) when other factors are held constant. That is, exporters in these industries pass on more than half of any change in the yen to the price seen by their foreign customers and absorb the remainder by adjusting profit margins on their foreign sales.

We also address other key issues related to the behavior of profit margins. For example, the short-run response of profit margins to exchange rate movements appears to be most pronounced in the transportation equipment and electrical machinery industries. One explanation

Thomas Klitgaard is a senior economist at the Federal Reserve Bank of New York.

for this is that these two industries have a greater tendency to invoice their goods in foreign currency terms so that prices, when measured in yen terms, respond automatically to exchange rate swings. In addition, the direction of the yen's movement is found to have no effect on how willing Japanese exporters are to use profit margins to stabilize prices in foreign markets. Firms are just as likely to raise profit margins when the yen depreciates as they are to cut margins when the yen appreciates. Finally, an examination of profit margins since the beginning of the Asian currency crisis in mid-1997 reveals that only firms in the electrical machinery industry have altered their pricing behavior. The higher than expected profit margins on exports from this industry, however, do not appear to be related to how these firms are responding to yen movements.

The consequences for the U.S. economy from a change in the yen's value depend on how much of any change is passed through by Japanese exporters to the prices seen by their U.S. customers.

Exchange Rates and Export Prices

The consequences for the U.S. economy from a change in the yen's value depend on how much of any change is passed through by Japanese exporters to the prices seen by their U.S. customers.[1] Chart 1 shows that by 1995, prices of imports from Japan were up roughly 20 percent from 1991, the first year for which data are available. But if Japanese export prices had remained unchanged in yen terms (meaning a full pass-through of changes in the yen), then U.S. import prices of Japanese goods would have tracked the dollar/yen index. The U.S. import price of Japanese goods did not rise by nearly as much as the dollar/yen exchange rate in the first half of the 1990s because Japanese firms lowered their export prices in yen terms. When the yen started to depreciate in early 1995, the price of U.S. imports from Japan did not fall as much as the currency rate did because Japanese firms took this opportunity to lift their yen export prices back up.

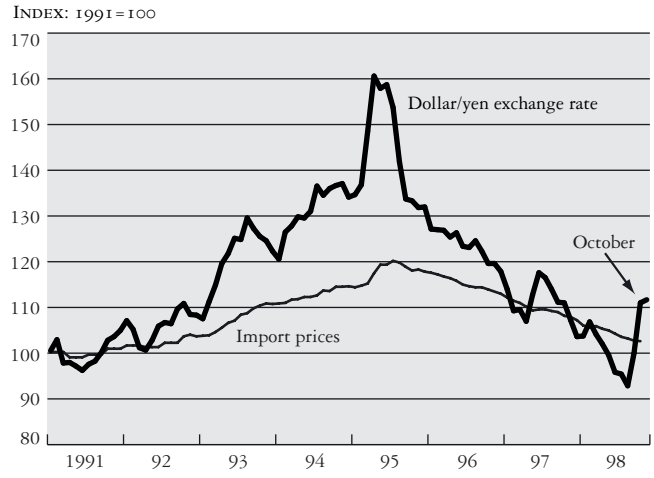
There are two possible explanations for how Japanese firms are able to offset yen movements. One is that the yen has a significant impact on production costs. For example, a stronger yen lowers the cost of imported inputs. The drop in production costs, in yen terms, then makes it easier for firms to lower yen export prices (Box A). The second explanation is that Japanese exporters absorb part of the yen's movement into their profit margins, an action that reduces the profit on each item sold when the yen appreciates and raises the profit margin when the yen depreciates. It is this latter explanation that will now be explored.

The Yen's Impact on Profit Margins

Studies that focus on profit margins are derived from the belief that firms, having found a profit-maximizing price

Chart 1

U.S. Import Prices for Japanese Goods



Sources: U.S. Department of Labor, Bureau of Labor Statistics; Federal Reserve Bank of New York.

Box A: The Yen's Impact on Input Costs

The yen affects the price of imported goods used by Japanese exporters. When the yen appreciates, the yen price of imports such as oil and other commodities, which are typically contracted in dollar terms, drops. During the yen's rise from 1990 to 1995, for example, import prices fell 25 percent, suggesting that exporters were significantly aided in their efforts to reduce the yen price of their goods during this period through lower production costs.

The data, though, suggest that any help for Japanese exporters trying to stabilize the foreign currency price of their goods is limited. For example, from 1990 to 1995, the raw material price of fuel in the Japanese wholesale price index fell 25 percent, in line with the overall import price index. Over the same period, the intermediate price of energy—the price seen by manufacturers—fell by a more modest 7 percent. Indeed, prices for all inputs (both imports and domestically produced goods) declined by roughly 5 percent for the industrial machinery, transportation equipment, and precision equipment industries during the yen's sharp rise in first half of the decade (see table). Input prices of electrical machinery fell more sharply, by 13 percent, but this was due in part to the strong deflationary trend in this industry.

The modest change in input costs for manufacturers, relative to the size of the yen's movements, was also evident when the yen depreciated from 1995 to 1998. Import prices rose 18 percent, and the wholesale price of raw material fuel jumped 15 percent. Nevertheless, the intermediate price of energy was up 2 percent and the index of input prices for Japan's four major exporting industries fell in the range of 0 to 4 percent.

In general, input prices seen by Japanese firms are much more stable than exchange rates, a factor that limits how much exchange-rate-induced swings in production costs can help Japanese exporters offset currency movements. The more modest the impact the yen has on production costs, the more the efforts to offset the yen's impact on the foreign currency price of Japanese exports must be accomplished by varying profit margins.

Percentage Change in Input Prices

Industry	1990-95	1995-98
Industrial machinery	-3.5	-0.3
Electrical machinery	-12.0	-3.9
Transportation equipment	-3.7	-1.6
Precision equipment	-5.7	-1.6

Source: Bank of Japan.

Notes: Percentage changes are not annualized. Data for 1998 are through October.

in each market based on supply and demand conditions, will attempt to keep their goods close to this price. This idea of pricing to market means that firms are inclined to absorb currency swings into their profit margins in order to stabilize prices seen by foreign customers.[2]

Data on profit margins of exports and domestic sales are not available separately, but we can construct a good proxy variable since Japanese wholesale price data contain two separate price indexes. One is for prices charged by Japanese firms to their foreign customers and the other is for prices charged to their domestic customers. Changes in the ratio of the two indexes can be interpreted as measuring changes in firms' relative profit margins.[3] That is, if export prices are falling relative to prices charged to domestic customers, then the markup over costs for exports has fallen relative to the markup for domestic sales, assuming the same production costs for both sets of goods.

A comparison of export prices and domestic prices reveals that profit margins on exports relative to domestic sales varied substantially over the 1990s. Table 1 shows that the prices Japanese firms charged domestic customers in Japan's four major exporting industries were stable from 1990 to 1995,[4] with the exception of those for electrical machinery, which declined 13 percent (in line with the deflationary trend of prices in this industry). During the

Table 1
PERCENTAGE CHANGE IN JAPANESE GOODS' EXPORT AND DOMESTIC PRICES IN JAPAN'S FOUR MAJOR EXPORTING INDUSTRIES

	1990-95		1995-98	
Industry	Export Prices	Domestic Prices	Export Prices	Domestic Prices
Industrial machinery	-6.7	-1.1	10.6	0.0
Electrical machinery	-35.0	-12.7	2.6	-14.9
Transportation equipment	-8.9	-1.9	23.3	-1.7
Precision equipment	-9.8	-1.3	13.0	-0.9

Source: Bank of Japan.

Notes: Percentage changes are not annualized. Data for 1998 are through October.

same period, export prices dropped 7 to 10 percent for all industries except electrical machinery, which fell 35 percent. As a consequence, there were substantial differences in the markup between domestic and foreign sales in 1995 compared with markup differences in 1990.

Divergences also occurred when the yen started falling in 1995. From 1995 to 1998, domestic prices continued on the same path, with prices being stable except for electrical machinery prices, which fell 15 percent. But the behavior of export prices was very different. Prices for industrial machinery were up 11 percent and those for transportation equipment were up 23 percent. Even electrical machinery, with its strong deflationary trend, saw prices rise 3 percent during this period.

These data show that Japanese firms charge different prices for their Japanese and foreign customers when the yen changes value. Firms try to stabilize prices as seen by their customers in both foreign and domestic markets, which means that their relative profit margins rise and fall with the yen. The next section explains why a profit-maximizing strategy leads firms to vary markups across markets.

PROFIT MAXIMIZING WITH EXCHANGE RATE CHANGES

A useful model for understanding why profit margins vary between domestic and foreign markets was developed by Marston (1990). Firms in this model are assumed to have some control over their prices because of product differentiation or some other market imperfection. Manufacturers produce goods locally but sell them in both domestic and export markets. These firms charge P_h (in yen terms) in the domestic market and P_x (in foreign currency terms) in export markets. We assume that imperfect arbitrage between markets allows prices to differ in each market. Therefore, firms can take advantage of the profit-maximizing strategy of setting prices according to each market's demand characteristics.

To illustrate, we think of prices as markups over the same marginal costs:

(1) $P_h = M(P_h/P, Y)MC$ and
$P_x/S = N(P_x/P^*, Y^*)MC.$

The exchange rate, S, is foreign currency per yen, P is the general price level, and Y is income. The asterisk represents foreign variables. The destination-specific markup functions M and N depend on price elasticities of demand in each market and how these elasticities change with prices.[5] A number of factors—such as consumer tastes, the substitutability with competing products, and the firm's market share—dictate these demand characteristics. Any gap between P_h and P_x/S reflects differences between the markup functions M and N.

An exchange rate movement alters profit margins on exports because firms know that letting prices automatically rise when their currency falls reduces the demand for their goods.

Essentially, the model says that with common production costs, differences in prices for any particular market are based on marginal revenue calculations made by the firm, which in turn are dictated by the responsiveness of demand to changes in prices. Any negative relationship between demand and prices implies a negative relationship between prices and markups.[6] An exchange rate movement alters profit margins on exports because firms know that

letting prices automatically rise when their currency falls reduces the demand for their goods. As a result, export prices, in foreign currency terms, do not adjust one-to-one with exchange rate changes.

Production costs and income also affect relative profit margins when consumer demand characteristics differ across markets. For example, an increase in input costs such as energy would push a firm to raise prices in both markets, but not necessarily by the same amount. The relative change in the two prices depends on how customers in the two markets react to higher prices. The impact of income on profit margins is determined by differences in demand elasticities with respect to prices and to income. The dependence on differences in demand characteristics across markets means that the model does not require any particular direction for relative margins to move with changes in production costs or income.

In sum, Marston's model suggests that the yen and a set of other variables influence the relative markup measured by the ratio of the export price index to the price index for Japanese goods sold in Japan. We will now use the model to evaluate empirically the impact of exchange rate changes on these margins across Japan's four major exporting industries.

The Long-Run Response of Profit Margins to Changes in the Yen

Marston's model suggests the following empirical specification:

$$(2)\quad p_{xt} - p_{bt} = \beta_0 + \beta_1(s_t + p^*_t - p_t) + \beta_2(c_t - p_t) + \beta_3 y_t + \beta_4 y^*_t + u_t,$$

where p_{xt} is the yen price of exports, p_{bt} is the price of Japanese goods sold in Japan, s_t is the exchange rate, p_t is the overall wholesale price index, c_t is production costs, and y_t is income. An asterisk designates a foreign variable. All variables are in log levels. The coefficients on the real exchange rate, real production costs, and real output measures are dictated by the demand characteristics faced by each industry in both foreign and domestic markets. The only sign implied by the model is that the coefficient on the real exchange rate, β_1, is negative.

Dynamic ordinary least squares regressions are a statistically efficient method for estimating the long-run response of relative export prices to each of these variables (Box B). Table 2 shows that the real yen index has a significant impact on relative profit margins. In particular, the estimates for β_1 are around -0.4 for industrial machinery, electrical machinery, and transportation equipment, three industries that together make up 70 percent of Japanese exports. This means that a 10 percent appreciation of the yen, all else being kept constant, decreases yen export prices by 4 percent relative to prices charged by Japanese firms to their domestic customers over the long run.[7] The fourth industry, precision equipment, has profit margins that respond much more modestly to the yen, with relative export prices falling only 2 percent for every 10 percent

Table 2
DYNAMIC ORDINARY LEAST SQUARES REGRESSION RESULTS

	Industrial Machinery	Electrical Machinery	Transportation Equipment	Precision Equipment
Constant	3.11	2.08	-0.06	5.93
	(75.1)	(9.6)	(1.4)	(10.4)
Real exchange rate	-0.38	-0.37	-0.46	-0.21
	(37.2)	(11.5)	(22.9)	(6.9)
Japanese industrial production	-0.46	0.37	—	-0.76
	(23.6)	(8.9)		(9.3)
Foreign industrial production	0.19	-0.37	0.50	—
	(11.8)	(4.9)	(22.7)	
Real unit labor costs	—	—	—	-0.29
				(4.1)
Real input costs	—	0.84	-0.71	—
		(7.7)	(4.6)	
Adjusted R^2	.99	.99	.95	.93
Sum of squared errors	.01	.04	.03	.14
ADF statistic	-5.5	-4.2	-5.7	-4.7
Error-correction coefficient	-0.11	-0.13	-0.19	-0.10
	(2.9)	(3.5)	(4.4)	(3.6)

Source: Author's calculations.

Notes: The sample period extends from January 1981 to June 1997. Variables are in log-level form. The regressions follow the dynamic ordinary least squares method as described in the article. The t-statistics in parentheses are based on Newey-West adjusted standard errors.

The Campbell and Perron method is used to select lags for the ADF statistic: The regression is initially run with twelve lags; if the twelfth lag is insignificant, then the lag is deleted and the regression is run again. This process is repeated until the last lag is significant at the 5 percent level. The critical values for the ADF depend on the number of variables in the regression and the sample size. For all regressions but electrical machinery, the critical values are -3.8 (5 percent) and -4.4 (1 percent). Because the electrical machinery regression has one more variable, the critical values are -4.2 (5 percent) and -4.7 (1 percent). The data are described in the appendix.

Box B: Estimating Long-Run and Short-Run Pricing-to-Market Behavior

Japanese pricing-to-market behavior is estimated in two stages. The first stage calculates the long-run relationship between the variables in equation 2 with a dynamic ordinary least squares (DOLS) regression. The second stage measures the short-run behavior of relative export prices using an error-correction (EC) regression. The two regressions are connected since the difference between actual values and fitted values in the DOLS regression is used in the EC regression to predict relative export price movements.

The DOLS approach, as used by Stock and Watson (1993), modifies basic ordinary least squares estimation techniques by including both leads and lags of the first difference of all explanatory variables. These additional regressors are necessary because estimates in a single equation model can be biased by endogeneity among the variables. (In our regressions, four leads and lags were used, with the longest leads and lags eliminated if they were statistically insignificant. If the fourth lead or lag was significant, then additional leads or lags were added. The coefficients on the first difference variables are of no economic interest and are therefore not listed in Table 2.)

Certain conditions must be satisfied when conducting a DOLS regression:

- The level data of all variables must be nonstationary, while the first differences of the variables must be stationary. Essentially, a variable is stationary if its unconditional expected value and standard error do not change over time. The data used here satisfy this requirement.
- The DOLS regression results must yield stationary residuals. The test statistic is the augmented Dickey-Fuller test, listed as ADF in Table 2.
- The DOLS residual must be significantly correlated with subsequent monthly changes in relative export prices.

Short-run behavior is evaluated using an EC regression. In this regression, all the variables are converted into first differences, which, since the variables are in logs, is similar to converting the data into percentage changes. The change in relative export prices is then regressed against the lag of the residual from the DOLS regression, u_t, lags of changes in the explanatory variables, and lags of changes in relative export prices.[a]

$$\Delta(p_{xt} - p_{bt}) = a_1 + b_1 u_{t-1} \sum_{i=0}^{n} c_i \Delta(s_{t-i} + p_{t-i} - p^*_{t-i}) + \sum_{i=1}^{n} f_i(\Delta(c_{t-i} - p_{t-i})) + \sum_{i=1}^{n} g_i \Delta y_{t-i} + \sum_{i=1}^{n} h_i \Delta y^*_{t-i} + \sum_{i=1}^{n} j_i \Delta(p_{xt-i} - p_{bt-i}) + e_i .$$

The residual is included since it should help predict how relative export prices will change in subsequent months. That is, any divergence of the relative export price index from its long-run value should tend to disappear. A negative and statistically significant residual is evidence that the DOLS coefficients do indeed represent a long-run relationship between the variables. The estimates of b_1, listed as error-correction coefficients in Table 2, are all negative and statistically significant, ranging from –0.10 for precision equipment to –0.19 for transportation equipment.

The EC regression estimates will be used to illustrate how relative export prices respond in the short run to a change in the yen's value.

[a] The contemporaneous value of the real yen is included to capture the automatic change in relative export price from Japanese exporters invoicing their goods in foreign currency terms.

rise in the yen. Apparently, this industry has foreign customers that are relatively insensitive to price changes.

The model discussed above makes no restrictions on the sign or the magnitude of the other coefficients since these estimates reflect reduced-form representations of differences in demand characteristics between markets. Of note is the fact that the electrical machinery regression calculates a sign on its foreign industrial production, domestic income, and input costs that is the opposite of the signs estimated for the other industries.

With these results, it is now possible to address issues about how Japanese profit margins respond in the

short run to the yen, whether the response depends on the direction of the yen's movement, and whether markup behavior changed during the Asian currency crisis.

The Short-Run Response of Profit Margins to Changes in the Yen

It is likely that the short-run response of relative profit margins to changes in the yen differs from the long-run responses in Table 2. For example, if firms list the prices of their exports in dollar terms, one might see export prices, in yen terms, overshoot their long-run value. Alternatively, export prices might be slow to respond if firms contract out their prices in yen terms.

Chart 2 lists the response of relative export prices to a 10 percent rise in the real yen. (See Box C for details on how these values were calculated.) Essentially, the chart plots the month-to-month change following a rise in the yen. The reactions of profit margins for firms producing electrical machinery and transportation equipment are similar. For transportation equipment, there is an immediate 7 percent drop in export prices relative to prices charged to Japanese customers. Profit margins on exports are consequently squeezed sharply in the first few months, while foreign customers see relatively modest increases in the price of Japanese goods. Firms in this industry, though, do not view a drop in markups of this magnitude as being in their best interest. They pull export prices up shortly thereafter so that within twelve months the decline in relative export prices is near the long-run response of roughly 4.5 percent (represented by the horizontal lines in the chart). The overshooting of yen export prices suggests that a substantial portion of Japanese exports in both the electrical machinery and transportation equipment industries are invoiced in foreign currency terms, making the initial reaction of export prices to the yen more a passive response than a strategic choice by firms to reduce profit margins.

Exporters of industrial machinery and precision equipment are much less prone to overreact to a yen appreciation, implying that they are less likely to set contract prices in dollar terms. Firms producing industrial machinery adjust their margins to their long-run levels almost immediately, while those exporting precision equipment shift their margins to near their desired long-run levels within four months.

Symmetry

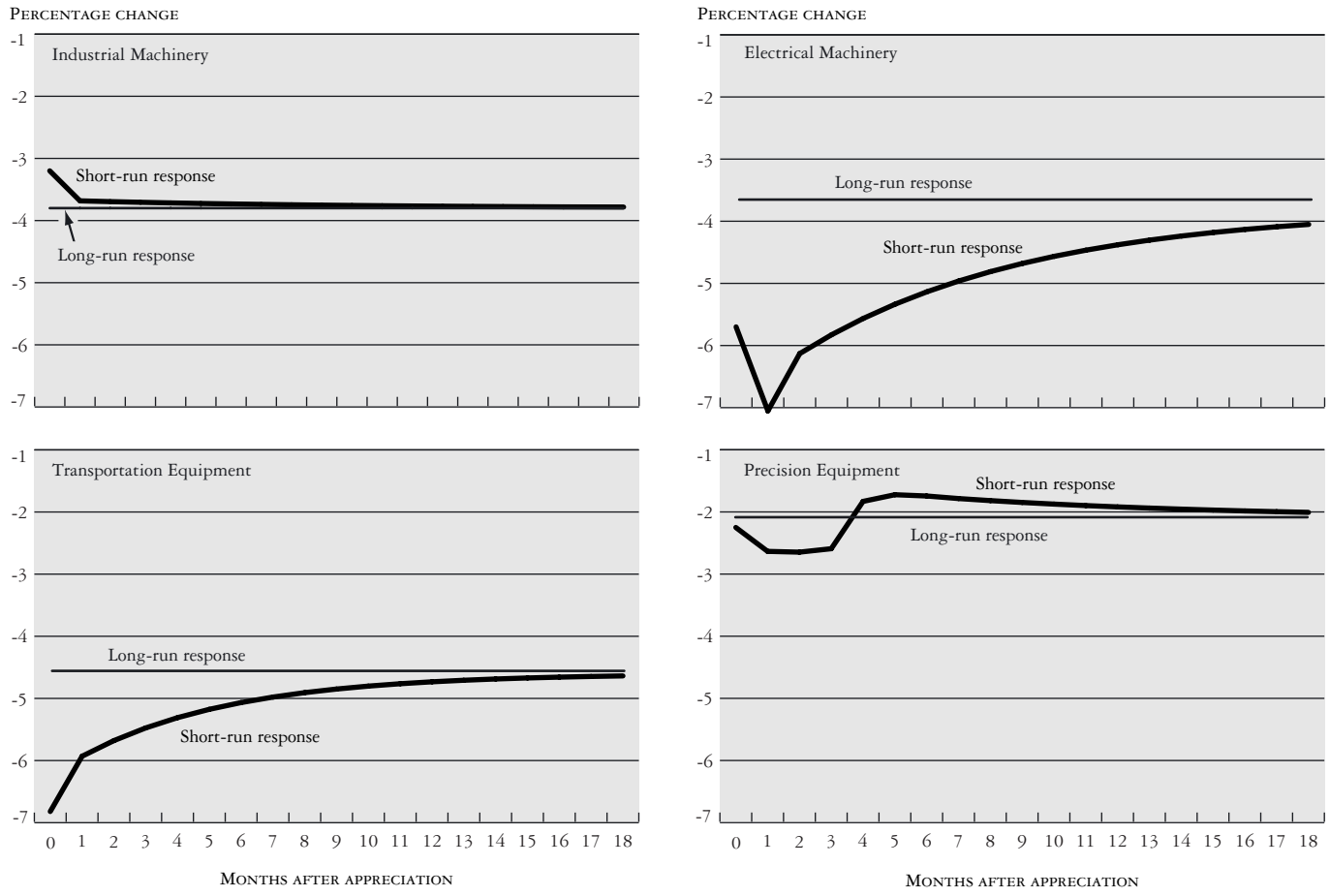
When Japanese firms cut the yen price of their exports to offset a yen appreciation, they are sacrificing profit margins to protect sales. However, when the yen depreciates, do these firms raise the yen price of their exports to the same extent in order to build their margins, or do they view a weak yen as an opportunity to gain market share by forgoing profits?

Since the beginning of the floating rate period, there have been only two episodes in which the yen experienced a prolonged depreciation: November 1988 to April 1990 and May 1995 to April 1997. To address the issue of how firms respond to a yen depreciation, we created an event dummy variable with a value of 1 for these two episodes and a value of 0 for all other months. This dummy variable was then multiplied by the exchange rate series to create an additional variable for the regression. The statistical significance of the dummy exchange rate variable is a simple test of whether the exchange rate coefficient depends on the direction of the yen's movements. The extent of any change is measured by adding the two exchange rate coefficients.

In all four regressions, the responses of relative export prices to the yen were found to be the same regardless of the yen's direction, with the size of the coefficients on the dummy variables being too small to change the values in Table 2. Japanese exporters of electrical machinery, industrial machinery, transportation equipment, and precision equipment respond in the same fashion regardless of the yen's direction. When the yen falls, the firms allow the foreign currency price of their exports to fall. The drop in prices seen by foreign customers is not as great as the yen's slide because Japanese firms strive to keep prices near other competing market prices. As a consequence, a falling yen helps profit margins to the same extent as a rising yen hurts them.

Chart 2

SHORT-RUN RESPONSE OF RELATIVE EXPORT PRICES TO A 10 PERCENT YEN APPRECIATION



Source: Author's calculations.

Note: Calculations are explained in Box C.

THE ASIAN CURRENCY CRISIS

The recent currency crisis in Asia created considerable uncertainty for Japanese exporters. The crisis started in early 1997 when the Thai government spent heavily to prop up its financial sector. Efforts to defend the currency against speculators failed, and the bhat was eventually allowed to float in early July. Pressures on exchange rates and government reserve holdings subsequently spread throughout the region, leading Indonesia, Malaysia, South Korea, and Thailand to suffer major devaluations while Singapore and Taiwan experienced significant but relatively modest declines.

The crisis complicated decision making for Japanese firms. In particular, exporters faced increased uncertainty over the level at which these currencies would eventually settle and the extent of their Asian customers' decline in demand for Japanese goods. In addition, Japanese firms faced greater uncertainty about the pricing and availability of imported components and materials from their Asian suppliers.

Because the Asian crisis occurred at the end of our sample period, it is possible to investigate the change in markup behavior by looking at the out-of-sample performance of the regressions estimated above. A successful forecasting of relative export prices would provide evidence that the markup behavior of Japanese firms was unaffected by the turmoil in Asia. A poor forecasting performance would

Box C: Simulating Short-Run Dynamics

The dynamic ordinary least squares (DOLS) regression results in Table 2 represent estimates of the long-run relationship between the export-weighted real yen index and the index of export prices relative to the index for domestic wholesale prices. The error-correction (EC) equation specified in Box B estimates how month-to-month changes in relative export prices are related to all variables considered and to the difference between the current level of relative export prices and the value suggested by the coefficients in Table 2. A combination of the DOLS and EC regressions can be used to illustrate how a permanent change in the real yen works to affect relative export prices over time. Specifically, the DOLS regression defines u so that the EC regression can be used to track monthly changes. (The coefficients from the EC regression appear in the table.)

A spreadsheet can show how relative export prices would react to a permanent 10 percent increase in the real export-weighted yen index. All other variables are assumed to be unchanged in this exercise. In the first month, the yen affects the change in relative export prices through the contemporaneous yen coefficient in the EC regression. In the second month, the yen works through the lagged yen variable (if it was statistically significant) and through the lagged residual value from the DOLS regression. This value is nonzero if the change in relative export prices in the first month did not push it to its long-run value dictated by the DOLS regression. The process continues, with the change in relative export prices in each month added to the change in the previous month to arrive at the results in Chart 2.

Error-Correction Regression Coefficients

	Industrial Equipment	Electrical Machinery	Transportation Equipment	Precision Equipment
Yen	-0.32 (25.8)	-0.57 (25.4)	-0.68 (31.7)	-0.22 (7.6)
Yen (-1)	-0.04 (3.4)	-0.16 (6.5)		
Yen (-2)		0.05 (2.0)	0.05 (2.1)	
Yen (-4)				0.07 (2.8)
Relative export price (-1)				0.18 (2.7)
Real input prices (-3)		-0.30 (2.0)		
Real unit labor cost (-1)				0.03 (2.8)
Japanese industrial production (-3)	-.05 (2.5)			
EC (-1)	-0.11 (3.6)	-0.13 (3.5)	-0.19 (4.4)	-0.10 (3.9)
R^2	.81	.81	.84	.29
Sum of squared errors	.003	.012	.012	.019

Source: Author's calculations.

Notes: The sample period extends from January 1981 to June 1997. The t-statistics are based on Newey-West adjusted standard errors. The regressions were originally run as specified in Box C and then all statistically insignificant variables were dropped. The EC variable is the time series of residuals from the regression results in Table 2. The number in parentheses next to a variable name represents the lag of the variable.

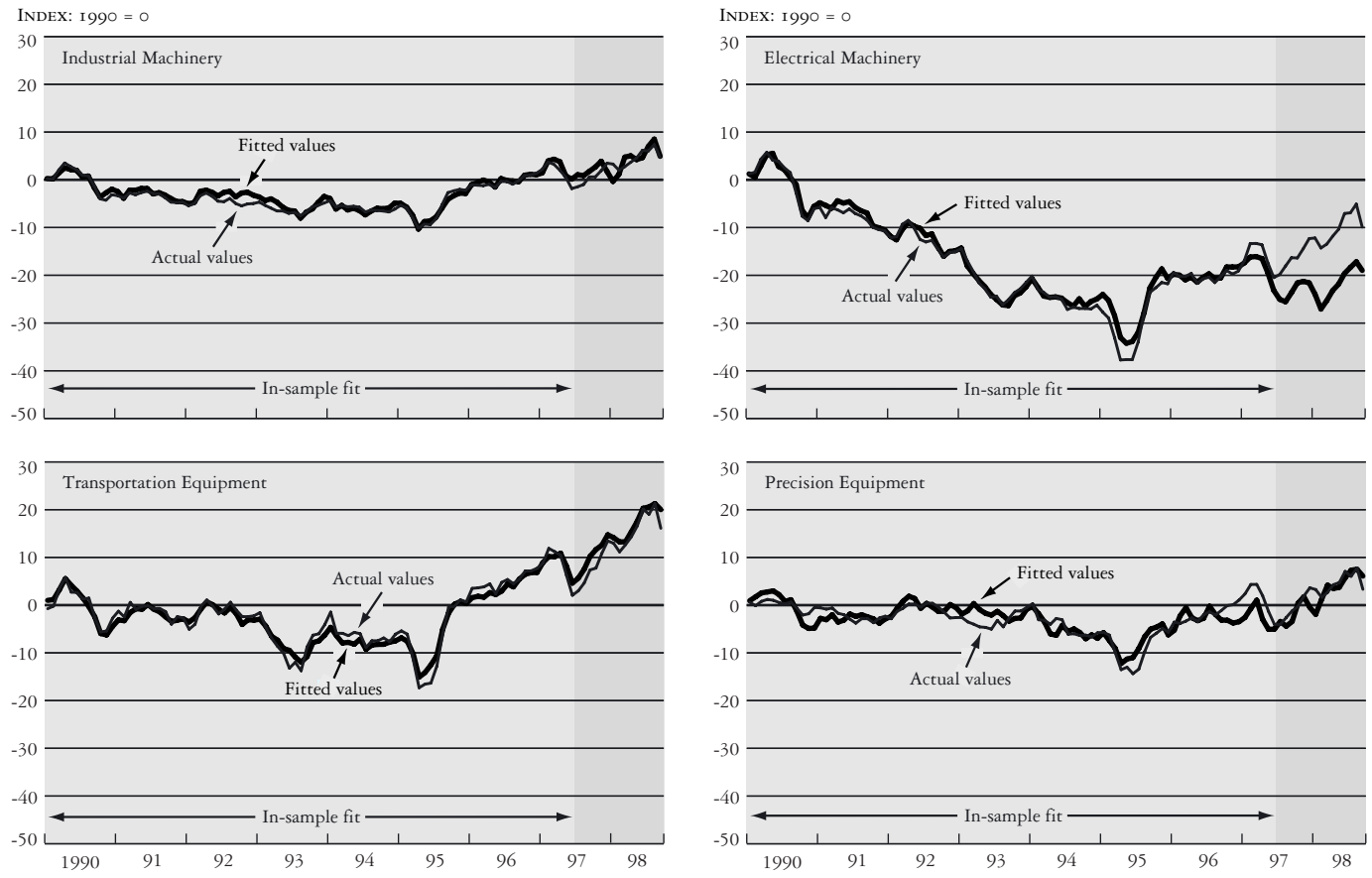
suggest that markup behavior changed in the aftermath of the crisis. Chart 3 plots the percentage difference between the prices Japanese firms charged their foreign and domestic customers, with the difference set to zero in 1990. (A decline reflects the falling of export prices relative to domestic Japanese prices.) For industrial machinery, transportation equipment, and precision equipment, the behavior of relative export prices appears to have been unaffected by the Asian currency crisis. All three industries raised their export prices relative to domestic prices after June 1996. In doing so, they took advantage, in a predictable way, of the yen's weakness against the dollar and European currencies to boost their profit margins on exported goods relative to goods sold in Japan.

For electrical machinery, however, relative export prices quickly went off track, with the gap widening considerably during the height of the crisis at the end of 1997. Specifically, Japanese firms in this industry raised relative export prices—an action that boosted margins on exported goods—while our regression predicted no such increase. The gap remained essentially unchanged during the first nine months of 1998.

Chart 3

BEHAVIOR OF RELATIVE EXPORT PRICES SINCE THE BEGINNING OF THE ASIAN CRISIS

Percentage Gap between Export and Domestic Price Indexes



Sources: Bank of Japan; author's calculations.

Notes: Data are through September 1998. Fitted values are based on regressions in Table 2. Fitted values in shaded areas are out-of-sample forecasts starting in July 1997. A decline represents a fall in export prices relative to Japanese domestic prices.

The source of our regression's failure to predict an increase can be found by again using dummies to look for changes in coefficient estimates during the crisis period. We ran our regression through September 1998 with four additional variables that were calculated by multiplying each variable by a dummy. The dummy is defined as equal to 0 before July 1997 and equal to 1 for the rest of the sample. The results show that the uncertainty faced by exporters did not change the specific response of relative export prices to the yen. Instead, the coefficients on the other three variables all moved to explain why relative export prices increased during the crisis period. Such instability suggests that firms were uncertain about the demand characteristics of their foreign and domestic customers. Nevertheless, this uncertainty did not appear to have caused Japanese firms to alter their willingness to absorb exchange rate swings into their profit margins.

CONCLUSION

Japanese firms adjust the yen prices of their exports when the yen's value changes, a strategy that makes profit margins an important channel through which exchange rates affect Japan's economy. We find that in three of the four industries examined, the firms aggressively shield their foreign customers from price swings by allowing the profit

margins on exports to fall 4 percent (relative to margins on goods sold in Japan) for every 10 percent appreciation of the yen.

Our findings also reveal that in Japan's electrical machinery and transportation equipment industries, the short-run responses of profit margins to changes in the yen are significantly greater than the long-run responses. This behavior is likely due to the fact that many exports in these two industries are denominated in foreign currency terms, making the change in export prices and profit margins an automatic, proportional response to changes in the yen. Moreover, the response of profit margins to changes in the yen is not found to depend on the direction of the yen's movements. Firms are as aggressive at raising export prices and building up profit margins after a favorable yen shift as they are at reducing profit margins after the yen moves against them.

Finally, the instability observed in pricing behavior in the wake of the Asian currency crisis seems to be limited to Japan's electrical machinery industry. Our forecasts predicted that firms in this industry should not have raised profit margins on exports relative to domestic sales as much as they did. Our findings suggest that firms in this industry have not changed the way in which they adjust profit margins in response to yen movements. Rather, the recent instability in markup behavior stems from changes in how exporters respond to other relevant variables.

Appendix: Data Sources

Japanese price data, at the wholesale level, are available for Japanese exports and for goods made by Japanese firms that are sold in the Japanese domestic market. The price indexes, published by the Bank of Japan, are Laspeyres, with weights altered every five years. These price data are significantly better than unit value export price indexes, which are simply the value of exports divided by the number of items shipped with no adjustments made for changes in the quality and composition of exports over time. The Bank of Japan is also the source of price indexes for inputs purchased by firms in each industry. The real unit labor cost measure is calculated using indexes for wages and productivity for each industry available in the *Monthly Statistics of Japan*. These indexes are seasonally adjusted using the X-11 (multiplicative) command in the EViews 3 software package.

Foreign variables are indexes constructed using data from the United States, Canada, Germany, the United Kingdom, France, the Netherlands, Korea, Taiwan, Hong Kong, and Singapore. The weights are based on the share of Japanese exports to each country, by each industry, in 1990. The data on industrial production, wholesale prices, and exchange rates are gathered from the International Monetary Fund, Data Resources International, Datastream, the Federal Reserve Bank of New York, and country sources.

Industrial production data from the four Asian countries are seasonally adjusted using the X-11 (multiplicative) command in EViews 3.

ENDNOTES

1. Examples of pass-through studies on Japan include Athukorala and Menon (1994), Loopesko and Johnson (1988), Marston (1990), and Tange (1997).

2. The pricing-to-market concept goes back at least as far as Krugman (1987). Pricing-to-market studies on Japanese exporters include Marston (1990), Ohno (1991), Khosla (1991), and Gagnon and Knetter (1995).

3. The ratio of the two indexes cannot tell you how the profit margin for exports compares with the margin for goods sold in Japan, since by construction both indexes are equal in the base year.

4. The four industries made up approximately 75 percent of Japanese exports in 1997. Industrial machinery and electrical machinery were each 24 percent, transportation equipment was 22 percent, and precision equipment was 5 percent.

5. Marston's model also has markups influenced by the derivative of marginal cost with respect to output.

6. The special case is when foreign customers do not respond at all to prices.

7. This result is similar to those found in other empirical studies. A survey of the literature in this field done by Goldberg and Knetter (1997) reported that measurements of pricing to market tend to be around 50 percent. They cite, as an example, the results reported by Marston (1990).

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