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Effectiveness of Exchange-Rate Changes on the Trade Account: The Japanese Case

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Many economists have criticized adherents of flexible exchange rates for overestimating the effectiveness of exchange-rate changes on redressing external imbalances. The critics argue that, since the advent of generalized floating in May 1973, large and persistent trade-account imbalances have occurred despite substantial swings in exchange rates. The issue, however, is not a new one among international economists.

According to traditional theory, an exchange-rate depreciation will improve the trade account of a devaluing country by increasing its price competitiveness in world markets. For example, a dollar depreciation can correct a trade deficit because it lowers the price of U.S. exports in terms of foreign currencies and raises the dollar price of imports in the U.S. market. Because U.S. goods become relatively cheaper to foreigners and imported goods more expensive to Americans, a dollar depreciation will improve the price competitiveness of U.S. export industries and likewise import-competing industries. The improved price competitiveness will boost U.S. export sales while reducing foreign sales in the U.S., leading to an improvement in the trade account.

In the past, many economists and policy makers doubted that these exchange-rate effects would be great enough to eliminate payment shortfalls. In their view, the volume effects of a dollar depreciation might not be large enough to produce an improvement in the U.S. trade balance. For analyzing this question, economists estimate price elasticities, which measure the degree of responsiveness of the quantity demanded to changes in its price. Numerically, a price elasticity of demand for exports (imports) of -2.0 indicates that a 1-percent rise in export (import) prices will lead to a 2-percent drop in the quantity demanded of exports (imports). A devaluation will improve the trade account in both domestic and foreign currency if the sum of the demand elasticities for exports and imports after reversing signs exceeds unity (the Marshall-Lerner condition). This assumes that an exchange-rate depreciation will lead to a proportional decline in the foreign-currency price of exports and a proportional rise in the home price of imports — and that the trade account will initially be in balance.

Many studies during the 1940s argued that the measured price elasticities were substantially less than one, so that a devaluing country would experience a worsening of its trade account. Such elasticity pessimism consequently led policymakers to consider policies other than relative-price changes to correct trade imbalances. However, the state of the art for empirical research improved considerably in the 1950s and 1960s. This, in turn, led to higher estimated price elasticities of demand, and contributed to renewed optimism about the success of a devaluation. In this view, the volume effects (higher exports, lower imports) would offset the adverse movement in the terms of trade and thus would lead to an improvement in the trade account.

The focus of the debate has subsequently shifted. While many critics do not dispute that a currency depreciation will eventually improve the trade account, they argue that the long time lags between changes in prices and

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changes in quantities diminish its usefulness as an instrument of adjustment. That is, it takes time for buyers and sellers to recognize changes in competitive situations and act accordingly. In the case of a dollar devaluation, Americans in the meantime will be spending more dollars on imported goods and foreigners will be spending less of their own currency on U.S. goods. An exchange-rate change thus is likely to lead to an initial deterioration (and a subsequent improvement), in the trade account of the country with a depreciating currency, and to an improvement in the trade balance of the country with an appreciating currency. The initial deterioration and subsequent improvement in the depreciating country's trade account resemble the letter J when the trade account is plotted on the vertical axis against time on the horizontal axis.

Some critics also have argued that the pricing behavior of exporters has changed with the adoption of flexible exchange rates, with exporters changing their profit margins rather than their prices in order to maintain sales. Hence, a depreciation simply tends to increase the home-currency price of exports and to lower the foreign-currency price of imports, leaving the devaluing country's competitive position unchanged.

The contentious debate about the ability of a freely floating exchange rate to restore price competitiveness has surfaced most recently in the controversy over the Japanese-U.S. automobile trade. That particular conflict has been resolved temporarily through the imposition of "voluntary" quotas on Japanese cars. But Japan has been running a persistently high surplus not only with the U.S. but also with the European community, and this has brought forth protectionist pressures against Japanese products.

This paper is designed to investigate the effectiveness of exchange-rate changes on the Japanese trade account. The view that exchange-rate movements will be completely passed forward into export and import prices can no longer be taken for granted. Thus the first stage of our analysis considers the impact of an exchange-rate change on the prices of exports and imports, and the second stage considers the effects of these price changes on the quantities demanded of exports and imports.[1] This two-stage procedure allows us to trace out the J-curve measuring the effects of a yen depreciation on the Japanese trade account.

Sections I and II provide the theoretical and empirical framework for measuring the effects of exchange-rate changes on export and import prices. Section III discusses the responsiveness of trade volumes to changes in relative prices, and Section IV describes the derivation of the J-curve. The paper concludes with a discussion of the policy implications.

I. Determination of Export and Import Prices

In the traditional view of trade adjustment, an exchange-rate depreciation will lead to a proportional decline in the foreign-currency price of exports and a proportional rise in the domestic-currency price of imports. The effectiveness of a devaluation thus will depend upon whether or not the absolute value of the sum of the price elasticities of demand is greater than one.

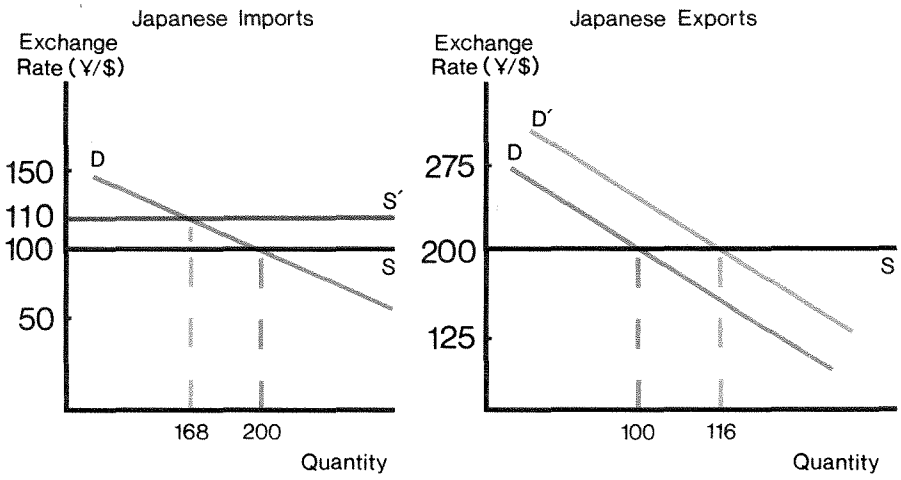
To illustrate, consider the impact of a yen depreciation on the Japanese trade account (Chart 1). Suppose a yen depreciation of 10 percent vis-a-vis the dollar leads to a proportional rise in the yen price of U.S. goods in the Japanese market. (In this example, the average price of an American good rises from 100 yen to 110 yen.) The rise in price makes American goods less attractive to Japanese buyers. Assume a demand elasticity of -1.6. The 10-percent price increase prompts a 16-percent fall in the quantity demanded of U.S. goods by Japanese importers. This is illustrated diagrammatically by a shift in the supply schedule from ss to s's'. The quantity demanded of U.S. goods falls from 200 million to 168 million units. The lower volume of American goods demanded more than offsets the price increase, so that the value of

Japanese imports in yen falls in response to a yen depreciation. In this example, the yen value of Japanese imports (price x quantity) declines from 20 billion yen to 18.48 billion yen. With the dollar price unchanged, the value of Japanese imports in dollars falls by the percentage change in the quantity demanded (16 percent).

Conversely, on the export side, a 10-percent yen depreciation produces a fall in the dollar price of Japanese exports, improving the price competitiveness of Japanese goods in the U.S. market. The greater demand stemming from the price decline is illustrated by a rightward shift in the demand schedule from DD to D'D'. Again, assume a demand elasticity of -1.6. The fall in the dollar price of Japanese exports boosts the quantity demanded by Americans of Japanese goods by 16 percent. With the yen price unchanged, the yen value of Japanese exports rises in direct proportion to the percentage increase in the quantity demanded. In dollars, the higher volume of Japanese exports more than compensates for the price decline, so that the dollar value of Japanese exports rises following a yen depreciation.

Chart 1

Impact of 10-Percent Yen Depreciation on the Japanese Trade Account



Impact of a 10-Percent Yen Depreciation on Japanese Trade Account (quantities in millions of currency units)

	Pre-10% yen depreciation*		Post-10% yen depreciation†	
	Yen	Dollars	Yen	Dollars
Trade balance (in millions)	0	0	4720	21.5
Exports (in millions)	20,000	100	23,200	105.5
Imports (in millions)	20,000	100	18,480	84.0
Export price	200	1.0	200	0.91
Import Price	100	0.5	110	0.50
Export quantity (in millions)	100	100	116	168
Import quantity (in millions)	200	200	168	168
Exchange rate	200	0.005	220	0.00455

*$1 = ¥200, or ¥1 = 0.50 cents
† $1 = ¥220, or ¥1 = 0.455 cents

On balance, the value of Japanese exports rises in both yen and dollars following a yen depreciation, while import value falls in both currencies. This is, however, predicated on the assumptions that the demand elasticities are greater than unity, and that import and export prices both adjust to the full extent of exchange depreciation.

In the short run, export and import quantities tend to be unresponsive to price changes. That is, buyers and sellers need time to recognize changes in competitive positions and act accordingly. In fact, an exchange-rate change initially is likely to lead to a deterioration in the trade account of the country with a depreciating currency.

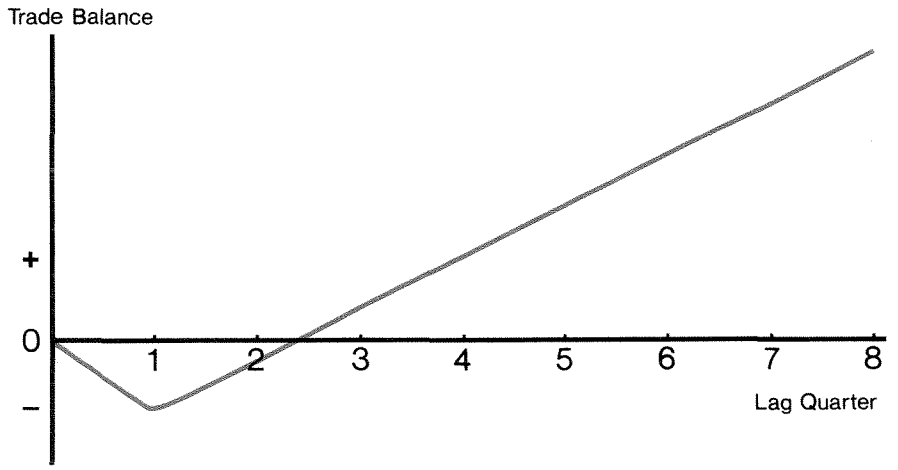
We may assume, as above, that the long-run price elasticities of demand are -1.6 for both exports and imports — and that their responses are uniform over time, so that export and import volume each decline 0.2 percent per quarter for eight quarters following a yen depreciation. In this case, the Marshall-Lerner condition is met only in the third quarter following the exchange-rate change. This movement in the trade account is depicted graphically in Chart 2, illustrating the so-called J-curve phenomenon.

Separately, various observers have argued that exchange-rate changes are totally ineffective in eliminating trade imbalances, because exporters will absorb those changes into higher or lower profit margins so as to maintain sales. For example, a yen depreciation (appreciation) will prompt Japanese exporters to raise (lower) their yen prices by the same percentage amount. This implies that Japanese exporters set their prices on the basis of foreign-competitor prices measured in yen, and not on the basis of domestic cost considerations.

Export prices in yen would rise by the full amount of the depreciation only when supply is fixed or the demand schedule is perfectly horizontal. The former condition may be relevant for a country which is operating at full capacity and has a large export sector relative to total output. In the one case, the full utilization of resources would not permit export firms to increase supply. In the second case, their ability to increase supply would depend upon bidding away resources from the nontradeable goods sector, and this capacity would be limited if the export sector is large relative

Chart 2

J-Curve Effects of Yen Depreciation



to the total economy.

Japanese firms meanwhile would face a horizontal demand schedule only if their product cannot be differentiated from foreign products and their supply represents a small part of total world production. In the case of undifferentiated products — such as silver, tin and copper, but not motor vehicles — buyers are indifferent to the country from which they purchase. Thus, the law of one price holds and no one exporter can sell at a different price. At the same time, if the quantity supplied by the firm or country is small relative to total world supply, then its own output will have little effect on price. Under these two conditions, the export price is given exogenously and the quantity of exports is determined in the long-run via a supply curve.

In the Japanese case, its exports represent a small proportion of total domestic production but loom large relative to European and American exports of manufactured goods. Consequently, the supply of Japanese exports should be highly sensitive to prices and should strongly influence international prices in turn. Moreover, Japanese producers should have a certain amount of control over price, because their exports are composed largely of finished goods with a high degree of product differentiation. With this information, one would expect Japanese export prices to be jointly determined by cost conditions and foreign competitor prices.

In contrast, Japanese imports are heavily weighted with basic commodities (primary raw materials) which are noted for a high degree of homogeneity. As a consequence, Japan should largely be a price taker on the import side; that is, a yen depreciation should lead to a proportional rise in Japanese import prices in yen. This proposition will be tested below.

II. Specification of Export and Import Price Equations

The rise in export prices in response to an exchange-rate change may be tested empirically. Here we specify a chain of causation running from exchange rates to prices to export quantities.[2] For clarity of exposition, we assume that export quantities do not adjust to prices immediately,[3] since the literature indicates that long lags are involved.

In measuring the pass-through effect, we consider four export commodity groupings: machinery and equipment, metal products, chemicals, and textiles. Recent empirical research (e.g., Spitaller, 1980) has attributed no significance to domestic-cost variables in the setting of export prices. The result may simply reflect aggregation bias, and not the determination of domestic prices by international prices. Separate equations thus may be estimated for each price series, which in turn permits us to determine the responsiveness (and time lag) of export prices to exchange-rate changes.

Within individual product categories, the extent of the pass-through depends upon the nature of the product and the cost characteristics of the industry. As a proxy for domestic costs, researchers have generally relied upon unit labor costs. However, this measure fails to account for the dramatic recent rise in raw material prices, which suggests the need to utilize a more comprehensive measure, such as the wholesale-price index. Another consideration is the tendency for a higher level of capacity utilization to limit the supply response of exporters, causing them to allocate output by raising prices instead.[4]

We hypothesize, then, that Japanese exporters set prices on the basis of 1) the yen exchange rate, 2) the prices of foreign competitor goods expressed in local currency, 3) the level of capacity utilization, and 4) labor and other input costs (proxied by wholesale prices). The general form of the specification can be written as:

$$XP = f(WP, EX, CP, CU)$$

where XP = export prices,
WP = wholesale prices,
CP = foreign competitive prices,
CU = capacity utilization,
EX = exchange rate.

In contrast, Japanese imports (as noted) are heavily weighted with basic commodities with a high degree of homogeneity. The "law of one price" thus should hold, so that a depreciation of the dollar leads to a proportional fall in imported commodity prices in yen terms. For example, the 36-percent depreciation of the dollar against the yen between the first quarter of 1976 and the fourth quarter of 1978 paralleled a 32-percent decline in the yen price of oil over that period. The prices of Japanese imports in yen terms will be related to the yen/$ exchange rate and to the world commodity-price index denominated in dollars[5]. A coefficient value of one attached to the yen/$ exchange rate would be consistent with complete pass-through. This proposition will be tested with respect to food, fuels, raw materials, and metals — categories accounting for 75 percent of all imports.

The next step after estimating price equations is to determine the effects of changes in the terms of trade (export prices over import prices) on the quantities of exports and imports. That is, having established the extent and duration of the price response to an exchange-rate change, we must next relate export and import quantities to their respective prices. By substituting the price equations into the respective volume equations, the estimated time path between an exchange-rate depreciation and its impact on export and import quantities can thereby be derived.

III. Determination of Export and Import Quantities

The theory of consumer demand provides a basis for analyzing the demand for exports and imports. As for imports, the quantity of a good that a consumer wants to purchase depends upon his income and the price of competing substitutes. A higher level of income increases the consumer's ability to purchase more goods. The allocation of his income among foreign and domestic goods depends upon their prices and their degree of substitutability. At the national level, a rise in real income translates into increased demand for domestic and foreign goods. The allocation of income among domestic and foreign goods depends upon the prices of foreign goods relative to import-competing substitutes. The demand for imports can therefore be written as a function of domestic real income[6] and the prices of imported goods relative to domestic goods. The general model is:

$$MV = f(Y, PM/WP)$$

where MV = import volume,
Y = Japanese industrial production
PM = import prices,
WP = wholesale prices.

The same reasoning applies to exports. A higher level of income abroad will increase the demand for a country's exports. An increase in the price of the export good relative to foreign competitors' goods will diminish the demand for it. Moreover, an increase in demand for a good may not bring forth a supply response due to production bottlenecks. An exporter faced with supply constraints thus may decide to allocate his output by slowing delivery times instead of raising prices. The waiting time imposes a cost on the buyer which is not incorporated into the price of the product. In the general form, we can write the export-volume equation[7] as follows:

$$XV = f(Y, PX/WPX, CU)$$

where XV = export volume,
Y = real GNP abroad,
PX = price of exports,
WPX = foreign competitor prices (in yen),
CU = capacity utilization in Japan.

IV. Empirical Results

Our results (Table 1) indicate that only about 38 percent of an exchange-rate change is passed forward into export prices expressed in foreign currency.[8] That is, Japanese exporters respond to a 10-percent depreciation (appreciation) of the yen by raising (lowering) their yen prices by about 6 percent. They respond slightly more to changes in foreign competitor prices expressed in foreign currency, matching on average about 66 percent of competitors' price increases.

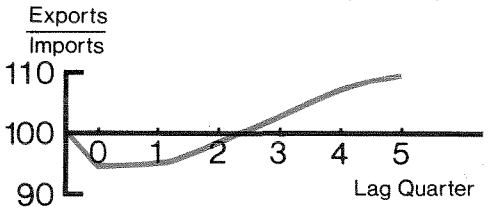
Contrary to some earlier empirical evidence, domestic cost variables have played a role in setting Japanese export prices, for three of the four commodity categories. These variables proved insignificant only in the case of machinery and equipment, which suggests that further disaggregation was necessary. Overall, export prices of Japanese manufacturers were jointly determined by domestic cost considerations and foreign competitor prices.

Estimated price equations for different import categories tend to confirm that Japan is a price taker on the import side (see Table 2). That is, an exchange-rate appreciation (depreciation) will lead to a proportional fall (rise) in the domestic currency price of Japanese imports. This result, combined with the estimated pass-through on the export side, suggests that a 10-percent yen depreciation will lead to about a 3.8-percentage-point deterioration in the terms of trade. With no change in export and import quantities, this terms-of-trade effect will lead to an initial deterioration in the trade account. The duration of the worsening trade balance — the duration of the first segment of the J-curve — will depend upon the time lag between movements in quantities and prices, and upon the size of the export and import elasticities.

The long-run price elasticities of demand were estimated at -0.35 for imports and at -2.5 for exports (Table 3). The price responsiveness of Japanese imports extended over a four-quarter period, whereas on the export side, the price effect was fully absorbed within five quarters.

Chart 3

J-Curve Effects with 10-Percent Yen Depreciation (domestic currency units)



On the basis of both volume and price equations, a depreciation of the yen will worsen the trade balance during the first half year (see Chart 3). Between the second and third quarters, the trade balance will show an improvement in both domestic and foreign currency units, and the maximum improvement will occur during the fifth quarter following the depreciation. At the maximum point, the value of Japanese exports and imports in yen[9] would have risen by 15.9 percent and 6.5 percent, respectively. The time lag between an exchange-rate change and a trade-account improvement would be considerably less than the four to five years generally suggested in the literature.

Simulation, 1980-1981

Using the parameter estimates obtained from the model, we performed several experiments to measure the impact of exchange-rate movements on Japan's trade account in 1980 and 1981. In this connection, we cannot ignore the effects of oil-price hikes on Japan's recent trade performance. From the fourth quarter of 1978 through the fourth quarter of 1979, Japan's trade balance shifted from a surplus of ¥842 billion to a deficit of ¥916 billion. The marked deterioration largely reflected the concurrent run-up in oil prices from $12.80 to $24.28 a barrel, which was then followed by a further rise to $33.81 a barrel in the fourth quarter of 1980. Moreover, economic growth during 1980 increased at a 3.6-percent rate in

Table 1
Effects of Movements in the Exchange Rate, Foreign Competitive Prices, and Wholesale Prices on Export Unit Values of Japanese Manufactured Goods

Commodity Category	Percentage Change in Japanese Export Prices from One-Percent Change in: Value of Yen (depreciation)	Foreign Competive Prices (in foreign currency)	Foreign Competive Prices (in domestic currency)[3,4]	Domestic Wholesale Prices
Machinery and equipment[1]	0.46***	0.50***	0.48***	0.00
Metal Products	1.11**	1.64***	1.32***	1.02*
Chemicals	0.58**	0.58**	0.58**	1.57***
Textiles	1.22***	0.53	0.89***	1.06***
All Manufactured Goods[5]	(0.62)[2]	(0.72)[2]	(0.66)[2]	(0.34)[2]

*Signifies coefficient is significantly different from zero at an alpha level of 0.10;** for alpha level of 0.05;*** for alpha level of 0.01.

1. Tests of significance in the machinery-and-equipment equation should be viewed warily, because of first-order autocorrelation in the residuals.

2. The elasticity of export prices with respect to the exchange rate, foreign competitive prices and wholesale prices was calculated as a weighted average of the elasticities for each commodity category, with weights proportional to the share of each commodity in total manufacturing exports. The weights are 0.698 for machinery and equipment, 0.184 for metal products, 0.058 for chemicals and 0.054 for textiles. These calculated elasticities are shown without parentheses.

3. The elasticity of export prices with respect to foreign competitive prices, measured in domestic currency units, was calculated as a weighted average of the elasticities of export prices with respect to the exchange rate and foreign competitive prices, denominated in foreign currency units. The weights were proportional to the standard errors of the coefficients.

4. The tests for significance refer to F-tests for the joint influence of the exchange rate and foreign competitive prices. The null and alternative hypotheses were:

H_0: $B_1 = B_2 = 0$

H_A: $B_1 = B_2 = 0$

where & = 0.05. this was the case for machinery and equipment, metal products and textiles.

5. In 1980, manufacturing exports constituted 90 percent of all exports.

Table 2
Effects of Movements in the Dollar/Yen Rate on the Prices of Imported Commodities[3]

Import Prices in Yen for	Exchange Rate: Constant	EX$[1]	Export Prices	R^2	D.W.
Food	-0.24	0.736*	0.294	0.56	0.47
Fuels	-3.81**	0.979*	0.849*	0.96	1.21
Raw Materials	-5.00**	1.045*	0.960*	0.83	0.74
Metals[2]	-5.00	0.919*	1.168*	0.69	1.28

*Denotes significance to 0.05 level. However, because of first-order autocorrelations in the residuals, tests of significance should be viewed warily due to biased standard errors of coefficients.

1. The coefficient attached to the exchange rate for each commodity category was insignificantly different from one.
2. The metals equation was corrected for first-order correlation.
3. The four commodity categories constituted over 75 percent of all imports.

Table 3
Distributed Lag of Relative Prices on Japanese Export and Import Volumes

Dependent Variable	Current Quarter	Volumes: t-1	t-2	t-3	t-4	t-5	Sum
XV	0.79	-0.10	-0.68	-0.97	-0.95	-0.62	-2.53
MV	0.03	-0.07	-0.11	-0.12	-0.08	—	-0.35

Japan while stagnating in the U.S. and major European countries. The growth differential in Japan's favor should have stimulated faster growth in Japanese imports relative to exports. When combined with the oil-price rise, a substantial widening of the trade deficit thus should have been realized in 1980. On the contrary, the Japanese trade account showed a ¥216-billion surplus in the fourth quarter of 1980, a turnaround of ¥1132 billion over the year. The explanation for this paradoxical turnaround may be found in a review of our regression equations.

We noted earlier that a yen depreciation will tend to raise the yen prices of Japanese exports and imports, while a yen appreciation will have the opposite effect. The yen's trade-weighted exchange rate (the effective exchange rate) depreciated by 29 percent during 1979, but then appreciated by 14 percent during 1980 (fourth quarter to fourth quarter). Largely reflecting these movements, Japanese exporters raised their yen prices by 22 percent during 1979 but by little more than zero in 1980. With an estimated offset coefficient of 0.62, exchange-rate movements contributed 18 percentage points to the 1979 price rise (0.62 times effective yen depreciation of 29 percent) but reduced the 1980 price rise by almost 9 percentage points (0.62 times effective yen appreciation of 14 percent). The marked deceleration in export prices during 1980 thus was consistent with the evidence presented in the text.

On the import side, the 1979 yen depreciation should have inflated the yen prices of imports while the subsequent appreciation of 1980 should have had the opposite effect. Reflecting the oil-price hikes, Japanese import prices in yen actually rose by 70 percent during 1979 and by 8½ percent during 1980. According to the regression model, exchange-rate movements contributed almost 26 percentage points to import prices in 1979 while lowering import prices by almost 12 percentage points in 1980. As before, recent data thus bear out the empirical evidence in the text.

Overall, movements in the terms of trade attributable to exchange-rate changes made a relatively modest contribution to the trade account. The reverse J-curve effects stemming from the 1980 yen appreciation contributed about ¥350 billion to that year's trade surplus. The improvement in trade volumes was more important to this turnaround. Movements in exchange rates, particularly the 33.6-percent effective yen depreciation between the third quarter of 1978 and the first quarter of 1980, can more than account for the 16.3-percent growth in export volume and 6.8-percent drop in import volume. On balance, the outside sample estimates indicate that movements in effective exchange rates made a positive contribution to the Japanese trade account of ¥3100 billion between 1979IV and 1980IV — more than offsetting the oil-price rise and the activity effect (higher economic growth in Japan than abroad).

In 1981, the effective exchange rate of the yen remained fairly stable. However, much to the consternation of Japan's trading partners, the trade surplus continued to expand — to a ¥400-billion quarterly surplus in the first three quarters of 1981, compared with a ¥900 billion deficit in the corresponding 1980 period. For one reason, the terms of trade have improved due to a fall in import prices, reflecting weakness in world commodity prices. On the other hand, export volume has increased while import volume has fallen. In the first nine months of 1981, export volume rose 12.8 percent above the corresponding 1980 figure. While less robust than the 1980 gains, these export increases are nonetheless substantial, reflecting as they do the relative price changes of the preceding year. From the model's outside-sample estimates, about two-thirds of the 1981 export-volume increase can be attributed to movements in the yen's effective exchange rate, which in 1980 produced a 6.4-percent improvement in Japan's price competitiveness as measured by relative export prices of manufactures. In fact, the 29-percent rise in Japanese export volume since 1979 can, according to the model's results, be attributed to exchange-rate movements. (The estimated contribution was 31 percent.) In particular, movements in the yen's exchange rate more

than accounted for the 13.5-percent fall between 1978 and 1980 in the relative prices of Japanese manufactured-goods exports. Moreover, foreign activity contributed little if any impetus to export volume growth, reflecting the virtual stagnation in U.S. and European economic activity in the 1980-81 period.

On the import side, exchange-rate movements would have predicted a 1.0 percent fall in import volume over the last two years. This compares with an 8.8-percent actual decline in the first three quarters of 1981 compared to the corresponding period of 1979. Energy conservation, stemming from the oil-price rise, apparently made the major contribution to falling import quantities over this period.

V. Policy Implications

The size of the Japanese trade surplus with the U.S. and the European Economic Community (E.E.C.) has seriously impaired trade relations among the three major trading partners. The E.E.C. trade deficit with Japan is estimated at roughly $10 billion for 1981, and the U.S. bilateral trade deficit is expected to approach $15 billion. E.E.C. policymakers thus are calling on Japan to take appropriate measures to redress the imbalance — just as U.S. policymakers did when pressing for Japanese curbs on auto exports. Without voluntary restraint, the Brussels Commission has said that it would consider curbing Japanese access to E.E.C. markets for motor vehicles, TV sets and machine tools over the next five years.

The Japanese Government has announced certain short-term measures to reduce the trade deficit, such as increasing Government stockpiles of crude oil and possibly increasing imports of nickel, cobalt, and other metals. But these moves are unlikely to placate Americans and Europeans, since their deficits vis-a-vis Japan are mainly concentrated in manufactured-goods trade.

The empirical estimates in the text suggest that Japan's expanding surplus vis-a-vis the U.S. and Europe could have been expected in light of recent exchange-rate movements. The yen depreciated by 33.6 percent against the U.S. dollar and major European currencies between 1978III and 1980I, apparently prompted by the concurrent run-up in oil prices. With oil representing 40 percent of Japanese imports, the sharp rise in oil prices greatly enlarged Japan's import bill, requiring additional financing to erase the shortfall through higher export growth. As a result, the yen exchange rate depreciated, improving the price competitiveness of Japanese goods and thereby creating the foreign demand for a higher level of Japanese exports. The increased exports found their way into the U.S. and E.E.C. markets, raising Japan's market share during a period of widespread recession and unemployment.

The empirical results show that Japanese exporters offset about 62 percent of a yen depreciation (appreciation) by raising (lowering) their yen prices. Despite less than 40-percent pass-through into export prices, the yen's effective exchange rate declined substantially, producing a 13.6-percent decline in the relative prices of Japanese manufactured-goods exports between 1978 and 1980. With an estimated price elasticity of demand of -2.52, the fall in the yen rate and the related improvement in price competitiveness can more than account for a 29-percent growth in Japanese export volume between 1979 and 1981 (first three quarters). Further contributing to the improvement in the Japanese trade account was a fall-off in import volume. But because of the small price elasticity of demand of -0.35, the resulting reduction in import quantities was modest by comparison. Overall, the empirical results indicate that movements in the yen's effective exchange rate contributed substantially to Japan's trade performance in the 1980-81 period.

According to the empirical findings, the growing controversy between Japan and its major trading partners does not stem from the

ineffectiveness of exchange-rate changes to produce adjustments in the trade account. On the contrary, the yen depreciation following the oil-price hikes may have gone too far. Japan's 1981 trade surplus more than offset its traditional deficit on services and transfers, placing the current account in surplus.

The signs are particularly ominous for the U.S. While the effective exchange rate remained fairly stable during most of 1981, the yen depreciated by 9 percent against the dollar over the first three quarters of the year — and by 22 percent since 1978IV. Japan's price competitiveness vis-a-vis the U.S. also increased because of higher U.S. inflation, as U.S. export prices in 1981 rose an estimated 3.4 percentage points more than Japanese export prices measured in local currency. Given the U.S. inflation and given the dollar's appreciation against the yen, the U.S. thus has suffered a marked erosion of its competitive position vis-a-vis Japan. This portends an expanding bilateral trade deficit in 1982. This situation, coupled with rising U.S. unemployment, almost insures continued tensions in the trade relations of these two countries in the foreseeable future.

Appendix A

Data Series and Sources

The data come from numerous sources, including various issues of the Bank of Japan's Economic Statistics Monthly, the Monthly Statistics of Japan published by the Statistics Bureau, The National Institute of Economic and Social Research Review, IMF International Financial Statistics and the UN Bulletin of Statistics. Estimation period extends from Q1, 1974 to Q4, 1979.

1) **Exchange Rate** — The exchange-rate variable was defined in yen per foreign currency units, and included the currencies of the U.S., Germany, Britain, France and Italy. In constructing the index, we weighted each exchange rate by that country's share in total manufactured-goods exports.[10] In the index, 1975 = 100.

2) **Foreign Competitor Prices** — Unit-value indices of manufactured-goods exports were used as a proxy for foreign competitor prices in each of the four product categories. An index was calculated with 1975 as the base period. The countries involved and the weights are identical to those employed for the exchange-rate index.

3) **World Export Prices for Basic Commodities** — We used a weighted average of commodity-price indices, expressed in dollars, taken from various UN publications. The base period was 1975, and weights were calculated on the basis of shares in Japanese imports for each product category.

4) **Foreign Real Income** — We used a weighted average of real GNP for the same countries used in calculating the exchange-rate and foreign-competitor price indices. The base period was 1975, and the weights present world-trade shares.

Appendix B: Export Price Equations

Machinery and Equipment

$$\underset{\quad}{\text{Ln}(PX)} = \underset{(0.22)}{-0.31} + \underset{(2.23)}{0.464}\text{Ln}(EX) + \underset{(3.97)}{0.505}\,\text{Ln}(CP)_t + e_t$$

$R^2 = 0.54$

$S_e = 0.04$

D.W. = 0.95

Textiles

$$\underset{(4.8)}{\text{Ln(PX)} = -2.03} + \underset{(4.11)}{1.06\,\text{Ln(WP)}} + (4.22)\text{Ln(EX)} + \underset{(1.11)}{0.53\,(\text{CP})_t} + \underset{(4.80)}{0.44\,(\text{CU})_t} + e_t$$

$R^2 = 0.79$
$S_e = 0.029$
D.W. = 2.0
Q(22) = 6.9

Chemicals

$$\underset{(-3.66)}{\text{Ln(PX)} = -2.34} + \underset{(4.11)}{1.57\,(\text{WP})_t} + \underset{(1.74)}{0.58\,\text{Ln(EX)}_t} + \underset{(1.74)}{0.58\,\text{Ln(CP)}_t} + \underset{(3.03)}{0.42\,\text{Ln(CU)}_t} + \underset{(0.43)}{0.07\,\text{Ln(CU)}_t} + e_t$$

$R^2 = 0.86$
$S_e = 0.036$
D.W. = 1.81
Q(22) = 6.9

Metals

$$\underset{(-2.19)}{\text{Ln(PX)} = -0.05} + \underset{(1.34)}{1.05\,\text{Ln(WP)}_t} + \underset{(2.58)}{1.11\,\text{Ln(EX)}_t} + \underset{(2.51)}{1.64\,\text{Ln(CP)}_t} - \underset{(-1.82)}{0.134\,\text{Ln(PX)/WP)}_{t-1}} + e_t$$

$R^2 = 0.84$
$S_e = 0.029$
D.W. = 2.01

where t-statistics are in brackets below the estimated parameters.

Variable Names:

PX = export prices (machinery and equipment, textiles, chemicals, metals, and manufactured goods).
EX = trade-weighted exchange rate (yen per foreign currency unit)
CP = trade-weighted competitor prices
CU = capacity utilization (textiles and chemicals)
WP = wholesale prices (textiles, chemicals, and metals).

Notes on Export Price Equations

Machinery and Equipment

1) Wholesale prices and capacity utilization for machinery and equipment proved to be insignificant and were dropped from the equation. Thus, pricing decisions of machinery and equipment manufacturers were almost entirely influenced by external factors rather than domestic cost considerations. However, these results may be tentative, since further disaggregation may be required to pick up the effects of domestic costs on export prices.

2) Across export product categories, only the machinery and equipment equation exhibited first-order autocorrelation. This result is consistent with the actual behavior of the export-price series of machinery and equipment, which was also identified as a first-order autoregressive process.

Textiles

1) The equations for textiles, metal products, and chemicals were estimated in first-difference form, although either levels or first differences would be theoretically sound.

2) Of all the variables, only foreign competitor prices proved to be insignificant. But this may simply reflect the downward bias associ-

ated with errors in variables stemming from the much broader coverage of the competitor-price series.

3) A one-percent depreciation of the yen will lead to a 1.22-percent increase in domestic currency prices of Japanese exports. This implies more than complete passthrough. However, the coefficient on the exchange-rate term is not significantly different from one. As a consequence, it would be better to say that Japanese exporters raise (lower) their prices by the same percentage amount as the exchange rate.

Chemicals

1) The coefficient values on Ln(EX) and Ln(CP) and their respective t-statistics are the same, reflecting the merging of Ln(EX) and Ln(CP) into a single variable, referred to as foreign-competitor prices expressed in yen. This composite variable was used because of the strong correlation among the independent variables in the estimating equation, yielding inconclusive results. The hypothesis of equality between the coefficients on the exchange-rate variable (EX) and the foreign-competitor price term (CP) could not be rejected at the 0.5 level of significance. For the purposes of measuring pass-through, a coefficient value of 0.58 is used for the exchange rate. With this result, only 42 percent of an exchange-rate change is passed forward into foreign currency prices of Japanese chemical exports.

Metals

The specification for metal products is similar to the equations for chemicals and textiles, but with several modifications. In particular, the capacity utilization rate was dropped because of its insignificance. As a result, the change in metal-product export prices is a function of changes in metal wholesale prices, the exchange-rate index, and foreign-competitor prices denominated in foreign currency. Moreover, disequilibrium effects were incorporated into the specification, as exemplified by lagged ratios of export prices to foreign competitors' prices and to wholesale prices. Estimation of the model with either one or both of the ratio variables yielded a significant value only for the variable with wholesale prices in the denominator. The model has the long-run property that export prices are determined by domestic cost considerations (See Davidson, 1978).

Manufactured Goods

We estimated a separate equation relating the prices of all manufactured goods to the exchange rate (EX) and foreign competitor prices measured in foreign currency (CP). The specification was the same as for the machinery-and-equipment equation. The results are not reported here because of the equation's low explanatory power ($R^2=0.16$) and the insignificance of the exchange-rate term (EX). Moreoever, wholesale prices and capacity utilization proved to be insignificant when added to the model. These results justify the disaggregated approach adopted here. In fact, the insignificance of domestic cost variables and the autocorrelation in the residuals suggest that further disaggregation should have been undertaken for machinery and equipment.

Appendix C: Export and Import Volume Equations

Variable Names:

XV = export volume
D1, D2, D3 = seasonal dummies
WGNP = world GNP
CU = capacity utilization
PX = price of exports
CP = competitor prices
EX = exchange rate
MV = import volume
IP = Japanese industrial production
PM = import prices
WPI = Japanese wholesale prices

Export Volume Equation

$$LN(xv)_t = 27.5 - 0.19\,D1 - 0.17\,D2 - 0.39\,D3 + 1.85\,LN\,(WGNP)_t - 8.66\,LN\,(CU) - 2.52\,LN\left(\frac{PX}{CP \cdot EX}\right)_{t-k} + e_t$$

(1.79) (-1.52) (-1.21) (-1.83) (2.08) (2.43) (-2.29)

Lag(k)	Coefficient on $LN\left(\frac{PX}{CP \cdot EX}\right)_{t-k}$	t-statistic
0	0.79	1.11
1	-0.10	-0.52
2	-0.68	-2.14
3	-0.97	-1.89
4	-0.95	-1.79
5	-0.62	-1.75
Sum	-2.52	-2.29

$R^2 = 0.67$, $S_e = 0.148$, D.W. = 1.74
$Q(18) = 11.4$, $n = 19$

Import Volume Equation

$$LN(MV)_t = 1.80 + 0.01D1 + 0.01\,D2 + 20.03\,D3 + 0.61LN(IP)_t - 0.35\,LN\left(\frac{PM}{WPI}\right)_{t-k} + e_t$$

(3.81) (1.00) (0.71) (3.13) (6.01) (-3.74)

Lag(k)	Coefficient on $LN\left(\frac{PM}{WPI}\right)_{t-k}$	t-statistic
0	0.03	1.25
1	-0.07	-3.21
2	-0.11	-3.88
3	-0.12	-3.79
4	-0.08	-3.71
Sum	-0.35	-3.74

$R^2 = 0.98$, $S_e = 0.169$, D.W. = 1.53, $Q(19) = 9.9$
$n = 20$

Notes on Trade Equation

The price elasticities of demand for exports and imports were estimated by the Almon lag technique, to offset the limited sample size and strong correlation between lagged independent variables. The relative price terms Ln(PX/CP EX) and Ln(PM/WPI) were entered as second-degree polynomials constrained at the far endpoint. The number of lags were determined sequentially by the addition of lagged terms until they turned insignificant.

The long-run price elasticities of demand were estimated at -2.52 for exports and -0.35 for imports, both of which appear reasonable. Almost all Japanese exports are manufactured goods, while imports are mainly basic commodities. Low price elasticities are generally associated with goods with few available substitutes. In natural-resource starved Japan, a rise in prices of imported commodities will bring little reduction in demand due to the unavailability of domestic substitutes. By comparison, manufactured goods should have a much larger price elasticity. For example, a higher price for Sony stereos should lead U.S. consumers to buy domestic substitutes or comparable European models instead.

The contemporaneous price effect on export and import volumes apparently has a perverse sign. But this result could be expected, since others have also found a positive price elasticity in the short run (see, for example,

Wilson and Takacs). This reflects the fact that trade volumes depend not only upon actual prices but also on expected prices. For example, a Japanese petroleum importer who expected oil prices to rise would accelerate his purchases to avoid later price increases. The central question concerns how expectations are formed. If, for example, buyers expected price one quarter ahead is equal to the current price (P_t) plus a positive fraction of the price change from the preceding quarter ($P_t - P_{t-1}$), then a direct relationship between prices and trade volumes should be observed contemporaneously. A rise in price will generate expectations of higher prices in the future, leading buyers to speed up their purchases from supplying countries.

The real-income variable in the export-volume equation is a weighted average of real GNP for the countries used in constructing the indices of foreign competitor prices and exchange rates. Several weighting schemes were tried, including shares of a country's imports from Japan as a proportion of total Japanese exports, shares of a country's imports of manufactured goods as a proportion of world manufacturing trade, and shares of a country's net exports of manufactured goods in relation to the total trade in manufactures. All weighting schemes were normalized to sum to one. These real-income series proved to be highly correlated with lagged values of the relative price term, yielding insignificant values for both variables. The only weighting schemes that did not produce high correlation between the activity and relative-price effects were the export-share weights used in the exchange-rate and foreign-competitor price series. Our export-volume equation estimates incorporate the real GNP variable with these export-share weights.

FOOTNOTES

1. The induced price and income effects resulting from exchange-rate changes will largely be ignored here. For example, a yen depreciation, by increasing the price competitiveness of Japanese export and import-competing industries, will produce a shift in demand towards Japanese products. The higher level of production will generate increased demands for imported goods. At the same time, the exchange-rate depreciation will raise the cost of imported goods which serve as intermediate goods in the production of exports. This, in turn, will put upward pressure on export prices, partially offsetting the effects of exchange-rate changes. Moreover, imported goods are part of the consumption bundle whose price forms the basis for union wage demands. Higher import prices stemming from currency depreciation will require higher nominal wage settlements to maintain the same pattern of real wage gains. The increase in labor costs would produce a deterioration in price competitiveness. Since these secondary effects will tend to offset (partly or fully) the impact of an exchange-rate depreciation on the trade account, the estimates presented here represent upper-bound estimates of its effectiveness in reducing trade imbalances.

2. The cause-and-effect relationship, as specified in the basic model, runs from wholesale prices, exchange rate and foreign competitor prices to export prices. This chain of causation is necessary for estimating the price equations, even though (according to purchasing-power parity) the predicated cause-and-effect relationship runs from prices to the exchange rate in a period of freely fluctuating rates.

3. The time interval before export quantities start adjusting can be subdivided, according to Magee, into currency contract and pass-through periods. The discussion so far has emphasized the latter. The former stems from statistical deficiencies inherent in using unit-value indices. That is, unit-value indices refer to prices at the time of delivery and not at the time of contract negotiation. Because of time lags between orders and deliveries, the pricing behavior of exporters and importers immediately following a devaluation may not be contemporaneously incorporated into the index. However, this does not necessarily mean that unit-value indices will fail to reflect contemporaneous movements in exchange rates. For example, suppose that 50 percent of Japanese exports are invoiced in dollars; a ten-percent appreciation of the yen vis-a-vis the dollar then will translate, everything else held constant, into a five-percent decline in Japanese export prices. Moreover, suppose that Japan sells 30 percent of its exports to Germany and that 50 percent of these contracts are invoiced in marks; then, a ten-percent appreciation of yen relative to the DM will lower export prices by 1.5 percent. The higher the proportion of contracts invoiced in foreign currency, the greater will be the effect of an exchange-rate change on the unit-value index measured in domestic currency.

4. Any general effects of capacity utilization on the price level should already be incorporated in the wholesale-price index. The use of capacity utilization in conjunction with wholesale prices simply measures whether export prices respond differently to the former than to the latter.

5. The composition of Japanese imports within each commodity category will differ from the product mix in the international price index for that commodity. Otherwise, the relationship would be an identity and no coefficient estimates would be obtainable.

6. Since basic commodities account for most Japanese imports, industrial production would be a more appropriate argument for import demand than real GNP. A higher level of industrial output will require larger inputs of raw materials, leading to increased demand for imported commodities.

7. In 1980, manufactured goods accounted for 90 percent of Japanese exports. As a reasonable approximation, the estimated coefficient measuring the effects of exchange-rate changes on manufactured-goods prices will be used to measure the pass-through of an exchange-rate change on aggregate export prices.

8. The estimated pass-through of an exchange-rate change into export prices was obtained by weighting each one of the pass-through coefficients for different commodity groupings by their respective share in Japanese exports.

9. Exports-import movements are virtually the same in foreign currency as in yen. The trade balance in foreign currency improves following an exchange-rate change between the second and third quarters. The maximum improvement occurs during the fifth quarter, where the rise in export value in foreign currency would be 5.8 percent, compared with a 3.2-percent decline in import value.

10. The index is weighted by world export shares instead of bilateral trade values. This reflects the geographical distribution of Japanese trade. That is, about 50 percent of Japan's exports go to the Far East and OPEC, as compared with a 4-percent share taken by Germany. However, Japan faces considerably more competition from Germany in third markets than do other suppliers. As a consequence, the use of bilateral-trade weights may seriously understate the importance of exchange-rate movements between two countries that specialize in the same goods but do little trade with each other, such as Germany and Japan. World-trade weights thus seem most appropriate for Japan.

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