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External Adjustment and the Strong Yen: Recent Japanese Experience

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Abstract

The parameters of a conventional model of Japan's current account were found to be stable in the period of the steeply rising yen between the fourth quarter of 1985 and the end of 1987. This suggests that Japan's current account has been adjusting to the strengthening yen in accordance with established historical relationships--a conclusion that is substantiated by the model's reasonably accurate tracking of the current account in this period. Furthermore, simulations of the model show that the rise in the yen has already made a substantial contribution to correcting Japan's external imbalance.

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Summary

Japan's current account surplus grew steadily in the first half of the 1980s and by 1985 amounted to 3 1/2 percent of GNP. The rise in the surplus took place against a background of improving Japanese competitiveness. Since late-1985, however, the yen has been appreciating sharply in effective terms, more than reversing these earlier gains in competitiveness. The effective loss of competitiveness has had an immediate and dramatic impact on real trade flows: import volume growth picked up strongly while export volume growth halted abruptly. Nevertheless, the nominal current account surplus remained high during 1986-87 because of a strengthening of the terms of trade.

This paper investigates adjustment of Japan's current account between the fourth quarter of 1985 and the end of 1987 through means of a conventional model of trade- and services-account transactions. The parameters of the estimated model are stable during this period, thus providing evidence that Japan's current account has been adjusting to the strong yen according to normal historical relationships. This conclusion is supported by an examination of the model's forecast errors in the period of the rising yen: the errors are found to be small in the context of near $90-billion surpluses. Finally, the model is simulated to measure the effects of the realignment of exchange rates since the fourth quarter of 1985 on Japan's current account. The current account surplus would have been substantially larger during 1986-87 as a percent of GNP had there been no exchange rate realignments. Measured in terms of U.S. dollars, however, the current account might have been lower in 1986 because of the usual J-curve effects.

I. Introduction

Japan's current account surpluses in the 1980s have been large both in nominal terms and as a percent of gross national product (GNP). Furthermore, the persistence of large surpluses in the face of the recent sharp appreciation of the yen has called into question whether the process of external adjustment has been proceeding at a satisfactory pace. Specifically, many commentators have argued that sluggish adjustment of Japan's current account surplus has been due either to a lack of openness of the Japanese market or to unfair trading practices by Japanese exporters. With these concerns in mind, this paper examines the developments in Japan's current account in the period following the start of the yen's rapid rise toward the end of 1985.

The paper concludes that, by and large, Japan's current account has been adjusting to the higher yen since 1985 according to established historical relationships. Export growth was slightly faster than might have been expected, but the effect of this on the trade surplus was offset by exceptionally strong import growth. Services account transactions are less well explained than those of the traded goods sector but they too could have been broadly predicted on the basis of past behavior. The paper therefore concludes that the yen's recent appreciation has already exerted a significant corrective influence on the current account. In dollar terms, however, the current account has not declined appreciably because of the usual J-curve effects.

The paper is organized as follows. In Section II, recent developments in Japan's current account are described. Section III describes the specification and estimation of a fairly conventional model of current account transactions. This model is used as the vehicle in Sections IV and V to analyze developments in the current account since the yen began its steep ascent. Analysis is conducted in two parts. First, formal and informal evidence is examined for a break in behavior of trade flows during the period 1985:IV-1987. Second, simulations are conducted with the model to measure the extent to which exchange rate realignments have affected Japan's current account in the last two years. Conclusions are presented in Section VI.

II. Current Account Developments in the 1980s

Japan's current account was last in balance in 1980. Over the the next five years, the current account recorded steadily increasing surpluses and, by 1985, the surplus amounted to 3 1/2 percent of GNP. The rise was largely accounted for by a growing trade surplus, although the deficit on the services account also narrowed in this period owing mainly to a rise in net investment income from the accumulated stock of foreign assets (Chart 1). The already large surplus was given fresh impetus in 1986 by the collapse in oil prices, and the surplus rose to 4 1/4 percent of GNP. The current account surplus began to decline as a

ratio of GNP in 1987, although its value in terms of U.S. dollars remained roughly unchanged at $87 billion.

The buildup of the current account surplus in the first half of the 1980s took place against a background of improving Japanese competitiveness but this pattern changed markedly toward the end of 1985 when the yen began to appreciate sharply against most currencies. The yen had already been appreciating against the U.S. dollar since February of that year--which is when the dollar began to fall in effective terms--but it was only after the Plaza Accord of September 1985 that the yen's effective value began to move sharply upward. The extent of the appreciation since then has been remarkable. Between the third quarter of 1985 and the end of 1987, the yen rose by 45 percent in nominal effective terms (MERM weights) and by 76 percent against the dollar. In terms of relative normalized unit labor costs, the appreciation was over 30 percent, pushing the real exchange rate to the heights of its short-lived peak in 1978.

The appreciation of the yen had a powerful effect on real trade flows. The rapid growth in real exports seen in the first half of the 1980s was brought to an abrupt halt, while import growth accelerated sharply. Measured in 1980 prices, the real trade surplus declined by about 3 percent of GNP in two years. However, the nominal trade and current account surpluses, which are the focus of attention, remained at high levels because of terms of trade gains.

III. A Model of Japan's Current Account

In this section, a model of current account transactions is developed and econometric estimates presented. The model forms the basis for the empirical analysis, described in Sections IV and V, of current account adjustment to the strong yen.

1. Model specification

a. Exports

The demand for and supply of merchandise exports were modeled at the aggregate level because of the comparatively homogeneous composition of Japanese exports. 1/ The market for a typical export good was assumed to be characterized by imperfect competition--Japanese exports are not perfect substitutes for foreign-produced goods--and supply

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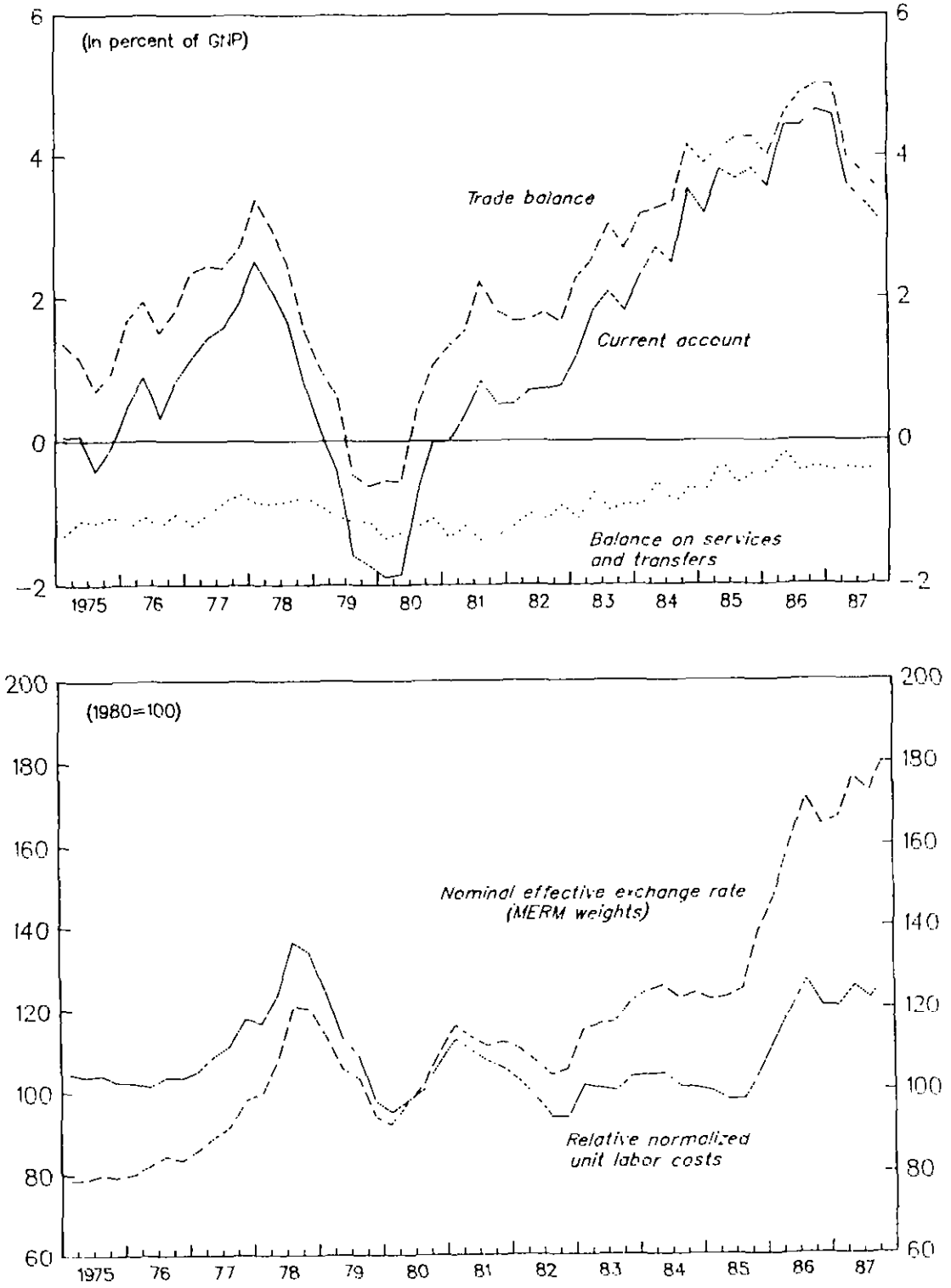
1/ Roughly three fourths of Japanese exports are manufactured goods while the remainder is composed mainly of other heavy or light industrial products.

CHART 1

JAPAN

CURRENT ACCOUNT AND COMPETITIVENESS, 1975–87



Source: IMF, *International Financial Statistics.*

decisions, to be made on the basis of profit maximization. Two equations were specified: an export demand equation and a reduced form price equation.

The demand for exports is determined by the price of Japanese exports relative to competing goods and on a foreign income variable. This is a fairly conventional treatment (see, for example, Goldstein and Khan, 1978) although some researchers (for example, Citrin, 1985) also add cyclical terms. It was assumed that demand does not adjust to changing relative prices or income instantaneously because, for example, of fixed contracts. The export demand equation is thus:

$$x = x(a(L)(px/pw),\ b(L)yw) \qquad (1)$$

where x is export volume; px, export prices (in dollars); pw, competitors' prices (also in dollars); and yw, income in Japan's export markets. The notation a(L) denotes a polynomial function in the lag operator, L. 1/

In recent years, certain Japanese exports have been subject to voluntary export restraints (VERs). 2/ To the extent that these restraints have been binding, export volume would have been lower than the free market level while average prices would have been higher. Empirical tests were conducted to examine the importance of VERs at the aggregate level.

Under imperfect competition, a downward sloping demand curve and production technology impose constraints on suppliers' pricing behavior. The usual first-order conditions for profit maximization lead to export prices being a markup on input costs where the markup depends on the elasticity of demand for exports. Except in restricted cases, 3/ export prices can then be written as a reduced form of input costs and the arguments of the export demand equation. Furthermore, in an intertemporal framework, where there are costs associated with changing prices or where exporters rationally take into account the sluggish

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1/ $L^j Z_t = Z_{t-j}$.

2/ The most important VER in value terms has been imposed on exports of automobiles to the United States (since April 1981) and, more recently, to the European Community and Canada. However, VERs have also been imposed on steel, textiles, certain machine tools, and forklift trucks. For an analysis of the effects of VERs on Japanese auto prices in the U.S. market, see Collyns and Dunaway (1987).

3/ For example, if the elasticity of demand and the marginal cost of production were both independent of quantity, export prices would be a constant markup on input costs.

adjustment of demand, it can be shown that export prices depend on the whole spectrum--past, present, and expected--of input costs, competitor prices, and any other factors that shift supply and demand. 1/ An important component of the expected variables would be expectations about exchange rate movements that would affect the course of domestic-currency-denominated profits. Some researchers (for example Froot, 1988) have argued that pricing behavior will differ in the face of permanent or transitory exchange rate changes. No attempt was made in the paper to test this hypothesis and all expectations were proxied by past values of explanatory variables. The export price equation thus resembles:

$$px = px(d(L)pw, e(L)p, f(L)yw) \qquad (2)$$

where p represents domestic costs (proxied by domestic wholesale prices, in dollars 2/).

Careful attention was paid to both the equation's long-run and short-run properties. Regarding the equation's long-run properties, it can be shown that export prices depend on, among other things, a weighted average of foreign prices and domestic costs where the weights reflect the relative size of export supply and demand elasticities. 3/ The implied coefficient restrictions needed to produce this result--which has implications for the degree of long-run exchange rate pass through--were tested for empirically. Regarding the short-run properties, some commentators (for example, Loopesko and Johnson, 1987 and Hooper and Mann, 1987) have suggested that Japanese exporters react differently to an exchange rate depreciation than to an exchange rate appreciation. Such potential nonlinear behavior was also examined empirically.

b. Imports

Imports were disaggregated into four categories--mineral fuels, raw materials, food and drink, and manufactures--because demand behavior for each of these components is very different. Demand for each category was assumed to depend, with adjustment lags, on domestic activity variables and the price of the import relative to domestic wholesale prices (both in dollars). That is:

1/ See, for example, Cuthbertson (1986).

2/ This is a fairly commonly used proxy although Cuthbertson (1986) and Citrin (1985) use a weighted average of labor and energy costs.

3/ See Appendix I.

$$m_i = m_i(g(L)y,\ h(L)(pm_i/p)) \qquad (3)$$

where m_i is the volume of import i; pm_i its price; and y domestic activity. Import prices were assumed to be exogenous.

In addition, Japan's imports are affected by a number of nontariff barriers. Quotas and domestic pricing policies play a particularly important role in determining agricultural imports while exporters of manufactured goods to Japan frequently claim they face a number of intangible trade barriers (see Christelow, 1985/86). Furthermore, demand for mineral fuel imports is strongly influenced by an energy policy which, given Japan's lack of fuel resources, heavily promotes conservation. Attempts were made to incorporate such factors into the import demand equations.

c. Services

The services account was divided into four subcategories: transport, travel, investment income flows, and other services. 1/ For all categories except investment income, equations were specified for both payments and receipts. It was assumed that competitiveness is an important determinant of the demand for services and so these equations resembled the trade volume equations ((1) and (3) above) in structure. That is, demand for real service flows depends on activity and relative price terms:

$$sr_i/p_i = sr_i(k(L)yw,\ m(L)z) \qquad (4)$$

$$sp_i/p_i^* = sp_i(n(L)y,\ q(L)z) \qquad (5)$$

where sr_i and sp_i are respectively dollar receipts and payments for service category i; p_i, p_i^* price deflators (in dollars); and z a relative price term.

Net investment income was modeled as the average return (assumed exogenous) on the net stock of overseas assets. The latter is determined endogenously in the model, accumulating in line with the current account. 2/ This feature makes the model nonlinear because increases in the current account are compounded by larger inflows (at

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1/ The last category was defined residually and is made up in large part by fees and royalties. Unilateral transfers were assumed to be exogenous.

2/ For a similar treatment, see Dunaway (1988).

unchanged rates of return) of investment income from the augmented stock of net foreign assets.

2. Equation estimates

All equations were estimated by OLS using quarterly data for the period 1975-87. 1/ Log-linear specifications with fairly general dynamic structures were used throughout. A full listing of the estimated equations is contained in Appendix II.

a. Exports

In line with other researchers, this study finds Japanese export demand much less sensitive to relative prices than to world activity. The long-run relative price elasticity is estimated to be just under -1.1, which is somewhat lower than most estimates based on earlier data periods, but more recent studies report broadly comparable results. 2/ However, the long-run elasticity of exports with respect to world activity--a weighted average of trading partners' GNP--was found to be just over 2.0. 3/

Dynamic adjustment of demand to a change in world activity or relative prices takes place over a period of about two years, although 80 percent of the adjustment process is completed by the end of the first year. The stickiness of volumes implies that a rise in Japanese export prices is accompanied by a rise in export value in the short run. However, as the long-run price elasticity is greater than one, rising prices eventually lead to falling export value.

No significant shift in export demand could be found in the period after 1981 which might otherwise have indicated an important role at the aggregate level for VERs. Various constant shift or trend dummies were added to the basic equation, but, although their coefficients generally had the expected (negative) sign, t-statistics were always insignificant.

1/ Instrumental variables estimates of the export volume/price equations were tried in order to avoid potential bias arising from simultaneity. The results were little different from the OLS results presented here; for export volumes, only predetermined variables enter the equation.

2/ For example, the average price elasticity of studies on Japanese exports reported in Goldstein and Khan (1985) is -1.4, although the spread of results is quite wide. More recently, William Helkie at the Federal Reserve Board has estimated the price elasticity at just over -1.1 (reported in Loopesko and Johnson, 1987) while Ueda (reported in Froot, 1988) estimates the elasticity at close to -0.9.

3/ Compare with an average of 2.6 reported in Goldstein and Khan (1985) and 1.6 estimated by Helkie (reported in Loopesko and Johnson, 1987).

A key feature of the export price equation is that, although in the short run exporters follow, in part, changes in competitors' prices, long-run export prices depend only on domestic costs (proxied by wholesale prices). By implication, long-run export supply is perfectly elastic (see Appendix I).

Dollar Export Price Elasticities

	Short-run impact	Long-run impact
With respect to:		
Competitors' prices	0.36	--
World GNP	0.99	--
Domestic wholesale prices (in yen)	0.54	1.00
Dollar-yen exchange rate	0.54	1.00

The particular mix of short- and long-run properties arises from a specification of the equation dynamics that is analogous to the well-known Davidson-Hendry consumption function. 1/ Changes in export prices depend on changes in competitors' prices, domestic wholesale prices and world GNP as well as on the lagged ratio of the level of export prices to wholesale prices. The latter term, which can be interpreted as past profitability, ensures that if export prices fall below domestic costs they eventually must rise to restore profitability. A further term in the lagged ratio of export prices to competitors' prices--past competitiveness--was initially included in the specification but was found to be statistically insignificant. Had it been significant, export prices would have been a weighted average of wholesale and competitors' prices in the long run. Also statistically insignificant were dummy variables to capture the effects of VERs.

The immediate pass through of a yen appreciation to export prices is, ceteris paribus, just over one half, although it eventually rises to one. 2/ The ceteris paribus qualification is important because observed pass-through (actual percentage change in foreign-currency-denominated export prices divided by the percentage change in the yen) will depend on developments in world prices and world GNP as well as on domestic costs and the level of profitability. Importantly, in a general equilibrium framework, domestic costs in yen would fall with an appreciating exchange rate, and this would limit the long-run increase in export prices.

1/ See Davidson et al (1978). The specification of the export price equation in this paper is similar to that in Masson et al (1988).

2/ Pass-through is about 70 percent after one year, and 95 percent by the end of three years.

Some observers have suggested that dollar-denominated Japanese prices are stickier when the yen appreciates than when it depreciates. Tests were carried out to examine the validity of this proposition by measuring the statistical significance of a number of additional nonlinear terms in the estimated price equation. These terms were products of either changes in competitors' prices or domestic wholesale prices multiplied by a dummy variable that was one for an exchange appreciation or zero otherwise. Neither terms involving real or nominal exchange rate changes were found to have any statistical significance. This provides counterevidence to the proposition that short-run pass-through depends on the direction of exchange rate changes. 1/

b. Imports

All import categories showed some sensitivity to relative prices and domestic activity (see tabulation below) and for the three primary goods categories, time trends and dummy variables also helped the econometric explanation. Aggregate imports have a relative price elasticity of just under -0.6 which is below the range of estimates reported in Goldstein and Khan (1985) but slightly higher than recent estimates by Helkie at the Federal Reserve Board. 2/ Two measures of domestic activity were used--real total domestic demand and industrial production--and the long-run elasticity of aggregate imports with respect to each variable was found to be about 0.9. Therefore, if domestic demand and industrial production were to increase pari passu, the long-run elasticity of imports with respect to domestic activity could be as high as 1.8. This would be in excess of most other estimates for Japanese imports but lower than typical estimates of the income sensitivity of U.S. imports. 3/ This latter factor is often cited as one of the reasons for the persistence of the present U.S. trade deficit.

1/ Loopesko and Johnson (1987) report the opposite finding, using a similar methodology. However, they incorporate in their price equation a nonlinear variable that is a function of the dependent variable. Hence, there is every reason to suspect that the coefficient estimate of this variable is heavily biased.

2/ The mean price elasticity reported in Goldstein and Khan (1985) is -1.0 (range -0.7 to -1.2). Helkie (reported in Loopesko and Johnson, 1987) estimates the elasticity at under -0.5.

3/ Goldstein and Khan (1985) report elasticities for Japanese imports in the range 0.8-1.7; Helkie's estimate is 1.1. Dunaway (1988) estimates the income elasticity of U.S. imports at 2.5.

Long-Run Import Demand Elasticities

	Elasticity with respect to		
	Relative prices	Domestic demand	Industrial production
Import category:			
Manufacturing 1/	-0.91	1.84	0.99 2/
Raw materials	-0.27	--	1.24
Mineral fuels	-0.11	--	1.04
Food and drink	-0.55	0.45	--
Total imports 3/	-0.55	0.88	0.89

1/ Excluding nonmonetary gold.
2/ Elasticity with respect to the operating ratio in manufacturing.
3/ Based on 1987 shares of each category in total imports.

The low aggregate price elasticity of imports is due to the low price elasticities of commodity imports (see tabulation above). Least sensitive to relative price changes are mineral fuel imports, but raw material and food and drink imports were also found to be quite price inelastic. By contrast, the price elasticity of manufacturing imports (-0.9) is more comparable to recent estimates of the price elasticity of U.S. imports. 1/

Typically, each import category was found to be sensitive to one but not both of the activity variables. The exception was manufacturing imports which, reflecting the amalgamation within the category of consumer and capital goods, was found to be sensitive to both domestic demand and manufacturing capacity utilization. It was also found that the short-run elasticities with respect to the industrial production variables exceeded the long-run elasticities in both the raw materials and manufacturing goods equations. This suggests that domestic producers build up inventories of imported inputs and intermediate goods when there is an acceleration in demand.

A negative time trend was found to play an important explanatory role in the mineral fuels equation; it most likely reflects long-term energy conservation. Time trends were also included in the raw materials and food and drink equations. In the latter case, the time trend (which was assumed to begin in 1982) captures the positive effects of a relaxation of agricultural quotas and other restrictions. A liberalization dummy was not required in the manufacturing equation although a time trend that started in the second half of 1985 to capture

1/ For example, Dunaway (1988) estimates the price elasticity of U.S. imports to be -1.0.

the effects of the most recent market opening measures 1/ had a positive, but statistically insignificant sign.

c. Services

Relative price and income effects were found for most services account components (see tabulation below). Payments were found to be more price sensitive than receipts, while the average long-run income elasticities of both payments and receipts were close to one. The price elasticity on payments is large enough to ensure an eventual deterioration of the services balance (excluding investment income) in the face of a real exchange rate appreciation. In general, the services equations had higher standard errors than the trade equations, reflecting, in part, a lack of adequate price deflators.

Long-Run Elasticities of Service Transactions

	Elasticity with respect to:		
	Relative prices	Domestic real GNP	World GNP
Payments			
Transport 1/	-6.09	--	--
Travel	-1.86	0.97	--
Other	-0.18	1.53	--
Weighted average 2/	-2.68	0.86	--
Receipts			
Transport 3/	--	--	--
Travel	-0.45	--	2.39
Other	-0.73	--	1.69
Weighted average 2/	-0.40	--	1.01

1/ Short-run elasticity with respect to export volume of 0.51.
2/ 1987 component shares.
3/ Short-run elasticity with respect to export volume of 0.54.

The large long-run price elasticity of the transport payments equation is perhaps a misleading indicator of this category's sensitivity to changing competitiveness. This equation is dominated by a strong autoregressive term, which implies that adjustment to a change in relative prices is spread out over a very long period. Indeed, after two years, only about one fourth of the adjustment is complete. Long-run activity effects could not be found in either the transport payments nor receipts equations, although both were sensitive in the short run to

1/ The Action Program, July 1985-March 1988.

changes in Japanese exports. Japanese overseas travel payments were found to be more sensitive to relative prices than travel receipts although the latter were more sensitive to income.

IV. Current Account Adjustment and the Strong Yen: Was There a Structural Break?

Some commentators have suggested that Japan's current account has been extraordinarily slow to adjust in the face of the large appreciation of the yen. In particular, interest has focused on whether Japanese exporters went to exceptional lengths to maintain market share and whether Japanese import restrictions have unduly suppressed import demand. If either factor had been important, it should be possible to find evidence of a structural break in the behavior of external transactions during 1986 and 1987. Tests for such a break were conducted at two levels. First, formal econometric tests were carried out on the equations described in the previous section. Second, an informal examination was made of the model's ability to forecast current account developments in 1986 and 1987.

1. Parameter stability tests

Two tests of parameter stability in the period 1985 quarter four to end-1987 were carried out on the model equations. The first, the familiar Chow test, is known to have fairly weak power. Hence, forecast tests of the kind suggested by David Hendry were also performed. 1/ These are biased toward rejection of the hypothesis of parameter stability and thus provide a much more stringent test for a structural break. Of course, passing a Chow or Hendry test--although a necessary requirement of parameter stability--is not a sufficient condition to rule out a structural break in behavior. But it should also be borne in mind that the turbulent events of 1986-87--which include sharp currency changes and the collapse in international oil prices--provide a stiff background for these tests.

Most of the equations pass both these tests (Table 1). All the trade equations pass the tests at the 95 percent confidence level providing evidence that the elements of the trade account did not deviate in the statistical sense from historical behavior between the fourth quarter of 1985 and the end of 1987. However, the results for the services account equations are mixed. The equations for travel payments, other service payments, transport receipts, and other service

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1/ Hendry (1980).

Table 1. Parameter Stability Tests of Current Account Equations, 1985:IV-1987:IV

	Parameter Stability Tests 1/		
	Pass at 95 percent confidence level	Pass at 99 percent confidence level	Fail
Equation:			
Export volume	C,H		
Export prices	C,H		
Manufacturing imports	C,H		
Raw materials imports	C,H		
Mineral fuels imports	C,H		
Food and drink imports	C,H		
Transport payments			C,H
Travel payments	C,H		
Other service payments	C,H		
Transport receipts	C,H		
Travel receipts			C,H
Other service receipts	C	H	

1/ H = test result for Hendry forecast test (Hendry, 1980); C = test result for Chow test (Chow, 1960).

receipts all have stable coefficients, but the equations for transport payments and travel receipts fail both the Chow and Hendry tests. 1/ Therefore, apart from a couple of components of the services account, there is no statistical evidence of a break in behavior during the period of the rising yen.

2. Forecast performance

An examination of the forecasting record of the current account model from the fourth quarter of 1985 to the end of 1987 provides a less formal analysis of whether there was a break in behavior. All the equations were first estimated using a data sample that ended in the third quarter of 1985, and then used to predict events in the subsequent two years. Three types of forecasts were made. The first two looked at the static and dynamic tracking of events in 1986 and 1987 of each individual equation; the third involved full dynamic simulation of the current account model. 2/

A key feature of the trade account forecasts is the overprediction of the fall in real exports in 1986 and 1987 while real import growth was stronger than might have been expected (Table 2 and Chart 2). For both real exports and imports, the errors were compounded in the dynamic forecasts by the carrying forward of previous errors in the lagged dependent variables. Nevertheless, the average errors of the trade volume forecasts were all less than two standard errors of the equation--even for the dynamic forecasts.

1/ Travel receipts account for less than 10 percent of total service receipts, but transport payments make up about one third of total payments.

2/ The static forecasts assume lagged dependent variables take on actual historical values. In the dynamic forecasts, lagged dependent variables assume previously predicted values. The principal simultaneous element of the model simulation was the feedback of predicted export prices onto export demand, although there is also feedback from exports to transport payments and receipts.

Table 2. Current Account Forecast Errors, 1985:IV-1987:IV

(Predicted minus actual as a percent of actual)

	Mean Percentage Error		
	Single equation errors		Model errors
	Static forecast	Dynamic forecast	
Export volume	-2.01	-4.12	-4.91
Export prices	0.65	1.58	1.58
Import volume	...	...	-2.79
Manufacturing 1/	-1.66	-2.03	-2.03
Mineral fuels	-3.51	-3.51	-3.51
Raw materials	-2.97	-4.66	-4.66
Food and drink	-0.67	-0.69	-0.69
Service payments 2/	2.15	8.53	7.51
Service receipts 2/	4.42	18.74	16.57

1/ Excluding nonmonetary gold.
2/ Excluding investment income.

A possible factor behind the higher export growth might have been the consumer loyalty to Japanese goods that was created when Japanese exporters moved into dominant market positions in the early 1980s. 1/ By contrast, the exceptional strength of import growth may have been due to the removal of trade restrictions that are not adequately captured in the equations. In this respect, it should be noted that the period of interest coincides with the authorities' latest Action Program to promote trade liberalization.

The model also predicted faster export price growth than that which occurred, although the average error is small and less than the standard error of the equation. The implied slower pass-through of the yen appreciation to export prices occurred despite more buoyant-than-predicted export demand. This might have been expected to have put additional upward pressure on export prices. Notice also that, had export prices risen as much as the model predicted, export volume would have fallen by even more than the single equation predicted (compare the

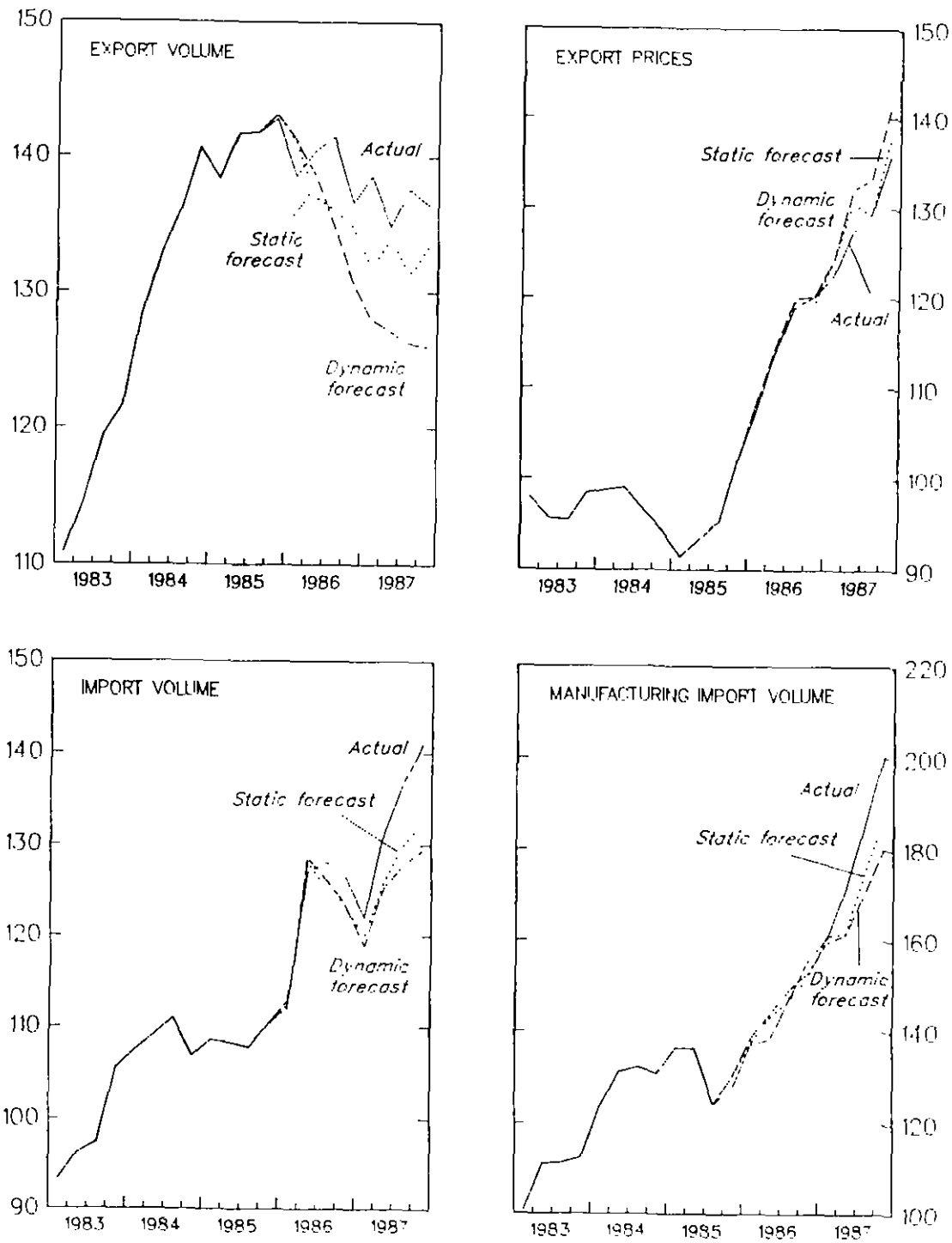
1/ Support for this proposition is provided by evidence of falling export price elasticity over the course of the data sample period which implies falling substitutability of Japanese exports for competing goods. On the truncated sample (ending in the third quarter of 1985) the long-run price elasticity was -1.3 compared with -1.1 for the full sample--although the change is not statistically large enough to cause failure of the parameter stability tests.

CHART 2

JAPAN

TRADE EQUATION FORECAST ERRORS, 1983–87

(1980=100)



Sources: *The Summary Report on Trade of Japan*; and author's calculations.

second and third columns of Table 2). Even so, the average error was less than twice the equation standard error.

The overprediction of export prices reduces the underprediction of export value stemming from sticky volume demand. In net trade terms, this error on the export side is, in turn, offset in large part by the underprediction of imports. Overall, the model predicted a slightly smaller trade surplus in 1986 and 1987 than actually occurred.

Model Dynamic Forecast Errors

(Predicted minus actual; in billions of U.S. dollars)

	1985	1986	1987
Trade balance	0.14	-3.45	-5.17
Services balance	0.53	1.58	0.11
Current account balance	0.67	-1.88	-5.07

Offsetting errors also occurred in the prediction of the services account. Both payments and receipts were overpredicted, particularly in 1986, with the worst errors being found on the transport components. Overall, the services account deficit was forecast to be lower in both 1986 and 1987, although the error is small in comparison with the size of the gross flows. Adding the errors on both services and trade accounts produces a current account prediction error of less than $2 billion in 1986 and only $5 billion in 1987--small errors in the context of $86 billion surpluses.

In summary, it does not appear that current account transactions deviated significantly from historical behavior. On the contrary, the parameter stability tests find no evidence of a structural break--apart from some components of the services account. However, the model's reasonably accurate tracking of the large current account surpluses in 1986 and 1987 results from a number of small offsetting errors. In particular, export demand was stronger than might have been expected while the growth of imports exceeded the model's predictions. Nonetheless, these errors were well within the predictive tolerance of the equations.

V. Effects of the Yen Appreciation

The continuing rise of Japan's current account surplus during 1986 and 1987, while the yen appreciated sharply, should not be taken to imply that external adjustment was not taking place. Rather, the pertinent question would seem to be: what would Japan's external surplus have been had there been no realignment of exchange rates? To

answer this question, the current account model was simulated under the assumption that exchange rates had remained at their third quarter 1985 levels. 1/

A basic simulation is first described below and this is followed by a discussion of the sensitivity of the results to changing one of the more contentious underlying assumptions. Both sets of results are presented as differences from a base forecast constructed from the model's tracking of history. Unlike in the previous section, the model equations used in the simulations were all estimated over the full data sample (1975-87). As a consequence, the tracking errors of the components of the current account are all quite small, especially in relation to the size of the simulated changes.

1. Basic simulation: no exchange rate realignment

If there had been no realignment of exchange rates, the world economic environment would have doubtless been very different in 1986 and 1987. In particular, maintenance of unchanged exchange rates would have required a different international economic policy mix which, in turn, would have had important consequences for relative growth and inflation rates. The absence of a full general equilibrium model of the world's economy precludes a detailed analysis of the world environment under unchanged exchange rates. Instead, a number of simplifying assumptions were made about those variables which impinge directly on Japan's external transactions.

a. Additional assumptions

The first assumption was that world GNP, Japanese total domestic demand, and Japanese industrial production were unchanged from their historical values. Japan's real GNP was determined endogenously in the simulations by an identity linking domestic demand and (endogenous) external demand. To the extent that changes in world GNP and Japanese domestic demand under no realignment would have been in the same direction, there would be partially offsetting effects on the current account. 2/ The effects of relaxing the assumption regarding industrial production are discussed below in part 2 of this section.

1/ The "no realignment" assumption of this section is interpreted as no change in both the yen and the dollar effective exchange rates.

2/ Owing to (a) the high elasticity of exports with respect to world GNP, and (b) feedback of domestic demand onto export prices (via the effect of GNP on wholesale prices--see below), world GNP has a stronger effect on the current account than domestic demand. If both world GNP and domestic demand had been 1 percent higher in 1986-87, it is estimated that the current account would have been about $3 billion higher in these years.

The second assumption concerned the effect on competitors' dollar traded goods prices of the simulated stronger dollar. It was assumed that a 10 percent increase in the dollar's effective value reduces export- and import-weighted dollar prices of competitors' manufactured traded goods prices by 5.6 percent and 4.5 percent, respectively. 1/ The pass-through is spread out over the course of a year. Furthermore, borrowing from the analysis of Sachs (1985), it was assumed that a 10 percent effective appreciation of the dollar leads to a 7.5 percent fall in dollar commodity prices with adjustment being spread over one year.

The third assumption was to link Japanese wholesale prices by way of a simple regression equation to imported mineral fuel and raw material prices (measured in yen), and actual minus potential GNP. 2/ In this way, the impact of the yen's appreciation on the sharp decline in wholesale prices was captured. The long-run elasticity of each of the imported price terms was about 0.1. The effects of the exchange rate realignment on other domestic and world price variables, which play a relatively minor role in the model, were assumed to be of second-order significance. 3/

b. Effects of the exchange rate realignment on competitiveness

In the simulation, the deterioration of Japan's export competitiveness in 1986-87 is sharply reduced (Table 3). However, the improvement in competitiveness is considerably smaller than the simulated nominal yen depreciation because of the short-run stickiness of export prices and because competitors' dollar export prices fall with the assumed stronger dollar. Similarly, the competitiveness of imports worsens, but by less than the simulated nominal yen depreciation, because of falls in dollar-denominated commodity and world manufactured goods prices.

The simulation result can be inverted to arrive at a measure of how much the actual increase in Japanese export prices between the fourth quarter of 1985 and the end of 1987 can be attributed to the rising yen. The outcome is summarized in the tabulation below in which a distinction is made between the direct impact of exchange rate changes and their indirect effects--that is, those due to lower domestic wholesale prices and higher competitors' prices. It was found that more

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1/ Estimates were based on simple regressions.

2/ See Appendix II for details.

3/ For Japan's CPI this is probably quite reasonable given the small observed change in the index during the period of the yen's sharp rise.

Table 3. Basic Simulation: Assumptions and Competitiveness Effects, 1985:IV-1987:IV

(Percentage difference from base)

	1985	1986	1987
Dollar/yen exchange rate	-3.0	-29.6	-39.9
U.S. dollar effective exchange rate	1.7	20.5	36.7
Japanese wholesale prices (yen)	0.3	4.6	9.4
Japanese export prices ($)	-1.8	-20.0	-30.6
World manufactured traded goods prices:			
Export weighted	-0.4	-7.1	-15.4
Import weighted	-0.9	-8.9	-14.1
Commodity prices ($)	-0.2	-8.4	-18.8
Export competitiveness 1/	-1.4	-13.8	-17.9
Import competitiveness 2/	-2.7	-19.1	-19.4
Japanese real GNP	-0.1	-0.4	2.3

1/ Japanese export prices relative to world manufactured traded goods prices (export weighted). Japanese export prices are endogenously determined in the model.

2/ Japanese wholesale prices relative to import prices.

than the actual increase in Japanese export prices in this period could be attributed to the yen's appreciation despite the offsetting effect of the yen's rise on domestic wholesale prices. 1/

Effect of the Yen Appreciation on Japanese Export Prices

(Cumulative percentage change)

	1985:IV-1987:IV
Actual price change ($)	42.4
Of which:	
Total exchange rate effect	50.6
Direct effect	57.2
Indirect effect	-4.2
(Owing to lower wholesale prices)	(-8.1)
(Owing to higher competitor prices)	(4.0)

c. Effects on the current account

The implied improvement in competitiveness in the simulation would have had a dramatic impact on real trade flows. Export volumes, instead of stagnating, would have grown at a 6 percent annual rate while import growth would have been more than halved (Table 4). Imports of manufactures would have been most affected owing to their comparatively high price sensitivity while, at the other end of the scale, mineral fuel imports would have been only about 2 percent lower. Overall, the real trade surplus would have continued to grow steadily in 1986 and 1987 instead of declining.

The effects of exchange rate realignments on the nominal surplus are confused by the familiar problem of choice of units of measurement. Measured in dollars, the simulated nominal trade surplus was $12 billion lower in 1986 but close to its actual historical level in 1987 (Chart 3). This result can be interpreted as a measure of the

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1/ This result suggests that the yen appreciation had a strong effect on export prices during 1986-87. Nevertheless, the observed pass-through of the yen appreciation to export prices was only about 55 percent in this period compared with about 70 percent during the 1977-78 appreciation. One factor limiting the pass-through was the collapse in oil prices. Had oil prices not fallen, the model estimates that the pass-through would have risen to 60 percent. This is a conservative estimate since no account is taken of the effects of oil prices on the price of competitors' manufactured goods prices.

Table 4. Basic Simulation: Effects of Exchange Rate Adjustments on Japan's Current Account, 1985:IV-1987:IV

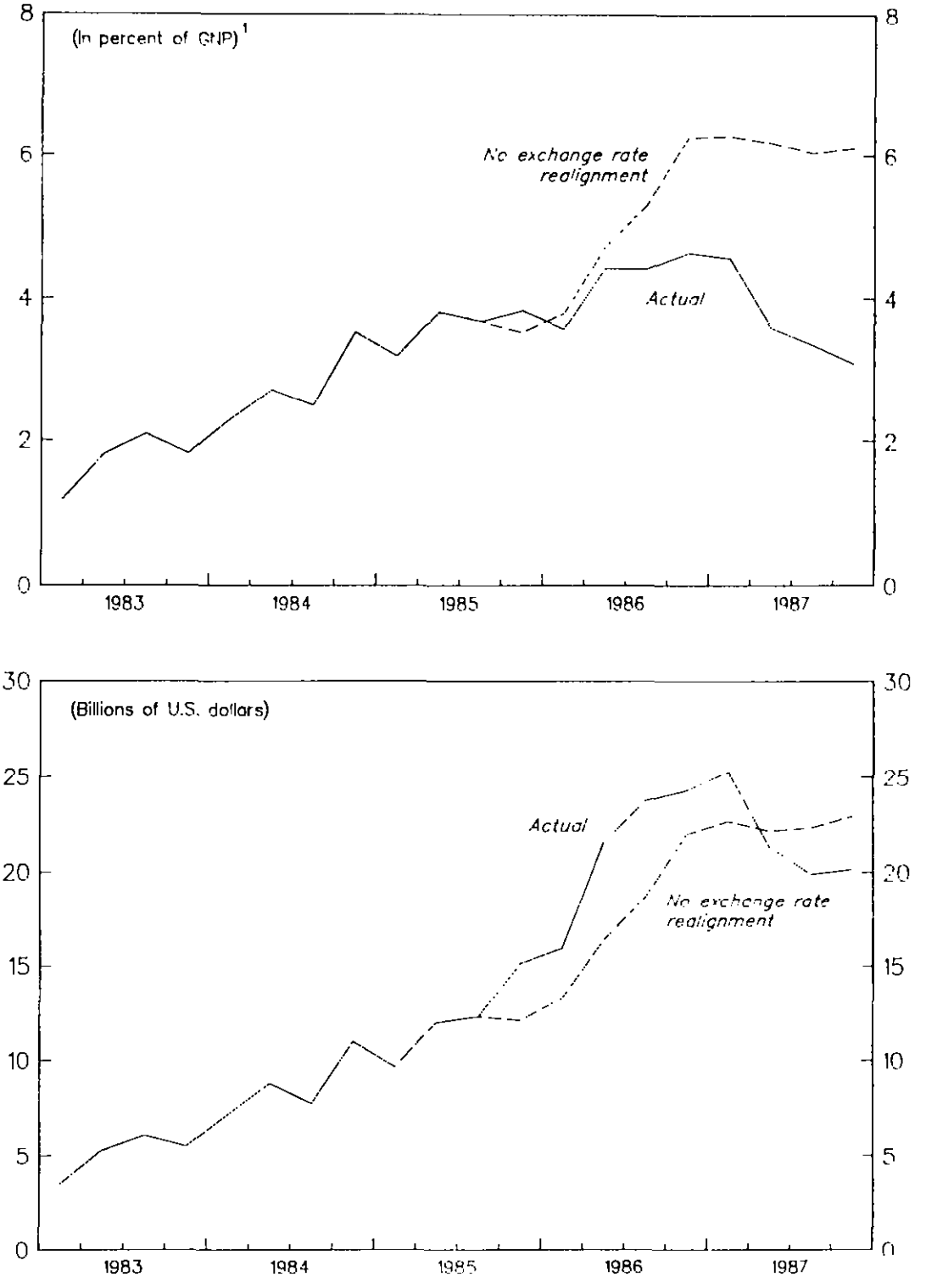
(Predicted minus actual; in billions of U.S. dollars) 1/

	1985	1986	1987
Unchanged exchange rates			
Exports	-3.23	-29.67	-40.13
Volume 2/	--	7.2	18.6
Price ($) 2/	-1.8	-20.6	-30.6
Imports	-0.53	-17.48	-38.78
Volume 2/	--	-5.0	-4.5
Price ($) 2/	-0.4	-9.2	-18.5
Trade balance	-2.70	-12.19	-1.35
Service balance	-0.86	-3.18	4.47
Current account balance	-3.56	-15.37	3.11
(in trillions of yen)	(-0.38)	(2.54)	(9.11)
Current account balance/GNP 3/	-0.1	0.7	2.5

Source: Basic simulation.

1/ Unless otherwise specified.
2/ Percentage difference between predicted and actual levels.
3/ Percentage point difference between predicted and actual.

CHART 3
JAPAN
CURRENT ACCOUNT, 1983–87



Sources: Bank of Japan, *Balance of Payments Monthly*; and author's calculations.
[1] Seasonally adjusted annual rate.

J-curve effect: or, turning the result on its head, part of Japan's trade surplus in 1986, measured in dollars, was due to the yen's appreciation.

A somewhat different picture emerges when the trade surplus is measured in yen. Because of the assumed lower value of the yen in the simulation, a lower dollar trade surplus converts to a higher yen surplus in both years. The extent of the increase in domestic currency terms is substantial: it is equal to some 2 1/2 percentage points of GNP in 1987. The disappearance of the J-curve in domestic currency can be explained in terms of the familiar Marshall-Lerner conditions. These show that adjustment of the trade balance to an exchange rate change depends not only on the price elasticities of exports and imports but also on the initial value of the trade surplus. 1/ Correction of a trade surplus by exchange rate appreciation is more difficult in foreign currency terms when exports initially exceed imports--as was the case in Japan in 1985--but the converse is true for correction in terms of domestic currency.

J-curve effects were also found for the simulated services balance. The deficit on the services account widened in 1986 relative to the base forecast before strengthening in 1987. The J-curve effect in 1986 is compounded by lower net investment receipts because of a slower accumulation of net overseas assets. Unlike the trade balance, there is a J-curve effect in both dollars and yen.

Summing the results for the trade and services accounts, the model predicts that the current account would have been some $15 billion lower in 1986 had there been no exchange rate realignment, but the current account would have been slightly higher in 1987. Or, stated another way, about one sixth of Japan's dollar current account surplus in 1986

1/ Assuming full pass-through of an appreciation to prices, the Marshall-Lerner condition for a yen appreciation to lower the dollar trade surplus is:

$$ML(\$) = 1 - E_x - E_m/R < 0$$

while to lower the yen surplus, the condition is:

$$ML(¥) = 1 - R.E_x - E_m < 0$$

where E_x and E_m are the price elasticities of exports and imports respectively and R the initial ratio of real exports to imports. For Japan, R was about 1.3 at end-1985, E_x = 1.1, and E_m = 0.6. Therefore, ML($) = -0.56 and ML(¥) = -1.03 implying that the Marshall-Lerner condition is more comfortably satisfied in yen than in dollars. The ease at which the Marshall-Lerner condition is satisfied determines the speed of trade surplus reduction following an exchange appreciation.

can be attributed to the stronger yen, and it was not until about mid-1987 that exchange rates began working to reduce this measure of the surplus. However, while for some purposes it is desirable to measure the current account in a foreign currency, the choice of the dollar gives a misleading picture of the extent of external imbalance because of its rapidly declining value. A more relevant measure of the current account surplus is its ratio to GNP. Measured this way, Japan's current account would have increased appreciably more in the last two years in the absence of exchange rate realignment. This would have meant that any subsequent external adjustment would have been even more protracted and probably would have required substantially greater exchange rate changes.

2. No exchange rate realignment and higher industrial production

Stagnant export demand, brought about by the appreciating yen, was a major cause of weak Japanese industrial production in 1986-87. Hence, with no exchange realignment, industrial production would almost certainly have been stronger and, in turn, the demand for imports higher. To measure the potential magnitude of this indirect effect of the exchange rate on imports, a variant of the basic simulation was constructed in which, in addition to the assumptions made for the basic simulation, it was assumed that industrial production grew in line with its historical trend. The main results are summarized in the tabulation below.

Effect of the Exchange Rate Realignment with no Collapse in Industrial Production, 1985:IV-1987:IV

(Predicted minus actual; billions of U.S. dollars)

	1985	1986	1987
Trade balance	-3.2	-17.5	-6.9
Services balance	-0.9	-3.3	4.0
Current account	-4.1	-20.7	-2.9
(percent of GNP)	(-0.2)	(0.4)	(2.1)

Industrial production was assumed to grow by nearly 5 percent in each of 1986 and 1987 instead of declining slightly in 1986 and growing by less than 4 percent in 1987. 1/ This stronger growth in industrial production would have reduced the fall in real imports stemming from the assumed higher real value of the yen by about 4-5 percent. As a consequence, the trade balance would have been a further $5 billion

1/ In addition, this assumption was interpreted to imply that there was no fall in the operating ratio is manufacturing from its third quarter 1985 level.

lower in both 1986 and 1987 than predicted in the basic exchange rate realignment simulation. The effect on the current account would have been slightly greater because of a loss of net investment income from abroad. Altogether, the J-curve effects are thus deeper and more prolonged when the indirect effects of the exchange realignment on Japanese industrial production are taken into account. Nevertheless, the simulation predicts that Japan's current account surplus would still have grown substantially--by more than 2 percent of GNP in 1987--had there been no realignment.

VI. Conclusions

The first main conclusion of this paper is that recent developments in Japan's current account balance have broadly followed historical relationships. The conclusion is reached mainly through formal statistical tests that find little evidence of a break in the behavior of the equations of a conventional current account model. Furthermore, these same equations can track, with only a small amount of underestimation, Japan's current account surpluses in 1986 and 1987.

The second main conclusion is that Japan's current account surplus would have been considerably larger if the yen had not appreciated. Putting this another way, the recent exchange rate changes have already exerted a significant corrective influence on external imbalances. However, part of the frustration at the continued high Japanese current account surplus is probably because the surplus is usually measured in U.S. dollars. Simulations on a model of the current account find significant J-curve effects when the current account is measured in dollars. These J-curve effects added to the surplus in 1986 and it was not until the second half of 1987 that the current account began to decline on account of the yen's appreciation. But J-curve effects are negligible when the current account is measured as a ratio to GNP: without the appreciation of the yen, the current account would have been about 2 percent of GNP higher by the end of 1987.

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APPENDIX I

Long-Run Restrictions on the Export Price Equation

In the main text, equation (2) is a reduced form market clearing price. The demand and supply functions can be written, assuming log-linear specifications, as:

$$x^d = -a_1(px - pw) + a_2 yw \qquad (II.1)$$

$$x^s = b_1(px - p) \qquad (II.2)$$

where a_1 is the elasticity of demand and b_1 the elasticity of supply. Equating supply and demand and solving for price:

$$px = \alpha\, pw + (1 - \alpha)\, p + \beta yw \qquad (II.3)$$

where,

$$\alpha = \frac{a_1}{a_1 + b_1}, \quad \beta = \frac{a_2}{a_1 + b_1}$$

That is, export prices are a weighted average of competitor prices (pw) and factor costs (p), where the weights depend on the relative size of demand and supply elasticities. It is found that $\alpha = \beta = 0$ in the long run. Hence, for a finite demand elasticity (a_1), the long-run elasticity of supply must be perfectly elastic ($b_1 \dashrightarrow \infty$).

Equation Estimates

The full sample estimates of the trade and services account equations are presented below. All equations were estimated by OLS, using quarterly data over the period 1975-87, and with variables in logarithms. DH is the Durbin-h statistic, DW the ordinary Durbin-Watson statistic, SE the standard error, and $\bar{R}^2$ the coefficient of determination adjusted for degrees of freedom; t-statistics are in parentheses.

a. Exports

$$X = \underset{(9.31)}{0.663}\ X_{-1} - \underset{(5.33)}{0.367}\ (PX_{-1} - PWX_{-1}) \qquad (1)$$

$$+ \underset{(4.71)}{0.689}\ YW_{-1} - \underset{(4.43)}{1.594}$$

$\bar{R}^2 = 0.988$ SE = 0.028 DH = 0.44

$$\Delta PX = \underset{(2.31)}{0.357}\ \Delta PWX - \underset{(3.84)}{0.155}\ (PX_{-1} - WP_{-1}) \qquad (2)$$

$$+ \underset{(9.31)}{0.543}\ \Delta WP + \underset{(2.40)}{0.993}\ \Delta YW - \underset{(3.95)}{0.233}$$

$\bar{R}^2 = 0.765$ SE = 0.016 DW = 2.01

b. Imports

$$MRM = \underset{(5.80)}{0.664}\ MRM_{-1} - \underset{(1.83)}{0.092}\ (PMRM_{-1} - WP_{-1}) \qquad (3)$$

$$+ \underset{(4.20)}{1.142}\ IP - \underset{(2.48)}{0.727}\ IP_{-1} - \underset{(1.71)}{0.017}\ TT + \underset{(1.75)}{32.249}$$

$\bar{R}^2 = 0.789$ SE = 0.035 DH = 0.17

$$MMF = \underset{(8.01)}{-0.107}\ (PMMF_{-1} - WP_{-1}) + \underset{(8.33)}{1.044}\ IP \qquad (4)$$

$$\underset{(8.64)}{-0.048}\ TT + \underset{(9.07)}{94.995}$$

$\bar{R}^2 = 0.693$ SE = 0.031 DW = 1.93

$$MFD = \underset{(2.78)}{0.343}\ MFD_{-1} - \underset{(4.52)}{0.358}\ (PMFD_{-1} - WP_{-1}) \qquad (5)$$

$$+ \underset{(2.12)}{0.293}\ RTDD_{-1} + \underset{(3.99)}{0.021}\ DUMMY - \underset{(0.82)}{1.106}$$

$\bar{R}^2 = 0.970 \quad SE = 0.034 \quad DH = -1.03$

$$MMN = \underset{(6.41)}{0.562}\ MMN_{-1} - \underset{(4.37)}{0.397}\ (PMMN_{-1} - WP_{-1}) \qquad (6)$$

$$+ \underset{(4.27)}{0.804}\ RTDD_{-1} + \underset{(4.81)}{1.078}\ ORM$$

$$-\underset{(2.73)}{0.645}\ ORM_{-1} - \underset{(5.00)}{10.523}$$

$\bar{R}^2 = 0.990 \quad SE = 0.032 \quad DH = 0.56$

c. Services

$$(SPTRAN - PYW) = \underset{(21.55)}{0.966}\ (SPTRAN - PYW)_{-1} + \underset{(4.96)}{0.207}\ (PY - PYW)_{-1} \qquad (7)$$

$$+ \underset{(3.31)}{0.517}\ (X - X_{-1}) + SEAS$$

$\bar{R}^2 = 0.907 \quad SE = 0.037 \quad DH = 0.78$

$$(SPTRL - PWC) = \underset{(7.23)}{0.620}\ (SPTRL - PWC)_{-1} - \underset{(4.60)}{0.707}\ (PWC - CP)_{-1} \qquad (8)$$

$$+ \underset{(2.95)}{0.369}\ GNP_{-1} + SEAS$$

$\bar{R}^2 = 0.951 \quad SE = 0.080 \quad DH = -2.01$

$$(SPO - PYW) = \underset{(4.91)}{0.568}\ (SPO - PYW)_{-1} + \underset{(3.55)}{0.660}\ GNP_{-1} \quad (9)$$
$$+ \underset{(1.47)}{0.078}\ (PY - PYW)_{-1} + SEAS$$

$\bar{R}^2 = 0.968$ SE = 0.046 DH = 1.04

$$\Delta(SRTRAN - PY) = \underset{(3.31)}{0.419}\ \Delta(SRTRAN - PY)_{-1} + \underset{(2.03)}{0.542}\ \Delta X + SEAS \quad (10)$$

$\bar{R}^2 = 0.284$ SE = 0.064 DH = 0.85

$$(SRTRL - CP) = \underset{(2.44)}{0.378}\ (SRTRL - CP)_{-1} + \underset{(1.69)}{0.280}\ (PWC - CP)_{-1} \quad (11)$$
$$+ \underset{(3.61)}{1.483}\ YW_{-1} + SEAS$$

$\bar{R}^2 = 0.904$ SE = 0.106 DW = 2.10

$$(SRO - PY) = \underset{(1.57)}{0.294}\ (SRO - PY)_{-1} + \underset{(3.28)}{1.190}\ YW \quad (12)$$
$$- \underset{(2.61)}{0.518}\ (PY - PYW)_{-1} + SEAS$$

$\bar{R}^2 + 0.837$ SE = 0.093 DW = 2.05

d. Wholesale prices (used in simulations)

$$\Delta(WP + E) = \underset{(6.47)}{0.445}\ \Delta(WP + E)_{-1} + \underset{(4.59)}{0.059}\ \Delta(PMMF + E)$$
$$+ \underset{(3.52)}{0.065}\ \Delta(PMRM + E) + \underset{(2.00)}{0.314}\ (GNP - GNP^*)$$

$\bar{R}^2 = 0.851$ SE = 0.008 DH = -0.63

Variable Mnemonics

CP = Consumer price index (1980 = 100) multiplied by dollar-yen exchange rate

DUMMY = Food imports liberalization dummy; 1982 II = 0.25, 1982 III = 0.5, etc.

E = Yen-dollar exchange rate

GNP* = Potential GNP (constructed)

GNP = Real GNP; 1980 yen

IP = Industrial production, seasonally adjusted; 1980=100

MFD = Volume of food and drink imports, seasonally adjusted; 1980 = 100

MMF = Volume of mineral fuel imports, seasonally adjusted; 1980 = 100

MMN = Volume of manufacturing imports, excluding nonmonetary gold, seasonally adjusted; 1980 = 100

MRM = Volume of raw material imports, seasonally adjusted; 1980 = 100

ORM = Operating ratio in manufacturing; 1980 = 100

PMFD = Implicit dollar deflator for food and drink imports, seasonally adjusted; 1980 = 100

PMMF = Implicit dollar deflator for mineral fuels imports, seasonally adjusted; 1980 = 100

PMMN = Implicit dollar deflator for manufactured imports, seasonally adjusted; 1980 = 100

PMRM = Implicit dollar deflator for raw materials imports, seasonally adjusted; 1980 = 100

PWC = Import-weighted average of trading partners' consumer prices in dollars; 1980 = 100

PWX = Weighted average of competitors' dollar export unit values; 1980 = 100

PX = Implicit dollar deflator for exports, seasonally adjusted; 1980 = 100

PY = GNP deflator; 1980=100

PYW = Weighted average of competitors' GNP deflators, in dollars; 1980=100

RTDD = Real total domestic demand; 1980 yen

SEAS = Seasonal dummies

SPO = Service payments, other (excluding investment income); millions of U.S. dollars

SPTRAN = Service payments, transport; millions of U.S. dollars

SPTRL = Service payments, travel; millions of U.S. dollars

SRO = Service receipts, other (excluding investment income); millions of U.S. dollars

SRTRAN = Service receipts, transport; millions of U.S. dollars

SRTRL = Service receipts, travel; millions of U.S. dollars

TT = Time trend (1975:I = 1975.25, 1975:II = 1975.50, etc.)

WP = Overall wholesale price index (1980 = 100) multiplied by dollar-yen exchange rate

X = Export volume, seasonally adjusted; 1980 = 100

YW = Export-weighted average of partner countries' GNP; 1980 = 100