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The Trade Effects of the 1971 Currency Realignments

THE YEAR 1971 SAW A MAJOR realignment of exchange rates among the world's important currencies. The basic cause of these changes was the continuing deterioration of the U.S. trade and payments position, and their proximate cause the massive speculation against the dollar throughout the year and suspension of convertibility by the United States in August. The changes in exchange rates against the dollar—the dollar price of foreign currencies—are expected to initiate a major swing toward surplus in the U.S. trade balance and consequently to reduce substantially the surpluses of some other countries.

This paper attempts to provide reasonable and consistent estimates of the effects of the realignment on the trade balances of the major countries, based on current knowledge of the theoretical and empirical relationships involved. No new empirical evidence is produced here; I try rather to

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present a coherent picture of the state of the art regarding both the analytics and empirical estimates of the effects of exchange rate changes, and to give my best guess concerning the outcome.

In the first two major sections of the paper the analytics of revaluation are discussed, first from the point of view of a single revaluing country, with attention to the difficulties concerning export supply elasticities and the "pass-through" issue; and then from the standpoint of multilateral trade, using a model originally developed by Paul Armington.[1]

The next three sections focus on quantitative estimates of the long-run effects of the realignment. The first reports an extension of the Armington model, under several assumptions about the relevant demand, substitution, and supply elasticities; it develops a figure of a bit less than $8 billion for the swing in the U.S. trade surplus from a 1971 base, and consistent estimates for the whole trade matrix. Next comes a brief discussion of the empirical model for U.S. bilateral trade developed by Stephen Magee, which provides estimates of the U.S. row and column of the world trade matrix.[2] It also shows a swing of about $8 billion, although it implies a somewhat different distribution of U.S. gains across bilateral balances. Then some empirical estimates are presented of the effects on the total trade balances of seven of the major countries from the trade model of the Organisation for Economic Co-operation and Development (OECD), developed by F. G. Adams and his associates.[3] This model predicts the row and column sums of the world trade matrix—total exports and imports—for the seven major OECD countries and two residual categories, and although it gives a lower estimate of the general level of effects, it yields a further check on the distribution of effects across major countries.

None of the models used in these three sections is useful for studying the *timing* of the effects; Armington's is explicitly comparative static; Magee's uses annual data with no price lags; and Adams' relies on semi-annual

1. See Paul S. Armington, "A Theory of Demand for Products Distinguished by Place of Production," International Monetary Fund (IMF), *Staff Papers*, Vol. 16 (March 1969), pp. 159–76, and further references cited in note 10 below.

2. See Stephen P. Magee, "United States Trade and the New Economic Policy," Studies in International Business and Economics 9 (University of California, Berkeley, Institute of International Studies, September 1971; processed), and further references in note 21 below.

3. See F. G. Adams, H. Eguchi, and F. Meyer-zu-Schlochtern, *An Econometric Analysis of International Trade* (Paris: Organisation for Economic Co-operation and Development, January 1969), and note 27 below for a further reference.

data with at most one half-year lag. So the sixth section reviews briefly the evidence on timing. What little evidence there is suggests lags of at most two years if the exchange rate changes are immediately passed on in changes in export prices stated in the importer's currency, and substantially longer if they are not. The paper ends with some brief conclusions from my survey of the existing literature.

Two crucial aspects of the estimates here deserve note. First, they do not predict changes in *actual* trade balances. Rather, they give the partial, or differential, outcome of the realignments a few years hence compared to what would otherwise have resulted. For example, an estimate of a $7 billion swing in the U.S. trade balance is *not* a prediction that the actual balance will change by $7 billion over some base period, but instead that after, say, 1973, the surplus will be $7 billion higher at any given time than it would have been under the exchange rates of April 30, 1971.

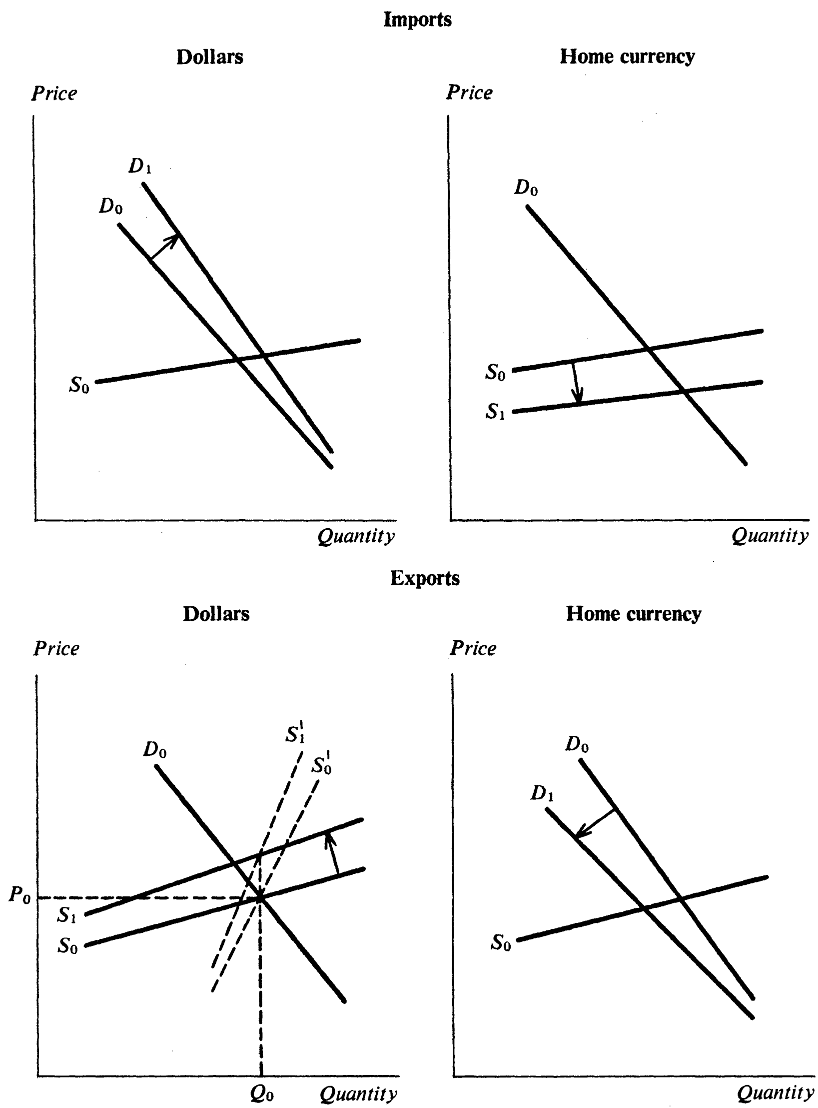
Second, the estimates are the "exogenous" or "initial" effects of the realignment, before any compensating effects working through income or the general price level set in. On one interpretation, these estimates give the final results if governments act to prevent a net effect on income and price levels. Such action is unlikely, at least in the United States, where the stimulus to income will be welcome even though it will increase imports and dilute the initial impact of the change. On a second interpretation, the estimates are the exogenous changes in net exports to be fed into macroeconomic models that will then calculate the feedbacks for whatever path is assumed for government policy variables.

The Basic Analytics of Revaluation

The effects of a revaluation on the export receipts and import payments of a typical country other than the United States, in dollar terms, can be analyzed in a straightforward fashion with reference to a set of supply-and-demand diagrams borrowed from Charles Kindleberger and shown in Figure 1.[4] They assume that both suppliers and demanders state their schedules in their own currencies, with the exchange rate r (equal to dollars per unit of foreign currency) translating between the two. The initial equilibrium values of imports and exports, in dollars and in home currency,

4. Charles P. Kindleberger, *International Economics* (3rd ed., Richard D. Irwin, 1963), p. 165.

Figure 1. Effects of Revaluation on Imports and Exports of a Typical Country other than the United States, in Dollar and Home Currency Terms



Source: Adapted from Charles P. Kindleberger, *International Economics* (3rd ed., Richard D. Irwin, 1963), p. 165.

are given by the intersections of the supply and demand curves with zero subscripts.

To reveal the effects of a revaluation in dollar terms, the pair of graphs on the left in Figure 1 uses as an example a revaluation of the deutsche mark (DM), whose dollar value rises from \$0.275 to \$0.310. In terms of dollars, this process has no effect on the supply of imports to Germany but it shifts the German demand curve up by the percentage of the revaluation to D_1. From the German point of view, an item worth one DM has risen in value from 27½¢ to 31¢. Similarly, the U.S. demand function for German exports is fixed in dollars, but if German supply is set in DM, the dollar supply curve shifts left to S_1.

The result is unambiguous for dollar import payments by Germany—plainly, they rise—but not for dollar export receipts. If the short-run demand curve for German exports is inelastic at the initial equilibrium, export receipts in dollars may even rise.[5]

In terms of the currency of the revaluing country, the situation is just reversed. German demand for imports is fixed in DM, while the revaluation shifts the supply curve down. On the other hand, the U.S. demand for German goods is fixed in dollar terms, so the U.S. demand function in DM shifts down. German export receipts in DM drop unequivocally but import payments are subject to ambiguity.

THE ROLE OF SUPPLY ELASTICITIES

With Germany still the example, the extent of the increase in import payments in dollars that would follow from a revaluation of the DM against the dollar obviously depends on the elasticities of both the supply of exports to Germany and the German demand for imports.[6] If in the upper left graph the elasticity of supply were infinite, so that S_0 were horizontal, the increase in dollar import payments by Germany would be larger the greater the elasticity of demand, in absolute value. In fact, the

5. The symmetrically opposite possibility is that if the short-run U.S. import demand function is inelastic, U.S. import expenditures in dollars will rise in the short run as a result of the general foreign revaluation, or dollar devaluation.

6. The results below can, of course, be derived algebraically by manipulation of a model such as that set forth below in note 7. For an extension to the complete elasticity condition giving the effect of a revaluation on the trade balance—the famous Marshall-Lerner condition—see Egon Sohmen, "The Marshall-Lerner Condition," in Kindleberger, *International Economics*, Appendix D, pp. 656–58.

percentage increase in payments would, in that case, be equal to the percentage revaluation times the elasticity of demand.

The elasticity of demand governs the effect that reducing the supply elasticity has on imports. If the demand elasticity is less than unity, a lower supply elasticity, raising dollar prices of imports, will make the rise in import payments even larger. If demand is elastic, a reduction in supply elasticity will reduce the amount by which import payments rise.

The lower left graph suggests that the dollar value of German export receipts will rise or fall in response to a revaluation depending on whether the elasticity of foreign demand for German exports is greater or less than unity. If export demand is elastic at the initial P_0, Q_0 intersection, export receipts in dollar terms will fall.

Again, the effect of a lower supply elasticity of German exports depends on the elasticity of demand. A reduction in supply elasticity from the flat S_0 and S_1 curves to the steeper S_0' and S_1' curves in the lower left panel holds down the increase in the dollar price of German exports. That in turn reduces the effect on export receipts in absolute value; but whether this implies an arithmetic increase or decrease depends on the elasticity of demand. If demand is elastic, so that receipts fall, a lower supply elasticity reduces the decrease.

Thus if, in general, both import and export demand functions have elasticities greater than unity in absolute value at the initial equilibrium point, a reduction in the elasticity of supply from an infinite value to a smaller positive value will, by raising dollar import prices and reducing dollar export prices, blunt the effect of revaluation on the trade balance of the typical non-U.S. country in dollar terms. It will mean both less decrease in export receipts and less increase in import payments.

AN ESTIMATE OF THE SUPPLY EFFECT

An explicit adjustment for the extent to which imperfectly elastic supply schedules reduce the ratios of effects on export receipts and import payments to the percentage revaluation is required for the quantitative estimates developed below. Imperfectly elastic supply exerts upward pressure on import prices and downward pressure on export prices in the revaluing country. Thus one convenient way to make a supply adjustment is to estimate the effective price change that follows from revaluation.

Extending the supply-and-demand model discussed just above yields an expression relating the percentage foreign revaluation, or U.S. devaluation, dr/r, to the percentage change in foreign export prices, or U.S. import prices, both in dollar terms, dp/p:

$$\frac{dp/p}{dr/r} = \frac{1}{1 - d_x/s_x},$$

where d_x and s_x are, respectively, the demand and supply elasticities of foreign exports, shown in the lower left-hand graph of Figure 1.[7] This relationship has been used to construct Table 1, which shows the ratio of price change to revaluation for selected values of d_x and s_x.

Table 1 demonstrates that at demand elasticities in the range of -2.0 to -3.0, a supply elasticity in the range of 5.0 to 10.0 suggests ratios of dp/p to dr/r that run between 63 percent and 83 percent. The only econometric estimates of trade supply elasticities that I have found are those of Stephen P. Magee, who obtained values of 10.0 for U.S. exports, and 8.5 for U.S. imports.[8]

Combined with Magee's supply elasticity estimates, demand elastici-

7. This result can be derived from a log-linear model, based on constant elasticities of supply and demand, for the typical revaluing country as follows, where p is price and q is quantity:

$$\text{Demand: } \ln p = \ln a_0 - a_1 \ln q.$$
$$\text{Supply: } \ln p = \ln b_0 + b_1 \ln q.$$

Here the elasticity of demand, $d = -1/a_1$; of supply, $s = 1/b_1$. Subscripts x and m will be used to denote exports or imports.

If the model is interpreted as determining import payments in dollars, a revaluation shifts the demand curve up and can be represented by da_0/a_0. Total differentiation of the two equations, holding b_0 constant, then yields

$$\frac{dp}{p} = \frac{da_0}{a_0}\left(\frac{1}{1 + \frac{a_1}{b_1}}\right) = \frac{da_0}{a_0}\left(\frac{1}{1 - \frac{s_m}{d_m}}\right).$$

On the export side, the equivalent expression is

$$\frac{dp}{p} = \frac{db_0}{b_0}\left(\frac{1}{1 + \frac{b_1}{a_1}}\right) = \frac{db_0}{b_0}\left(\frac{1}{1 - \frac{d_x}{s_x}}\right).$$

The sum of the two coefficients of da_0/a_0 and db_0/b_0 is unity, so that if, for example, a 10 percent devaluation raises import prices 2 percent, it will raise export prices 8 percent, yielding the supply adjustment described in the text.

8. See Stephen P. Magee, "A Theoretical and Empirical Examination of Supply and Demand Relationships in U.S. International Trade," A Study for the Council of Economic Advisers (October 1970; mimeo.), Part I, p. 5, for U.S. total exports, and p. 8 and Table 9 for U.S. total imports, where the elasticity is the inverse of the coefficient 0.118 of *QM* (quantity of U.S. imports) in the total supply equation.

Table 1. Ratio of Foreign Export or U.S. Import Price Change to Percentage Revaluation in Dollar Terms, by Selected Elasticities of Demand and Supply

Elasticities of supply	Elasticities of demand				
	−1.0	*−2.0*	*−3.0*	*−5.0*	*−10.0*
1.0	0.50	0.33	0.25	0.17	0.09
2.0	0.67	0.50	0.40	0.29	0.17
5.0	0.83	0.71	0.63	0.50	0.33
10.0	0.91	0.83	0.77	0.67	0.50
∞	1.00	1.00	1.00	1.00	1.00

Source: Derived by author; see text for equation and discussion.

ties in the range from 2.0 to 3.0, which are employed below, suggest an effective revaluation correction ranging from 0.72 when $s_m = 8.5, d_m = 3.0$, to about 0.83 when $s_m = 10.0, d_m = -2.0$. A correction of this order will be used in connection with the Armington model of bilateral trade balances. For example, a demand elasticity of −2.2 coupled with a supply elasticity of 9.0 would yield an effective revaluation ratio of 0.8, and a supply elasticity adjustment factor of 0.2, a convenient central value.

THE "PASS-THROUGH" ISSUE

Some argue that because exporters might not, in the immediate aftermath, pass through the effects of the revaluation by changing their prices in foreign currency, but might instead absorb the change in margins on foreign sales, the supply and demand shifts depicted in Figure 1 may not occur at all.[9] As an example, consider an exporter in the revaluing country. If he does not raise his price, exports will not drop, given the foreign demand curve.

But such a response is likely to be only temporary. Losses in the export industry should *eventually* push capital and labor out of the industry, constricting output, pulling up the price, and reducing export sales. Conversely, the exporters in a devaluing country—in 1971, the United States—

9. The symmetrically opposite case of U.K. exporters not cutting prices and passing through the effects of the 1967 devaluation was suggested in "The Economic Situation," *National Institute Economic Review*, No. 42 (November 1967), p. 6. The likelihood that foreign sellers in the United States would not raise prices and U.S. sellers abroad would not reduce prices in foreign currencies has been discussed frequently in the past few months. See "After the Fall," *Wall Street Journal*, April 19, 1972, p. 1.

may resist a decline in the foreign exchange price of their goods, letting profits on foreign sales swell as a result of the devaluation. But eventually, in the absence of overwhelming barriers, such profits should draw entrants into the industry, causing the quantity to increase gradually through changes in the number of firms, rather than immediately through the output of existing firms.

Thus whether or not the exchange rate change is passed through governs mainly the timing of its effect. Immediate pass-through will mean relatively short lags, while attempts to absorb the effects of a change will lengthen the lags considerably. We will return to these matters below in a review of the evidence on lags, after some more attention to the framework of the analysis and a look at some estimates of the long-run effects of the recent exchange rate changes.

A Framework for Analyzing Multilateral Trade Effects

A single exchange rate change will, in general, have an effect on each cell of a trade matrix T_{ij}, where the i rows run across sellers and the j columns run across buyers. The ij entry in such a matrix, as shown in Table 2, gives the sales by the ith country to the jth country. With a change in the exchange rate or price level in country k, an estimate of the change in trade DT_{ij} should in theory be possible, with the kth row of DT_{ij} generated by direct elasticities of demand for k's exports, and the other elements in DT_{ij} generated by cross-price elasticities of the j buyers for the goods of the non-k sellers.

Estimation of such a model would ensure consistency in the prediction of the effects of exchange rate changes. This is true because, excluding the diagonal elements—which show each country's purchases from itself—the columns must add up to each country's change in total imports; the rows must sum to the changes in total exports; and, aggregated across countries, these two sums must be equal if the model is closed. In addition, this model would give us a more detailed view of the effects on trade than the usual one-country bilateral models, or the models yielding only the row and column totals.

While an empirical implementation of this model has not yet been published, the theoretical basis for it, and the restrictive assumptions that are needed to make it operational, have been developed by Paul Armington in three articles in recent IMF *Staff Papers*.[10] It provides the framework for the quantitative estimates of the effects of recent exchange rate changes discussed below.

THE ARMINGTON MODEL

The Armington model in the version used here assumes that purchasers $j(= 1, \ldots, J)$ demand a single tradeable commodity X_1 and a single non-traded good X_2. For the tradeable good they distinguish among sources of supply $i(= 1, \ldots, I)$ so that, for example, German and Japanese goods are not perfect substitutes.[11] Next Armington assumes that the distribution of demand within each commodity is independent of changes in the distribution within each other commodity, which allows him to write the demand functions of a typical purchaser j for traded goods X_1 as

$$X_1 = X_1(Y, P_1, P_2).^{12} \tag{1}$$

Here X_1 is defined as a quantity index of purchases of tradeable goods from each source:

$$X_1 = f(X_{11}, X_{12}, \ldots, X_{1I}).^{13} \tag{2}$$

The prices P_1 and P_2 are weighted averages of the prices from each supplier such that for each purchaser j

$$\frac{dP_1}{P_1} = \sum_i S_i \frac{dP_{1i}}{P_{1i}}. \tag{2a}$$

10. See "A Theory of Demand for Products Distinguished by Place of Production"; "The Geographic Pattern of Trade and the Effects of Price Changes," IMF, *Staff Papers*, Vol. 16 (July 1969), pp. 179–99; "Adjustment of Trade Balances: Some Experiments with a Model of Trade Among Many Countries," IMF, *Staff Papers*, Vol. 17 (November 1970), pp. 488–523. The theoretical results discussed here are developed in "Theory of Demand," while the quantitative estimates in the next section are extensions of the "Geographic Pattern" paper. I understand that work on empirical implementation of the model is going forward at the IMF.

11. Note that in general $I = J$ since all countries buy and sell.

12. In this section I am concerned mainly with the demand of a "typical" purchaser j for tradeable products X_{1i}—goods X_1 distinguished by source of supply i. To minimize multiple subscripting, I will omit the j subscript as long as the focus is on the typical purchaser. Later, when this model is used to analyze trade among many countries, the j subscript will be reintroduced.

13. The assumption of independence is required for aggregation across suppliers and separation of the problem into the two steps that follow. This is well known from the literature on aggregation. See Robert M. Solow, "The Production Function and the Theory of Capital," *Review of Economic Studies*, Vol. 23 (1955–56), pp. 101–08; and Franklin M. Fisher, "The Existence of Aggregate Production Functions," *Econometrica*, Vol. 37 (October 1969), pp. 553–77.

The weights S_i are the shares of each seller i in total demand of j for tradeable goods.

With the assumption of independence, the demand for tradeable goods breaks down into two parts. Given money income Y and the price indexes of X_1 and X_2, purchasers determine demand for tradeable goods from (1). Within the given purchases of tradeable goods the buyer will distribute his demand across sellers i according to their relative prices. To simplify the model, Armington assumes that the elasticity of substitution in each buyer's distribution function $f(\cdot)$ between suppliers of X_1, σ_j, is constant and has the same value for each pair of sources of tradeable goods. Thus the distribution function $f(\cdot)$ for each buyer j in equation (2) is given by the constant-elasticity-of-substitution (CES) form

$$X_1 = [b_{11}X_{11}^{-\rho_j} + \ldots + b_{1I}X_{1I}^{-\rho_j}]^{-\frac{1}{\rho_j}}.$$

In this case, the distribution function across sellers is

$$\frac{X_{1i}}{X_1} = b_{1i}^{\sigma_j}\left(\frac{P_{1i}}{P_1}\right)^{-\sigma_j}, \tag{3}$$

where σ_j, the elasticity of substitution, is given by $1/(1 + \rho_j)$.[14]

Equations (1), determining X_1, and (3), distributing it among suppliers, yield a complete model of demand by the typical buyer j for tradeable goods X_1 by source of supply. To determine the effect of price, or exchange rate, changes on demand for X_{1i}, (1) and (3) can be differentiated, holding Y and P_2 constant. With some manipulation, this yields for each purchaser j,

$$\frac{dX_{1ij}}{X_{1ij}} = -\,[(1 - S_{ij})\sigma_j + S_{ij}\eta_j]\frac{dP_{1i}}{P_{1i}} + \sum_{k\neq i} S_{kj}(\sigma_j - \eta_j)\frac{dP_{1k}}{P_{1k}}, \tag{4}$$

where η_j is the own-price elasticity of demand for commodity 1 by purchaser j.[15]

14. Equation (3) can be obtained by partially differentiating (2) with respect to X_{1i}, setting the differential equal to P_{1i}/P_1, and solving for X_{1i}/X_1.

15. Differentiating (3) for X_{1i} yields

$$\frac{dX_{1i}}{X_{1i}} = \frac{dX_1}{X_1} - \sigma_j\left(\frac{dP_{1i}}{P_{1i}} - \frac{dP_1}{P_1}\right).$$

From (1), $\dfrac{dX_1}{X_1} = \eta_j\dfrac{dP_1}{P_1}$, and, from 2a

$$\frac{dP_1}{P_1} = S_1\frac{dP_{1i}}{P_{1i}} + \sum_{k\neq i} S_{1k}\frac{dP_{1k}}{P_{1k}};$$

substitution gives the final differential.

The first bracketed coefficient gives the direct elasticity of demand in country j for imports of tradeable goods from country i, given a change in the price i charges. The second set of coefficients, $S_{kj}(\sigma_j - \eta_j)$, are the cross-price elasticities of demand of country j for exports from i of tradeable goods, given third-country k changes in price. For each country j, an estimate of the elasticity of demand for tradeable goods, η_j, an estimate of the elasticity of substitution by source of supply, σ_j, and a trade shares matrix by supplier of tradeables, S_{ij}, would yield a complete set of direct and cross-price elasticities of demand for tradeable goods from each source X_{1ij} with respect to changes in relative prices or exchange rates. Thus, η_j and σ_j are the two key elasticities determining the influence of price changes on trade flows.

THE THEORETICAL BASIS FOR A MODEL OF TRADE SHARES

The Armington model provides a theoretical basis for export share models, such as that of Adams and his associates. Armington assumes that products are distinguished in utility functions by place of production; from this assumption, the derivation of basic share equations such as (3), with relative prices as the fundamental arguments, follows directly. To say this, however, does not answer Armington's initial question: Why would buyers purchase the same good from different sellers if their prices were different? He offers a tautological answer: Because they distinguish between sources in their utility functions.

Several reasons may explain why purchasers distinguish among sources of supply. For example, the distribution function (3) is consistent with a monopolistic competition model of the market for tradeable goods with a market demand for X_1 and individual firm demand curves for X_{1i}. In this case the supply adjustment discussed earlier would depend on the marginal revenue and cost functions of the monopolistic competitors, rather than arising from a movement along a competitively determined supply curve.

Another possibility would be to recognize risk as an element in determining shares, given different prices among suppliers. Where changing suppliers internationally incurred no fixed transactions costs, and where deliveries were immediate, it would make sense, if prices differed, to buy only from the cheapest source. But if switching sellers is costly, and if it means losing a place at the head of the queue, paying a higher price to a stable supplier (in terms of variance of price and delivery time) may prove cheaper. If the various suppliers were distributed continuously along a spectrum of such risks, to buy from several of them, balancing a marginal reduction in risk against a marginal increase in total cost, would be worthwhile. This kind of basic model could also yield stable share relationships as functions of relative prices. In that case the unmeasurable risk factors are "suppressed," although in fact the coefficients would be combinations of the relevant variances. Either the monopolistic competition or the risk-and-return approach, in place of the simple assumption that sources of supply enter the utility function, seem to put the whole Armington approach on a better footing, while preserving all of its usefulness.

Application of the Armington Model

The Armington model yields an efficient and theoretically satisfactory way to obtain consistent estimates of the effects of the realignments of exchange rates on trade balances. The changes in trade balances across countries should sum to zero, since a rest-of-the-world sector is included, and they should be systematically related to the underlying structure of trade. The model insures consistency while permitting variation of the assumptions that go into the estimates.

The illustrative applications of the model presented in Armington's second and third papers, and this extension to suggest some a priori "reasonable" values for expected trade changes, simplify world trade by dividing all goods into two separate sub-components, traded and nontraded goods. Such a division seems to imply, for example, that if the elasticity of substitution among sources of tradeable goods in the demand function of country j is the same value of σ_j for each pair of sources, each source must be supplying a similar mix of tradeable goods. Thus an important step in empirical implementation of the model would be to disaggregate by types of commodity according to standard international trade classifications.[16]

16. Actually, Armington switched from a matrix of trade in manufactures, used in "Geographic Pattern," to trade in all commodities in "Adjustment of Trade Balances," without explaining the reasons for the switch. He also reduced his assumed elasticity of substitution from 3 to 2 in the transition, probably due to the inclusion of trade in agricultural goods. Below I use a matrix of total trade, following Armington's lead but updating to 1971, and experiment a bit with elasticities.

Table 2. Direction of External and Internal Trade, Fourteen Major OECD Countries and the Rest of the World, 1971

Millions of U.S. dollars at annual rates, f.o.b.

	Buying						
Selling country	United States	Canada	Japan	Austria	Belgium-Luxembourg	Denmark	France
United States	114,022.8	10,365.7	4,054.7	100.6	1,077.7	254.6	1,380.2
Canada	12,080.9	6,186.0	783.8	8.8	178.9	23.2	154.4
Japan	7,445.3	852.2	15,366.4	38.9	213.5	64.7	184.9
Austria	127.8	41.9	14.3	1,776.8	39.6	69.5	73.0
Belgium-Luxembourg	834.0	57.8	75.0	74.0	1,458.4	108.6	2,498.6
Denmark	285.2	36.0	32.4	56.5	48.7	1,467.8	92.2
France	1,101.7	221.5	154.4	155.4	2,284.3	187.3	22,039.2
Germany	3,752.9	412.4	511.4	1,804.8	3,300.1	824.9	4,803.5
Italy	1,483.7	163.7	116.4	279.2	572.8	107.8	2.047,0
Netherlands	562.7	86.0	75.6	122.2	1,845.4	193.4	1,442.9
Norway	180.1	19.1	21.6	18.4	59.9	189.4	115.3
Sweden	489.8	111.7	72.8	135.7	230.0	739.3	377.0
Switzerland	495.1	76.2	164.5	328.6	127.8	105.0	505.7
United Kingdom	2,644.9	852.6	381.1	258.7	826.8	566.9	958.7
Rest of the world	10,697.8	866.4	11,164.2	457.6	918.6	806.0	5,018.0

Source: Organisation for Economic Co-operation and Development, *Overall Trade by Countries*, Series A, Supplement (OECD, March 1972). Foreign sales of the fourteen countries and the rest of the world are f.o.b. export data using a standard adjustment from c.i.f. to f.o.b. Internal trade figures—the diagonal element of the table—were calculated by setting the ratio of each country's internal trade to its total imports equal to the value Armington gives for

But the focus here is the effects of exchange rate changes on total trade, eliminating any commodity index from the analysis, so the T_{ij} matrix of trade among many countries is used. Again, indexes run across i sellers and j buyers, and $I = J$ so that the trade matrix is square.

The trade matrix for 1971 is shown in Table 2. The table is derived from export data, and the entries are in millions of U.S. dollars at annual rates, f.o.b. Note that the diagonal elements of the matrix give an estimate of each country's internal trade in tradeable goods. The size of these entries reflects the fact that gross trade in inputs as well as final products is under consideration, so that the total trade of any country will greatly exceed its gross domestic product (GDP) of tradeable goods measured as final product or as value added. The internal trade entries were obtained by using Armington's data to derive ratios for each country of internal trade to total imports, averaged over the three years 1966–68, which were then applied to the corresponding country's total imports for 1971.[17] The trade share matrix S_{ij}, which gives the share of each country i of the market for tradeable goods of country j, is given in Table 3. Each entry in this table is the ratio of the corresponding cell of Table 2 to its column total.

17. See Armington, "Adjustment of Trade Balances," Table 9, pp. 518–19, and Appendix A, pp. 512–14.

country							
Germany	*Italy*	*Netherlands*	*Norway*	*Sweden*	*Switzerland*	*United Kingdom*	*Rest of the world*
2,832.0	1,314.0	1,785.4	184.9	469.9	626.8	2,374.0	17,196.1
316.3	208.0	232.4	184.7	44.8	37.9	1,347.5	2,074.9
629.5	181.4	355.1	215.2	117.7	205.8	555.4	12,360.6
719.9	291.0	92.4	42.5	122.8	350.8	224.8	928.3
3,069.7	538.1	2,332.6	102.8	206.9	260.5	443.0	1,699.2
448.3	129.7	90.5	267.0	584.2	107.2	696.5	740.3
4,381.4	2,237.2	1,164.1	100.7	251.5	967.9	933.8	6,378.4
28,540.6	3,244.8	4,139.5	549.7	1,297.9	2,283.4	1,529.8	9,963.7
3,440.5	10,864.9	694.2	84.0	181.2	712.1	585.0	4,655.2
4,713.2	730.0	2,174.6	112.7	295.6	266.5	1,018.8	2,371.2
397.2	57.8	75.7	893.0	436.4	28.2	481.0	484.7
832.6	215.6	327.7	765.2	2,781.4	217.1	1,006.6	1,918.4
875.4	508.4	150.8	81.5	189.7	3,672.8	419.2	1,735.6
1,303.3	607.3	997.2	410.8	933.8	564.4	13,488.5	11,047.4
7,299.8	4,518.6	1,539.5	681.5	1,396.8	237.2	10,534.3	73,405.8

1966–68 annual averages. (Paul S. Armington, "Adjustment of Trade Balances: Some Experiments with a Model of Trade Among Many Countries," International Monetary Fund, *Staff Papers*, Vol. 17, November 1970, Table 9, pp. 518–19, and Appendix A, pp. 512–14.)

DIRECT AND CROSS-PRICE ELASTICITIES

Given the total trade matrix, the direct and cross-price elasticities of demand of each country j for the tradeable goods of each country i, in response to a change in price of one country k, are (from equation (4) above),

(5) $$d_{ij} = -(1 - S_{ij})\sigma_j - S_{ij}\eta_j = -[\sigma_j - S_{ij}(\sigma_j - \eta_j)]$$

for the direct elasticity of demand for the goods of the country whose price changes, $i = k$, and

(6) $$c_{ij} = S_{ij}(\sigma_j - \eta_j)$$

for the cross-price elasticity of demand by country j for the goods of all other (non-k) countries given a change in price in country k. The direct and cross-price elasticities are closely related, since the two expressions show that

$$c_{ij} - d_{ij} = \sigma_j.$$

Normally the elasticity of substitution σ_j would exceed (in absolute value) the elasticity of demand for tradeables as a whole η_j by a substantial amount. If that is the case, equations (5) and (6) make clear that, as the share S_{ij} of any given seller in a market rises, the direct price elasticity of demand for his goods falls and the cross-price elasticity rises. If S_{ij} ap-

Table 3. Market Shares of External and Internal Trade, Fourteen Major OECD Countries and the Rest of the World, 1971
Percentage

	Buying						
Selling country	*United States*	*Canada*	*Japan*	*Austria*	*Belgium-Luxembourg*	*Denmark*	*France*
United States	73.0	50.9	12.3	1.8	8.2	4.5	3.3
Canada	7.7	30.4	2.4	0.2	1.4	0.4	0.4
Japan	4.8	4.2	46.6	0.7	1.6	1.1	0.4
Austria	0.1	0.2	0.0	31.6	0.3	1.2	0.2
Belgium-Luxembourg	0.5	0.3	0.2	1.3	11.1	1.9	6.0
Denmark	0.2	0.2	0.1	1.0	0.4	25.7	0.2
France	0.7	1.1	0.5	2.8	17.3	3.3	52.9
Germany	2.4	2.0	1.5	32.1	25.0	14.4	11.5
Italy	0.9	0.8	0.3	5.0	4.3	1.9	4.9
Netherlands	0.4	0.4	0.2	2.2	14.0	3.4	3.5
Norway	0.1	0.1	0.1	0.3	0.4	3.3	0.3
Sweden	0.3	0.5	0.2	2.4	1.7	12.9	0.9
Switzerland	0.3	0.4	0.5	5.8	1.0	1.8	1.2
United Kingdom	1.7	4.2	1.2	4.6	6.3	9.9	2.3
Rest of the world	6.8	4.3	33.8	8.1	7.0	14.1	12.0

Source: Table 2.

proaches unity, d_{ij} approaches η_j, the total market demand elasticity; as it approaches zero, d_{ij} approaches σ_j, the substitution elasticity. If one seller has only a small share of the market, his price cut attracts trade from other sellers, and he also gains from an expansion of the market. But if he already has the entire market, his price cut cannot divert trade from other sellers. This again is a principal feature of a monopolistic competition model.

With a trade shares matrix S_{ij} and an assumption concerning the values of η_j and σ_j, the matrixes of elasticities giving the change in purchases of any country j from any country i, given a change in the price level or exchange rate of any country, can be generated. One modification that is useful is to state first the direct elasticity in value terms, in order to generate a trade change matrix in value terms. To do this requires simply adding 1.0 to the d_{ij} expression.

The $d_{ij} + 1$ and c_{ij} matrixes for 1971 are shown in Tables 4 and 5 under Armington's assumptions, reported in "Geographic Pattern," that all $\eta_j = 1.0$ and all $\sigma_j = 3.0$.[18] The assumption that η_j is unity means that a

18. I have no specific evidence that 3.0 is a correct value for σ_j. Armington asserts that values in this range are consistent with empirical evidence, and this value leads to trade elasticities consistent with Magee's empirical work, as shown in Table 10 below. See Armington, "Geographic Pattern of Trade," p. 182. Hendrik S. Houthakker also believes this is consistent with the econometric evidence, as is evidenced in his comment on this paper.

country							
Germany	*Italy*	*Netherlands*	*Norway*	*Sweden*	*Switzerland*	*United Kingdon*	*Rest of the world*
4.7	5.1	11.0	3.9	5.1	5.9	6.7	11.7
0.5	0.8	1.4	3.9	0.5	0.4	3.8	1.4
1.0	0.7	2.2	4.6	1.3	1.9	1.6	8.4
1.2	1.1	0.6	0.9	1.3	3.3	0.6	0.6
5.1	2.1	14.4	2.2	2.2	2.5	1.2	1.2
0.7	0.5	0.6	5.7	6.3	1.0	1.9	0.5
7.3	8.7	7.2	2.1	2.7	9.2	2.6	4.3
47.6	12.6	25.6	11.8	13.9	21.7	4.3	6.8
5.7	42.4	4.3	1.8	1.9	6.8	1.6	3.2
7.9	2.8	13.5	2.4	3.2	2.5	2.9	1.6
0.7	0.2	0.5	19.1	4.7	0.3	1.3	0.3
1.4	0.8	2.0	16.4	29.9	2.1	2.8	1.3
1.5	2.0	0.9	1.7	2.0	34.8	1.2	1.2
2.2	2.4	6.2	8.8	10.0	5.4	37.8	7.5
12.2	17.6	9.5	14.6	15.0	2.2	29.6	49.9

given fraction of income is spent on tradeable goods, and hence that changes in prices of other goods do not affect the demand for tradeables. In cells with very low shares, the direct value elasticity is near 2.0, while cells with high shares have absolute values below 1.5. For example, the direct value elasticity of Austria for Canadian goods is 1.997, while that for German goods, which take 32 percent of the Austrian market, is 1.357. The cross-price elasticities simply multiply the shares matrix by 2.0, from equation (6).

COMPUTATION OF THE TRADE CHANGE MATRIX

The computation of the change in the trade matrix resulting from a revaluation by an individual country, assuming infinite supply elasticities to start with, involves multiplying the elements of that country's row of the $d_{ij} + 1$ matrix by the same elements of the T_{ij} matrix. The product is the corresponding row in the DT_{ij} trade change matrix. Then the elements in that country's row in the c_{ij} matrix are multiplied by the corresponding elements in all the other rows of T_{ij} to fill out DT_{ij}.

Thus for a percentage revaluation dP_k by country k, the trade change matrix is given by

$$(7) \qquad DT_{ij} = \begin{cases} (d_{kj} + 1)(T_{kj})(dP_k), & \text{for row } k; \\ (c_{kj})(T_{ij})(dP_k), & \text{for all other rows.} \end{cases}$$

Table 4. Direct Value Elasticities of Demand $d_{ij} + 1$ for Fourteen Major OECD Countries and the Rest of the World, 1971

	Demander						
Goods producer	United States	Canada	Japan	Austria	Belgium-Luxembourg	Denmark	France
United States	−0.540	−0.982	−1.754	−1.964	−1.836	−1.911	−1.934
Canada	−1.845	−1.392	−1.952	−1.997	−1.973	−1.992	−1.993
Japan	−1.905	−1.916	−1.068	−1.986	−1.968	−1.977	−1.991
Austria	−1.998	−1.996	−1.999	−1.367	−1.994	−1.976	−1.996
Belgium-Luxembourg	−1.989	−1.994	−1.995	−1.974	−1.779	−1.962	−1.880
Denmark	−1.996	−1.996	−1.998	−1.980	−1.993	−1.486	−1.996
France	−1.986	−1.978	−1.990	−1.945	−1.653	−1.934	−0.943
Germany	−1.952	−1.959	−1.969	−1.357	−1.499	−1.711	−1.770
Italy	−1.981	−1.984	−1.993	−1.901	−1.913	−1.962	−1.902
Netherlands	−1.993	−1.992	−1.995	−1.956	−1.720	−1.932	−1.931
Norway	−1.998	−1.998	−1.999	−1.993	−1.991	−1.934	−1.994
Sweden	−1.994	−1.989	−1.996	−1.952	−1.965	−1.741	−1.982
Switzerland	−1.994	−1.993	−1.990	−1.883	−1.981	−1.963	−1.976
United Kingdom	−1.966	−1.916	−1.977	−1.908	−1.875	−1.801	−1.954
Rest of the world	−1.863	−1.915	−1.323	−1.837	−1.861	−1.718	−1.759

Source: Elasticity formula described in the text, and Table 3, with elasticity of substitution $\sigma = 3$ and elasticity of demand $\eta = 1$ in each market.

Table 5. Cross-price Elasticities of Demand c_{ij} for Fourteen Major OECD Countries and the Rest of the World, 1971

	Demander						
Country changing its price	United States	Canada	Japan	Austria	Belgium-Luxembourg	Denmark	France
United States	1.460	1.018	0.246	0.036	0.164	0.089	0.066
Canada	0.155	0.608	0.048	0.003	0.027	0.008	0.007
Japan	0.095	0.084	0.932	0.014	0.032	0.023	0.009
Austria	0.002	0.004	0.001	0.633	0.006	0.024	0.004
Belgium-Luxembourg	0.011	0.006	0.005	0.026	0.221	0.038	0.120
Denmark	0.004	0.004	0.002	0.020	0.007	0.514	0.004
France	0.014	0.022	0.010	0.055	0.347	0.066	1.057
Germany	0.048	0.041	0.031	0.643	0.501	0.289	0.230
Italy	0.019	0.016	0.007	0.099	0.087	0.038	0.098
Netherlands	0.007	0.008	0.005	0.044	0.280	0.068	0.069
Norway	0.002	0.002	0.001	0.007	0.009	0.066	0.006
Sweden	0.006	0.011	0.004	0.048	0.035	0.259	0.018
Switzerland	0.006	0.007	0.010	0.117	0.019	0.037	0.024
United Kingdom	0.034	0.084	0.023	0.092	0.125	0.199	0.046
Rest of the world	0.137	0.085	0.677	0.163	0.139	0.282	0.241

Source: Same as Table 4.

For changes in many exchange rates, this procedure can be repeated to obtain a stack of DT_{ij} matrixes, one for each change, which can then be added vertically—summing each ij across k matrixes—to obtain the net effect.

This exercise has been performed with the vector of exchange rate changes shown in Table 6, which are percentage changes in the dollar price of each currency from April 30 to December 31, 1971, and the trade

			Demander				
Germany	*Italy*	*Netherlands*	*Norway*	*Sweden*	*Switzerland*	*United Kingdom*	*Rest of the world*
−1.906	−1.898	−1.779	−1.921	−1.898	−1.881	−1.867	−1.766
−1.989	−1.984	−1.971	−1.921	−1.990	−1.993	−1.924	−1.972
−1.979	−1.986	−1.956	−1.908	−1.975	−1.961	−1.969	−1.832
−1.976	−1.977	−1.989	−1.982	−1.974	−1.933	−1.987	−1.987
−1.898	−1.958	−1.711	−1.956	−1.956	−1.951	−1.975	−1.977
−1.985	−1.990	−1.989	−1.886	−1.875	−1.980	−1.961	−1.990
−1.854	−1.826	−1.856	−1.957	−1.946	−1.816	−1.948	−1.913
−1.048	−1.747	−1.487	−1.765	−1.721	−1.567	−1.914	−1.864
−1.885	−1.153	−1.914	−1.964	−1.961	−1.865	−1.967	−1.937
−1.843	−1.943	−1.731	−1.952	−1.937	−1.949	−1.943	−1.968
−1.987	−1.995	−1.991	−1.618	−1.906	−1.995	−1.973	−1.993
−1.972	−1.983	−1.959	−1.673	−1.403	−1.959	−1.944	−1.974
−1.971	−1.960	−1.981	−1.965	−1.959	−1.303	−1.976	−1.976
−1.957	−1.953	−1.877	−1.824	−1.799	−1.893	−1.243	−1.850
−1.756	−1.648	−1.809	−1.709	−1.700	−1.955	−1.409	−1.001

			Demander				
Germany	*Italy*	*Netherlands*	*Norway*	*Sweden*	*Switzerland*	*United Kingdom*	*Rest of the world*
0.094	0.102	0.221	0.079	0.102	0.119	0.133	0.234
0.011	0.016	0.029	0.079	0.010	0.007	0.076	0.028
0.021	0.014	0.044	0.092	0.025	0.039	0.031	0.168
0.024	0.023	0.011	0.018	0.026	0.067	0.013	0.013
0.102	0.042	0.289	0.044	0.044	0.049	0.025	0.023
0.015	0.010	0.011	0.114	0.125	0.020	0.039	0.010
0.146	0.174	0.144	0.043	0.054	0.184	0.052	0.087
0.952	0.253	0.513	0.235	0.279	0.433	0.086	0.136
0.115	0.847	0.086	0.036	0.039	0.135	0.033	0.063
0.157	0.057	0.269	0.048	0.063	0.051	0.057	0.032
0.013	0.005	0.009	0.382	0.094	0.005	0.027	0.007
0.028	0.017	0.041	0.327	0.597	0.041	0.056	0.026
0.029	0.040	0.019	0.035	0.041	0.697	0.024	0.024
0.043	0.047	0.123	0.176	0.201	0.107	0.757	0.150
0.244	0.352	0.191	0.291	0.300	0.045	0.591	0.999

and elasticity matrixes shown in Tables 2 to 5. The result is the trade change matrix shown in Table 7. Use of the unadjusted vector of exchange rate changes to calculate Table 7 implicitly assumes infinite supply elasticities; the results of applying a 20 percent supply elasticity adjustment to the vector of rate changes are reported in Table 8. Below the matrix are given the arithmetic and percentage changes in exports and imports, and the change in the trade balance for each country. Above the matrix are shown

Table 6. Percentage Changes in Exchange Rates of Thirteen Major OECD Countries and the Rest of the World, April 30–December 31, 1971

Country	*Percentage change in terms of U.S. dollars*[a]
Canada	0.79
Japan	16.88
Austria	11.59
Belgium	11.57
Denmark	7.45
France	8.57
Germany	13.58
Italy	7.48
Netherlands	11.57
Norway	7.49
Sweden	7.49
Switzerland	13.88
United Kingdom	8.57
Rest of the world	3.76

Sources: Data for all countries except as noted are from International Monetary Fund, *International Financial News Survey*, Vol. 23 (December 22–30, 1971), p. 421; Switzerland is from *Economic Report of the President, January 1972*, p. 143; Canada is from *ibid.* and IMF, *International Financial Statistics*, various issues; rest of the world is from *ibid.* and *International Financial News Survey*, cited above.

a. All exchange rates (r) are stated in $1 units of foreign currency. The percentage change formula is

$$([r(12/31)/r(4/30)] - 1) \times 100.$$

the vector of exchange rate changes. Since these are all stated relative to the dollar, the U.S. entry in the price change vector is zero, and the U.S. rows in the elasticity matrix play no direct role in the calculation of the trade change matrix.[19]

Table 7 shows that under the assumption of infinite supply elasticities, the trade balances of the United States and the rest of the world (ROW), mainly less developed countries, increase substantially. The United States gains $10.0 billion (annual rates) while the ROW gains $7.6 billion, based on the 1971 levels of trade. As would be expected, Japan and Germany show the biggest downward shifts; Japan's surplus is projected, under these assumptions, to fall by about $7.8 billion, and Germany's by $6.5 billion. Canada, which stayed with the U.S. dollar, also gains substantially.[20]

19. The changes shown in Table 7 come from a comparative-static exercise based on the assumed elasticities. While the resulting direct value elasticities and cross-price elasticities are not very different in general magnitude from those obtained empirically by Magee, it should be emphasized that they come from arbitrary assumptions, not empirical estimation.

20. While the U.S. dollar price of the Canadian dollar was virtually unchanged during 1971, it rose by 7.31 percent from December 31, 1969, to April 30, 1971. Under the same

ADJUSTMENTS FOR ELASTICITIES OF SUPPLY AND OF SUBSTITUTION

To allow for effects of the revaluations on supply prices, the vector of the exchange rate change has been reduced by a factor of 0.2; that is, the original exchange rate change vector was multiplied by 0.8 before applying it to the elasticity and trade matrixes. As noted above, this kind of adjustment would be consistent, analytically, with supply elasticities of 9.0, which seem reasonable by Magee's estimates.

The resulting trade change matrix, with $\sigma_j = 3.0$, $\eta_j = 1.0$, and the reduced exchange rate change vector, is shown in Table 8. The entries are all smaller than those in Table 7 by 20 percent. The supply adjustment reduces the swing in the U.S. trade balance from \$10.0 billion with universally infinite supply elasticities to \$8.0 billion with supply elasticities of around 9.0–10.0. Of the \$8.0 billion swing, about \$3.5 billion comes from reduced import payments, and \$4.4 billion from increased export receipts. With the supply adjustment, Japan's surplus is projected to fall by \$6.2 billion, and Germany's by \$5.2 billion. Canada's surplus rises by about \$1 billion, and the United Kingdom's falls by \$1.1 billion. Belgium-Luxembourg, the Netherlands, and Switzerland also sustain substantial reductions in their trade surpluses.

The other area with a large increase in its trade surplus is ROW, with a gain of \$6.0 billion, probably concentrated in the group that stayed with the dollar (another followed the European changes). The \$6.0 billion is probably an overstatement, since the elasticity of substitution between exports of less developed countries and those of advanced countries is likely to be much smaller than that among advanced countries.

Finally, the row and column sums for exports and imports show a drop of about \$2.7 billion, which is also the sum of the diagonal elements of Table 8. The devaluations in the United States and ROW promote growth in their internal trade of \$3.5 billion and \$2.9 billion, respectively, more than offsetting the drops in most other countries.

Next, the effect of reducing the elasticity of substitution from 3.0 to 2.5, retaining the 0.2 supply adjustment, is reported in Table 9. As is apparent both analytically and from the table, this reduction simply scales down all the effects of revaluation. The swing in the U.S. surplus falls from

assumptions as those of Table 7, this will result in an ultimate drop of \$3.1 billion in the Canadian trade surplus, and a \$1.8 billion rise in the U.S. surplus.

Table 7. Changes in Trade Using Elasticity of Substitution $\sigma = 3$ and Zero Supply Adjustment, Fourteen Major OECD Countries and the Rest of the World, 1971

Amounts of change in trade in millions of U.S. dollars at annual rates, f.o.b.

	Buying country and						
Selling country	*United States 0.0*	*Canada 0.0079*	*Japan 0.1688*	*Austria 0.1159*	*Belgium-Luxembourg 0.1157*	*Denmark 0.0745*	*France 0.0857*
United States	4,398.4	438.2	785.6	22.0	205.9	41.3	236.7
Canada	275.1	163.8	139.5	1.8	31.4	3.4	24.0
Japan	−2,226.3	−251.7	−2,210.4	−4.6	−31.3	−11.4	−30.7
Austria	−24.7	−7.9	−0.5	−22.5	−1.6	−4.8	−4.4
Belgium-Luxembourg	−160.8	−10.9	−2.8	−0.9	−58.8	−7.5	−149.6
Denmark	−31.5	−3.8	1.4	4.0	2.0	19.2	2.1
France	−146.3	−28.6	3.5	7.4	44.9	−1.7	2.5
Germany	−874.5	−94.6	−39.8	−94.6	−265.7	−90.3	−480.8
Italy	−164.7	−17.6	5.1	19.4	23.8	1.3	44.9
Netherlands	−108.5	−16.3	−2.8	−1.5	−74.4	−13.4	−86.4
Norway	−20.0	−2.1	0.9	1.3	2.5	2.3	2.5
Sweden	−54.5	−12.0	3.2	9.4	9.5	9.1	8.2
Switzerland	−118.3	−17.9	−13.8	−19.2	−11.1	−12.1	−53.6
United Kingdom	−351.3	−110.1	8.5	12.4	16.3	−5.3	0.1
Rest of the world	−391.8	−28.5	1,323.5	65.9	106.4	70.0	483.3
Change in total exports							
Dollar amount	5,552.9	1,030.6	−5,559.6	−224.5	−799.2	−6.0	−270.6
Percent	12.62	5.83	−23.74	−7.15	−6.50	−0.17	−1.32
Change in total imports							
Dollar amount	−4,398.2	−163.9	2,211.5	22.7	58.6	−19.2	−3.7
Percent	−10.43	−1.16	12.55	0.59	0.50	−0.45	−0.02
Change in trade balance	9,951.2	1,194.4	−7,771.1	−247.2	−857.8	13.3	−266.9

Sources: Derived from Tables 2, 4, 5, and 6. Figures are rounded and may not add to totals.

Table 8. Changes in Trade Using Elasticity of Substitution $\sigma = 3$ and 0.2 Supply Adjustment, Fourteen Major OECD Countries and the Rest of the World, 1971

Amounts of change in trade in millions of U.S. dollars at annual rates, f.o.b.

	Buying country and						
Selling country	*United States 0.0*	*Canada 0.0063*	*Japan 0.1350*	*Austria 0.0927*	*Belgium-Luxembourg 0.0926*	*Denmark 0.0596*	*France 0.0686*
United States	3,518.7	350.6	628.5	17.6	164.7	33.0	189.4
Canada	220.1	131.0	111.6	1.4	25.1	2.7	19.2
Japan	−1,781.1	−201.4	−1,768.3	−3.7	−25.0	−9.1	−24.6
Austria	−19.8	−6.3	−0.4	−18.0	−1.3	−3.9	−3.5
Belgium-Luxembourg	−128.7	−8.8	−2.3	−0.7	−47.0	−6.0	−119.7
Denmark	−25.2	−3.1	1.2	3.2	1.6	15.3	1.7
France	−117.1	−22.9	2.8	5.9	36.0	−1.4	2.0
Germany	−699.6	−75.7	−31.9	−75.7	−212.6	−72.3	−384.6
Italy	−131.8	−14.1	4.1	15.5	19.0	1.1	35.9
Netherlands	−86.8	−13.0	−2.3	−1.2	−59.5	−10.7	−69.1
Norway	−16.0	−1.6	0.8	1.0	2.0	1.9	2.0
Sweden	−43.6	−9.6	2.6	7.5	7.6	7.3	6.5
Switzerland	−94.7	−14.3	−11.0	−15.4	−8.8	−9.7	−42.9
United Kingdom	−281.0	−88.1	6.8	9.9	13.0	−4.2	0.1
Rest of the world	−313.4	−22.8	1,058.8	52.7	85.2	56.0	386.6
Change in total exports							
Dollar amount	4,442.4	824.4	−4,447.7	−179.6	−639.4	−4.8	−216.5
Percent	10.09	4.66	−18.99	−5.72	−5.20	−0.13	−1.06
Change in total imports							
Dollar amount	−3,518.6	−131.1	1,769.2	18.2	46.9	−15.4	−3.0
Percent	−8.34	−0.93	10.04	0.47	0.40	−0.36	−0.02
Change in trade balance	7,960.9	955.5	−6,216.9	−197.8	−686.3	10.6	−213.5

Sources: Tables 2, 4, and 5, and the exchange rate change vectors in Table 6 reduced by 20 percent. Figures are rounded and may not add to totals.

price change

Germany 0.1358	Italy 0.0748	Netherlands 0.1157	Norway 0.0749	Sweden 0.0749	Switzerland 0.1388	United Kingdom 0.0857	Rest of the world 0.0376
589.0	202.9	333.6	29.5	75.4	139.9	320.3	2,132.5
60.8	28.8	39.8	26.6	6.5	7.9	160.5	224.5
−81.6	−33.2	−53.5	−38.3	−20.8	−23.5	−112.5	−2,640.1
−17.1	−22.5	−4.2	−3.1	−8.8	−3.0	−21.8	−100.1
−71.9	−41.4	−103.9	−7.4	−14.7	−2.1	−42.7	−182.5
26.4	0.7	3.4	2.9	6.7	8.0	−9.8	−18.5
160.3	−38.0	18.0	−1.2	−2.7	50.2	−34.0	−302.3
−1,815.4	−380.3	−350.9	−61.5	−144.2	−110.4	−209.1	−1,470.5
200.9	52.1	25.9	0.8	2.0	52.5	−8.6	−119.1
−110.3	−56.2	−96.9	−8.1	−21.0	−2.2	−98.3	−254.6
23.1	0.3	2.8	8.9	4.7	2.1	−7.1	−12.5
48.4	1.0	12.1	7.6	29.8	15.9	−15.0	−49.5
−60.9	−62.6	−13.7	−9.6	−22.2	−199.6	−59.8	−266.6
47.7	−10.3	15.4	−4.8	−10.2	29.3	−491.8	−523.5
969.4	357.9	171.9	57.6	119.2	35.1	629.3	3,582.9
−4,667.2	66.6	−854.0	0.7	−6.5	−741.6	−885.9	3,969.1
−12.15	0.44	−6.17	0.03	−0.09	−12.87	−3.96	7.07
1,784.2	−53.2	96.6	−8.9	−30.0	199.7	491.5	−3,582.8
5.71	−0.36	0.69	−0.23	−0.46	2.91	2.22	−4.87
−6,451.4	119.7	−950.6	9.6	23.6	−941.2	−1,377.4	7,551.9

adjusted price change

Germany 0.1086	Italy 0.0598	Netherlands 0.0926	Norway 0.0599	Sweden 0.0599	Switzerland 0.1110	United Kingdom 0.0686	Rest of the world 0.0301
471.2	162.3	266.9	23.6	60.3	111.9	256.3	1,706.0
48.6	23.1	31.8	21.3	5.2	6.3	128.4	179.6
−65.3	−26.6	−42.8	−30.6	−16.7	−18.8	−90.0	−2,112.1
−13.7	−18.0	−3.3	−2.4	−7.0	−2.4	−17.4	−80.1
−57.5	−33.1	−83.1	−5.9	−11.7	−1.7	−34.2	−146.0
21.2	0.6	2.7	2.3	5.4	6.4	−7.8	−14.8
128.3	−30.4	14.4	−0.9	−2.2	40.2	−27.2	−241.8
−1,452.3	−304.2	−280.7	−49.2	−115.3	−88.3	−167.2	−1,176.4
160.7	41.7	20.7	0.7	1.6	42.0	−6.9	−95.3
−88.3	−45.0	−77.5	−6.5	−16.8	−1.7	−78.6	−203.7
18.5	0.2	2.2	7.1	3.7	1.7	−5.7	−10.0
38.8	0.8	9.7	6.1	23.8	12.8	−12.0	−39.6
−48.7	−50.1	−11.0	−7.7	−17.8	−159.7	−47.8	−213.3
38.2	−8.3	12.3	−3.8	−8.1	23.4	−393.4	−418.8
775.5	286.3	137.5	46.1	95.3	28.1	503.4	2,866.3
−3,733.8	53.2	−683.2	0.6	−5.2	−593.2	−708.7	3,175.3
−9.72	0.35	−4.94	0.02	−0.07	−10.29	−3.17	5.66
1,427.4	−42.5	77.3	−7.1	−24.0	159.7	393.2	−2,866.2
4.57	−0.29	0.55	−0.19	−0.37	2.33	1.78	−3.90
−5,161.1	95.8	−760.5	7.7	18.9	−753.0	−1,101.9	6,041.5

Table 9. Changes in Trade Using Elasticity of Substitution σ = 2.5 and 0.2 Supply Adjustment, Fourteen Major OECD Countries and the Rest of the World, 1971

Amounts of change in trade in millions of U.S. dollars at annual rates, f.o.b.

	Buying country and						
Selling country	*United States 0.0*	*Canada 0.0063*	*Japan 0.1350*	*Austria 0.0927*	*Belgium-Luxembourg 0.0926*	*Denmark 0.0596*	*France 0.0686*
United States	2,639.0	262.9	471.4	13.2	123.6	24.8	142.0
Canada	165.1	98.3	83.7	1.1	18.8	2.0	14.4
Japan	−1,335.8	−151.0	−1,326.3	−2.8	−18.8	−6.8	−18.4
Austria	−14.8	−4.8	−0.3	−13.5	−1.0	−2.9	−2.6
Belgium-Luxembourg	−96.5	−6.6	−1.7	−0.5	−35.3	−4.5	−89.8
Denmark	−18.9	−2.3	0.9	2.4	1.2	11.5	1.2
France	−87.8	−17.2	2.1	4.5	27.0	−1.0	1.5
Germany	−524.7	−56.8	−23.9	−56.8	−159.4	−54.2	−288.5
Italy	−98.8	−10.5	3.1	11.7	14.3	0.8	26.9
Netherlands	−65.1	−9.8	−1.7	−0.9	−44.6	−8.0	−51.8
Norway	−12.0	−1.2	0.6	0.8	1.5	1.4	1.5
Sweden	−32.7	−7.2	1.9	5.6	5.7	5.4	4.9
Switzerland	−71.0	−10.8	−8.3	−11.5	−6.6	−7.3	−32.2
United Kingdom	−210.8	−66.1	5.1	7.4	9.8	−3.2	0.1
Rest of the world	−235.1	−17.1	794.1	39.5	63.9	42.0	290.0
Change in total exports							
Dollar amount	3,331.8	618.3	−3,335.8	−134.7	−479.5	−3.6	−162.4
Percent	7.57	3.50	−14.24	−4.29	−3.90	−0.10	−0.79
Change in total imports							
Dollar amount	−2,638.9	−98.3	1,326.9	13.6	35.2	−11.5	−2.2
Percent	−6.26	−0.69	7.53	0.35	0.30	−0.27	−0.01
Change in trade balance	5,970.7	716.7	−4,662.7	−148.3	−514.7	8.0	−160.2

Sources: Table 2, elasticity matrixes analogous to Tables 4 and 5, and the exchange rate change vectors in Table 6 reduced by 20 percent. Figures are rounded and may not add to totals.

$8.0 billion to $6.0 billion, while the changes for Japan and Germany fall from $6.2 billion to $4.7 billion, and from $5.2 billion to $3.9 billion, respectively.

The choice of values for σ_j depends on one's view of plausible elasticities; while a typical value of $d_{ij} + 1$ with σ_j at 3.0 was about 1.98, it falls to about 1.48 with σ_j at 2.5. Magee's empirical elasticities, shown in the next section, are typically in that range, averaging out at 1.74.

In evaluating these a priori estimates, the reader should remember that the object is to obtain a set of numbers that seem "reasonable," and, as important, that are consistent across countries. The sum of the trade balance effects should be zero, and they should bear some relation to the initial structure of trade, the base trade matrix. The Armington model permits enforcement of this consistency in an efficient and theoretically acceptable way.

Tables 7 and 9 seem to me to bound the plausible range of effects the 1971 realignments will have on trade balances. Although they appear a bit

adjusted price change							
Germany *0.1086*	*Italy* *0.0598*	*Netherlands* *0.0926*	*Norway* *0.0599*	*Sweden* *0.0599*	*Switzerland* *0.1110*	*United Kingdom* *0.0686*	*Rest of the world* *0.0301*
353.4	121.7	200.1	17.7	45.3	84.0	192.2	1,279.5
36.5	17.3	23.9	15.9	3.9	4.7	96.3	134.7
−49.0	−19.9	−32.1	−23.0	−12.5	−14.1	−67.5	−1,584.1
−10.3	−13.5	−2.5	−1.8	−5.3	−1.8	−13.1	−60.0
−43.1	−24.9	−62.4	−4.4	−8.8	−1.3	−25.6	−109.5
15.9	0.4	2.1	1.7	4.0	4.8	−5.9	−11.1
96.2	−22.8	10.8	−0.7	−1.6	30.1	−20.4	−181.4
−1,089.3	−228.2	−210.5	−36.9	−86.5	−66.2	−125.4	−882.3
120.5	31.3	15.5	0.5	1.2	31.5	−5.1	−71.5
−66.2	−33.7	−58.1	−4.8	−12.6	−1.3	−59.0	−152.8
13.9	0.2	1.7	5.3	2.8	1.2	−4.3	−7.5
29.1	0.6	7.3	4.6	17.9	9.6	−9.0	−29.7
−36.6	−37.6	−8.2	−5.8	−13.3	−119.7	−35.9	−159.9
28.6	−6.2	9.2	−2.9	−6.1	17.6	−295.1	−314.1
581.6	214.7	103.1	34.6	71.5	21.1	377.6	2,149.7
−2,800.3	39.9	−512.4	0.4	−3.9	−444.9	−531.5	2,381.5
−7.29	0.26	−3.70	0.02	−0.05	−7.72	−2.38	4.24
1,070.5	−31.9	58.0	−5.3	−18.0	119.8	294.9	−2,149.7
3.42	−0.22	0.41	−0.14	−0.28	1.74	1.33	−2.92
−3,870.9	71.8	−570.4	5.8	14.2	−564.7	−826.4	4,531.1

high, I would use as a central estimate the Table 8 numbers, which include the 20 percent supply adjustment. The tables establish a plausible range of \$6 billion to \$10 billion for the eventual swing in the U.S. trade balance *due to the realignments alone*, with a central estimate of perhaps \$7 billion to \$8 billion. This and the associated numbers from the last two rows of Table 8 for the other thirteen countries and ROW are estimates of the "exogenous" (from the macroeconomic point of view) impacts of the realignments that should be fed into macro models to obtain estimates of the effects on real income, and to estimate the feedbacks of these domestic effects onto the trade balances that reduce the size of the initial influences.

Empirical Estimates for U.S. Bilateral Trade

The empirical model developed by Stephen P. Magee provides estimates of the U.S. row and column of the trade change matrix, given a vector of exchange rate changes.[21] Magee's model uses the basic framework discussed in the first section of this paper to estimate equations for U.S. bilateral trade with the fourteen countries of Table 2 except Austria, plus Australia, South Africa, and the ROW.[22] For each pair of countries, the United States and country *i*, Magee specifies demand for imports as a function of domestic income, a demand pressure variable such as unemployment, import prices, the domestic wholesale price index, and average prices of competing suppliers, for example, non-*i* sellers in the U.S. market. All of the prices in the import demand equation are denominated in the importer's currency. Export supply is specified as an increasing function of export prices, denominated in the exporter's currency. Then an exchange rate identity brings supply and demand together for each trade flow. An exchange rate change shifts the relevant curve, as Figure 1 depicts.[23]

The model was estimated on annual data for the period 1951–69; for the estimates presented in Table 11 a base trade matrix for 1971 was used.

EMPIRICAL ELASTICITY ESTIMATES

The Magee model, estimated in log-linear form, yields the direct value elasticity and cross-price elasticity estimates shown in Table 10. The direct value elasticities are the coefficients of the import and export price terms in his equations, reduced by one in absolute value to convert them to value elasticities. As long as the price elasticities exceed unity in absolute value, the value elasticities will also be negative; in three cases Magee's direct value elasticities are positive, indicating inelastic demand.

The direct value elasticities from the U.S. row in Table 4 are comparable with Magee's estimates of direct value elasticities for exports, while the

21. The basic references are "A Theoretical and Empirical Examination of Supply and Demand Relationships in U.S. International Trade," and "United States Trade and the New Economic Policy," both cited earlier. An early version of the model was published in H. S. Houthakker and Stephen P. Magee, "Income and Price Elasticities in World Trade," *Review of Economics and Statistics*, Vol. 51 (May 1969), pp. 111–25. In addition, "The Effect on the United States Trade Balance of Currency Revaluations by the EEC and Japan," Studies in International Business and Economics 2 (University of California, Berkeley, Institute of International Studies, March 1971; processed), provides some preliminary estimates of the type shown below.

22. In the comparisons below in Table 11, Austria, Australia, and South Africa are all included in the ROW totals for both the Armington and Magee models.

23. See "A Theoretical and Empirical Examination," Introduction and Part II, pp. 1–8, and "United States Trade," pp. 3–5, for the theoretical structure of the model.

Table 10. A Priori and Magee Estimates of Direct Value and Cross-price Elasticities for U.S. Exports and Imports, 1971

	Direct value elasticities[a]				*Cross-price elasticities*			
	U.S. exports		*U.S. imports*		*U.S. exports*		*U.S. imports*	
U.S. trading partner	*A priori*	*Magee*	*A priori*	*Magee*	*A priori*	*Magee*	*A priori*	*Magee*
Canada	−0.982	−3.290	−1.845	0.548	0.374	1.625	0.385	0.452
Japan	−1.754	−1.080	−1.905	−2.516	0.824	0.503	0.445	0
Belgium-Luxembourg	−1.836	−1.761	−1.989	−3.086	1.614	0	0.529	2.023
Denmark	−1.911	−1.167	−1.996	−0.114	1.397	0	0.536	−2.167
France	−1.934	−2.974	−1.986	−4.064	0.876	3.974	0.526	1.201
Germany	−1.906	−0.988	−1.952	−1.504	0.948	1.988	0.492	−4.258
Italy	−1.898	−2.300	−1.981	−2.355	1.050	3.300	0.521	0
Netherlands	−1.779	−1.624	−1.993	−1.975	1.510	1.090	0.533	0
Norway	−1.921	−0.383	−1.998	−0.583	1.538	1.383	0.538	0
Sweden	−1.898	1.000	−1.994	−2.351	1.301	0	0.534	0
Switzerland	−1.881	−0.387	−1.994	−0.762	1.183	0	0.534	1.762
United Kingdom	−1.867	−0.639	−1.966	−0.556	1.110	1.133	0.506	0
Rest of the world[b]	−1.766	−1.118	−1.863	0.295	0.767	2.118	0.403	0

Sources: Cols. 1 and 3—Table 4, U.S. row and column, respectively; col. 5—Table 5, summation of relevant country column, less U.S. and own-country entries; col. 7—Table 5, summation of U.S. column, less U.S. and own-country entries; all Magee columns—Stephen P. Magee, "United States Trade and the New Economic Policy," Studies in International Business and Economics 9 (University of California, Berkeley, Institute of International Studies, September 1971; processed), Table 2, *PX* and *PO* cols. (for col. 2, one has been added to Magee's U.S. export price index (*PX*) to convert to value elasticities, and for col. 4, one has been subtracted from *PX*).

a. All direct *price* elasticities are negative. The positive entries here have price elasticities of 1.0 or less in absolute value, and thus have positive direct value elasticities. The change in the value of U.S. exports in dollars is related to the direct price elasticity, while the change in import values in dollars is related to direct value elasticities.

b. Austria is excluded in a priori estimates. Australia and South Africa are excluded from the empirical estimates.

for the distribution function is legitimate. It would also show whether a true η_j exists for "traded-goods-as-a-whole," as opposed to a different η_j for each source of supply, testing the independence assumption on the original utility function. These are problems for further exploration in empirically implementing the Armington model.

ADJUSTMENTS FOR SUPPLY ELASTICITIES

The supply adjustment made on Table 7 estimates and reported in Table 8 was based on Magee's estimate of U.S. total import supply elasticity of about 8.5. It reduced the swing on the U.S. trade balance by 20 percent.

In making *his* supply adjustment, however, Magee uses a different supply elasticity for each country. His are lower than the 8.5–10.0 range, with an implicit overall elasticity of supply of imports to the United States of 5.6.[25]

Table 1 demonstrates that, with an elasticity of supply of 5.6 and demand elasticities in the range of 2.0–3.0, the supply adjustment would be about 35 percent, as opposed to the 20 percent used above; 35 percent is also the average adjustment that Magee uses in his empirical estimates, shown in Table 11.

I tend to hold to the earlier estimate for U.S. import supply elasticity, which was statistically significant. In addition, with relatively slack conditions prevailing in the United States, Europe, and Japan in 1971–72, export price reactions should be smaller than they are in the average conditions that dominate an elasticity estimated over a twenty-year sample.

RESULTS FOR U.S. BILATERAL TRADE BALANCES

The effects of the exchange rate realignment in the a priori model of Table 8 and in the Magee model are shown in Table 11. The a priori entries show the U.S. row less the U.S. column of Table 8—changes in U.S.

25. For structural reasons, Magee argues that the total export supply elasticity will be lower the larger the fraction of total production of exportables sold abroad. Thus Magee relates export supply elasticity to the ratio of GNP to exports. Since the U.S. supply elasticity is about one-half the U.S. ratio of GNP to exports—$10 \approx 1/2(1000/40)$—Magee assumes that the supply elasticities of all countries can be approximated by half the ratio of GNP to exports. See "United States Trade," Table 1, column 3, for these estimates. They are carried over, along with the reasoning behind them, from "Effect on the U.S. Trade Balance," pp. 5–6 and Table 2. Magee provided the 5.6 estimate based on the experimental runs of his model for this paper.

U.S. column of Table 4 provides direct value elasticities for imports. For comparison with Magee's results, these are also shown in Table 10, which makes apparent that the empirical estimates are much more scattered than are the a priori theoretical ones. This simply reflects the substantial variation among countries of the actual elasticities of substitution σ_j, so that the assumption that all $\sigma_j = 3.0$ gives a false appearance of regularity to the elasticity matrix of Table 4.

Some notable discrepancies between the two estimates of elasticities that will be important in the appraisal of the exchange realignment appear for Canadian exports, Japanese imports, German exports, and U.K. exports. There are other discrepancies, but they generally relate to components—Swedish exports, for example—that are not significant in total U.S. trade.

Magee's cross-price elasticities are the coefficients on the weighted average of third-country competitive suppliers in each of his bilateral log-linear regressions. Thus they are average elasticities, not directly comparable with the c_{ij} entries of Table 5, which are individual elasticities. However, numbers comparable with Magee's can be obtained on the export side by summing the Table 5 columns omitting the U.S. entry and the diagonal own-price entry. This yields the change in U.S. exports to each country, assuming a uniform price change in all other countries. Similarly, on the import side, the U.S. column of Table 5 can be successively summed, leaving out the U.S. entry and one other country each time. This gives the change in U.S. imports from the omitted country, assuming all other prices change.

The results of this operation are shown in the cross-price elasticities of Table 10. Since all the Table 5 entries are positive, so are those in Table 10, because the original assumption that $\sigma_j > \eta_j$ means that all tradeable goods are substitutes. In Magee's results, the negative cross-price elasticities for U.S. imports from Denmark and Germany indicate complementarity between their exports and those of all other suppliers to the United States.[24]

If empirical estimates of *individual* c_{ij} coefficients were available, equations (5) and (6) above would permit solution for the implicit σ_j and η_j values, given d_{ij}, c_{ij}, and S_{ij}. Thus each set of bilateral estimates for these three variables would imply a value for σ_j and η_j, testing the assumption that σ_j is the same for each pair of suppliers—that is, that the CES form

24. While there is no theoretical reason to exclude complementarity, Magee is dubious about these empirical results, and is reexamining these cases.

Table 11. Magee and A Priori Estimates of Effects of the 1971 Realignment of Exchange Rates on U.S. Bilateral Trade Balances with Twelve Major OECD Countries and the Rest of the World

Millions of 1971 U.S. dollars at annual rates

	Changes in trade					
	Magee model					
			Final effect			
U.S. trading partner	*Initial trade balance*	*Supply adjustment*	*Exports*	*Imports*	*Trade balance*	*A priori*
Canada	1,082.6	−479.9	772.0	169.3	602.7	130.5
Japan	3,441.1	−442.2	1,195.6	−1,803.3	2,998.9	2,409.6
Belgium-Luxembourg	508.1	−64.5	381.8	−61.8	443.6	293.4
Denmark	87.0	−21.2	42.4	−23.4	65.8	58.2
France	886.6	−579.4	256.5	−50.7	307.2	306.5
Germany	1,601.2	−779.4	184.5	−637.3	821.8	1,170.8
Italy	695.7	−424.5	185.3	−85.9	271.2	294.1
Netherlands	643.8	−184.6	420.1	−39.1	459.2	353.7
Norway	29.9	−19.4	8.9	−1.6	10.5	39.6
Sweden	71.4	−51.5	0	−19.9	19.9	103.9
Switzerland	88.6	10.0	122.8	24.2	98.6	206.6
United Kingdom	411.6	−180.2	182.3	−49.1	231.4	537.3
Rest of the world[a]	3,269.2	−1,486.6	1,920.7	138.1	1,782.6	2,056.8
Total	12,816.7	−4,703.4	5,672.9	−2,440.5	8,113.3	7,960.9

Sources: Magee model, Magee, "United States Trade and the New Economic Policy," reestimated equivalents from Table 12B, D-INIT and ADJ-ER columns; a priori, Table 8, U.S. row entry for exports less U.S. column entry for imports. Figures are rounded and may not add to totals.

a. Includes Australia, South Africa, and Austria.

bilateral trade balances. The first column of the empirical entries shows the initial effects on the trade balance with infinite supply elasticities, as Table 7 does. The next column gives the supply adjustments for individual countries, which vary greatly in percentage terms; the third and fourth columns, the effects on U.S. bilateral exports and imports; and the fifth column the effect on the trade balances, to be compared with the a priori estimates from Table 8.[26]

In addition to the supply adjustment, Magee's model provides adjustments for the *direct* effects on internal prices and real income due to higher import prices. These adjustments, which are small, take another $1 billion off his estimate shown in Table 11, bringing the final total down to $7.1 billion. I have not included these in Table 11, since no comparable adjustments were made in Table 8. But they suggest that the a priori estimates may be about $1 billion high.

It seems clear from Table 11 that the a priori estimates and Magee's empirical results are roughly similar in composition and quite close in total. Considering the statistical significance of all the numbers involved, even $2 billion to $3 billion would not represent a significant difference between estimates of the swing in the U.S. trade balance.

Four differences between Table 8 and the Magee results stand out, however. These are in the values for Canada, Japan, Germany, and the United Kingdom. In the case of Canada, the difference can be traced to those in estimates of the direct value elasticity of demand for Canadian imports from the United States. The large U.S. share of the Canadian market suggests a low elasticity, but Magee's estimate is the largest of all U.S. export elasticities. Here I prefer the a priori model and the small effect on the United States-Canada balance.

For the United Kingdom and Germany, the situation is just the opposite. Magee finds a much lower elasticity of both U.K. and German demand for U.S. exports than the a priori model suggests. I can see no reason for his conclusion. To the contrary, these are two of the more advanced manufacturing countries on the list, so they should have relatively high substitutability of home goods for U.S. products. Here again the a priori model seems preferable.

In the case of Japan, the difference arises from the small supply adjustment relative to the average 35 percent in the Magee estimates. For Japan

26. These estimates were provided by Stephen P. Magee, along with a number of alternative runs of his model, in response to my request for help in preparing this paper. I reemphasize my debt to him here.

his adjustment is only 13 percent; if it were raised to 35 percent, the net effect on the United States-Japan trade balance would fall to \$2.2 billion, just a bit less than the a priori estimate.

The result of these comparisons would be to reduce Magee's estimate for Japan by \$0.6 billion, reflecting a larger supply adjustment, to cut the estimate for Canada by \$0.5 billion, and to increase those for Germany and the United Kingdom by \$0.3 billion each. This would reduce the total by \$0.5 billion, and shift the distribution away from Japan and Canada to the United Kingdom and Germany. Thus, in total the empirical estimates from the Magee model and the a priori estimates match fairly well.

Empirical Estimates for Total Trade Balances

The OECD world trade model, originally estimated by Adams, Eguchi, and Meyer-zu-Schlochtern, and since updated by A. Yajima and Meyer-zu-Schlochtern, provides empirical equations explaining the row and column sums of the trade change matrix, given a vector of exchange rate changes, for seven major OECD countries—the United States, Canada, Japan, France, Germany, Italy, the United Kingdom—and two residual categories—other OECD and non-OECD.[27] Such row and column sums are shown at the bottom of Tables 7–9 as changes in total exports and imports, respectively.

This model, referred to here as the Adams model, uses the export share approach to explain total trade flows. For each country imports depend on domestic production, a demand pressure variable, and import prices relative to domestic prices. This approach is modified for other OECD, where production alone appears in the equation, and for the non-OECD group, whose imports are assumed to depend only on lagged foreign exchange inflows.[28]

The total import sum given by these individual country import equations is then divided among the countries as exporters by a series of export share equations. Here each country's exports are specified as a function of total

27. The original exposition of the model is Adams, Eguchi, and Meyer-zu-Schlochtern, *Econometric Analysis of International Trade*. The updated version, on which this section is based, is given in the appendix to F. Gerard Adams and Helen B. Junz, "The Effect of the Business Cycle on Trade Flows of Industrial Countries," *Journal of Finance*, Vol. 26 (May 1971), pp. 251–68.

28. See Adams and Junz, "Effect of the Business Cycle," p. 267. Since no price terms appear in the other OECD and non-OECD equations, these areas will be dropped from the empirical estimates discussed below.

imports, export prices relative to those of competing exporters, and domestic pressure of demand (with a negative sign). In terms of the trade change matrixes of Tables 7, 8, and 9, the Adams import equations determine the column sums for the relevant countries. These then total to an aggregate import change, which is then shared among the export row sums as determined by the export share equations.

The Adams model was originally estimated on quarterly data covering the period 1955:4–1965:4. The updated equations given in the Adams-Junz paper are estimated on half-yearly data covering the period 1955–68. In general, the equations do not have extensive lag structures. Of the eighteen equations for exports and imports, five show a lag of one half-year on an independent variable, and one has a two-period lag.

EMPIRICAL ELASTICITY ESTIMATES

The updated Adams model, estimated like the Magee model in log-linear form, yields the estimates of total trade value elasticities shown in the Adams columns of Table 12. These are the coefficients of the relative price terms in equations explaining constant-dollar trade flows, reduced by one in absolute value to convert them to value elasticities. Half of the estimates are positive, indicating that demand elasticities in those equations were less than one in absolute value.

The total trade value elasticities implicit in the direct elasticity matrix of Table 4, shown as the a priori estimates in Table 12, can be calculated as follows: On the export side, the total value elasticity gives the change in total exports—the row sums—as a country's own price changes or as all foreign prices change together. To obtain this estimate, one can average the nondiagonal elements of the relevant row of Table 4, using as weights the fractions of each exporter's total sales taken by each importer. On the import side, the total import value elasticity plus the diagonal element of Table 4 must sum to -2.0, with the assumptions that $\sigma_j = 3.0$ and $\eta_j = 1.0$.[29]

29. If S_j is the total import share in purchases by j and d_j is the j total import elasticity, from text equation (5), using $S_j + S_{jj} = 1$,

$$\begin{aligned} d_j + 1 &= -(1 - S_j)\sigma_j - S_j\eta_j + 1 \\ &= -S_{jj}\sigma_j - (1 - S_{jj})\eta_j + 1. \end{aligned}$$

The expression for $d_{jj} + 1$ from (5) is simply

$$d_{jj} + 1 = -(1 - S_{jj})\sigma_j - S_{jj}\eta_j + 1.$$

Summed, these two expressions yield

$$(d_j + 1) + (d_{jj} + 1) = -\sigma_j - \eta_j + 2.$$

Table 12. A Priori and Adams Estimates of Total Trade Value Elasticities for Seven Major OECD Countries, 1971

	Exports		*Imports*	
Country	*A priori*[a]	*Adams*[b]	*A priori*[c]	*Adams*[b]
United States	−1.61	0.17[d]	−1.46	0.59
Canada	−1.88	0.21[d]	−0.61	−0.24
Japan	−1.87	−0.12	−0.93	0.23
France	−1.86	−0.41	−1.06	−0.49
Germany	−1.73	−0.18	−0.95	0.73
Italy	−1.92	−0.50	−0.85	−0.04
United Kingdom	−1.88	0.76[d]	−0.76	1.00[e]

Sources: A priori—Table 4; Adams—F. Gerard Adams and Helen B. Junz, "The Effect of the Business Cycle on Trade Flows of Industrial Countries," *Journal of Finance*, Vol. 26 (May 1971), Appendix Table 1.

a. A priori export value elasticities are the weighted averages of the appropriate rows of Table 4, excluding diagonal elements. Weights are given by the share each importing country takes of the relevant country's total exports. Thus for each exporting country i, the total export value elasticity is given by

$$\sum_{j} d_{ij} \cdot \frac{T_{ij}}{\sum_{j} T_{ij}}, \quad j \neq i.$$

b. Export elasticities are unity plus the coefficients of *PX* (relative export unit value index) in each equation in the Adams-Junz table cited under sources; import elasticities are the coefficients of *PM* (import unit value index) plus unity. The original equations are in real terms, in log-log form. (It should be noted that "*TM*" in the equation for Italy in the Adams-Junz table should be "*PM*.")

c. A priori total import value elasticities are simply $-2.0 - (d_{ii} - 1)$, or -2 plus the absolute values of the relevant diagonal elements of Table 4.

d. Since the table shows value elasticities, a positive entry means that demand was inelastic—between 0 and −1.0—in the Adams-Junz table.

e. No price coefficient was given for U.K. imports in the Adams-Junz table, indicating an implied price elasticity of 0.

The main impression given by Table 12 is that the price elasticity estimates in the Adams model are far too small. Not one of the figures from the Adams model reported in Table 12 is larger in absolute value than its a priori counterpart. The highest total export price elasticity (in absolute value) estimated from the Adams model is −1.41 for France; the lowest a priori estimate is −2.61 for the United States. On the import side, the highest Adams value is −1.49 for France; the lowest a priori estimate is −1.61 for Canada.

Thus it is clear that the Adams model will yield much smaller estimates of the effects of the exchange rate realignments than were obtained from the Armington model even with the elasticity of substitution set at 2.5, or from the Magee model. This general underestimation of price coefficients in the Adams model is quite understandable. Price terms have at most a one-period lag in half-yearly terms in the equations, no attempt was made to eliminate simultaneous equations bias, and in general the price series used are unit-value, rather than fixed-weight, indexes.[30] The primary purpose of the model was to capture the effect of cyclical movements in business activity on the matrix of OECD trade, which it does quite successfully, rather than to provide precise estimates of the effects of exchange rate changes.

Nevertheless, the distribution of effects from the Adams model, as compared with their general level, is of considerable interest. If the distribution among the seven major OECD countries is not too far from the earlier estimates from the Armington model, our confidence in the a priori estimates will be increased.

RESULTS FOR TOTAL TRADE BALANCES

The Adams model can be used to estimate the effects of the exchange rate realignments. First, the model can be run using actual values for independent variables to obtain a "base" path for exports and imports. The base reported here is the same as that used by Adams and Junz earlier to study the effects of cyclical developments.[31] Next the model can be rerun changing only relative prices by the amounts indicated by the vector of exchange rate changes shown in Table 6. Once the lags in the system have been worked out, the difference between the two paths of exports and imports is the estimated effect of the realignment.

Since the model has been updated only through the second half of 1968, the realignment was assumed to take effect at the beginning of 1968, and the effect was measured for the second half of 1969. The model gives the differential results in 1963 dollars at half-yearly rates. These were blown up to 1971 post-devaluation prices at annual rates using 1971 values for export and import price indexes.

Since the Adams model gives the results in real terms, the actual 1971 values for the price indexes were used to calculate the base exports and imports in 1971 dollars. Then, to allow for the direct effect of the exchange rate changes on import prices in the United States and export prices in the other countries, all in dollars, the U.S. import price index for 1971 was

30. This means that, for example, when an export price rises and sales of that item fall, the weight of the item in the index falls. Thus the price change is not fully reflected in the export unit value index, and its coefficient in a demand equation will be estimated with a downward bias.

31. See Adams and Junz, "Effect of the Business Cycle," p. 255.

increased by 80 percent of the weighted average U.S. devaluation, using imports as weights, and foreign export price indexes were adjusted upward in a similar fashion. These indexes were then used to put the alternative export and import values into 1971 dollars.

Table 13 shows the average percentage revaluation for the seven countries in the Adams model, weighted alternatively by that country's exports and imports, and then each country's 1971 export and import price index, both actual and adjusted as described above. The actual indexes in Table 13

Table 13. Weighted Revaluations and Export and Import Price Indexes for Seven Major OECD Countries, 1971

	Weighted revaluation[a] *(percent)*		*Trade price indexes, 1971 (1963 = 100)*			
			Exports		*Imports*	
Country	*Exports*	*Imports*	*Actual*	*Adjusted*[b]	*Actual*	*Adjusted*[b]
United States	−6.17	−7.14	125.3	125.3	126.2	133.3
Canada	−1.87	−1.90	118.7	116.8	111.8	111.8
Japan	13.62	13.47	110.2	122.3	106.1	106.1
France	0.28	−0.02	132.5	134.0	124.6	124.6
Germany	6.20	6.03	121.5	127.2	104.8	104.8
Italy	−0.42	−0.42	116.1	115.8	121.7	121.7
United Kingdom	2.96	2.93	141.3	144.7	132.3	132.3

Sources: Weighted revaluation, derived from Tables 2, 3, and 6. Actual trade price indexes, International Monetary Fund, *International Financial Statistics*, Vol. 25 (March 1972), country tables, lines 74X and 75X when available, otherwise lines 74 and 75, and information supplied by IMF; adjusted trade price indexes, see note *b*.

a. For each country this is the percentage change in that country's currency value relative to all others, from Table 6, weighted alternatively by export and import shares.

b. To evaluate post-realignment trade, the U.S. import price index and all other export price indexes were adjusted as described in the text.

were used to evaluate the base exports and imports, and the adjusted indexes were applied to the alternative path. The resulting differentials, in 1971 dollars, are shown in Table 14.[32]

The estimated effects on the total trade balances of the seven major OECD countries calculated from the Adams model and from the a priori model of Table 8 are shown in Table 14.[33] The other OECD and non-

32. The Adams model contains no explicit adjustment for supply elasticities. Since the results for total trade balances from the Adams model are to be scaled up to the level shown by the a priori and Magee models, and only the distributions studied, and since the supply adjustment made above was a scale adjustment also, no explicit adjustment for supply effects is made here.

33. The estimates of Table 14 were provided by F. Gerard Adams, along with some alternative runs and advice on how to use the results, in response to my request for help in preparing this paper. I should reemphasize my debt to Adams here.

Table 14. Adams and A Priori Estimates of the Effects of the 1971 Realignment of Exchange Rates on Total Trade Balances, Seven Major OECD Countries

Millions of 1971 U.S. dollars at annual rates

	Changes in trade flows			
	Adams model[a]			
Country	*Exports*	*Imports*	*Balance*	*A priori*
United States	3,700.0	850.0	2,850.0	7,960.9
Canada	570.0	100.0	470.0	955.5
Japan	−260.0	1,350.0	−1,610.0	−6,216.9
France	30.0	−190.0	220.0	−213.5
Germany	−880.0	220.0	−1,100.0	−5,161.1
Italy	100.0	−300.0	400.0	95.8
United Kingdom	440.0	0	440.0	−1,101.9

Sources: Adams model—estimated, derived by F. Gerard Adams using the price indexes in Table 13; a priori model—Table 8, change in trade balance entry.

a. The estimates were calculated on a base of second-half 1969 trade, in 1963 dollars, which were converted to annual rates and 1971 price levels using the price indexes in Table 13. Complete 1971 data were available only for the United States and Japan. For the other five countries the price adjustment was made using the average for January–November 1971.

OECD estimates from the Adams model are not reported because of the absence of price terms on their import equations.

Considering the many differences among the sources of the estimates, the *distributions* of trade balance effects of the 1971 realignment among the United States, Japan, and Germany are reasonably similar. The country with the largest increase in surplus is the United States, while the two with major decreases, Japan and Germany, appear in the same rank order. The small German and Japanese effects relative to the U.S. effect, reported in Table 14, may be due to the lack of response of the ROW trade balance, compared with the response reported in Table 8.

Substantial discrepancies appear, however, in the cases of the other countries, the largest in the estimates of the effects on U.K. trade. According to the a priori model, the U.K. trade balance falls by about $1 billion. But the Adams model shows no effect for imports and an increase for exports. The import result reflects the elasticity estimate of Table 12: The U.K. import equation in the Adams model has no price term. In addition the model showed no change in U.K. exports in real terms, so that, with the U.K. export price index rising (Table 13), U.K. exports in dollar terms rise. This result suggests that the effect on the U.K. trade balance may be somewhat overestimated by the a priori model. But in general, the distributional results from the Adams model are only broadly consistent with the a priori results of Table 8 in the cases of the United States, Japan, and Germany.

The Timing of the Effects on Trade Balances

The last three sections have given estimates of the long-run equilibrium effects of the exchange rate realignment, with no attention paid to the timing of their occurrence. None of the three models contains much information about timing: The Armington model uses a theoretical, comparative-static approach; the Magee model is estimated on annual data with no lags; and the Adams model uses semi-annual data with at most one half-year lag.

This lack of information on price lags is characteristic of empirical models of trade. For example, the original work by Rhomberg and Boissonneault for the Brookings model and my model in 1968 both used Koyck lags, lumping the price lag in with all the other variables in the equation.[34] The more recent quarterly model by Kwack, which is part of the Brookings model, has no price lags, as is also the case in Marston's recent model of U.K. import demand.[35] Timing, therefore, warrants a separate discussion.

Timing raises once more a question asked at the outset: Do exporters pass through the exchange rate changes in the form of changes in the foreign currency prices of their exports, or let profits absorb them, holding foreign currency prices constant? If pass-through dominates, evidence from experience with everyday price changes would be relevant, and the quantity adjustments would come basically from changes existing firms make in their output levels. If profits bear the brunt, the quantity adjustment will

34. See Rudolf R. Rhomberg and Lorette Boissonneault, "The Foreign Sector," in James S. Duesenberry, Gary Fromm, Lawrence R. Klein, and Edwin Kuh (eds.), *The Brookings Quarterly Econometric Model of the United States* (Rand McNally, 1965), and William H. Branson, "A Disaggregated Model of the U.S. Balance of Trade," Staff Economic Studies 44 (Board of Governors of the Federal Reserve System, February 1968; processed).

35. See Sung Y. Kwack and George R. Schink, "A Disaggregated Quarterly Model of United States Trade and Capital Flows: Simulations and Tests of Policy Effectiveness" (presented at the Brookings Conference on Econometric Model Building and Development, February 1972; processed), and Richard Marston, "Income Effects and Delivery Lags in British Import Demand: 1955–67," *Journal of International Economics*, Vol. 1 (November 1971), pp. 375–99.

come later with entry into the export industry in the upvaluing countries and exit in the devaluing countries, a process that should involve a much longer period of adjustment than the pass-through case.

PASS-THROUGH IN 1971

To the extent that the exchange rate changes are passed through—that is, that the shifts illustrated in Figure 1 are actually occurring—fairly small changes in export price indexes should develop, measured in the domestic currency of the exporter, and larger changes in the foreign currency prices of exports. On the assumption of a 0.2 supply adjustment, the exporters' prices in their domestic currencies should change by 20 percent of their average exchange rate change, while the prices in foreign exchange should move by 80 percent of the change in the exchange rate. This means that in devaluing countries the domestic currency price index of imports should be rising substantially, while in upvaluing countries it should be falling.

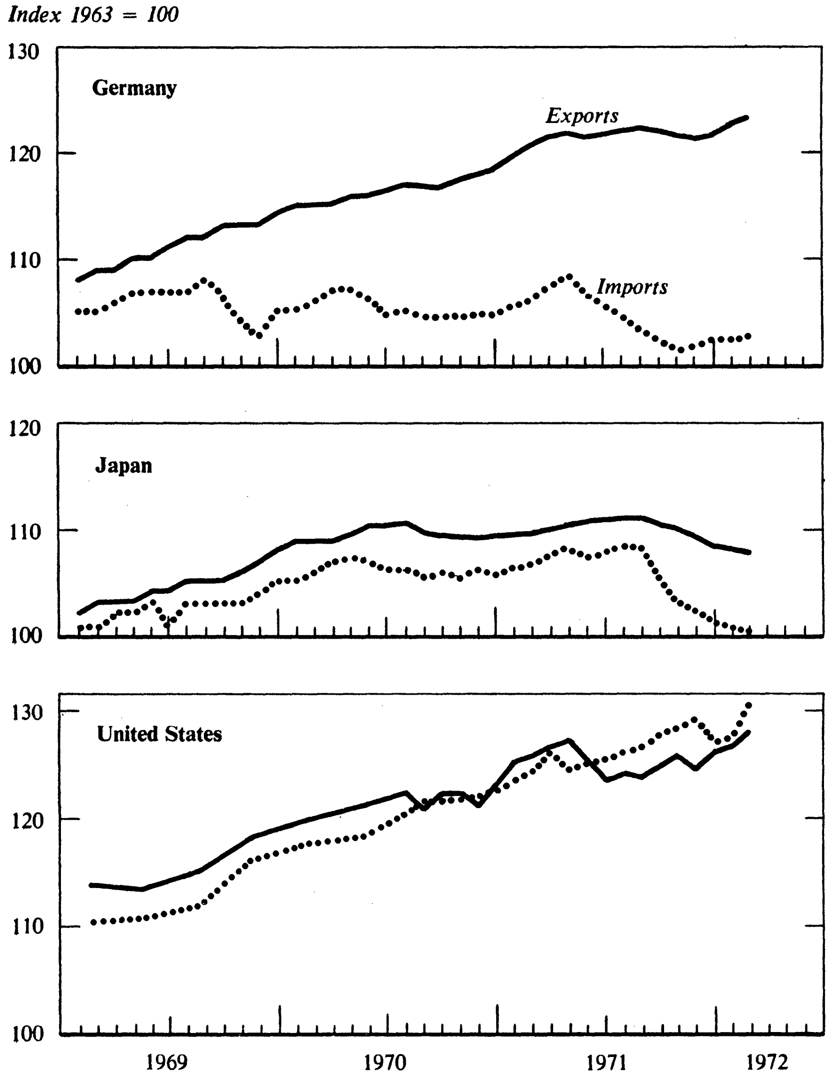
Some evidence on these price movements is assembled in Figure 2, which shows movements in the domestic currency export and import price indexes for the three major countries with the biggest exchange rate changes, Germany, Japan, and the United States.

The average German revaluation from April 30 to December 31, 1971, was 6.20 percent, weighted by German exports in 1971, and 6.03 percent, weighted by imports. Complete pass-through of the revaluation, with a 20 percent supply adjustment, would lead to a drop of 1.24 percent in German export prices and a drop of 4.82 in import prices, compared with what would have obtained otherwise. A clear drop in both indexes relative to trend values is obvious from April 1971. By December the German export price index was about 2.7 percent lower, and the import index about 4.3 percent lower, than their extrapolated trend values.[36] Taken at face value, these data suggest that by the end of 1971 all but 1.5 percentage points of the revaluation had been passed through by German exporters, and all but 0.5 point by importers. At the least, these data do not suggest that pass-through is a problem in the German case.

The average Japanese revaluation from April 30 to December 31, 1971, was 13.6 percent weighted by exports and 13.5 percent weighted by im-

36. The data in Figure 2 are not seasonally adjusted, and there seems to be a seasonal drop in the German import price index from around March–April to October–November. But the December values all are quite near their trend values except for 1971.

Figure 2. Indexes of Export and Import Prices, Germany, Japan, and the United States, Monthly, 1969–72



Source: International Monetary Fund, *International Financial Statistics*, various issues, country pages, lines 74 and 75 for the United States, lines 74X and 75X for Germany and Japan. The U.S. and Japanese series are indexes of unit values and the German series is derived from the relevant wholesale price index components. The series are not seasonally adjusted. Up to mid-1970, only quarterly data for the United States were published in *International Financial Statistics*.

ports. Again with a 20 percent supply adjustment, these changes suggest a drop of 2.72 in the index of Japanese export prices, and a drop of 10.80 in the import price index. A definite drop in Japanese export and import prices from mid-1971 is apparent in Figure 2. Judging by 1970 patterns, part of this might be seasonal, but not all. On the export side, an extension of the trend beginning in early 1970 might have taken the index to 111 by January 1972, as opposed to the actual 108.1, suggesting a drop in yen export prices of about 2.6 percent, well within the range of full pass-through. On the import side, the actual value in January was 100.7, about 7.6 percent below a rough trend value of 109, indicating that importers in Japan passed through perhaps three-quarters of the effect by January 1972.

The U.S. indexes are much harder to interpret than the plausible movements in the German and Japanese cases. The January values of both indexes are clearly below trend, exports more than imports. The shortfall of the export price index may be due to the price freeze, although the sharp drop came from April to June 1971. Import prices seemed to be moving up fairly well until December 1971, when the index dropped from 129.2 to 127.0; the rise was resumed in January.

This lack of response of U.S. dollar import prices to the devaluation is not necessarily inconsistent with the DM and yen export prices of Germany and Japan, which moved about as expected. On the other hand, it may indicate that Japanese and German exporters are, to a large extent, not passing through the exchange rate changes, but rather are holding dollar prices fairly constant while home currency prices fall a bit. Thus, such as it is, the evidence concerning pass-through is mixed. The exchange rate changes seem to be passed through on the import side in Japan and Germany, but the results for U.S. imports are open to some doubt.

In general, I would say that the realignments are not being fully passed through, especially on the side of U.S. imports. This means that, in addition to the possibility of a short-run increase in import payments in U.S. dollars due to the short-run inelasticity of demand, the favorable effects of the devaluation on the import side may take substantially longer to appear than econometric evidence on normal price lags would suggest.

EVIDENCE ON PRICE LAGS

As noted earlier, econometric studies of trade flows have tended to focus on income and activity as determinants of trade and largely to ignore the problem of price lags.[37] However, a study by Bruce T. Grimm, completed in 1968, focused on just this problem.[38] Grimm estimated equations on quarterly data for U.S. exports and imports by end-use categories covering the period from 1954:1 to 1966:4. He used the Almon technique for estimating distributions of coefficients of lagged income, activity, and price variables in the equations. His results for the lengths of price lags are summarized in Table 15.[39]

Table 15. Estimates of Length of Price Lag in U.S. Export and Import Equations, 1954–66 Quarterly Data
Quarters

Exports		*Imports*	
Category	*Lag length*[a]	*Category*	*Lag length*[a]
Crude materials	1	Industrial supplies	
Foodstuffs	5	and materials	5
Semimanufactures	6[b]	Food, feed, and beverages	2[c]
Finished manufactures	1	Capital goods	3
Electrical machinery	5	Consumer goods	1
Autos and parts	7	Autos and parts	5
		Other	1

Source: Bruce T. Grimm, "An Analysis of the Lagged Determinants of United States Import and Export Components" (Ph.D. thesis, University of Pennsylvania, 1968).
a. A one-quarter lag length indicates that only the contemporaneous value of the relative price term enters the equation.
b. Semimanufacture exports were found to be price inelastic, so the total coefficient in Grimm's value equation is positive. See Grimm, p. 107.
c. Food, feed, and beverage imports were also found to be price inelastic in demand.

Many of Grimm's results are puzzling, especially the single-period lags on exports of crude materials and finished manufactures and on imports of consumer goods. Also, it is not clear why the capital goods import lag is so short; nor why most of the price lags in the export equations were not statistically significant, although they had reasonable shapes.[40]

Where lags were apparent, they were concentrated in distributions with lengths of five to seven quarters, with peaks in the second through the fourth quarters. A certain consistency in the results points to a lag length

37. There is good reason for this. As noted earlier, the price data are generally unit-value indexes instead of sampled, fixed-weight indexes. They also exhibit a high degree of serial correlation.

38. Bruce T. Grimm, "An Analysis of the Lagged Determinants of United States Import and Export Components" (Ph.D. thesis, University of Pennsylvania, 1968).

39. See Grimm's Chapter 4, pp. 126–39, for a more detailed summary of the results and for graphs of the price lags.

40. This is noted by Grimm, p. 133.

covering perhaps one and one-half to two years, with the peaks of the adjustment coming perhaps one year after the price change.

Thus to the extent that the exchange rate changes are passed through, and that the evidence from these U.S. trade equations is relevant, we should expect to see adjustment begin in a year's time after the realignments—toward the end of 1972—with the full effect appearing by the end of 1973. This conclusion should apply to the U.S. export side. But the possibility that the changes are not being passed through on the U.S. import side suggests that the lags there may extend well beyond 1973.

Summary

The a priori estimates using the Armington framework and the empirical estimates from the Magee model point to a central estimate of a swing of $7 billion to $8 billion in the U.S. trade balance due to the exchange rate realignments of 1971, with more than half appearing as exports. The other major increases in trade balances from the realignment come in the nonindustrial countries—the ROW ($6 billion) and Canada ($1 billion), although the gain to the ROW is surely overstated. The countries with major reductions in trade surpluses are Japan ($6 billion), Germany ($5 billion), and the United Kingdom ($1 billion).

These estimates, from Table 8, give the effects of the exchange rate changes alone, holding all else constant; they are not predictions of *actual* changes. They also do not build in reactions of income or the price level to the initial effects; they represent the exogenous net export effects the macro forecasters should feed into their models. They also are full effects without a timing dimension, and thus do not allow for possible short-run inelasticities in demand and supply schedules.

Very little of use has been published on the timing question. The study by Bruce Grimm suggests that the effects of the realignments should be visible by the end of 1972 (assuming nothing else changes too much), and that most of the pass-through effect should come by the end of 1973. But it is very hard to see how the conventional wisdom became so firmly settled on a two-year lag. Presumably the people who form it are not closely acquainted with the Grimm study.[41] And the two-year lag estimate

41. While I have heard the British experience since 1967 used to confirm the conventional wisdom, it is hard to know why. The turn to surplus in U.K. trade was closely connected with its worst postwar recession, and even the *National Institute Economic Review* has not published an attempt to disentangle the effects of devaluation from the effects of recession, a problem that may be impossible even in theory.

does not allow for the possibility that absorption will spread out the effects beyond 1973. But to the extent that the realignments are passed through, the popular guess of a two-year lag does turn out to be a best guess, as far as I can tell.

This paper has produced fairly large estimates of the partial effects of the exchange rate realignments on trade balances, especially that of the United States. But this should not be taken as a projection of the actual movements in the U.S. trade balance over the next year or so, for at least three reasons. Two have been mentioned: The partial effects themselves will take time to appear, and they will tend to generate price and income movements that, in turn, will reduce the impact of the realignments on trade balances. The third reason is that the trade balance is highly sensitive to short-run cyclical changes in income. With the U.S. economy expected to expand relatively more rapidly than Europe's over the next year or so, downward cyclical pressure will be exerted on the trade balance. One projection by Stephen Magee shows a deterioration from cyclical forces of some $2 billion from 1971 to 1972. Thus the short-run movements in trade balances may well be dominated by cyclical changes in demand. But the long-run effect of the devaluation over the next two or three years will be to reduce substantially the U.S. trade deficit.

Comments and Discussion

Lawrence R. Klein: All economists may be divided into four groups: (1) trade elasticity optimists; (2) trade elasticity pessimists; (3) those who have no a priori opinion; and (4) those who don't care. William Branson is an optimist, and I am a pessimist. He takes his opinion on intuition, while I go strictly with the econometric evidence. He is in good company, however, joining an impressive array of students of trade theory who share his intuition and are quite willing to recommend trade policy on this basis.

In addition to my concern over the lack of hard evidence on the magnitude of trade elasticities, I question the methodology of the approach. The problems being studied cannot be answered in terms of trade relationships alone. Trade policies will have repercussions on the domestic economies of the trading nations, and these must be taken into account in a fully consistent way. Also, counter or support measures, as the case may be, will be taken in the domestic economies concerned and will feed back on the trading system. Branson tells us that his estimates of the impact of the realignments should "be fed into macroeconomic models that will then calculate the feedbacks for whatever path is assumed for government policy variables." His results, however, provide only the first iteration of the solution of a complicated feedback mechanism between domestic and trade sectors of the world economy, and without an explicit structure of the mechanism, it is questionable whether he has obtained an indicative estimate of the outcome.

First, let me develop some ideas on elasticity optimism or pessimism. Branson suggests that estimates of demand elasticities are expected to be between -2.0 and -3.0. For some commodities in some bilateral movements, own-price elasticities may be this large, but overall imports and exports in given countries do not seem to be that sensitive to relative price changes. In the case of the United States, between one-fourth and one-third of both exports and imports are in basic materials, food, or beverages.

These goods are not particularly price elastic. This is especially important on the side of U.S. imports, where devaluation of the dollar will simply mean higher outlays for coffee, tea, cocoa, sugar, oil, and basic materials.

Manufactures are more elastic, but after extensive study of this group, subdivided by cars and all other, the best values I can find are -1.3 for manufactures excluding road motor vehicles[1] and -2.1 for road motor vehicles. For the total import mix the overall elasticity is somewhere between -1.0 and -1.5. Services are not likely to make the total import bill more elastic. These elasticity estimates are used in the U.S. import equations for the LINK model,[2] and have been obtained after careful allowance for lags, price measurement, and many disturbing factors in world markets.

Oil requirements are a particularly disturbing aspect on the horizon of American import performance that Branson overlooks in his calculations. Considering the institutional structure of the world petroleum market, we have come to regard SITC 3 imports as exogenous in the U.S. part of the LINK system. Industry specialists feel that the United States is near capacity in the use of domestic petroleum resources and that, even allowing for retrieval from the North Slope in Alaska, major oil imports will grow during the rest of the decade, increasing from 3.4 million barrels per day in 1970 to 7.3 million barrels per day in 1975, and to 10.7 million barrels per day in 1980. Allowing for annual price increments of 25 cents per barrel in 1972, 11 cents in 1973, and 5–7 cents over the rest of the decade, projections of the Wharton long-term model with exogenously added oil imports suggest that all the trade balance gains of the new economic policy (NEP) realized by 1974–75 in the form of a positive balance fade away and that net exports are a negligible quantity by 1977. In this case, rising prices and rising imports result in a perverse effect for Branson's type of analysis.

On the side of exports, the elasticities are not much larger. National export equations are not used explicitly in the LINK system because they are determined through the trade matrix in a world simulation solution; nevertheless, separate estimates of export equations are available for each model. The U.S. results indicate elasticities of -1.3 for all goods excluding

1. Standard international trade classification (SITC) 5–9 excluding 732 (road motor vehicles).

2. LINK is a project that aims to build a world economic model by linking the models of the major trading nations.—The editors.

Table 1. Estimates of Long-run Price Elasticities from the LINK Econometric Model

Country	Imports, by SITC classification[a] 0, 1	2, 4	3	5–9	Exports
Japan	b	b	b	−0.692	−2.378
Germany	−0.956	b	−1.577	−1.677	−1.682
United Kingdom	b	b	b	b	−0.711
Italy	−1.663	−0.521	b	−1.130	−0.720
Canada	−0.961	−0.303	−0.811	−2.492	−0.587
Netherlands	−0.420	−0.420	b	−0.490	−2.390
Belgium	−1.055	b	−0.653	b	−2.580
Sweden	b	b	b	b	−1.920
Austria	b	−0.077	b	b	n.a.
Finland	b	−0.500	b	b	−0.750

Source: LINK models.
a. The standard international trade classifications cover the following commodities:
0, 1—food and beverages.
2, 4—crude materials and animal and vegetable oils and fats.
3—mineral fuels, lubricants, and related materials.
5–9—manufactures.
b. Not statistically significant.
n.a. Not available.

military grant-aid and road motor vehicles, and −1.16 for road motor vehicles.[3]

The other LINK models for individual countries have elasticity estimates that are either in the same general range as the U.S. estimates or lower (see Table 1). Japanese, Dutch, and Belgian exports are fairly elastic, and so are Canadian manufactured imports; but most of the others are quite inelastic—below 2.0 in absolute value and often below 1.0. Branson suggests that the Adams trade model underestimates effects on the United Kingdom because the import equation has no price term and a low price elasticity of exports. The London Business School model in LINK agrees with the Adams results. There is no valid empirical evidence of significant price effects on imports; some discrete effects are noticeable in connection with the import surcharge, but no statistically significant price variables. As in the other LINK studies, this result comes after extensive and careful testing for price effects and lag distributions. The data do not show what many trade analysts insist must follow from their intuitive insight. LINK econometricians have been quite aware of the problems of lag re-

3. The long-run estimates for exports of cars alone is −1.68.

sponse. They have searched carefully for estimates of lagged price effects, but have found little empirical evidence to support popular hypotheses.

Branson argues that the Adams model underestimates price coefficients generally because it does not have long enough lags and does not deal with simultaneous equations bias. These are things worth looking at, but I doubt that they are really responsible for serious underestimates. Rather long lags, up to three and four years in duration, have not been studied in depth, a fact that may have some bearing on the results; but the real problems for good estimates of trade elasticities are in obtaining proper price data and taking account of disturbing factors. The key disturbances to U.S. postwar trade have been (1) U.S. stockpile purchases during the Korean War; (2) the closing of the Suez Canal; (3) frost in Brazil; (4) dock strikes; (5) the Canadian automobile agreement; (6) P.L. 480; (7) U.S. foreign aid; and (8) Canadian wheat sales to China and the USSR. Most of these influences have been carefully monitored and dealt with by some special statistical treatment in LINK studies. We have worked hard at getting good estimates of the trade equations, yet we find no evidence to support the assumed values of elasticities used by Branson.

As to simulation of the world economy, the Armington model used by Branson has great mathematical elegance but must be based on a number of highly restrictive assumptions in order to be applied. I find implausible the implications of the generalized CES function relating total trade to several bilateral flows. The elasticity of substitution between any pair of bilateral arguments must be identical. This does not seem to be realistic. The trade model of the Organisation for Economic Co-operation and Development, and its extension by Adams, is a useful construction, but it does not deal fully with the problem of judging the effects of the new exchange rate realignments.

The LINK system, in a nutshell, interrelates existing large- and medium-scale econometric models across major industrial countries and regional groupings of the developing countries through the world trade matrix in a consistent way that preserves trade accounting identities—world exports equal world imports; import prices equal export prices on average—while seeking a compatible simultaneous solution for the global economy. This solution gives values for both trade flows and domestic variables for each country. The models used are described in more detail in *ITEMS* and LINK working papers.[4]

4. Social Science Research Council, *ITEMS*, Vol. 23 (December 1969); Vol. 24 (December 1970); and Vol. 25 (December 1971). See also Lawrence R. Klein, Chikashi

The principal result in the LINK simulations for 1971 and 1972 are that, for both years, the introduction of NEP reduced the volume of world trade below the path that otherwise it would have followed:

	Without NEP	*With NEP*
	(billions of 1963 dollars)	
1971	258.2	257.5
1972	275.9	274.0

Given the modest estimates of trade elasticities in almost all country models, the results are different in magnitude for nominal and real magnitudes. For example, the U.S. balance should become positive in real terms but smaller or even slightly negative in nominal terms. The developing countries should improve their balance in real but not in nominal terms, and similar differences occur for other countries. For covering deficits in payments balances, nominal trade figures are more important than real; for studying the immediate effect on growth and employment, real trade figures are more important.

The impact is slight in 1971 since the policies were in effect for only part of the year. Although the $2.0 billion effect estimated for 1972 may also seem to be small, it consists of the mutual offsetting of fairly large shifts for the United States, Canada, and the developing countries on the one hand and Germany, Japan, Italy, France, and Belgium on the other (see Tables 2 and 3). These country line-ups generally agree with Branson's but he does not consider the developing countries in any detail and deletes France and Italy from the list of countries losing trade on balance.

Our finding of insensitivity of the United Kingdom is in agreement with Branson's estimates. Also, the downward adjustment by Germany and Japan, and upward adjustment by Canada and the United States, agree with his independent calculations.

For the developing countries, the United Nations Conference on Trade and Development has developed four regional models for LINK: Africa (excluding Libya); South and East Asia; Latin America; and the Middle East and Libya. They show no real change for the Middle East, substantial changes for Africa, and sizable trade changes for Latin America. The Middle East trade is dominated by oil and ought not to change in real terms.

Moriguchi, and Alain Van Peeterssen, "NEP in the World Economy: Simulation of the International Transmission Mechanism," LINK Working Paper No. 2 (University of Pennsylvania, Economic Research Unit, 1972; processed).

Table 2. Effects of New Economic Policy on Trade and Output, Developed Countries, 1972

Values with NEP minus values without NEP

				Goods F.O.B.[a]	
Country	*Imports*[b]	*Exports*[c]	*GNP*[c]	*Imports*	*Exports*
Belgium	−0.2	−17.3	−5.0	1.27	1.13
Canada	0.1	1.2	0.4	0.82	2.11
France	−0.5	−5.8	−10.0	1.35	1.39
Germany	0.0	−2.9	−5.0	2.04	4.37
Italy	−0.7	−1,100.0	−1,200.0	1.56	1.27
Japan	−0.4	−1.2[d]	−700.0[e]	1.41	2.83
Netherlands	−0.2	0.5	−0.4	−0.13	0.97
Sweden	0.0	0.4[f]	−0.3[f]	0.47	0.73
United Kingdom	0.0	0.1	0.0	1.35	2.00
United States	0.5	4.1[g]	1.5[g]	3.61	3.57

Source: LINK models.
a. Billions of current U.S. dollars.
b. Billions of 1963 dollars.
c. Billions of 1963 national currency units, except as noted.
d. Billions of 1965 U.S. dollars.
e. Billions of 1965 yen.
f. Billions of 1959 kroner.
g. Billions of 1958 U.S. dollars.

Table 3. Effects of the New Economic Policy on Trade, Output, and Prices of Developing Areas, 1972

Values with NEP minus values without NEP, in billions of 1960 U.S. dollars

Area	*Imports*	*Exports*	*Gross domestic product*	*Terms of trade*[a]
Africa (excluding Libya)	−0.3	0.4	0.8	−3.8
South and East Asia	0.0	0.1	0.0	−4.2
Latin America	−0.2	0.8	0.0	−4.2
Middle East and Libya	0.0	0.0	0.0	−1.5

Source: LINK models.
a. $(PX/PM)100$, where PX is the price index of exports and PM the price index of imports, both in U.S. dollars on a 1960 base.

In order to get a fuller picture of the expected effects on the developing world, however, I have added figures on dollar terms of trade (see Table 3).

The predicted deterioration in terms of trade for developing countries suggests that real improvements of trade balances will be associated with deterioration in nominal terms. The nominal increments in goods imports (f.o.b.) for all developing countries is estimated at \$5.65 billion against \$3.35 billion for goods exports (f.o.b.). For future years, this will cut into reserves and may lead to poorer real growth rates.

There are two particular comments on Branson's paper that I should like to add. He argues that quoted export prices will fall as a result of devaluation for two reasons:

(1) Mobility of capital and labor will eliminate excessive profits in export industries; and
(2) with U.S. industry operating at low capacity utilization, export price reactions on the supply side should be below average sample experience.

The assumption about mobility of labor and capital is consistent with Branson's elasticity optimism. He is placing much faith in a rapid, smooth-working, and sizable adjustment process that I find to be unrealistic.

Based on my reading of the Wharton capacity utilization index, I would be reluctant to put great weight on capacity utilization, as a favorable factor. It is not so low as to warrant a special adjustment to export prices below average experience in the sample period.

Hendrik Houthakker: I found this paper very illuminating. The theoretical exposition based on Armington's model is very clear and very useful, but there remains in my mind a basic question as to the economic logic of the Armington model.

International trade theory has traditionally been formulated in terms of commodities rather than countries, and neither Armington nor Branson provides the convincing link between a commodity model and a country model that needs to be forged at some point. Moreover, the uniform elasticity of substitution is a main theoretical weakness of the Armington model. In that respect, I am more sympathetic to Stephen Magee's assumption that the elasticity may vary.

As Branson himself indicates, the empirical results in his paper are really not very new. This is partly the result of selection of sources. The Armington model as such does not provide any empirical results, and though the results Branson derives from it agree with those updated from Magee's work, this is not reassuring, since we cannot reinforce a purely empirical by a purely theoretical model. He therefore does not add much support to Magee's findings, which to my mind are useful and convincing.

Perhaps I should reaffirm that I am an elasticity optimist. My optimism is based in part on the work that Magee and I have done together, and also on the fact that our work agreed very well with earlier studies such as those of Rudolf Rhomberg, R. J. Ball and K. Marwah, and Mordecai E. Kreinin. Their estimates of overall price elasticities are similar to ours.

Branson's empirical verification of the size of the elasticities leaves something to be desired. He attempts to incorporate the Adams OECD model, but then rejects it on the ground that its elasticities are so small. I wish he had tried more seriously to find the source of the discrepancies between that model and others. That is why I am not completely convinced, after reading Branson's paper, that he really has supported Magee's results as strongly as it appears at first sight.

One particularly important question is what happens to trade flows after the initial effects of a revaluation have been exhausted, that is, what the second- and third-round effects are in trade models. The issue is all the more pertinent in light of a recent paper by Arthur Laffer. On the basis of short time series for a number of countries that made exchange rate adjustments at some time during the last fifteen years, he maintains that the results of exchange rate adjustments are transitory. In virtually all the cases, Laffer finds that the effect of the exchange rate adjustment is exhausted in approximately three years. This disturbing result is not based on any detailed analysis, but the gross empirical evidence is quite contrary to what optimists, including myself, would have believed.

Sir Alec Cairncross: I should like to comment from a British point of view on some of the issues raised by Branson's paper.

Obviously, the size of elasticities is a relative matter, depending on the time period: They are smaller in the short run than in the long run. It therefore makes a big difference whether or not there is a great hurry to get the balance of payments into equilibrium. In the British case, we thought speed was at a premium; thus, we were very disappointed to see first a deterioration in 1968, and then a very slow improvement until well into 1969. Maybe, in the case of the American balance of payments, quick results may be less vital because not many good alternatives to holding dollars exist.

In the British case, the prospect of a high elasticity is greater on the export side than on the import side. British exporters sell to a very large world market outside the country, and the exports are almost entirely manufactures. These features make for high elasticities. On the import side, however, the large element of food and materials substantially reduces the elasticity. In addition, domestic producers who compete with imports will act to reduce the magnitude of shifts in the market.

The rate of expansion of the U.S. domestic economy today is probably faster than that of the world economy as a whole, and that must substantially affect the situation. In the British case we slowed down before we devalued and continued to slow down thereafter, which had quite an effect on the balance of payments. The impact of the U.K. exchange rate adjustment has not been disentangled from that cyclical effect.

In general, demand effects tend to swamp cost effects in movements from year to year. Even in tracing shifts in the balance of trade of the main industrial countries from the early 1950s to the late 1960s, it is hard to identify the effects of changes in competitive position indicated by export and import prices. Usually, one finds a very slow and progressive loss (or gain) of competitive power rather than any dramatic change in the balance of trade.

In the British case, most people sensed a major loss in competitive power during the 1960s, but the change in the balance of trade over a ten- or fifteen-year period was pretty small in relation to the movement in the price and cost indexes. That certainly led us to feel the elasticities must be low—that the sum of the export and import price elasticities might not be tremendously above unity.

Finally, the feedback from devaluation in jacking up domestic costs and prices weakens the net impact on the trade balance. The cost of raw materials moves up. Higher prices may lead to demands for higher wage settlements. The latter may be a less important consequence of devaluation in the U.S. case than in the British case, because U.S. imports are so much less significant in the U.S. cost of living.

General Discussion

Walter Salant stressed that the impact of a change in a country's exchange rate on its exports depends on cost changes as well as price changes. Whether the main impact will be on costs or prices, in turn, depends greatly on the industrial organization of the exporting industry and on its importance as a world supplier. In the extreme case of a small country exporting a homogeneous product (such as wheat) in a world market, devaluation could increase exports without creating any price advantage for that country's exporters relative to others. The world price measured in foreign currency would be unchanged, but wheat production would become more profitable in the devaluing country because the spread between the price and the production costs, both measured in domestic currency, would increase and more would be exported, even though the price in foreign currencies did not fall. In an oligopolistic industry in which the demand for the country's exports is not infinitely elastic, however, exports are not likely to be encouraged without a cut in the price measured in foreign currencies. Both the cost and the price effects must be taken into account, Salant concluded.

James Duesenberry felt that Salant's distinction between price and cost effects or supply and demand responses had general applicability. The elasticity estimates are really a compound of supply and demand elasticities. A cost advantage may enable one country to capture an entire market for a standardized product, a development that would present a case of tremendous elasticity.

When the commodity is not standardized, suppliers who get a cost advantage from devaluation may use it to lower prices or to improve quality in ways that are not measurable. Quality change tends to make the statistics understate elasticity. Producers in the home country have to decide how much to respond to tougher world competition by cutting their prices or improving their quality. The amount of that response will depend in part on the strength of demand and capacity utilization in the domestic economy. All of these decisions influence the impact on trade, Duesenberry concluded.

Thomas Juster felt that price elasticities that are calculated on the unit value measures of prices are likely to be underestimated. He reported that when Robert Lipsey of the National Bureau of Economic Research developed product categories by technical specifications, he found much larger elasticity responses than had been obtained with the standard definition of gross categories and unit values.

Juster also suggested a way to reconcile large price elasticities with the absence of dramatic, visible effects of devaluation in the time series data: The effects may be eroded by differential rates of productivity growth in the various countries. For example, annual increases in productivity are so much higher in Japan than in the United States that the U.S. advantage from a 17 percent revaluation will disappear in a few years. Thus, the exchange rate is important and yet it can be drowned out in the data. Moreover, if these big differences in productivity growth are recognized, they will weaken the response to devaluation; Japanese automobile firms, for example, will not slacken their sales efforts in the U.S. market if they expect to regain their competitive position in three or four years.

R. J. Gordon suggested alternatively that rapid adjustments of costs and prices in the domestic economy following an exchange rate move may offset the large elasticities. There are classical examples of rapid price level adjustments after devaluation, as in Australia, when the 31 percent devalution of 1949 was followed by an increase of over 40 percent in Australian prices relative to world prices over the next three or four years. Gordon underlined Cairncross' remark about the impact of sterling devaluation in stimulating British wage inflation, as another example.

Branson and Stephen Magee noted, and Gordon agreed, that the cost-push impact of devaluation is likely to be particularly strong in small countries but less pronounced for the United States.

Arthur Okun suggested that the outlook for increases in U.S. oil imports should be distinguished from the issue of how much difference the devaluation makes.

Franco Modigliani and Branson expressed concern that cyclical income effects and price responses were not distinguished in the results Klein presented, which showed no net improvement in the U.S. trade balance. They found it hard to understand how real U.S. imports in 1972 could be stimulated by NEP, as Klein's Table 2 suggests, in light of the devaluation and the estimated stimulus to real GNP of only $1.5 billion. Magee reported his estimate that the cyclical effect—growth in U.S. output more rapid than that of our trading partners—would subtract $2.5 billion from our trade balance in 1972. Branson quoted from a LINK study (see note 4, pages 62–63) in which Klein and his associates expressed their own suspicions that the estimates of price sensitivity were too small. Branson felt that Magee's empirical results offered solid confirmation of that intuitive feeling.