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THE EFFECTS OF RECENT EXCHANGE RATE CHANGES ON THE U.S. TRADE BALANCE

by

Peter B. Clark

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The Effects of Recent Exchange Rate Changes on the U.S. Trade Balance*

Peter B. Clark

As a result of the multilateral exchange rate changes that took place between the first quarter of 1971 and the second quarter of 1973, the dollar depreciated on a trade-weighted basis by about fourteen percent.[1] This paper presents some estimates of the change in the value of U.S. merchandise imports and exports over this nine-quarter period that may be ascribed to these adjustments in exchange rates. In the first section of the paper an attempt is made to calculate the rise in the dollar prices of U.S. imports and exports brought about by the depreciation of the dollar. The second section then gives the results of estimating import and export price elasticities of demand. Finally, in the third section the calculated price increases and import and export demand elasticities are combined to yield estimates of the impact of the dollar depreciation on the U.S. trade balance, quarter by quarter, between 1971I - 1973II.

This paper is frankly in the partial equilibrium mold.[2] The one step in the direction of a general equilibrium analysis is the calculation of the impact of the dollar depreciation on the prices of U.S. imports and exports. However, the induced effects of exchange rate changes on domestic prices, both in the United States and abroad, are not measured and thus are implicitly assumed to be zero.[3] Similarly, the real income effects of the dollar depreciation are also ignored. Since the induced responses in the levels of domestic prices and real income may partially or fully offset the international price advantage for U.S. imports and exports brought about by the exchange rate changes, the estimates set forth here provide an upper bound for the full *mutatis mutandis* effects of the depreciation of the dollar during 1971-1973.[4]

I. Effects of Exchange Rate Changes on the Prices of U.S. Imports and Exports

For a country that looms as large in world trade as the United States, it is unlikely that the domestic-currency, i.e., U.S. dollar, prices of its imports and exports would rise by the full amount of a depreciation of the dollar. A knowledge of supply elasticities would, together with demand elasticities, enable one to compute the percentage change in U.S. import and export prices associated with any given dollar devaluation. The estimation of such supply elasticities is, however, notoriously difficult.[5] First of all, in the case of trade in finished manufactures, the assumption of perfectly competitive conditions required to derive a supply curve is itself questionable. And second, for those classes of goods, e.g., agricultural commodities, whose prices are determined in highly competitive markets, the proper specification of supply conditions requires extensive institutional knowledge that the author lacks.

For these reasons the following expedient has been adopted in this paper: U.S. imports and exports have been dichotomized on the basis of the degree of competition in the market in which they are bought and sold. On the one hand, there are commodities that have standard characteristics and are traded on organized international commodity markets.

Arbitrage tends to make the prices of these goods in different countries differ by no more than the exchange rate and freight, insurance and interest charges. Such arbitrage is not perfect, however, because of tariffs, quotas, and special arrangements such as the Common Market's variable levies on agricultural imports. Nevertheless, for these commodities the perfectly competitive model is a good approximation, so that the impact of the multilateral exchange rate changes during 1971-1973 on the numeraire (in this case, the dollar) price of these commodities can be calculated from knowledge of the magnitude of the exchange rate changes and on the basis of assumptions regarding supply and demand elasticities. On the other hand, there are commodities that are not homogeneous, being characterized by substantial product differentiation. These goods are not traded on organized markets, and sellers have a substantial degree of discretion in setting prices. Since for these commodities the assumptions of perfect competition do not hold, the impact of the depreciation of the dollar on their prices is estimated by using an alternative pricing assumption.

A. Multilateral Exchange Rate Effects on Dollar Prices of Traded Goods Under Perfectly Competitive Conditions

The approach adopted here is an application of the methodology suggested in a recent paper by Ridler and Yandle [1972] and described by Yandle in his contribution to this volume.[6] They show that under conditions of perfect competition the effect of a multilateral exchange rate realignment on the numeraire price of an internationally-traded commodity depends on the shifts in each country's export supply and import demand in response to the change in its exchange rate vis-à-vis the numeraire currency. This result is derived here in a somewhat more general context.

Consider the total demand (D) and total supply (S) for a particular commodity where there are n countries in the world. Abstracting from all other factors affecting demand and supply except the world market price, and assuming constant demand and supply elasticities, we have:

$$(1) \qquad S = \sum_{i=1}^{n} S_i = \sum_{i=1}^{n} a_i (R_i P)^{b_i} \qquad a_i > 0,\ b_i > 0.$$

$$(2) \qquad D = \sum_{i=1}^{n} D_i = \sum_{i=1}^{n} c_i (R_i P)^{d_i} \qquad c_i > 0,\ d_i < 0.$$

where

R_i = price of the numeraire currency in terms of the i^{th} country's currency

P = price of the commodity in terms of the numeraire currency.

To determine the percentage change in the numeraire price in response to multilateral exchange rate changes, set D = S and take total differentials, thereby obtaining:

$$(3) \qquad \frac{dP}{P} = \left(\sum_{i=1}^{n} d_i D_i \frac{dR_i}{R_i} - \sum_{i=1}^{n} b_i S_i \frac{dR_i}{R_i}\right) / \left(\sum_{i=1}^{n} b_i S_i - \Sigma d_i D_i\right).$$

Thus the change in the numeraire price of the commodity is seen to depend on supply and demand responses induced by the exchange rate adjustments.

Alternatively, the change in the numeraire price can be expressed in terms of export supply and import demand elasticities. In this context of homogeneous goods, exports (X_j) represent "excess" domestic supply, i.e., the difference between total domestic supply (S_j) and total domestic demand (D_j):

(4) $\quad X_j \equiv S_j - D_j$ where the index $\underline{j}$ refers to exporting countries.

Similarly, imports (M_i) represent "excess domestic demand:

(5) $\quad M_i \equiv D_i - S_i$ where the index $\underline{i}$ refers to importing countries.

Since by definition:

$$m_i \equiv \frac{D_i}{M_i} d_i - \frac{S_i}{M_i} b_i \tag{6}$$

$$x_j \equiv \frac{S_j}{X_j} b_j - \frac{D_j}{X_j} d_j \tag{7}$$

where

m_i = import elasticity of demand

x_j = export elasticity of supply,

it follows that the percentage change in the numeraire price can also be expressed in terms of these two parameters and the quantities imported and exported:

$$\frac{dP}{P} = \left(\sum_{i=1}^{h} m_i M_i \frac{dR_i}{R_i} - \sum_{j=1}^{k} x_j X_j \frac{dR_j}{R_j}\right) / \left(\sum_{j=1}^{k} x_j X_j - \sum_{i=1}^{h} m_i M_i\right) \tag{8}$$

where there are $\underline{h}$ importers and $\underline{k}$ exporters, and $h + k \leq n$. For empirical applications equation (8) is more useful than equation (3) because data are more readily available for the exports and imports of commodities than for the total amount produced and consumed domestically. The only drawback to using equation (8) is that, strictly speaking, it is valid only at a point, since m_i and x_j are themselves functions of the exchange rate.

The expression given by equation (8) can be used directly to compute the change in the numeraire price of an individual commodity brought about by the exchange rate adjustments of many countries. However, for the purpose of analyzing the effects on the entire trade account of an exchange rate realignment, it is necessary to consider broad aggregates of commodities and measure the weighted average of the changes in the prices of the individual commodities making up the aggregate. Using the share of the individual commodity in the aggregate as the weight for that commodity greatly simplifies the computation. Thus the weighted average, or index, of price changes in a class of K commodities, represented by $\widehat{\frac{dP}{P}}$, is given by:

$$\widehat{\frac{dP}{P}} = \sum_{j=1}^{K} w_j \frac{dP_j}{P_j} \tag{9}$$

where

$w_j = \frac{M_j}{M} = \frac{X_j}{X}$, and

M_j = total world imports of j^{th} commodity

X_j = total world exports of j^{th} commodity

$M = \sum_{j=1}^{K} M_j = X = \sum_{j=1}^{K} X_j$, i.e., total world imports of the K commodities equals total world exports of the same commodities.

If one had estimates of the import demand and export supply elasticities for each of the K commodities, then one could use this information, together with data on imports, exports and exchange rate changes, to compute the weighted average price change. However, for the broad aggregates considered here, which include thousands of individual commodities, such information is not available. Therefore the simplifying assumption was made that the import demand elasticity (m) is the same for all commodities in the aggregate and for all countries, and similarly for the export supply elasticity (x).[7] On the basis of these assumptions it can be shown that the weighted average of the percentage changes in the individual commodities is given by:

$$(10) \qquad \hat{\frac{dP}{P}} = \sum_{i=1}^{n} \left\{ \frac{mM_i}{(x-m)M} - \frac{xX_i}{(x-m)M} \right\} \frac{dR_i}{R_i} .$$

where

M_i = total imports of country $\underline{i}$ of the K commodities included in the aggregate

X_i = total exports of country $\underline{i}$ of the K commodities included in the aggregate.

Thus the expression given by equation (10) is in fact a weighted average of exchange rate changes, where the weights depend on the import demand and export supply elasticities as well as the country's share in world imports and exports of the class of commodities in question.

Equation (10) was used to compute the impact of the 1971-1973 exchange rate changes on the dollar prices of three broad classes of commodities. These classes were dictated by the type of disaggregation used for the estimation of import and export price elasticities of demand described in the next section. There are two classes on the side of U.S. imports: foods, feeds and beverages, and industrial materials and supplies (less fuels and lubricants), and one class of U.S. exports, namely agricultural exports. It is clearly the case that not all of the items in these classes are homogeneous goods traded on international commodity markets linked by arbitrage. Nevertheless, the model of competitive markets should provide a fairly good approximation of the manner in which the prices of the commodities respond to exchange rate changes.

In using equation (10) the dollar was taken to be the numeraire currency and therefore exchange rates were measured in local currency units per dollar, with the first quarter of 1971 taken as the base period. Ideally, one would like to have total world imports (or exports) of the classes of commodities in question and include all countries in the sample. Since such data are not readily available, the sub-sample provided by OECD countries was used instead. Thus the larger of total OECD imports or exports for each class of commodities was used as a proxy for the world total.[8] In the absence of precise estimates for the import demand and export supply elasticities, a range of values for these parameters was used.[9] The results of using equation (10), together with the elasticities assumed to obtain these results, are given in Table 1.

The results in Table 1 depend heavily on the assumption that the commodities in each category are traded under highly competitive conditions. Only under this assumption will countries' supply and demand for the commodities respond automatically to exchange rate changes. Since for some commodities there are few sellers, and there are in fact barriers between markets in individual countries, such as quotas, exchange control and special marketing arrangements such as the Common Market's variable levy on agricultural imports, the results in Table 1 may overstate the increase in the dollar prices of these commodities resulting from the exchange rate realignments that took place between 1971I - 1973II. Another reason why these price rises may be overstated is that the sample of countries is limited to members of the OECD, and

Table 1. Impact of the 1971-19 Exchange Rate Changes on the Spot Dollar Prices of Selected Commodity Groups (percentage increase from 1971I)

Quarter	Foods, Feeds and Beverages			Industrial Materials and Supplies (less fuels and lubricants)			Foods, Feeds and Beverages plus Agricultural Industrial Supplies		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
1971II	0.05	0.06	0.07	0.06	0.07	0.08	0.05	0.06	0.07
1971III	0.26	0.32	0.36	0.33	0.39	0.46	0.29	0.35	0.40
1971IV	0.77	0.91	1.02	0.98	1.14	1.37	0.88	1.04	1.20
1972I	1.66	1.94	2.17	2.08	2.42	2.91	1.91	2.30	2.57
1972II	2.59	3.01	3.35	3.24	3.76	4.49	2.97	3.59	3.97
1972III	3.30	3.80	4.20	4.26	4.87	5.75	3.81	4.60	5.03
1972IV	3.69	4.17	4.56	5.02	5.60	6.45	4.29	5.14	5.52
1973I	4.23	4.67	5.02	6.12	6.62	7.37	4.94	5.83	6.16
1973II	5.20	5.67	6.04	7.71	8.20	8.97	6.06	7.07	7.40
Long-Run Elasticities									
m	-0.40	-0.56	-0.70	-0.5	-0.75	-1.0	-0.5	-0.64	-0.80
x	0.50	0.40	0.30	1.5	1.0	0.5	0.7	0.56	0.40

Sources: Exchange rates - for all countries other than Greece, Turkey, Iceland and Yugoslavia, quarterly average of daily rates from Federal Reserve Bulletin; for these four countries, quarterly average of end-of-month rates given in International Financial Statistics. Trade data - OECD trade tapes, rearranged into end-use categories by Kathryn A. Morisse, Board of Governors of the Federal Reserve System. It was assumed that the demand response was complete within one year and that the supply response was complete within two years, and that the demand elasticity was m/4 in each quarter and the supply response equal to x/8 in each quarter. Thus the price changes represent responses to exchange rate changes in previous quarters as well as the current quarter.

thus it leaves out a large number of countries that devalued relative to the United States during this period. While the results in Table 1 may therefore err on the high side, they are nevertheless considerably lower than the fourteen percent trade-weighted devaluation of the dollar between 1971I and 1973II.[10]

The figures reported in Table 1 are for the percentage changes in spot prices. Because of delivery delays, forward exchange commitments and long-term contracts, however, the value of current-quarter imports and exports will be less a reflection of current-quarter spot prices than spot prices in previous periods. As a rough correction for these lags it was assumed that current-quarter U.S. imports and exports (for the commodity class in question) reflect the dollar price that occurs in the previous quarter. Thus for the results reported in section III, which gives the combined price and quantity effects of the devaluation, the figures in Table 1 were lagged one quarter.

B. Exchange Rate Effects on the Dollar Prices of U.S. Imports and Exports Under Imperfectly Competitive Conditions

Not all commodities that enter the U.S. trade account have their prices determined under highly competitive market conditions. Many finished manufactures are differentiated products and are not sold on organized markets. If there are few sellers of the commodities exported and imported by the United States, then the producers of these goods will have considerable discretion in setting prices. In fact, there is some direct evidence (see Dunn [1970]) that exporting firms are able to administer the prices of traded goods. Furthermore, the occurrence of dumping implies that firms have the ability to discriminate between domestic and foreign markets. Finally, such discrimination is consistent with the large discrepancy that is observed between the change in export prices and in wholesale prices in those countries that revalued by significant amounts against the dollar between 1971 and 1973.

One approach to this price-setting behavior is to formulate a profit-maximizing model of a discriminating monopolist that takes account of the ability of the seller to segment the domestic from the foreign, i.e., export market. One such model was developed in a previous version of this paper.[11] It unfortunately involves the difficulty that it does not lead to an explicit expression for the export price in terms of all the exogenous variables in the model. In addition, it implies that if demand elasticities are constant, the relationship between the domestic price and the price charged to foreign buyers for the same commodity will also be constant, which, as noted above, does not appear to have been the case during the recent period of exchange rate adjustments.

Therefore instead of pursuing this explicit profit-maximizing avenue, a more heuristic approach based on the notion of a markup equation has been adopted here. The basic idea is that price, P, represents some markup over standard unit input costs:

$$P = \gamma(ULC^N + UMC^N) \tag{11}$$

where

γ = markup factor, where $\gamma > 1$

ULC^N = standard unit labor costs

UMC^N = standard unit materials costs.[12]

The price is set by the firm so as to cover all costs of production, including capital costs, which are included in γ. It is also assumed that the firm does not adjust its price to every change in actual costs, but rather responds only to changes in "standard," i.e., long-run or expected unit input costs.

Even though the firm can set its price, it need not therefore be impervious to demand conditions. In particular, for a firm that sells the same or similar goods both to domestic residents and to foreigners, the markup on goods sold abroad would tend to reflect both foreign and domestic demand conditions. By raising the price charged to buyers abroad in the face of increased foreign demand, the firm can directly increase its profits. The firm may also vary its markup on exports, and hence its export price, in response to an increase in domestic demand for the good. The markup on the exported commodity can therefore be represented by:

(12) $\gamma = f(K, CU_d, CU_f, PC_f)$

where

K = capital costs

CU_d = domestic capacity utilization rate

CU_f = foreign capacity utilization rate

PC_f = the price of foreign goods that compete with the export good.

In equation (12) the markup factor varies positively in response to changes in the arguments in the function. The capacity utilization variables are proxies for domestic and foreign demand conditions. The competitive price variable, PC_f, is designed to take account of shifts in foreign demand caused by changes in the prices of goods that compete with the export commodity. In particular, it is assumed that the exported commodity is an imperfect substitute for, and therefore competes with, the exports of other countries. This competitive price variable has two components: an exchange rate term, R, and the price of competitive exports expressed in foreign currency, PX_f, since PC_f is defined as $PC_f \equiv R \cdot PX_f$. A depreciation of the exporter's currency, for example, will raise R and thereby shift demand to the exporter because of the rise in competitors' prices (expressed in the exporter's currency). The exporter can therefore increase his profits by raising his markup and therefore his price. The competitive price variable thus provides the link between exchange rate changes and export prices.[13]

Combining equations (11) and (12) and assuming that capital costs, K, are constant, P can be expressed as a log-linear function of the following explanatory variables:

$$(13)\qquad \ln P = \alpha_0 + \alpha_1 \ln CU_d + \alpha_2 \ln CU_f + \alpha_3 \ln PC_f + \alpha_4 \ln ULC^N + \alpha_5 \ln UMC^N .$$

The log-linear form has two justifications. The theoretical rationale is that in the absence of constant returns to scale, explicit profit-maximizing models indicate that the price depends on both cost and demand factors in a non-linear manner.[14] From the pragmatic viewpoint the log-linear form makes it possible to decompose the PC_f term into its two components and estimate the separate influence of each on the export price.

1. Impact of the Dollar Depreciation on the Price of U.S. Exports of Manufactured Goods

A modified version of equation (13) was used to estimate the extent to which the dollar prices of U.S. exports of manufactured goods rose as a result of the effective depreciation of the dollar during 1971-1973. First, the ULC^N variable was separated into compensation per man-hour (W) and output per man-hour (OMH) in order to take account of the possibility that firms may respond differently to changes in the two components in unit labor costs. The second modification involves the specification of standard unit input costs. Four-quarter moving averages were used as proxies for standard W, OMH and UMC in initial estimates of equation (13), but the statistical results were somewhat inferior to those obtained using the actual values of the regressors. Therefore, these actual values were used in the results reported here.

In estimating equation (13) P was represented by a weighted average of the unit value indexes for U.S. exports of semi-manufactures and finished manufactures, the weights being the relative proportion of these two exports in 1965-1966. Since P is expressed in dollars, the competitive price term, PC_f, was also expressed in dollars. This variable was constructed as a weighted average of seven countries' (Belgium, Canada, France, Germany, Japan, Netherlands, and United Kingdom) unit value or price indexes for exports of manufactured products, with shares of exports of manufactures in 1965-1966 as weights.[15] These same weights were used to construct a weighted average of the aggregate Wharton capacity utilization indexes of the same seven countries, CU_f. A similar index, CU_d, was used for the United States. W and OMH were for the total U.S. manufacturing sector. Finally, UMC was approximated by the wholesale price index for crude materials less food. All variables are seasonally-adjusted index numbers. Data sources are given in the appendix.

The foreign capacity utilization variable, CU_f, was consistently insignificant and therefore does not appear in the results, reported in Table 2, which are based on quarterly observations over the period 1963I - 1973II. A second degree polynomial distributed lag over six quarters and constrained to zero at both ends was used for the wage rate, W. A second degree polynomial distributed lag over four quarters and constrained to zero only at the far end was used for output per man-hour, OMH. Both variables are significant and have reasonable coefficients. The U.S. capacity utilization variable lagged one quarter, CU_{t-1}, has a significant coefficient, indicating that U.S. exporters of manufactured goods vary their prices to foreign buyers in response to overall demand pressures in the United States. Finally, the proxy for unit materials cost lagged one period, UMC_{t-1}, also has a significant influence on the export price.

The results in Table 2 indicate that prices of U.S. manufactured exports do not respond positively to increases in the prices of competitive exports, PC_f. In regression 1 the current value of PC_f has a negative sign, and in regression 2 the sum of the coefficients of a second degree, four-quarter polynomial distributed lag constrained at the far end also has a negative sign. In regressions 3 and 4 the PC_f variable was decomposed into a weighted average exchange rate term, R,

Table 2

Effect of Dollar Depreciation on Unit Value Index for U.S. Exports of Manufactured Goods (1963I - 1973II)

Regression	Constant	CU_{t-1}	UMC_{t-1}	W	OMH	PC_f	PX_f	R	$\bar{R}^2$	DW	SE
1	3.43 (6.81)	.34 (4.84)	.23 (3.49)	.78 (10.95)	-.48 (-4.07)	-.078 (-1.50)			.992	1.73	.0088
2	3.66 (6.39)	.32 (3.53)	.23 (3.32)	.77 (10.41)	-.45 (-3.71)	-.10 (-1.93)			.993	1.78	.0086
					Lags						
					0	.0097 (.12)					
					1	-.031 (-1.93)					
					2	-.047 (-1.17)					
					3	-.036 (-.93)					
3	2.01 (1.33)	.36 (4.86)	.16 (1.56)	.69 (6.12)	-.49 (-4.15		.21 (.73)	-.094 (-.69)	.992	1.87	.0087
4	2.51 (1.65)	.40 (4.36)	.24 (6.49)	.71 (6.49)	-.48 (-4.11)		.069 (.24)	-.24 (-3.16)	.993	2.02	.0081
						Lags					
						0	-.24 (-.83)	.12 (1.21)			
						1	.021 (.24)	-.071 (-3.16)			
						2	.15 (1.60)	-.16 (-2.28)			
						3	.14 (1.46)	-.13 (-2.10)			

Note: the coefficients and t-statistics for W and OMH are for the sum of the lag coefficients.

and a weighted average of competitive export prices expressed in foreign currency, PX_f.[16] The current values of these variables enter in regression 3, and in regression 4 they enter with the same distributed lag used for PC_f in regression 2. Since the exchange rate variable--which increased by 22 percent between 1971I and 1973II--has a negative coefficient, the results in Table 2 are not consistent with the hypothesis that U.S. exporters of manufactured goods raised their dollar prices to foreign buyers as a result of the recent depreciation of the dollar.[17] This result will be used in section III in computing the change in the value of U.S. exports of manufactured goods that can be attributed to the exchange rate adjustments between 1971 and 1973.

2. Impact of the Dollar Depreciation on the Prices of U.S. Imports of Finished Manufactures

All that remains is to estimate the effect of the 1971-1973 adjustments in exchange rates on the dollar prices of U.S. imports of finished manufactures, which include capital goods, consumer durables and nondurables, and imports of automobiles and parts other than from Canada. The methodology described in the previous section can be used to obtain an estimate of this effect. It is first necessary to note that the dollar import price, PM, is identically equal to the exchange rate, R_f, times the foreign export price, PX_f:

(14) $$PM \equiv R_f \cdot PX_f.$$

In the preceding section it was argued that a country's export price for manufactured goods will be a function of its exchange rate. Therefore in order to estimate the impact of the dollar depreciation on the price of U.S. imports of finished manufactures, one must calculate the extent to which foreign exporters adjust the foreign-currency prices, PX_f, of the goods they ship to the United States.[18]

One can proceed in either of two ways. One can measure the impact of R_f on PX_f and then use (14) to calculate the effect on PM. Alternatively, one can substitute the variables determining PX_f, which include R, directly into (14) and estimate the effect of R_f on PM in one step. In the absence of measurement and specification errors the two methods would yield identical results. However, since such errors are present, both estimates have been made.

One approach to estimating the impact of R_f on PX_f would be to calculate for each country exporting to the United States the effect of the change in its exchange rate on its own export price. The change in the U.S. import price could then be computed as a weighted average of these export price changes. This disaggregated approach would allow for differences in the response to exchange rate changes across countries. For simplicity, however, an aggregative approach was used instead. This involved estimating an equation using a weighted average of foreign countries' export prices as the dependent variable. The same variables used in this equation were then substituted into (14), where PM is the dependent variable, to obtain a second estimate of the rise in U.S. import prices of finished manufactures resulting from the dollar depreciation.

In the initial estimation involving PX_f as the dependent variable a modified version of equation (13) was used:

$$\ln PX_f = \beta_0 + \beta_1 \ln CU_{US} + \beta_2 \ln CU_f + \beta_3 \ln UVM_f + \beta_4 \ln W_f + \beta_5 \ln R_f + \beta_6 t + \varepsilon . \tag{15}$$

where

PX_f = weighted average of export prices or unit values for manufactured goods, expressed in local currency.

CU_{US} = Wharton aggregate capacity utilization index.

CU_f = weighted average of Wharton aggregate capacity utilization indexes.

UVM_f = weighted average of overall import unit value indexes.

W_f = weighted average of wage rates in the manufacturing sector.

R_f = weighted average of exchange rates (dollars per unit of foreign currency).

t = linear time trend.

ε = disturbance term.

The weighted averages include the same seven countries used to construct PC_f. Here the weights are the shares in U.S. imports of finished manufactures in 1965-1966. The overall import unit value index was used as a proxy for the cost of inputs of raw materials in these countries. A time trend, t, was used as a proxy for increases in output per worker. In this aggregate export price equation there is no obvious competitive export price similar to PC_f in equation (13). One possibility would have been to use the U.S. unit value series for exports of manufactured goods. This would put one in the anomalous position of explaining the U.S. import price with its export price. Rather than include the U.S. export price, an exchange rate variable was retained in order to measure the impact of the depreciation of the dollar on foreign export prices.

In the initial estimation of equation (15) the proxy for U.S. demand pressure, CU_{US}, was consistently insignificant. In addition, the UVM_f variable had an unreasonably high coefficient, which probably reflects the fact that the components of PX_f make up a large proportion of UVM_f. Therefore in the results reported in Table 3 both CU_{US} and UVM_f were dropped from the regression equations. Seasonally-adjusted quarterly data from 1964I to 1972IV or 1973II were used in these regressions.

Regression 1 in Table 3 shows that the current value of R_f has the correct (negative) sign, but the estimated coefficient is small (-.11) and is not significant at the .05 level. However, in regression 2, R_f was entered as a six-quarter second degree polynomial distributed lag constrained to zero at the far end. The individual lag coefficients and their standard errors are given in Table 4. The sum of the lag coefficients is -.32, indicating that a 1% depreciation of the dollar against the seven countries whose currencies are included in R_f results in a cumulative -.32% decline in manufactured goods' export prices of these same countries. This decline in foreign export prices implies a long-run increase in dollar import prices, or pass-through of the exchange rate change, of .68%.

In both regressions 1 and 2 foreign cost conditions are represented by wage rates in manufacturing and a time trend. As an alternative to measuring costs directly, a weighted average of foreign wholesale prices of manufactured goods, WPI_f, was used as a proxy for the total costs of producing the exported good.[19] In regressions 3 and 4 in Table 3 WPI_f has been substituted for W_f and the time trend. In regression 3 the current value of R_f was entered, whereas in regression 4 a five-quarter

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Effect of Dollar Depreciation on U.S. Import and Foreign Export Unit Values of Manufactured Goods

Dependent Variable	Constant	Time	$CU_{f(t-1)}$	W_f	WPI_f	R_f	$\bar{R}^2$	DW	SE	ρ
1. PX_f (64I - 72IV)	1.56 (3.71)	-.0085 (-3.30)	.071 (1.16)	.64 (5.88)		-.11 (1.50)	.998		.0036	.70
2. PX_f (64I - 72IV)	1.15 (4.73)	-.012 (-7.43)	.0064 (.15)	.81 (11.22)		-.32 (-5.01)	.998		.0029	.50
3. PX_f (64I - 73II)	.10 (.18)		.024 (.34)		.95 (10.38)	-.082 (-1.60)	.998		.0038	.90
4. PX_f (64I - 73II)	-.38 (-.98)		-.0033 (-.055)		1.08 (20.50)	-.30 (-4.80)	.998		.0032	.80
5. PM (64I - 72IV)	.24 (.29)	-.014 (-2.91)	.027 (.19)	1.00 (4.57)		.22 (1.19)	.990		.011	.40
6. PM (64I - 72IV)	1.80 (1.39)	-.012 (-2.53)	-.19 (-.83)	.84 (3.96)		.48 (2.22)	.991		.011	.40
7. PM (64I - 73II)	-2.58 (-4.13)		.20 (1.87)		1.36 (26.06)	.46 (7.82)	.992	1.63	.011	
8. PM (64I - 73II)	-2.91 (-4.34)		.24 (2.20)		1.39 (24.18)	.52 (6.91)	.992	1.72	.011	

Notes: (1) t-statistics are given in parentheses below each coefficient.

(2) coefficients and standard errors for W_f, WPI_f and R_f are for the sum of the lag coefficients except in regressions 1, 3, 5 and 7 where the current value of R_f is used.

(3) The W_f variable entered the regression with a second degree, six-quarter polynomial distributed lag (p.d.l.) constrained at both ends, WPI_f with a second degree, five-quarter p.d.l. constrained at the far end, and R_f a five- or six-quarter p.d.l. constrained at the far end.

(4) Because of significant autocorrelation in the residuals in initial estimates of regressions 1-6, the Hildreth-Lu procedure was employed in the final regressions reported here. The estimated [illegible] coefficient, ρ, appears above in the last column.

polynomial distributed lag constrained to zero at the far end was used for R_f. It is reassuring that the estimates of the effect of a dollar depreciation on foreign manufactured goods' export prices (-.082 using the current R_f and -.30 for the long-run effect) are very close to those obtained in regressions 1 and 2, indicating that these estimates are not highly sensitive to the manner in which foreign costs are measured.

Table 4

Distributed Lag of Exchange Rate on U.S. Import and Foreign Export Manufactured Goods Unit Values

Dependent Variable	Current Quarter	t-1	t-2	t-3	t-4	t-5
PX_f (regression 2)	-.83 (-2.28)	-.073 (-4.07)	-.062 (-4.66)	-.048 (-2.9)	-.034 (-1.97)	-.018 (-1.51)
PX_f (regression 4)	-.045 (-1.39)	-.069 (-4.50)	-.077 (-4.00)	-.068 (-3.07)	-.042 (-2.63)	
PM (regression 6)	.11 (.83)	.11 (1.68)	.093 (2.04)	.076 (1.21)	.055 (.84)	.030 (.65)
PM (regression 8)	.20 (2.04)	.14 (6.78)	.10 (2.37)	.056 (1.00)	.026 (.57)	

The estimated increase in the dollar prices of U.S. imports of finished manufactures is roughly seventy percent when a weighted average of foreign export prices is the dependent variable. If the variables used to explain PX_f are substituted into equation (14), however, the estimate for the pass-through obtained from the resulting equation is somewhat lower. The equations underlying regressions 1-4 in Table 3 are:

(16a) $$PX_f = \beta_0 CU_f^{\beta_2} W_f^{\beta_4} R_f^{\beta_5} e^{\beta_6 t} \varepsilon$$

(16b) $$PX_f = \beta_0 CU_f^{\beta_2} R_f^{\beta_5} WPI_f^{\beta_7} \varepsilon$$

Substituting these expressions for PX_f into equation (14) gives:

(17a) $$PM = \beta_0 CU_f^{\beta_2} W_f^{\beta_4} R_f^{1+\beta_5} e^{\beta_6 t} \varepsilon$$

(17b) $$PM = \beta_0 CU_f^{\beta_2} R_f^{1+\beta_5} WPI_f^{\beta_7} \varepsilon.$$

Equations (17a) and (17b) were estimated in log-linear form and the results are given in regressions 5-8 in Table 3. The distributed lag coefficients and their standard errors appear in Table 4. Since $-1 < \beta_5 < 0$, the coefficient of R_f in these regressions, $1+\beta_5$, should be less than unity but greater than zero. It therefore provides a direct estimate of the effect of a devaluation of the dollar on the prices (as represented by a unit value index) of U.S. imports of finished manufactures. Regressions 6 and 8 indicate that the long-run, i.e., five or six quarter, impact is about fifty percent of the weighted average change in the dollar exchange rate.[20]

Thus the estimated increase in the prices of imported finished manufactures is somewhat lower when equations (17a) and (17b) are used instead of (16a) and (16b). One reason for this discrepancy may be that foreign exporters discriminate between the United States and other export markets in terms of the export price that is charged to foreign purchasers. In other words, an exporter may reduce the price of his own currency by a greater amount for U.S. buyers, since over the 1971-1973 period the dollar depreciated to a greater extent than all other currencies except the pound. Buyers in other countries may receive a smaller reduction in price. Thus the change in the export price or unit value index, expressed in the exporter's currency, would not properly measure the fall in price to U.S. buyers because it is a weighted average of export-price changes to many different countries. These considerations argue in favor of using the results from the regressions where the unit value index for imports of finished manufactures appears as the dependent variable. Therefore the distributed lag results for the pass-through obtained from regressions in Table 3 with PM as the dependent variable were used in the calculation of the impact of the dollar devaluation on the quantity and value of imports of finished manufactures.

II. Estimation of the Responsiveness of U.S. Imports and Exports to Exchange Rate Changes

In this section regression analysis is used to obtain estimates of the price or exchange rate responsiveness for five categories in the U.S. trade account. On the import side regressions are estimated for finished manufactures, foods, feeds, and beverages, and industrial materials and supplies (exclusive of fuels and lubricants). On the export side, because unit values indexes are not available before 1967 on an end-use breakdown, regressions were estimated for two broad categories of commodities, namely, agricultural and non-agricultural goods.

A. Finished Manufactures

For both imports and exports estimates of price elasticities were obtained by the common procedure of explaining a real trade flow in terms of an aggregate activity variable and the ratio of the price of imports to the price of domestic substitutes. Following Marston [1971], for imports of finished manufactures the activity variable was decomposed into trend and cyclical components in order to allow the response in imports to vary depending on the extent to which the activity variable differs from its trend value.[21] The basic equation for imports of finished manufactures is given by:

$$(18) \qquad \frac{FM}{PM} = \alpha_0 TY^{\alpha_1} (Y/TY)^{\alpha_2} \left[\frac{(1+T)PM}{WPI_{US}}\right]^{\alpha_3} v$$

where:

FM = imports of finished manufactures, seasonally adjusted annual rate

PM = unit value index for finished manufactures, not seasonally adjusted

Y = real GNP, seasonally adjusted annual rate, 1963$

TY = trend value of real GNP, computed by fitting an exponential time trend to the series and using the predicted value from the regression equation

T = tariff rate on imports of finished manufactures

WPI_{US} = U.S. wholesale price of manufactured goods, not seasonally adjusted

v = disturbance term.

Equation (18) was transformed into log-linear form and estimated over the period 1963I - 1973II. Four dummy variables were added to take account of dock strikes and the closing of the Suez Canal. Current values of Y and Y/TY were used, whereas a distributed lag was used for the relative price variable. The results are given in regression 1 of Table 5.

What is noteworthy about this equation is the very high long-run price elasticity of -4.72, which is the sum of the lag coefficients. In this regression the relative price term was entered as a second degree,

Table 5

Regressions for Imports of Finished Manufactures

(1963I - 1973II)

Regressions	Constant	D1	D2	D3	D4	TY_t	$(Y/TY)_t$	$\frac{(1+T)\cdot PM}{WPI_{US}}$				$\bar{R}^2$	DW	SE
1	-21.9 (-67.5)	-.076 (-4.01)	-.125 (-6.62)	-.054 (-3.00)	-.091 (-4.61)	3.63 (72.9)	1.90 (10.9)	-4.72 (-8.61)				.997	2.20	.027
								$\frac{(1+T)}{WPI_{US}}$	CU_f	R_f	WPI_f			
2	12.9 (-1.04)	-.077 (-3.71)	-.124 (-5.96)	-.055 (-2.77)	-.071 (-2.87)	4.45 (2.54)	2.60 (4.37)	-1.63 (-.79)	-.41 (-.71)	-4.07 (-1.24)	-2.70 (-.50)	.996	2.03	.029

Notes:

(1) t - statistics are given in parentheses below each coefficient.

(2) Current values are used for TY and Y/TY and polynomial distributed lags for all other variables. Coefficients and standard errors are for the sum of the lag coefficients for these variables.

(3) D1 = dummy for 1965 dock strike: D1 = 1.0 in 1965I and -1.0 in 1965II.
D2 = dummy for 1969 dock strike: D2 = 1.0 in 1969I and -1.0 in 1969II.
D3 = dummy for 1971 dock strike: D3 = -.5 in 1971III, 1.0 in 1971IV and -1.0 in 1972I.
D4 = dummy for Suez Canal closure: D4 = 1.0 in 1967II and 1967III; unless otherwise specified, D1 - D4 were set equal to 0.0.

20-quarter polynomial distributed lag constrained to zero at both ends. Estimates using shorter lags (16 and 12 quarters) gave lower long-run elasticities and slightly lower $\bar{R}^2$'s. This particular polynomial distributed lag generates a symmetrical inverted "U" shaped lag distribution with a minimum response in the current and 20th quarters of -0.061 and a maximum response of -0.337 in the 10th and 11th quarters. Such long lags in the adjustment of trade flows to relative price changes have been found by Hutton and Minford [1972] and Junz and Rhomberg [1973].

This estimated price elasticity for imports of finished manufactures, together with the estimated response of PM to exchange rate changes described in the previous section, can be used to obtain an estimate of the impact of a depreciation of the dollar on this category of imports. Alternatively, such an estimate can be obtained directly by substituting the expression for PM given by either equation (17a) or (17b) into equation (18). The resulting reduced-form expression for imports of finished manufactures will then include the exchange rate variable, R_f. Substituting (17b) into (18), for example, and taking logarithms of both sides gives:[22]

$$(19) \qquad \ln\left(\frac{FM}{PM}\right) = \ln(\alpha_0\beta_0^{\alpha_3}) + \alpha_1\ln(TY) + \alpha_2\ln(Y/TY) + \alpha_3\ln[(1+T)/WPI_{US}] + \alpha_3\beta_2\ln(CU_f) + \alpha_3(1+\beta_5)\ln(R_f) + \alpha_3\beta_7\ln(WPI_f) + \ln\varepsilon^{\alpha_3} + \ln(v).$$

In estimating equation (19) the total length of the lag for the variables other than TY and Y/TY is equal to the sum of the length of the lag of that variable in (17b) plus the 20-quarter lag for the relative price variable in equation (18). Thus $(1+T)/WPI_{US}$ has a 20-quarter lag, CU_f a 21-quarter lag, and R_f and WPI_f both have a 25-quarter lag. A second degree polynomial constrained at both ends was used for these four variables. The empirical results were, however, far inferior to those reported for regression 1 in Table 5: the estimated coefficients for $\tilde{TY}$ and WPI_f were unreasonably high (8.90 and -14.21 respectively), and the coefficient for R_f had the wrong sign. An alternative regression was estimated with all four variables entered with the same 20-quarter polynomial distributed lag, and these results are reported in regression 2 in Table 5. The overall explanatory power of the equation is about the same as regression 1. However, except for the dummy variables, the estimated coefficients have much larger standard errors. The coefficients of all three of the variables used to explain the unit value index for finished manufactures have the correct sign but are not significant at the .05 level. The lack of precision in these estimates is probably due to multicollinearity in the explanatory variables. Therefore the estimated relative price coefficient in regression 1 was employed in calculating the exchange rate impact on U.S. imports of finished manufactures.

It is nevertheless interesting to note that the estimated coefficient of R_f in regression 2 is less than the coefficient estimated for PM in regression 1. As a comparison of equations (18) and (19) shows, this result is consistent with the theoretical specification that $|\alpha_3| > |\alpha_3(1+\beta_5)|$.

In using an exchange rate variable directly in an import (or export) regression equation it is therefore not the case that the coefficient of this variable is necessarily the same as coefficient for the import price variable (PM). The coefficients will be equal only if one substitutes the right-hand side of the identity, $PM \equiv R_f \cdot PX_f$, for PM in equation (18). In this case one would indeed expect that the estimated coefficients for R_f and PX_f would be the same as that for PM, namely α_3. However, if one substitutes the determinants of PX_f into (18) and thereby obtains equation (19), it is apparent that the coefficient of R_f is now less than α_3. The reason is that in (19) the induced reduction in PX_f caused by a depreciation of the dollar is taken into account in the β_5 term that enters the coefficient of R_f.

Thus whether the estimated effect of an exchange rate change on imports is the same as that brought about by a variation in import prices depends on whether the foreign export price appears in the equation. If it does appear as a separate variable, one obtains an estimate of the exchange rate impact on imports based on the *ceteris paribus* assumption of unchanged foreign export prices. If, on the other hand, the variables determining the foreign export price (in particular, the exchange rate) appear in the equation, one will obtain a lower estimate of the exchange-rate effect on imports because the induced response (in an offsetting direction) in the foreign export price caused by the exchange rate change is taken into account.[23]

B. Industrial Materials and Supplies

The following equation was used to explain imports of industrial materials and supplies exclusive of fuels and lubricants:

$$(20) \qquad \frac{IMS}{UVIMS} = \alpha_0 IPI^{\alpha_1} \left[\frac{(1+T)UVIMS}{WPIM}\right]^{\alpha_2} \varepsilon$$

where:

IMS = total imports of industrial materials and supplies minus imports of fuels and lubricants, seasonally adjusted annual rates

T = tariff rate on IMS

UVIMS = unit value index for total imports of industrial materials and supplies, seasonally adjusted

IPI = aggregate Federal Reserve industrial production index, seasonally adjusted

WPIM = wholesale price index of industrial materials, seasonally adjusted

ε = disturbance term

Equation (20) was estimated in log-linear form over the period 1966I - 1973II. Data limitations precluded a longer sample. Dummy variables were added for dock strikes and the closing of the Suez Canal. No lag was used for IPI, whereas a second degree, eight quarter polynomial distributed lag constrained to zero at both ends was used for $\frac{(1+T)\cdot UVIMS}{WPIM}$. Because the initial estimates indicated significant autocorrelation in the residuals, the final results reported below were estimated using the Hildreth-Lu procedure. The estimated value of the autocorrelation coefficient was 0.50.

Constant	D2	D3	D4	IPI_t	$\frac{UVIMS}{WPIM}$	$\bar{R}^2$	SE
-2.00 (-1.47)	-0.122 (-5.32)	-0.079 (-3.83)	-0.075 (-2.07)	.96 (3.31)	-1.25 (-2.26)	0.889	0.0430

The long-run price elasticity, which is the sum of the lag coefficients, is equal to -1.25. The lag distribution is a symmetrical inverted

"U" shaped pattern with a response of -0.0836 in the current and eighth quarters, and response equal to -0.209 in the fourth and fifth quarters. The equation was initially estimated with IPI decomposed into trend and cyclical components. This approach yielded a positive price elasticity and consequently it was abandoned.

C. Foods, Feeds and Beverages

The following equation was used to estimate the price coefficient for imports of foods, feeds and beverages:

$$(21) \qquad \frac{FFB}{UVFFB} = \alpha_0 YD^{\alpha_1} [1+T) \cdot UVFFB]^{\alpha_2} DDFFB^{\alpha_3} \varepsilon$$

where:

FFB = imports of foods, feeds and beverages, seasonally adjusted annual rates

UVFFB = unit value index for foods, feeds and beverages, seasonally adjusted

YD = real personal disposable income, defined as personal disposable income divided by the deflator for personal consumption expenditures

T = tariff rate on FFB

DDFFB = deflator for personal consumption expenditures on foods, feeds and beverages, seasonally adjusted

ε = disturbance term

Dummy variables were added to take account of dock strikes. The dummy variable for the Suez Canal closure was found to be insignificant and consequently was excluded in the final results reported below. In the initial estimation both the trend value of YD and the ratio of YD to its trend value were included as explanatory variables. Since the latter proved to be insignificant, both variables were replaced with the actual value of YD. Since there was some indication that the response to a price change differed depending on whether the price variable was domestic or foreign, UVFFB and DDFFB were entered separately. Each price variable was estimated using a second degree, six quarter polynomial distributed lag constrained to zero at the far end. The equation was estimated in log-linear form over the period 1960I - 1973II with the following results:

Constant	D1	D2	D3	YD_t	(1+T)UVFFB	DDFFB	$\bar{R}^2$	DW	SE
-4.24 (-9.90)	-.11 (-3.07)	-.14 (-3.91)	-.19 (5.33)	.38 (2.76)	-1.14 (-3.86)	1.85 (5.54)	.897	1.66	.052

The distributed lag coefficients and standard errors are:

	Current	t-1	t-2	t-3	t-4	t-5
(1+T)UVFFB	-.28 (-1.86)	-.26 (-3.49)	-.22 (-3.42)	-.18 (-2.16)	-.13 (-1.54)	-.069 (-1.22)
DDFFB	.61 (1.81)	.47 (3.53)	.34 (4.39)	.23 (1.68)	.14 (.91)	.063 (.57)

D. Non-Agricultural Exports

On the export side an end-use breakdown was not used, as was the case with imports, because unit value series are not available on this basis. Rather, the series constructed by Parrish and Dilullo [1972] was used instead. This series includes all non-agricultural exports with the exception of automotive products shipped to Canada and aircraft. Also excluded are military shipments. Finally, the series was adjusted to exclude the effects of major industrial and dock strikes and certain other disturbances.

For exports of non-agricultural goods the same procedure was adopted as in the case of imports of finished manufactures: an equation was first estimated with a relative price term and then re-estimated using an explicit exchange rate variable. The following equation was used to estimate the coefficient of the relative price term:

$$\frac{NX}{UVNX} = \alpha_0 FIP^{\alpha_1} CU_f^{\alpha_2} \left(\frac{UVNX}{R_f \cdot PX_f}\right)^{\alpha_3} v \tag{22}$$

where:

NX = value of U.S. non-agricultural exports, seasonally adjusted annual rates.

UVNX = unit value index for non-agricultural exports, not seasonally adjusted.

FIP = weighted average of the seasonally adjusted industrial production indexes for Canada, Japan, the United Kingdom and continental Western Europe, the weights being the annual shares of these areas in U.S. exports. This index, together with NX, was taken from Parrish and Dilullo [1972].

CU_f = weighted average of foreign capacity utilization variables.

$R_f \cdot PX_f$ = weighted average of foreign export unit values converted to dollar terms.[24]

v = disturbance term.

In initial estimates of equation (22), which was transformed into log-linear form, the FIP variable was decomposed into trend and cyclical components. However, it was found that the actual level of FIP gave a better statistical fit when it was combined with CU_f as the foreign cyclical demand variable. Initial estimates of (22) also indicated considerable autocorrelation in the residuals, and consequently this equation was estimated over the period 1960I - 1973II using the

Cochrane-Orcutt transformation. The estimated value of the autocorrelation coefficient in the following regression was 0.340:

Constant	FIP_t	$(CU_f)_{t-1}$	$\frac{UVNX}{R_f \cdot PX_f}$	$\bar{R}^2$	SE
-2.02 (-1.78)	1.03 (22.0)	0.933 (4.51)	-0.906 (-4.61)	0.980	0.022

In this regression the current value of FIP was entered whereas the lagged value of CU_f was used. The relative price term was entered with a second degree, 12 quarter polynomial distributed lag constrained to zero at both ends. Longer or shorter lags gave a somewhat lower $\bar{R}^2$. This particular lag structure yields a symmetrical inverted "U" shaped distribution with the lag coefficient equal to -0.030 in the first and twelfth quarters and equal to -0.105 in the sixth and seventh quarters.[25]

In order to estimate a direct exchange rate effect on non-agricultural exports one should take into account the impact of a dollar devaluation on both the dollar price of U.S. manufactured exports, UVNX, as well as the induced response in the foreign currency price of foreign goods that compete with U.S. exports, PX_f. The results reported above in Table 2, however, indicate that prices of U.S. exports of manufactured goods do not rise as a result of a dollar devaluation. There is therefore no need to substitute for UVNX in equation (22). The possibility remains, however, that foreign exporters may reduce the prices of those commodities that compete with U.S. exports, since a devaluation of the dollar lowers the foreign currency cost of these exports. To take account of the possibility that PX_f may be a function of R_f, equation (16b) was used to substitute for PX_f in equation (22). Expressing the resulting equation in log-linear form gives:

$$(23) \qquad \ln(\frac{NX}{UNVX}) = \ln(\alpha_0\beta_0^{-\alpha_3}) + \alpha_1\ln(FIP)+(\alpha_2 - \alpha_3\beta_2)\ln(CU_f)+\alpha_3\ln(UNVX) + \alpha_3\beta_7\ln(WPI)_f+(1+\beta_5)\alpha_3\ln(R_f)+\ln(v)+\ln(\varepsilon^{-\alpha_3}).$$

Equation (23) was estimated with CU_f, UVNX, WPI_f and R_f all entering with the same 12-quarter polynomial distributed lag used for the relative price term in equation (22). The results were quite poor, most of these four variables having the wrong sign. Equation (23) was then constrained in two ways. First, β_2 was assumed to be zero and therefore CU_f^* entered with only a one period lag, as in equation (22). Second, since we know from Table 3 that β_7 is close to 1.0, UVNX and FWP were combined in ratio form. These changes gave the following empirical results:

Constant	FIP	$(CU_f)_{t-1}$	$\frac{UVNX}{WPI_f}$	R_f	$\bar{R}^2$	SE
-2.45 (-1.71)	0.880 (40.4)	0.907 (4.49)	-0.633 (-2.17)	-0.875 (-3.00)	0.990	0.021

Initial estimates of equation (23) indicated autocorrelated residuals and therefore the Cochrane-Orcutt transformation was used to obtain the above results. The estimated value for the autocorrelation coefficient was .38. In these results R_f was expressed in foreign currency units per dollar and therefore its estimated coefficient has the proper (negative) sign. The coefficients reported for $UVNX/WPI_f$ and R_f are the sum of the lag coefficients, and again the shape of the lag distribution was a

12-quarter symmetrical inverted "U". The estimated coefficient for R_f, -0.875, is essentially the same as that for the relative price term in equation (22), -0.903, so that the implied value of β_5 is zero. This means that foreign exporters competing with U.S. exporters do not cut their prices in response to the lower foreign currency prices of U.S. exports caused by the devaluation of the dollar. This behavior is not necessarily inconsistent with the results reported in Table 3 which show that β_5 ranges between .3 and .5; in the former case it is the price behavior of substitute goods that is relevant, whereas in the latter case it is the same good that is involved.[26] In other words, a dollar devaluation may cause exporters in other countries to reduce the foreign currency prices of the goods they ship to the United States, but it need not induce them to lower the prices of those commodities that are substitutes for U.S. exports.

The finding that the estimated coefficient for the exchange rate term is essentially the same as that estimated for UVNX in the regression explaining the quantity of U.S. exports is consistent with the earlier finding that the dollar prices of U.S. exports of manufactured goods do not increase as a result of a devaluation of the dollar. This implies that the foreign currency prices of U.S. exports fall by the full amount of the devaluation since there is no offset in the form of higher dollar prices.

E. Agricultural Exports

The following equation was used to estimate the price responsiveness of agricultural exports:

$$\frac{FX}{UVFX} = \alpha_0 TFY^{\alpha_1} \left(\frac{UVFX}{FPF}\right)^{\alpha_2} v \tag{24}$$

where:

FX = value of agricultural exports, seasonally adjusted annual rates, and adjusted for dock strikes and other disturbances; from Parrish and Dilullo [1972].

UVFX = unit value index for agricultural exports, seasonally adjusted; constructed by taking a weighted average of the unit values for crude foods and manufactured foods, with the average shares of these two components over 1965-1966 used as weights.

TFY = trend value of the weighted average of seasonally adjusted real GNP of Canada, Germany, Japan, and the U.K., with weights equal to shares in U.S. agricultural exports in 1965-1966; trend value equal to fitted value from an exponential time trend.

FPF = weighted average of seven countries' (Canada, France, Germany, Italy, Japan, Netherlands and U.K.) consumer price indices for food, seasonally adjusted, with weights equal to shares in U.S. agricultural exports in 1965-1966, and converted into dollars.

v = disturbance term.

This equation was estimated over 1959III - 1972IV using the current values of both explanatory variables. Experiments with a polynomial distributed lag on the relative price term were unsuccessful in obtaining a negative coefficient. Since the initial estimates indicated severe autocorrelation, the equation was estimated using a Hildreth-Lu transformation. The estimated autocorrelation coefficient in the results given below was 0.700.

Constant	TFY	$\left(\frac{UVFX}{FPF}\right)$	$\bar{R}^2$	SE
0.58 (0.82)	0.25 (1.68)	-0.38 (-1.32)	0.89	0.048

Both coefficients are only marginally significant and the results must therefore be considered highly tentative.

III. Exchange Rate Effects on the U.S. Trade Balance: 1971II - 1973II

Table 6 presents the calculated effects of exchange rate adjustments between 1971II and 1973II on the current and constant dollar trade flows for the five categories of U.S. imports and exports considered in this paper. The figures in this table are based on the computations in the previous two sections.

Looking first at imports of finished manufactures, the impact of the depreciation of the dollar on this category of imports was computed in two steps. First, the effect of the dollar depreciation on the unit value index for imports of finished manufactures was computed using the estimated coefficients from regression 8 in Tables 3 and 4. In this computation the exchange rate variable, R_f, was held constant at its 1971I value. This estimate of what the unit value index for finished manufactures would have been in the absence of a devaluation was then combined with the distributed lag coefficients that were estimated for the relative price term in equation (18). This calculation, reported in column 1 of Table 6, provides an estimate of the decline in real imports (expressed in 1963 dollars) that can be attributed to the depreciation of the dollar between 1971II - 1973II on the assumption that domestic prices and incomes are fixed. The fairly modest figure of only a $920 million reduction in imports by 1973II reflects both the very long 20-quarter lag for real imports to adjust and the 5-quarter lag for the full pass-through to occur, as well as the fact that the estimated pass-through is only 50 percent. The long lag in the adjustment of real imports to relative price changes also causes imports of finished

Table 6

Combined Effects of Recent Exchange Rate Changes on U.S. Import and Exports
(millions of dollars, seasonally adjusted annual rates)

	Imports of Finished Manufactures		Imports of Foods, Feeds &Beverages		Imports of Industrial Materials & Supplies (less fuels and lubricants)		Non-Agricultural Exports		Agricultural Exports		Combined Effects: Change in Exports-Change in Imports		Total Trade Balance (Billions of Curren $; B. of P. Basis)
	1963$ (1)	Cur.$ (2)	1963$ (3)	Cur.$ (4)	1963$ (5)	Cur.$ (6)	1963$ (7)	Cur.$ (8)	1963$ (9)	Cur.$ (10)	1963$ (11)	Current $ (12)	Current $ (13)
1971II	0	14	0	0	0	0	0	0	6	6	6	-8	-3.7
1971III	-5	81	-2	4	-1	9	10	10	50	61	68	-23	-1.5
1971IV	-23	228	-3	12	-5	42	50	60	156	200	237	-22	-6.1
1972I	-71	497	-21	46	-22	146	130	170	254	362	498	-157	-7.3
1972II	-151	632	-44	75	-58	284	260	340	242	456	755	-195	-7.1
1972III	-274	630	-82	100	-127	409	440	570	198	527	1,121	-42	-6.3
1972IV	-441	490	-127	96	-233	476	640	850	156	609	1,597	395	-7.0
1973I	-662	433	-171	66	-368	462	920	1,230	256	854	2,377	1,123	-3.9
1973II	-920	452	-212	48	-525	466	1,280	1,770	378	1,168	3,315	1,972	-1.0
Average Trade Flow: 71II-73II (billions)	14.07	19.52	5.11	7.33	13.18	15.31	26.12	34.22	8.40	10.34			

manufactures in current dollars to increase as a result of the dollar depreciation, as seen in column 2. This initial perverse effect simply reflects the fact that the increase in the dollar price of imported finished manufactures was not offset by a reduction in the quantity imported during the period covered by Table 6.

In computing the effects of the exchange rate adjustments on the other two categories of imports, use was made of the results given in Table 1. The figures in columns 3-6 of Table 6 were computed on the basis of the price effects that were generated using the mid-point estimates of the supply and demand elasticities, i.e., column 2, in Table 1.[27] Because demand is inelastic in the short run for both foods, feeds, and beverages and industrial materials and supplies, the reduction in the quantities imported is outweighted by the rise in the dollar prices of these imports, so that their dollar value has risen as a result of the depreciation of the dollar. Since the long-run elasticities for these imports exceed unity in absolute value, the depreciation (in this partial equilibrium context) will ultimately reduce the value of the goods imported.

A similar calculation was performed to obtain estimates of the devaluation effects on U.S. exports of agricultural goods. The price effects reported in column 2 of Table 1 were combined with the estimated price elasticity in equation (24) to yield the results reported in columns 9 and 10 in Table 6. As can be seen from a comparison of these two columns, the fairly large improvement in this sector of the trade balance is due mainly to the increase in the dollar prices of these exports, part of which was brought about by the depreciation.

The increase in non-agricultural exports was computed by setting the exchange rate in equation (22) equal to its value in 1971I and then using the estimated lag coefficients of α_3 to calculate the increase in this category of imports. Since the evidence in Table 2 suggests that export prices of manufactured goods did not rise as a result of the depreciation of the dollar, the increase in the value of non-agricultural exports reported in column 8 (over and above that due to the increase in quantity) is due solely to the rise in prices caused by factors other than exchange rate changes.

The figures at the bottom of Table 6 show the average value of the trade flows (in current and constant dollars) for the five categories of imports and exports between 1971II and 1973II. These figures are provided in order to facilitate comparison between the exchange rate effect in each category and the absolute magnitude of trade in that category. They show that in real terms the greatest percentage improvement occurred in imports of finished manufactures, whereas in current dollars the largest percentage gain was in agricultural exports.

The combined effects for the five categories of imports and exports are reported in columns 11 and 12. The improvement in the "real" trade balance was not sufficient to overcome the perverse effect of the higher dollar import prices, so that the time path of the response in the trade balance to a devaluation looks something like a "J" curve. However, the dip in the early part of the "J" is very modest indeed, reaching a maximum of only -$200 million in 1972II. This small deterioration reflects both the slow rate at which dollar prices of imports have been estimated to increase in response to a devaluation as well as the fact that the estimated long-run passthrough for imports of finished manufactures is only about 50%. Thus it appears unlikely that the U.S. trade account suffered dramatically as a result of transitory negative effect of the 1971-1973 exchange rate realignments. And after this perverse phase had run its course, there is an improvement that reaches $2 billion (seasonally adjusted annual rate) in the trade balance in the second quarter of 1973. This figure represents the cumulative impact of the exchange rate adjustments between 1971II and 1973II on the trade balance in 1973II.

The estimate for the "J" curve in the U.S. trade balance in Table 6 is quite different from the "J" curve for the U.K. trade balance obtained by simulation of the London Business School Model of the United Kingdom as described in Ball et al. [1972]. Using this model, the trade balance effect of the November 1967 devaluation is estimated as:

	1967	1968				1969			
	QIV	QI	QII	QIII	QIV	QI	QII	QIII	QIV
Change in U.K. trade balance (million current £, seasonally adjusted annual rate)	-128	-204	-228	-128	40	128	172	196	208

The initial deterioration in the trade balance in the first two quarters of 1968 was about equal to the eventual improvement that occurred by the fourth quarter of 1969. The primary reason for the accentuated U.K. "J" and the shallow U.S. "J" is that the prices of imports appear to have adjusted much faster to exchange rate adjustments in the United Kingdom.

In both absolute and relative terms, however, the trade balance response in the United Kingdom was quite small. This is evident when the above figures are compared with £6,400 million in merchandise exports and £7,100 million in merchandise imports in 1968. There was a large improvement in exports (£1,044 million, S.A.A.R., in 1969Q4), but this was offset to a great extent by a significant rise in the value of imports (£836 million, S.A.A.R., in 1969Q4) because the demand for imports is very price inelastic. Nevertheless, the 1967 devaluation did provide a substantial boost to the current account. As described by Ball et al. [1972] and the National Institute of Economic and Social Research [1972], the service account benefited by an amount at least as great as the trade account.

The results in Table 6 cannot be considered definitive for the entire trade balance, shown for the sake of comparison in column 13, because they do not include all exports and imports. Left out are shipments of military goods, trade in automobiles and parts with Canada, exports of aircraft, imports of fuels and lubricants, and imports and exports not elsewhere specified. The exchange rate impact on the value of imports of petroleum products would somewhat reduce the overall trade-balance effect of the devaluation below the figures reported in Table 6, but it is very difficult to say how much. Nevertheless, the results reported here suggest that a portion of the improvement in the overall trade balance between 1972 and the first half of 1973 can be attributed to the depreciation of the dollar.

It needs to be emphasized that these estimates pertain to only the direct or first-round effects of the dollar devaluation. They therefore provide an estimate of the maximum beneficial impact on the U.S. trade balance resulting from the multilateral exchange rate adjustments that took place between 1971 and 1973. The size of this estimated improvement in the trade balance depends on the ultimate magnitude and timing of the response in the quantities of imports and exports to price changes. These price changes in turn depend crucially on the speed with which import and export prices react to exchange rate changes. Thus one lesson that can be drawn from the results and methodology in this paper is that for a country as important in world trade as the United States, an understanding of how adjustments in exchange rates affect U.S. import and export prices is just as essential as knowing how the quantities of these goods respond to price changes. Clearly much more research is needed in this area.

An appraisal of the full effects of a devaluation on the U.S. trade balance of course requires that the induced or second-round domestic effects be taken into account. These include increases in expenditures on domestic output and in prices and wages. The degree to which these second-round effects offset the positive impact effect of a devaluation depends on the level of unemployment and capacity utilization, and as emphasized by Alexander [1952], on the extent to which domestic output rises above domestic absorption. Thus for a full analysis of the impact of a devaluation one must look at the savings behavior of an economy.

The results in this paper therefore cannot provide an answer to the full long-run effects on the U.S. trade balance resulting from the exchange rate realignments that took place between 1971 and 1973. They may nevertheless provide some guidance as to the plausible magnitude of the short-run impact before the second-round effects are complete. In addition, to the extent that the general-equilibrium savings and expenditure decisions depend on price level developments, the paper may be helpful in that it provides a framework for analyzing the linkage between exchange rate changes and import and export prices. It is, of course, not a substitute for a full general equilibrium analysis in which domestic money supply considerations are explicitly taken into account. This requires a fully-specified macroeconomic model.

Footnotes

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[1] This measure of the depreciation of the dollar is derived from the figures given on pp. 15-16 of World Financial Markets (October 23, 1973), Morgan Guaranty Trust Co., which in turn reflect bilateral export and import weights for fourteen countries. In this paper all references to a depreciation of the dollar refer to weighted average or effective exchange rate changes.

[2] The analysis in this paper is thus subject to the usual strictures against the elasticities approach to devaluation analysis leveled by those who adopt a general equilibrium perspective. For this latter, generally monetarist approach, see Dornbusch [1973] and Johnson [1972].

[3] The domestic price increase induced by the devaluation would in any case be attenuated by the price freeze and other restraints on price rises that were part of the New Economic Policy initiated by Nixon in August, 1971. It should be noted that these restraints did not apply to either import or export prices, and consequently the price freeze and the other phases of wage and price controls would tend to slow the rate at which domestic prices would respond to the higher import and export prices. For attempts to estimate the impact on the U.S. rate of inflation of the dollar devaluation, see the article by Kwack in this volume, "The Effects of Foreign Inflation on Domestic Prices and the Relative Price Advantage of Exchange Rate Changes," and Clark [1974].

[4] This qualification is the same as that which applies to *a priori* estimates of the effect of the 1971 realignment on the U.S. trade balance, as contained in Branson [1972], for example.

[5] For an attempt to estimate supply elasticities for U.S. exports and imports, see Magee [1970].

[6] This methodology is also used by Isard in his paper in this volume.

[7] This may appear to be a very restrictive assumption, but it is the same assumption that is used to derive aggregate import and export equations. For a discussion of aggregation problems of this type, see Leamer and Stern [1970].

[8]Since this measure of world trade in each commodity class is less than the true world total, the calculations using (10) may overestimate the rise in the dollar prices of these commodities because M in the denominator of (10) is too small. Such an overestimate can only occur, however, if there has been no net appreciation of the non-OECD countries vis-à-vis the United States.

[9]The author is indebted to Christopher Yandle, Commodities Division of the Research Department in the International Monetary Fund, for providing him with a range of export supply and import demand elasticities that would be appropriate for the kinds of agricultural commodities that a) the United States imports and b) that it exports. The range of elasticities in case a) was used for foods, feeds and beverages, and the range of elasticities for case b) was employed for those commodities that approximate U.S. agricultural exports, namely foods, feeds and beverages plus agricultural industrial supplies. A considerably wider range of elasticities was used for industrial supplies and materials. The results given in Table 1 show, however, that the calculated price changes are not very sensitive to large variations in the elasticities used to make the calculations.

[10]For particular commodities, however, the price effect of multilateral exchange rate changes may be significantly higher than indicated in Table 1. Bernstein [1973, pp. 5-6] for example, weights the exchange rate changes of the Group of Ten plus Switzerland by each country's consumption of four nonferrous metals (copper, lead, zinc and tin) and finds a weighted average price effect of about 11.5 percent from the end of December 1972 to the end of July 1973. This high figure stems from the fact that the sample includes countries that both appreciated the most against the dollar and consume most of the metals. For the impact of recent exchange rate changes on the dollar price of wheat, see the contribution by Yandle in this volume.

[11]See Clark [1973]. Jacques Artus has developed a model of export price determination (see his contribution to this volume) that is also based on profit-maximizing assumptions.

[12]For a discussion of this markup hypothesis, see Eckstein and Fromm [1968].

[13]This link is on the demand side. There is an additional relationship that comes through the impact of exchange rate changes on domestic cost conditions. Thus a devaluation will tend to increase ULC^N and UMC^N in equation (11) in the text, thereby increasing export prices. This link between exchange rate changes and export prices through repercussions on domestic costs is ignored in this paper. For an examination of this link, see the paper by Kwack in this volume entitled, "The Effects of Foreign Inflation on Domestic Prices and the Relative Price Advantage of Exchange Rate Changes." There is in addition a third link that arises if exports are denominated in foreign currency. In this case a devaluation would immediately raise the domestic currency prices of

those exports invoiced in foreign currency. This link would not appear to be of much importance for the United States, since at least up until the recent exchange rate changes most U.S. exports were probably denominated in dollars.

[14]This result is derived in Clark [1973] and Nordhaus [1972].

[15]As a rough correction for the fact that export price indexes record contract prices, whereas export unit values are a proxy for prices recorded at the time of shipment, export price indexes were lagged one quarter when combined with export unit values to construct this index. These export price or unit value indexes were first converted into dollars by using an exchange rate index based on quarterly averages of spot exchange rates.

[16]R was constructed by taking a weighted average of exchange rate indexes for the seven countries. The weights used to construct R and PX_f are the same as those used for PC_f.

[17]The fact that the sum of the lag coefficients for R in regression 4 is negative and significant at the .05 level would appear to be a statistical fluke, since there is no theoretical reason to expect a negative relationship between R and the export price. The paper by Artus in this volume and the OECD [1973] find that U.S. export prices of manufactured goods are only weakly related to the export prices of foreign competitors and thus they tend to support the conclusion that U.S. manufactured export prices are not substantially affected by demand shifts induced by exchange rate changes. This conclusion depends on the use of unit value indexes that admittedly may be poor proxies for the actual price behavior of U.S. exports. (See Lipsey [1963] for a discussion of the deficiencies in unit value indexes.) The close association between movements in the wholesale prices and in the export unit value indexes for manufactured goods described in Ripley [1974] may indicate, however, that unit values are not altogether inappropriate proxies for export prices.

[18]An exchange rate change has an immediate impact on the dollar import price if the imported commodity is invoiced in foreign currency. Since most U.S. imports have been invoiced in dollars, at least up until the recent exchange rate adjustments, this direct impact of a dollar depreciation on U.S. import prices has probably been small. On this point see Magee [1973] and Grassman [1973]. There is, unfortunately, an additional difficulty raised by U.S. Customs valuation practices. Imports invoiced in dollars are converted into foreign currencies at the rate prevailing on the date of the purchase contract and then reconverted into dollars at the date which prevailed on the date of shipment. Thus it would appear that imports nominally invoiced in dollars are effectively invoiced in foreign currency. Apparently, however, less than ten percent of import documents are being changed by the Customs Bureau for valuation purposes. The author is indebted to Daniel Roxon for this unofficial estimate. He is also indebted to Stephen Magee for

pointing out the implications of U.S. Customs valuation practices for the impact of exchange rate changes on U.S. import unit values. Since this paper was written, an article by Magee [1974] has appeared in which he presents some evidence on the currency denomination of U.S. imports and describes in detail the valuation procedures of the U.S. Customs.

[19]Wholesale prices of manufactured goods have also been used in a recent analysis by the OECD of the determinants of export prices of manufactured goods. See OECD [1973].

[20]This estimate is lower than the figure of eighty percent calculated by Branson [1972, pp. 20-22] that is based on the supply elasticities estimated by Magee [1970]. Branson's result relies on a perfectly competitive model of price determination, and as mentioned above, this model is not appropriate for trade in finished manufactures. For this reason, and because there is considerable uncertainty regarding estimates of supply elasticities for U.S. imports, the estimates given in Table 3 would appear to be more reliable than Branson's calculations.

Using regression analysis similar to that in this paper, Llewellyn [1974] found that a devaluation of the pound would raise the prices of imports entering the United Kingdom by about 60% of the devaluation. This result is consistent with the figure of 50% for the United States reported in this paper, and does not support Branson's conclusion that the figure should be 80%. The reason is that since the United Kingdom has a smaller share in world trade than the United States, one would expect that the exchange rate impact on its import prices would be larger, not smaller, than for the United States.

[21]If income, for example, is above its trend value, then this would tend to be associated with longer waiting times for the delivery of domestic goods and other manifestations of supply constraints, leading to increased purchases from abroad.

[22]Equation (17b) has been used in the following discussion because the WPI_f variable gave a better statistical fit than did the combination of the $\hat{W}_f$ and time trend variables in (17a). It should be pointed out that one implication of the methodology underlying equation (19), and especially the fact that the export price is a function of the exchange rate (as shown in equation (16a) and (16b)), is that foreign wholesale prices, expressed in dollar terms, are <u>not</u> a good deflator of nominal imports. The reason is that exchange rates changes break up the normal or usual link between foreign wholesale prices and foreign export prices. For an example of deflation using foreign wholesale prices, see Parrish and Dilullo [1972].

[23]Equation (19) also shows that the impact of the WPI_f variable on imports, $\alpha_3\beta_7$, is not equal to the exchange rate effect, $\alpha_3(1+\beta_5)$. Only if there is perfect arbitrage such that $PX_f = WPI_f$ will it be true that changes in foreign wholesale prices and in exchange rates will have the same effect on imports.

[24]The PX_f variable in this equation was constructed as a weighted average of the overall export unit value indexes for eight countries (the previous seven plus Italy), with shares in exports of manufactures used as weights.

[25]When equation (22) was estimated using a weighted average of both export prices and unit values for manufactured exports, the results were very similar to those reported in the text.

[26]One difficulty arises in estimation because the same export unit values are used in both cases, although the country weights are different in each case. Clearly what one would like to have are separate price indexes for those goods exported to the United States and for those exports that compete in world markets with U.S. exports, but such data unfortunately are not available.

[27]The price increases reported in Table 1 were lagged one period in calculating the effects of the depreciation of the dollar. This is designed as a rough adjustment for the fact that because of delivery delays and long-term contracts, imports and exports in the current quarter reflect the spot prices of previous quarters.

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Data for the unit value series for foods, feeds and beverages and industrial materials and supplies were obtained from the Bureau of International Commerce (Dept. of Commerce) unit value computer runs. For finished manufactures the unit value index for the economic class called "finished manufactures" was used. For 1958-71 this index was taken from Index Numbers of U.S. Exports and Imports 1919-1971 (U.S. Bureau of the Census, U.S. Government Printing Office, Washington, D.C., 1972). For 1972-1973II the index was taken from various issues of Export-Import Indices, an unpublished memorandum put out by the Foreign Trade Division of the Bureau of the Census.

Exports:

Data on the value of agricultural and non-agricultural exports, exclusive of automotive exports to Canada, aircraft and military equipment, were adjusted for dock strikes and other disturbances. These two series were obtained from the Balance of Payments Division of the Bureau of Economic Analysis, Department of Commerce. The series for non-agricultural exports is described in Parrish and Dilullo [1972]. The unit value series for these two categories of exports were obtained from the from the same source which provided the unit value series for imports of finished manufactures.

Import and Export Overall Unit Values:

International Monetary Fund, International Financial Statistics, country pages.

Price Index for Canadian Exports of Manufactured Goods (exclusive of automotive products):

Bank of Canada.

Wholesale Prices of Manufactured Goods:

For Belgium, Canada, France, Germany, Italy, the Netherlands, and the United Kingdom, OECD, Main Economic Indicators: Historical Statistics, 1955-1971, and Main Economic Indicators, March 1973. The series for the United Kingdom was updated through the second quarter of 1973 using Economic Trends, Central Statistical Office. For all countries except Canada, it was necessary to make an adjustment for the introduction of the value-added tax. The author wishes to thank Donald Curtis (U.S. Treasury Department) for making these adjustment factors available to him. The source for Japan is Basic Data for Economic Analysis, Bank of Japan.

Export Price and Unit Values Indexes for Manufactured Goods:

These series were obtained from national sources.

Exchange Rates:

For most countries, Federal Reserve Bulletin; otherwise International Financial Statistics.

Hourly Earning or Wage Rates in Manufacturing:

For non-U.S. countries, OECD, Main Economic Indicators: Historical Statistics 1955-1971 and Main Economic Indicators, various issues. For the United States, compensation per man-hour was defined as wages and salaries of employees plus employers' contributions for social insurance and private benefit plans. Both compensation per man-hour and output per man-hour were obtained from the Bureau of Labor Statistics, U.S. Department of Labor.

Aggregate Capacity Utilization Rates:

Wharton, EFA, Inc.

Index of Foreign Industrial Production:

Weighted average of industrial production indices for Canada, Japan, United Kingdom, and continental Western Europe, weighted by the annual shares of these areas in U.S. exports. The index for continental Western Europe is a weighted average of the indices for Germany, France, Italy and the Netherlands, with weights equal to the 1963 values of their gross domestic products. This series was obtained from the same source as the export value data.

U.S. Industrial Production Index:

Federal Reserve Bulletin.

Wholesale Prices of Total Manufactures and Industrial Commodities:

Survey of Current Business.

GNP, GNP Deflator, Disposable Personal Income and Deflator for Personal Consumption Expenditures:

Office of Business Economics.

Deflator for Personal Consumption Expenditures on Foods, Feeds and Beverages:

Department of Commerce, Mr. Bassett.

Foreign Consumer Price Indices for Food:

OECD, Main Economic Indicators, Historical Statistics, 1955-1971 and Main Economic Indicators, September 1973.

Foreign Real GNP:

Canada, National Income and Expenditure Accounts; Japan, Annual Report of the Economic Planning Agency (value in 1973II estimated on assumption of 10% growth rate in GNP); West Germany, Vierteljahrsheft (values in 1973I and 1973II estimated on assumption of a 6.2% growth rate in GNP); United Kingdom, Economic Trends (value for 1973II estimated on assumption of a 6% growth rate in real GNP); weights derived from 1970 value of agricultural exports, which were given in Overseas Business Reports, Dec., 1970, Department of Commerce. The author is indebted to Sung Kwack for making this data available to him.

Wholesale Price Index Excluding Crude Foodstuffs, Feedstuffs, Etc.:

Monthly Labor Review.

Tariffs:

Calculated using fixed 1964 import weights for all items for which global imports exceeded $1 million, and aggregated into end-use categories. Tariff levels for the 1958-1967 period were assumed to be constant. Starting in 1968 and ending in 1972, the tariff levels computed for 1964 were cut by 20% of the Kennedy Round concessions. The tariff rate on imports of finished manufactures was computed as a weighted average of the tariffs on capital goods, automotive goods and consumer goods, with 1964 import weights. The author is indebted to John Wilson for supplying him with this tariff data.