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Revised Estimates for the World Trade Model *

Prepared by Grant H. Spencer

Approved by Malcolm D. Knight

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Summary

This paper provides a general description of the revised version of the World Trade Model that is currently in use in the Research Department of the International Monetary Fund, both in research applications and as an input into the World Economic Outlook forecasting exercise. The paper supplements and updates the earlier description of the model given by Deppler and Ripley in the March 1978 edition of Staff Papers.

The World Trade Model attempts to explain the volumes and unit values of merchandise exports and imports for the 14 largest industrial countries and for four aggregate regions making up the rest of the world. The merchandise trade flows, modelled on a semiannual basis, are disaggregated into four commodity groupings: manufactures, agricultural goods, raw materials and fuels. In the volumes block of the model the demand for imports is determined mainly by real domestic demand, potential output in manufacturing, and relative prices. Export volumes are then determined primarily by weighted averages of the imports of partner countries and appropriately weighted relative price variables. While domestic demand and output variables are determined outside the model, the relative price variables are based on unit values generated within the price block of the model. The main exogenous variables entering the price block include wage rates in manufacturing, GNP deflators, exchange rates, and the dollar prices of a wide range of primary commodities, including oil.

Parameter estimates are based on a sample of semiannual data for the period from 1962 to 1979, extending the previous sample by 3 1/2 years. Compared to the previous version of the model, greater use is made of prior information in restricting parameter estimates and this has resulted

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in a greater degree of cross-country consistency in the behavior of the model, particularly with respect to the unit values of trade in manufactures. Also, the more flexible and comprehensive treatment of relative price effects in trade volume equations appears to have improved the model's responses to price and exchange rate shocks.

I. Introduction

This paper gives a general description of the revised version of the World Trade Model that is currently in use in the Research Department of the International Monetary Fund, both in research applications and as an input into the World Economic Outlook 1/ forecasting exercise. 2/ The paper concentrates on the economic structure of the model and supplements the earlier description given by Deppler and Ripley (1978). 3/ The revisions that have been made to the structure of the previous version of the model are not major, and consequently a certain amount of the descriptive material in the original paper by Deppler and Ripley (henceforth DR) is summarized here. 4/

The World Trade Model (WTM) attempts to explain the volumes and unit values of merchandise exports and imports for the 14 largest industrial countries and for four aggregate regions making up the rest of the world. 5/ The model is not a "world" macro model along the lines of that developed under Project Link. 6/ In particular, it does not attempt to explain the

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1/ See IMF Occasional Paper 21 (1983).

2/ The bulk of the estimation work on the model was completed in the summer of 1982 and reflects the data available in late 1981. Some of the parameter estimates used in the current forecasting version of the model are based on more recent revisions of the historical data set but in general these do not differ significantly from the estimates reported here.

3/ M. C. Deppler and D. M. Ripley, "The World Trade Model: Merchandise Trade," IMF Staff Papers, Vol 25, No. 1 (March 1978). Also see D. M. Ripley, "The World Model of Merchandise Trade: Simulation Applications" IMF Staff Papers, Vol. 27, No. 2 (June 1980).

4/ Two further documents are available; the first, a data dictionary, describes in detail the sources and definitions of model data, while the second describes the model's operating system. The two papers, A. G. Turner, "The World Trade Model: Data Dictionary," (forthcoming), and J. R. McKee, "The World Trade Model: Operations Manual," (March 1983) may be obtained from the External Adjustment Division, Research Department.

5/ See Table 1a for a listing of the countries and regions.

6/ See, for example, R. J. Ball (ed.), The International Linkage of National Economic Models (Amsterdam, 1973).

major national macroeconomic aggregates; rather, it takes rates of domestic inflation and real domestic demand growth as given and attempts to generate a set of aggregate trade flows, both in value and volume terms, that are consistent with these domestic variables.

As shown in Table 1(a), the main exogenous inputs into the model include, for each industrial country, the major components of real domestic demand, hourly earnings in manufacturing, the GNP deflator, the nominal exchange rate, and potential output and employment (in terms of man-hours) in manufacturing. The dollar prices of petroleum products and a wide range of primary commodities also enter the model exogenously. Taking these variables as given, the model then generates estimates of the trade volume and unit value variables on a semi-annual basis for each country and for four broad commodity classifications. 1/ In a forecasting context, these estimates are benchmarked on alternative sets of historical data to give projected levels of volumes and values of total merchandise trade on both a customs and a balance of payments basis. Disaggregated trade flows under the four commodity classifications are provided solely on a customs basis.

The sets of endogenous and exogenous variables in the present version of the model, as shown in Table 1(a), are not identical to those described in the earlier DR paper. 2/ For example, previously there were equations that attempted to explain the volume of fuel exports of industrial countries; some obvious difficulties in this area led to the elimination of these equations and fuel exports are now taken as exogenous. 3/ On the other hand, a number of variables that were previously assumed exogenous are now determined within the model. These include domestic wholesale prices for both manufactures and raw materials in the industrial countries and the volume of trade in automobiles between Canada and the United States. The inclusion of equations to determine domestic wholesale prices allows the set of variables exogenous to the industrial country prices block to be reduced to just unit labor cost and commodity price variables, while the U.S.-Canada auto trade equations contribute to an improvement in the model's explanation of the aggregate levels of U.S. and Canadian exports and imports of manufactures.

After the various structural modifications were introduced, all of the equations of the model were re-estimated on a sample of semi-annual data extending from the beginning of 1962 to the second semester

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1/ See Table 1(a).

2/ The previous sets of exogenous and endogenous variables are given in Table 1, p. 150 of the DR paper.

3/ In forecasting applications, import volumes of fuels for industrial countries and total import volumes for the regions are also determined exogenously.

Table 1(a). Summary of Model Specification

Geographic Disaggregation	Commodity Disaggregation (SITC) 1/		Endogenous Variables	Exogenous Variables
Industrial countries:	SITC 0+1:	Agricultural goods	Import volumes by commodity class, by country	Real domestic demand for manufactures by country
Austria	SITC 2+4:	Raw materials	Export volumes by commodity class, by country	Real personal consumption expenditure by country
Belgium-Luxembourg	SITC 3 :	Fuels	Export volumes of automobiles between the United States and Canada	Potential output in manufacturing by country
Canada	SITC 5-8:	Manufactures	Import unit values by commodity class (excluding fuels), by country	Exchange rates by country
Denmark			Export unit values by commodity class (excluding fuels), by country	Fuel prices
France			Domestic wholesale prices of manufactures by country	Implicit GNP deflators by country
Germany, Fed. Rep. of			Domestic wholesale prices of raw materials by country	Output per manhour in manufacturing by country
Italy			Total import volumes by region	Potential manhours of employment in manufacturing by country
Japan			Total export volumes by region	Spot prices for 35 non-oil commodities
Netherlands			Total import unit values by region	
Norway			Total export unit values by region	
Sweden				
Switzerland				
United Kingdom				
United States				
Regions:				
Developed primary producing countries				
Major oil exporting countries				
Centrally planned economies				
Non-oil developing countries				

1/ Standard Industrial Trade Classification.

of 1979. This involved a seven semester extension of the sample used in the previous version of the model, introducing data for the 3 1/2-year period from 1976 second semester to 1979 second semester. Extension of the sample to cover this period brought in observations representing an additional cyclical expansion of demand in industrial countries and a corresponding expansion in the volume of world trade. Furthermore, the extension of the sample provides additional quantitative information on the longer-term effects of the first oil shock, and of the initial impact effects of the second oil shock, thus offering scope for more precise estimation of the model's trade price elasticities. The equations of the new version of the model were estimated singly, using either Ordinary Least Squares or Instrumental Variable techniques. In several equations, coefficients were estimated subject to a priori linear restrictions. In particular, compared with the previous version of the model, greater use was made of prior information in the equations specifying the behavior of export unit values for manufactures and in the elasticities of manufacturing imports with respect to the potential output of the manufacturing sector. Finally, in estimating the lagged effects of relative prices on trade volumes, a more flexible scheme of "distributed lag" restrictions was adopted.

The detailed discussion of the model which follows is split into three sections corresponding to the three main blocks of equations: industrial country price equations, industrial country volume equations, and the price and volume equations for the regional groupings. The general functional forms of the equations in each block are presented in Tables 1, 2 and 3, while country-by-country coefficient estimates are set out separately in Tables 4 through 25. For each block, both the general descriptions and the functional forms describe structural equations for a single country ("i"), with foreign variables constructed using the "partner-country" index ("j").

II. Industrial Country Price Equations

Trade prices for manufactures, raw materials, and agricultural goods are all determined in a general two-step procedure. First, export prices are determined for each exporting country as a function of domestic costs and export prices of competitor countries. Import prices are then determined as functions of weighted averages of trading partners' export prices. In the case of raw materials and agricultural goods, weighted indices of world commodity prices also enter into both export and import price equations. 1/

1/ The structural equations in the industrial country prices block, together with definitions of the variables, are set out in Table 1. Coefficient estimates are presented for each of the price equations in Tables 3 through 11. It may again be noted that the tabulated estimates may differ slightly from the parameter estimates actually used in the current forecasting version of the model.

1. Price determination in the manufacturing sector

While the essential structure of the price equations for manufactures is carried over from the previous version of the model, a number of important changes are introduced here, including the inclusion of a new equation to explain the domestic wholesale price of manufactures, the use of homogeneity restrictions in both export and import unit value equations, and a fuller treatment of the effects of raw material and energy costs on export prices. A comparison between the coefficient estimates of export and import unit value equations in the previous and current model versions 1/ reveals some significant differences, particularly in those equations where the previous parameter estimates clearly did not exhibit suitable homogeneity properties.

For each of the 14 industrial countries included in the model, export unit values for manufactures are determined within the set of simultaneous equations described by equations (1) and (1a) in Table 1. 2/ Equation (1) gives the percentage rate of change in the export unit value for country i as a function of the rates of change of three categories of domestic input costs (raw materials, labor and energy), the rate of change of competitor country export prices converted into country i currency, and a variable representing cyclical movements in unit labor costs. 3/ Equation (1a) then expresses the index of export prices of country i's competitors as an appropriately weighted index of the (U.S. dollar) export prices of countries other than i. On the right hand side of (1a) all of the industrial country export prices are weighted up to give separate price indices for each of country i's export markets j, and these indices are then weighted by the shares of country i's total manufactured exports going to each market. The share matrices used here and elsewhere in the model are based on 1970 trade flows. 4/

Each equation of the form (1) is estimated subject to three linear restrictions. The first (1.1), is a homogeneity restriction; it requires that the sum of the elasticities for all domestic costs and competitor prices be equal to unity, thus ensuring that a common proportionate increase in all cost variables (across countries) results in an equiproportionate rise in the index of manufactured export prices for each

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1/ Tables 4 and 5 in the present paper compared to Tables 5 and 6 in DR.

2/ All tables are relegated to the end of the paper.

3/ In the model, the percentage rate of change of each variable is expressed as the semiannual first difference of its natural logarithm.

4/ In a behavioral model such as the WTM a fixed weighting system is necessary to avoid the problem of spurious relative price movements which would arise if weights were adjusted within the sample period. However, in choosing a mid-sample (1970) base period with the aim of obtaining a representative set of elasticity estimates, it is inevitable that approximation errors will begin to have a significant impact on some of the weighted variables in the forecast period.

country. Recalling that export unit values reflect the prices of "gross outputs" rather than value added deflators, such a restriction can be derived at the microeconomic level for the pricing behavior of a firm that maximizes profit subject to decreasing returns to scale, perfect competition in factor markets and less than perfect competition in its product market. 1/ In this context, the ratio of the total weight on the cost variables to the weight on the index of competitor prices is equal to $1/\alpha\eta$, where α is the elasticity of domestic marginal cost with respect to output and η is the absolute value of the price elasticity of foreign demand. The ratio can be interpreted as a measure of the effective degree of monopoly power exerted by the home country in the world market for manufactures, becoming larger as the price elasticity of demand decreases and/or as the price elasticity of export supply (i.e., $1/\alpha$) increases. Considering the coefficient estimates presented in Table 4, it is seen that the weight on the variable representing competitor prices is smallest in the case of the United States (0.204), implying the greatest effective monopoly power, and largest in the case of Austria (0.826), implying the least effective monopoly power. Most of the weights appear to lie in the region of 0.4 to 0.6 with the one notable exception being the United Kingdom, where the estimated weight of 0.785 implies a relatively low degree of effective monopoly power and therefore, given the large scale of U.K. manufactured exports, a relatively low export supply-price elasticity.

The second and third restrictions (1.2) and (1.3) require that the relative weights on the three cost variables reflect the relative contributions of the three factors of production in total (gross) manufacturing output. The relative factor contributions are represented by the ratios r_i^1 and r_i^2 which, for the base year 1970, give the relative values of raw material inputs to labor inputs and of energy to labor inputs, respectively. As with the adding up restrictions, the previous version of the model also did not employ these restrictions on the relative size of parameters in the equations for manufactured export prices. 2/ Comparing the current estimates shown in Table 4 with the previous set of estimates, 3/ there are no consistent differences in the relative contributions of explanatory variables. However, there is much less cross-country variation in the relative contributions of the explanatory variables than in the previous set.

The two "relative cost" restrictions, plus the homogeneity restriction were tested as a group for each country using a Chi-squared log

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1/ See Deppler and Ripley, p. 153.

2/ In the previous version no separate energy price terms were included and the weight on domestic raw material prices was set at 0.075 across all 14 industrial countries.

3/ See Table 5, p. 168 of DR.

likelihood test 1/ and it was found that 5 of the 14 sets of restrictions were not consistent with the data at the 1 percent level. While there was thus an indication that special factors had not been adequately accounted for in these five particular country cases, the full set of restrictions was nevertheless retained in the current version of the model in order to ensure that the prices block as a whole would exhibit the desired behavioral properties.

The proportional change 2/ in the import price of manufactures is determined in a straightforward manner by the percentage rate of change in a geometrically weighted average of partner countries' manufactured export prices (equations (2) and (2a)). While it appears from Table 1 that the restriction (2.1) completely determines the parameters of equation (2), the actual model equations (cf. Table 5) include current and lagged values of the weighted export price index and a number of dummy variables. Consequently, it is necessary to estimate the parameters of this equation subject to the homogeneity restriction that the total elasticity with respect to the weighted export price index be equal to one. The estimates displayed in Table 5 show that, in the majority of country cases, at least 70 percent of the total effect of this variable is felt in the current semester. The unity restriction applied here was not used in the previous model version, although most of the estimated coefficients on the partner-country export price variables were close to one. Two exceptions were the cases of Canada and the Federal Republic of Germany, where these coefficients were significantly smaller than one. 3/

The domestic wholesale prices of manufactures that are used in the relative price terms affecting import volumes, are determined in equation (3) as functions of domestic cost variables and of both export and import unit values. The rationale underlying this specification is as follows: The wholesale price of manufactures reflects prices of both imported and domestically produced goods. In turn, the price of domestically produced manufactures is influenced both by the prices prevailing in the export market and by domestic costs. Homogeneity restrictions are once again imposed across the coefficients of the equation for each

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1/ The test statistic used was $2 \ln(L_o/L_1)$. This quantity is asymptotically distributed $\chi^2(3)$ where

L_o = the value of the likelihood function obtained from the unrestricted estimation of equation (1).

L_1 = the value of the likelihood function obtained from the estimation of equation (1) subject to restrictions (1.1), (1.2), (1.3).

2/ As measured by the first difference of the logarithm.

3/ See Table 6, p. 170 of DR.

country in order that proportionate increases in all domestic costs and import and competing prices of manufactures (in local currency) should yield the same proportionate increase in the dependent variable. In the cases where a lagged dependent variable enters as an explanatory variable, "long run" homogeneity is achieved by including its coefficient in the unity summation restriction (3.1).

The equations explaining wholesale and import prices of manufactures were estimated using Ordinary Least Squares while the equations for the export prices of manufactures were estimated using a modified two stage least squares (TSLS) procedure. The modification to the usual TSLS procedure involves the set of "first stage" regressions, where the competitor country export price variables are regressed on weighted averages of competing country labor, energy, and raw material costs, rather than on the whole set of competing country cost variables.

2. Equations for the prices of agricultural goods and raw materials

The structural equations for agricultural and raw material prices are perhaps more similar to their counterparts in the previous version of the WTM than are the price equations for manufactures. Nevertheless, there are a number of significant modifications; the equations of the present version are in log first difference rather than log level form, a separate energy cost term is included in the export price equations of the current version, and an equation is now included for the domestic wholesale price of raw materials. As previously, all of the nonmanufacturing price equations are estimated by Ordinary Least Squares.

Export unit values are given in equations (4) and (7) of Table 1 as functions of the levels of spot commodity prices on world markets weighted to reflect the commodity composition of exports, and domestic processing costs represented by oil prices and normalized unit labor costs in manufacturing. Partial adjustment to long-run "equilibrium" rates of growth is allowed through the use of lagged dependent variables, but these are found to be statistically significant for agricultural export prices in only a small number of countries (cf. Table 10) and for raw material export prices in less than half of the cases (cf. Table 7). Considering the overall estimation results in Tables 7 and 10, the commodity price indices appear to attract elasticities that are not as large, overall, as one might expect. This is particularly so in the price equations for agricultural commodities, where the average elasticity on commodity prices is 0.27, compared to an average of 0.41 on the domestic cost variables. In the previous version of the model, the average elasticity on commodity prices was higher, at 0.32, but the average elasticity on the one domestic cost variable--wages--was probably too low at just 0.25. For raw materials prices in the current version

the average elasticity on commodity prices is 0.41, compared to an average of 0.35 on the domestic cost variables; the corresponding figures in the DR version of the model were both lower, at 0.35 and 0.23 respectively. As would be expected, the estimates in Tables 7 and 10 suggest that the impact of energy prices relative to labor costs is considerably greater in the production of raw materials than in the production of agricultural goods.

Following the same basic structure used in the equations for import unit values of manufactures, the equations ((5) and (8) in Table 1) for the import unit values of raw materials and agricultural goods incorporate geometrically weighted averages of partner countries' export unit values. However, while the bulk of trade in manufactures occurs between the 14 largest industrial countries, this is not true of trade in raw materials and agricultural goods; consequently the partner (industrial) country export unit value indices $PFRD_i$ and $PFAD_i$ do not provide full coverage of country i's imports and it is necessary to supplement them in the import price equations with the import weighted commodity price indices PRWDM and PAWDM. Nevertheless, the estimated equations presented in Tables 8 and 11 show that the averages of partner-country export prices generally carry larger elasticities than the commodity price indices. This is particularly true in the equations that determine raw material import prices, where many of the elasticities on the partner-country export price variables are close to one. The results obtained for the raw materials and agricultural import price equations appear, generally, to be very similar to those obtained in the previous model version. 1/

The domestic wholesale price of raw materials is given in equation (6) of Table 1 as a function of both the export and import weighted commodity price indices (converted into domestic currency) and of domestic labor and energy costs. Most of the 14 industrial countries in the model import considerably more raw materials than they export and, accordingly, the import weighted commodity price index is generally found to have greater explanatory power than the export price index (cf. Table 9). The one exception is the United States, where the export weighted commodity price index is the only significant explanatory variable.

III. Determinants of Industrial Country Export and Import Volumes

The essential structure of the block of equations that determines export and import volumes for each country is given in Table 2, along with definitions of the dependent and explanatory variables. Coefficient estimates for the seven sets of volume equations which explain,

1/ See Tables 9 and 10 (pp. 174, 175) of DR.

respectively: import and export volumes of manufactures, raw materials and agricultural goods, and import volumes of fuels, are set out in Tables 12-15 and Tables 18-20. 1/ A summary of the price elasticities of demand for imports and exports of manufactures is given in Table 16, and the two equations used to explain the volume of trade in autos between Canada and the United States are reported in Table 17.

1. Volume equations for manufactures

Retaining the same basic structure adopted by DR, each country's demand for imports of manufactures (equation (9) of Table 2) is given as a function of potential output in manufacturing, 2/ relative prices, and a cyclical excess demand variable that measures the logarithm of the ratio of potential output to a weighted average of final domestic demand for manufactures and the actual level of value-added in manufacturing. The weights used in the averaged demand variable are intended to reflect the relative shares of final and intermediate products, respectively, in total imports. The most important innovations in this block of the current version of the model include the use of more general lag structures on the relative price variables and an alternative method of determining the elasticities of imports with respect to potential output. In the previous version, the lag distributions on relative price terms were restricted to conform to simple step functions through the use of two averaged relative price terms, giving one constant weight for effects lagged one and two semesters and a further constant weight for effects lagged from three to seven semesters. In the current model version the two averaged price terms are replaced by polynominal distributed lag structures which allow a far greater flexibility in both the length and pattern of lagged responses.

In restricting the elasticity of imports with respect to potential output to equal 1.25 across all industrial countries, the objective in the previous (DR) model version was to keep trade balances in manufacturing neutral with respect to a general across country shift in potential output. An average elasticity greater than one was required for this purpose because levels of manufactured exports for industrial countries are generally greater than levels of manufactured imports. In the current version of the model, the potential output elasticities are freely estimated in the few cases where relatively precise estimates can be obtained, but otherwise they are restricted to values, derived in

1/ Again, the tabulated estimates may differ slightly from the parameters used in the current forecasting version of the model.

2/ Potential output series are derived using the method described in J.R. Artus, "Measures of Potential Output in Manufacturing for Eight Industrial Countries, 1955-78", IMF, Staff Papers, Vol. 24, pp. 1-35 (March 1977).

Appendix I, which give the required neutrality property under the assumption that the pattern and scale of trade flows remains approximately the same as that prevailing in the base period.

Table 12 presents the new estimates for the volume of imports of manufactures. All of the potential output elasticities 1/ lie between 1 and 2, with most falling above the 1.25 value used in the earlier version of the WTM. The estimated elasticities on the cyclical demand variable are all well determined and lie within the range of 1 to 2.5. These elasticities are found to be smaller than the potential output elasticities in about half of the equations; in such cases an increase in "excess demand," caused by a reduction in supply (potential output), will be accompanied by a reduction in imports. The estimated relative price elasticities shown in Table 12 are generally less than 1 and usually lie between 0.7 and 1; these estimates are considerably more uniform than the elasticity estimates of DR which ranged from zero to over 3. The lag distributions on the relative price elasticities presented in Table 13 are made up, in all but one case, of three or fewer terms. The maximum lag length is four semesters (two years) and the average lag, across all 14 industrial countries, is approximately one semester.

The volume of manufacturing exports supplied by each industrial country (equation (10) of Table 2) is linked to import volumes in trading partner countries through "foreign market" variables (FM). These variables are weighted averages, reflecting base year (1970) market shares, of volumes of manufactures imported by partner countries. The two other major explanatory variables in equation (10) are the price of domestic exports relative to a weighted index of the export prices of competitor countries, and the level of potential output in the domestic manufacturing sector relative to potential output in competing countries. The elasticities on the latter variable are set equal to one for all countries included in the model on the assumption that, for given levels of foreign demand and relative prices, export market shares tend to shift proportionately with differential rates of manufacturing capacity growth in supplying countries. The fourth explanatory variable shown in equation (10) is an index of capacity utilization in importing partner countries. This variable does not play an important role in the overall model, as it is only found to be a significant contributing factor to export volume growth in the case of the United States.

Estimates of the equations determining the volume of each country's manufactured exports are presented in Table 14, with the full lag distributions on the relative price terms displayed in Table 15. By and large, the estimated elasticities on the foreign market variable are found to lie between 0.7 and 1.3. Such a dispersion about one is of course to be expected if a proportionate change in all import volumes is to result in a similar proportionate change in overall exports.

1/ Those elasticities which are estimated have accompanying t values.

Considering the estimated relative price elasticities, these are generally larger than the estimated import price elasticities, with 9 of the 14 "total" elasticities falling between -1.1 and -1.7. The remaining five elasticity estimates lie between -0.3 and -0.9. As with the import price elasticities, the export price elasticities are considerably less variable between countries than in the DR model version; also, the average elasticity across all countries is again smaller than previously, at -1.17 as compared to -1.40 in DR. The estimated price elasticities for the volumes of both exports and imports of manufactures are summarized in Table 16. Figures given in the table measure the effects of a once-for-all relative price change after one semester, after two semesters, and in the "long run" when the total effect is felt. If one compares the total price elasticities with trade price elasticities estimated in other recent empirical studies, 1/ there would appear to be a general consistency, with WTM estimates lying well within the range of alternative estimates in almost every country case.

Again repeating the findings of previous empirical studies, the lag distributions of the response of export volumes to relative price movements are estimated to be considerably longer (Table 15) than the lags in the response of import demand to relative price changes (Table 13). 2/ In all but two of the export equations the maximum lag on the relative price term is less than or equal to five semesters, but in the remaining two cases the maximum lags stretch out to eight and ten semesters. 3/ The average length of lag for the 14 industrial countries is found to be approximately one year, as compared to the one semester lag found for import volume responses. In all of the export equations, the polynominal distributed lag structures are assumed to be of either the first or second degree; end point restrictions are employed in 5 of the 14 cases. 4/

1/ As summarized, for example, by M. Goldstein and M.S. Khan, "Income and Price Effects in Foreign Trade," Chapter 20 in Handbook of International Economics, Vol. 2, ed. by R. W. Jones and P. B. Kenen (North-Holland, 1984).

2/ The method adopted to determine the maximum length of lag was to successively reduce the lag length under a high degree polynominal, choosing that lag length which minimized the estimated standard error of the equation.

3/ As seen in Table 15, these two cases are the Federal Republic of Germany and the United Kingdom. The diagnostic statistics given in Table 15 indicate that, in both of the equations concerned, the relative price lag distributions are not well determined. Furthermore, in the United Kingdom case, the lag distribution is not very believable; the specification shown was chosen in preference to having no relative price effect at all.

4/ End point restrictions may be required to prevent "U" shaped lag distributions. These may arise when the lag distribution is ill-determined by the sample information, in which case end-point restrictions will tend not to be rejected by standard statistical tests, or when there is a mis-specification problem, in which case end point restrictions will tend to be rejected.

Chi-squared tests of all of the restrictions implicit in the lag structures (cf. Table 15) indicate that the restrictions can be accepted at the 5 percent level in all but three cases. 1/ In the import equations (cf. Table 13) only two of the lag structures involve binding restrictions, and these were found to be consistent with the data at the 5 percent level.

Components of trade in manufactures that are not included in the export and import volume aggregates determined by equations (9) and (10) (Table 2) include all exports and imports of ships and aircraft, which are treated as exogenous, and the trade in automotive products between the United States and Canada, which is determined by the equations described in Table 17. Items relating to ships and aircraft are "taken out" as these tend to be lumpy flows, while United States-Canada auto trade is treated separately in an attempt to allow for the major impact of the 1965 U.S.-Canadian Automotive Agreement. Under this agreement, free trade has been allowed in a wide range of automotive products but, running in parallel with the agreement, there has also been a requirement under Canadian law that Canadian auto firms should at least maintain the base year (1965) ratio of domestic assemblies to domestic sales. This requirement has effectively created a ceiling on Canadian auto imports in terms of Canadian auto exports. An attempt is made to take account of the ceiling in the first equation of Table 17, where the volume of Canadian auto exports is included as an explanatory variable in the Canadian auto imports (US exports) equation. Also entering this equation is the domestic demand variable (AVG) used in the aggregate manufactured imports equation, and a lagged dependent variable. The second equation in Table 17 explains the volume of U.S. auto imports (Canadian exports) in terms of U.S. domestic demand and U.S. demand relative to Canadian demand. Canadian manufacturing capacity and proxy relative price terms were included in this equation at an earlier stage in an attempt to capture Canadian supply effects, but with little success.

Estimates of the equations for the volume of total manufactured imports are obtained by the Instrumental Variables method, while the equations for each country's total manufactured exports are estimated by Ordinary Least Squares. The Instrumental Variables method is required for the import equations because of the simultaneity between the volume of imports MVM_i and the demand variable AVG_i. The latter variable is directly related to value added in manufacturing QM_i which in turn is defined as the domestic demand for manufactures DVM_i plus a fixed proportion of the excess of exports over imports of manufactures. Export volumes, on the other hand, are primarily determined as functions of the foreign demand variables and these are related only in a very indirect manner back to export volumes. Because of the recursive structure of the Canada-U.S. auto trade equations, these are estimated by OLS.

1/ The test used here is the same likelihood ratio test described in Section II.1.

2. Volume equations for nonmanufactured commodities

The specifications of the equations that determine the import and export volumes of raw materials and agricultural goods, and import volumes of fuels, are given in Table 2, equations (11) to (15). Compared to the previous model version described by DR, changes include; (i) the wider use of relative price terms which now enter all five equations in this block, rather than just the agricultural imports equation as previously, (ii) the inclusion of first differences of scale variables in the three import equations to allow for the acceleration effects of stock building, and (iii) the use of lagged dependent variables to allow for partial adjustment of import volumes to long-run equilibrium levels. In the case of the fuels import equations, an effort was made to identify finite (polynominal) distributed lag structures on the relative price variables; consequently, it was not necessary to include lagged dependent variables in these equations.

The logical structure of the import and export volume equations for nonmanufactured commodities is the same as that for the manufacturing block. Import volumes are explained as functions of domestic activity and import prices relative to domestic output prices. The activity variable entering the raw materials and fuels imports equations is real value added in manufacturing while total domestic consumption is used in the agricultural imports equations; compared to raw materials and fuels, agricultural imports have a considerably greater component going directly to final demand. With respect to the relative price variables, in the manufactures block the domestic wholesale price of manufactures is available to construct relative prices of manufactured imports, but in the case of nonmanufactures it is necessary to compare import prices with total GNP deflators.

As in the manufactures block, the export volume equations for raw materials and agricultural goods are "driven" by foreign market variables, constructed as weighted averages 1/ of the imports of partner countries. The relative price variables are also formed in the same manner as for manufactures, with export unit values being compared to double weighted indices of competing export prices.

All five sets of equations in this block are estimated by Ordinary Least Squares. In the case of imports of manufactures there was clear simultaneity between the dependent variable and the right hand side activity variable. However, in the import equations for nonmanufactures, neither of the activity variables--value added in manufacturing nor total final consumption--depends directly on the volume of imports of the commodities concerned.

1/ Using base year (1970) trade patterns to determine the weights.

Coefficient estimates for the equations explaining import volumes of raw materials, agricultural goods and fuels are presented in Tables 18, 20 and 22, respectively. Estimates of lag distributions for the effects of relative prices on the volume of fuel imports are given in Table 23. As one would perhaps expect, the accelerator terms 1/ are found to have the greatest impact in the explanation of raw material imports, where the coefficients on the first difference of QM_i are often found to be greater than one and, in most cases, greater than the corresponding coefficients on the level of QM_i. In the raw material volume equations, the average long-run elasticity 2/ on QM_i is just 0.71, while in the fuel volume equations where only one of the equations attracts an accelerator term, the average long-run elasticity is a more realistic 1.08. In the agricultural import volume equations (Table 20), the average estimated elasticity on total final consumption across all 14 countries is also close to one, at 1.06. With respect to relative prices, in both the raw materials and agricultural import equations, about half of the cases in each table are found to include significant relative price terms; the average long-run price elasticities for the volumes of raw material and agricultural imports are relatively low at 0.26 and 0.31, respectively. As previously mentioned, in the case of import volumes of fuels a somewhat more thorough analysis was undertaken of relative price effects, with a range of polynominal lag structures being tested. However, while statistically significant relative price effects were identified for the majority of countries in the model, the average long-run elasticity was nevertheless found to be only 0.23. As seen in Table 23, the maximum lag length adopted was six semesters, but only short-term relative price effects were detected in a number of cases and for the United States no price effect was detected at all. The typical length of lag, averaged across all countries, is 1.53 semesters or approximately ten months.

In terms of overall statistical fit, the estimated equations for export volumes of raw materials and agricultural goods (Tables 19 and 21) are clearly not as well determined as those for the imports of nonmanufactures. However, perhaps as a result of the more precise measurement of competing prices in the export equations, the estimated relative price elasticities of demand are better determined in the equations for export volumes. The export price elasticities are also generally larger with the cross-country average price elasticities for raw materials and agricultural goods reaching -0.75 and -0.80, respectively. As would be expected, the foreign market variables FR_i and FA_i also exhibit significant explanatory power and the across country average elasticities on these variables, at 1.09 and 1.17, come close to their prior expected values of one.

1/ First differences in the activity variables.

2/ When a lagged dependent variable is present, the long-run elasticity is taken as the impact elasticity divided by one minus the coefficient on the lagged dependent variable.

IV. Price and Volume Relationships for the Regions

The rest of the world, apart from the 14 major industrial countries, is represented in the WTM by four regions. The country groupings in the current model version are the same as in DR, and are consistent with the groupings used in the Fund's International Financial Statistics. The four categories consist of: (1) the developed primary producing countries, including those industrial countries not treated individually in the model, (2) the major oil exporting countries, (3) the non-oil developing countries, and (4) a final residual group made up primarily of centrally planned economies.

The algebraic forms of aggregate export and import price and volume equations for the regions are given in Table 3. The corresponding coefficient estimates for each of the four sets of equations are reported in Tables 24 and 25. In equation (16) of Table 3, the rate of change in the aggregate export unit value index (XPTDj) is expressed as a function of rates of change in world prices of fuels and manufactures (PFWD, PMWD), 1/ and of the rate of change in a region-specific export-weighted average of spot commodity prices (PPWDXj). As one would expect, the estimates in Table 24 show export prices of the centrally planned and major oil exporting countries to be closely related to the world price of manufactures and the world price of fuels, respectively. The export prices of the developed primary producing and non-oil developing countries appear to be influenced, in roughly equal proportions, by both commodity spot prices and the world price of manufactures.

Aggregate import prices for the regions are determined in equation (17) of Table 3 as a function of world price indices for agricultural goods, raw materials and fuels, and of import-weighted averages of industrial country manufactured export prices. In Table 24 it is apparent that the latter region-specific variables have the greatest influence on aggregate import prices in all four of the regions. However, while these variables are dominant in the equations for the centrally planned and oil producing countries, the price indices of the non-manufactured commodities also play an important part in determining import prices in the developed primary producing and non-oil developing countries.

Turning to the determination of aggregate regional trade volumes, equations (18) and (19) in Table 3 have essentially the same structure as the corresponding equations in DR. Aggregate export volumes depend

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1/ "World price" here means a unit value index for the group of 14 industrial countries. The indices for manufactures and agricultural goods are based on export unit values while the indices for raw materials and fuels are based on import unit values.

on an index of manufacturing output in industrial countries, and import volumes are determined as a function of the value of export receipts deflated by import prices. The hypothesis embodied in the import volume equation, that export receipts effectively constrain import demand, may be appropriate in certain countries; for the group of centrally planned economies, for example, the estimates in Table 25 show a relatively rapid adjustment of imports to movements in effective purchasing power. However, given the high level of international borrowing that has occurred since 1974, it is clear that this has not been the general rule over the past decade; this observation is reflected in relatively slow rates of partial adjustment for all of the aggregates excluding the eastern bloc region. Because of the looseness or "long-run" nature of the foreign exchange constraint and the absence of relevant short-term explanatory variables, the equations here are not particularly suitable for the purposes of short-term forecasting. Consequently, given that data inadequacies have so far prevented the development of more detailed equations, the recent practice in forecasting has been to fix regional import volumes exogenously.

V. Summary and Conclusions

The revised structural specification of the World Trade Model that has been presented here does not differ substantially from the previous version of the model presented by Deppler and Ripley (DR). Nevertheless, a number of significant structural modifications have been incorporated in the current version and, with the sample being extended by seven semesters (3 1/2 years) to include the period from second half 1976 to second half 1979, there have been many significant changes in coefficient estimates. The main structural differences are seen in the price and volume blocks for manufactures. In the price block, restrictions are imposed on the export unit value equations in order to ensure homogeneity under general shifts in the level of prices and to enforce actual base year cost patterns on the relative cost contributions to changes in export unit values. Restrictions are imposed on the equations explaining import unit values of manufactures to ensure homogeneity under general shifts in all partner country export prices. In the volume equations, more flexible (polynominal) structures are used to give an improved representation of both the overall size and timing of relative price effects. Some alterations have also been made to the nonmanufacturing volume and price equations. In particular, greater use is now made of relative price effects in export and import demand equations. While the current version of the WTM has not been estimated over the sample of data reported in DR for the purpose of a direct comparison, it indeed appears that the extension of the sample to include the 1976-79 period has contributed to an improvement in the identification of relative price effects in a large proportion of both the nonmanufacturing and manufacturing volume equations.

Although the new relative price terms in the model have increased the responsiveness of trade flows in raw materials and agricultural goods to relative price movements, the average long-run price elasticities for exports and imports of manufactures are found to be slightly lower, at -1.17 and 0.84, respectively, than in DR. The new estimates are also found to be considerably less variable across countries than in DR. No persistent differences are observed in estimated elasticities of trade volumes with respect to scale variables such as "foreign demand" in export equations and actual or potential output in import equations. However, the elasticities of manufactured imports with respect to potential output that are assumed a priori 1/ are now set at values ranging between 1.12 and 2.00, as compared to the uniform value of 1.25 adopted in DR. In the equations explaining export and import unit values there are, again, no persistent cross-country differences between the estimated coefficients of the two model versions. As with the price elasticities in the volume equations, however, there is generally a greater consistency in the parameters of the price equations in the current model version than in the DR version.

Considering the effects which the new changes are likely to have on the performance of the current specified model, the restrictions on the unit value equations for manufactures and the greater degree of cross-country consistency in the relative contributions to export and import unit values should lead to more realistic responses in relative trade prices under shocks to the exogenous labor cost and commodity price variables. Furthermore, the more comprehensive treatment of relative price effects on trade volumes might be expected to improve the model's predictions of how trade volumes respond to such relative price movements. In forecasting applications it has indeed become apparent that the new version of the model tends to generate more consistent patterns of trade volumes and prices, in particular for manufactures, than did its predecessor.

1/ Four of these elasticities are estimated in the current model as compared to two in the DR version. The aim of the restrictions is to make trade balances in manufactures neutral with respect to across-the-board changes in potential output.

Table 1. World Trade Model: Specification of the Prices Block for "Country i"

(i = 1 to 14 and all summations are from 1 to 14)

Manufactures

(1) $\Delta \ln XPM_i = a_1 \Delta \ln PRM_i + a_2 \Delta \ln NULC_i + a_3 \Delta \ln(POIL.LCD_i) + a_4 \Delta \ln(PFX_i.LCD_i) + a_5 \ln(NULC_i/ULC_i)$

Restrictions: (1.1) $a_1+a_2+a_3+a_4 = 1$

(1.2) $a_1 = r_i^1.a_2$

(1.3) $a_3 = r_i^2.a_2$

(1a) $\ln PFX_i = \sum_j smx_{ij} \sum_{k \neq i} \frac{smm_{kj}}{1-smm_{ij}} \ln(XPM_k/LCD_k)$

(2) $\Delta \ln MPM_i = b_1 \Delta \ln(PFMD_i.LCD_i)$

Restriction: (2.1) $b_1 = 1$

(2a) $\ln PFMD_i = \sum_j smm_{ji} \ln(XPM_j/LCD_j)$

(3) $\Delta \ln PM_i = c_1 \Delta \ln MPM_i + c_2 \Delta \ln PRM_i + c_3 \Delta \ln NULC_i + c_4 \Delta \ln (POIL.LCD_i) + c_5 \Delta \ln XPM_i + c_6 \Delta \ln(PM_i)_{-1}$

Restriction: (3.1) $c_1+c_2+c_3+c_4+c_5+c_6 = 1$

Raw materials

(4) $\Delta \ln XPR_i = d_1 \Delta \ln(PRWDX_i.LCD_i) + d_2 \Delta \ln NULC_i + d_3 \Delta \ln(POIL.LCD_i) + d_4 \Delta \ln(XPR_i)_{-1}$

(5) $\Delta \ln MPR_i = e_1 \Delta \ln(PRWDM_i.LCD_i) + e_2 \Delta \ln(PFRD_i.LCD_i)$

(5a) $\ln PFRD_i = \sum_j srm_{ji} \ln(XPR_j/LCD_j)$

Table 1 (continued). World Trade Model: Specification of the Prices Block for "Country i"

(i = 1 to 14 and all summations are from 1 to 14)

(6) $\Delta \ln PRM_i = f_1 \Delta \ln(PRWDM_i.LCD_i) + f_2 \Delta \ln(PRWDX_i.LCD_i) + f_3 \Delta \ln NULC_i + f_4 \Delta \ln(POIL.LCD_i) + f_5 \Delta \ln(PRM_i)_{-1}$

Agricultural goods

(7) $\Delta \ln XPA_i = g_1 \Delta \ln(PAWDX_i \cdot LCD_i) + g_2 \Delta \ln NULC_i + g_3 \Delta \ln(POIL \cdot LCD_i) + g_4 \Delta \ln(XPA_i)_{-1}$

(8) $\Delta \ln MPA_i = h_1 \Delta \ln(PAWDM_i \cdot LCD_i) + h_2 \Delta \ln (PFAD_i \cdot LCD_i) + h_3 \Delta \ln(MPA_i)_{-1}$

(8a) $\ln PFAD_i = \sum_j sam_{ji} \ln(XPA_j/LCD_j)$

Definition of variables 1/

Endogenous

XPM_i Index of export unit values of manufactured goods from country i, expressed in the currency of country i, 1970=100.

PFX_i Double-weighted index reflecting an average of competitor countries' export prices for manufactures in U.S. dollars.

MPM_i Index of import unit values of manufactures in country i, expressed in the currency of country i, 1970=100.

$PFMD_i$ Average of partner-country export unit value indices for manufactures in U.S. dollars.

PM_i Index of wholesale price of manufactures in country i, in the currency of country i, 1970=100.

XPR_i Index of export unit values of raw materials from country i, expressed in the currency of country i, 1970=100.

1/ Endogenous variables are listed in order of appearance in the equation set, while exogenous variables are listed alphabetically.

Table 1 (continued). World Trade Model: Specification of the Prices Block for "Country i"

(i = 1 to 14 and all summations are from 1 to 14)

MPR_i	Index of import unit values of raw materials in country i, expressed in the currency of country i, 1970=100.
$PFRD_i$	Average of partner-country export unit value indices for raw materials in U.S. dollars.
PRM_i	Index of domestic costs of raw materials in country i, in the currency of country i, 1970=100.
XPA_i	Index of export unit values of agricultural goods from country i, expressed in the currency of country i, 1970=100.
MPA_i	Index of import unit values of agricultural goods in country i, expressed in the currency of country i, 1970=100.
$PFAD_i$	Average of partner-country export unit value indices for agricultural goods in U.S. dollars.

Exogenous 1/

LCD_i	Exchange rate variable for country i, calculated as the number of currency units of country i per U.S. dollar, expressed in index form, 1970=100.
$NOMH_i$	"Normal" output per man-hour in manufacturing, in country i.
$NULC_i$	Normal unit labor costs in manufacturing, $WM_i/NOMH_i$, in country i, expressed in the currency of country i, 1970=100
OMH_i	Output per man-hour in manufacturing, in country i.
$PAWDM_i$	Index of world spot prices of agricultural goods in U.S. dollars, with weights for the 15 individual agricultural commodities reflecting the relative importance of the commodities in country i's imports in 1970.

1/ These variables are all exogenous both to the prices block and to the overall model.

Table 1 (concluded). World Trade Model: Specification of the Prices Block for "Country i"

(i = 1 to 14 and all summations are from 1 to 14)

$PAWDX_i$	Index of world spot prices of agricultural goods in U.S. dollars, with weights for the 15 individual agricultural commodities reflecting the relative importance of the commodities in country i's exports in 1970.
POIL	Average oil export unit value of the oil exporting countries, in U.S. dollars, 1980=100.
$PRWDM_i$	Index of world spot prices of raw materials in U.S. dollars, with the weights for the 20 individual goods reflecting the relative importance of the goods in country i's imports in 1970.
$PRWDX_i$	Index of world spot prices of raw materials in U.S. dollars, with the weights for the 20 individual goods reflecting the relative importance of the goods in country i's exports in 1970.
r_i^1	Ratio of raw material to labor inputs in gross manufacturing output, in country i, based on 1970 input-output weights.
r_i^2	Ratio of fuel to labor inputs in gross manufacturing output, in country i, based on 1970 input-output weights.
skm_{ij}	Share of commodity k imports from industrial countries in market j originating in country i, in value terms, in 1970, where k = a (agriculture), m (manufactures), and r (raw materials).
skx_{ij}	Share of commodity k exports of country i going to market j, in value terms, in 1970, where k = a (agriculture), m (manufactures), and r (raw materials).
ULC_i	Unit labor costs in manufacturing, WM_i/OMH_i, in country i, in the currency of country i, 1970=100.
WM_i	Index of compensation per man-hour in manufacturing in country i, expressed in the currency of country i, 1970=100.

Table 2. World Trade Model: Specification of the Volume Block for "Country i"

(i = 1 to 14 and all summations are from 1 to 14)

Manufactures

(9) $\ln MVM_i = a_o + a_1 \ln(AVG_i/QMT_i) + a_2 \ln QMT_i + a_3 \ln(RMPM_i)$

restriction: $a_2 = \bar{a}_2$ (see Appendix I)

(10) $\ln XVM_i = b_o + b_1 \ln FM_i + b_2 \ln RQMT_i + b_3 \ln RXPM_i + b_4 \ln RXCU_i$

restriction: $b_2 = 1$

(10a) $FM_i = \sum_j smm_{ij} . MVM_j . M_j$

Raw materials

(11) $\ln MVR_i = c_o + c_1 \ln QM_i + c_2 \Delta \ln QM_i + c_3 \ln RMPR_i + c_4 \ln(MVR_i)_{-1}$

(12) $\ln XVR_i = d_o + d_1 \ln FR_i + d_2 \ln RXPR_i$

(12a) $FR_i = \sum_j srm_{ij} . MVR_j . R_j$

Agricultural goods

(13) $\ln MVA_i = e_o + e_1 \ln CC_i + e_2 \Delta \ln CC_i + e_3 \ln RMPA_i + e_4 \ln(MVA_i)_{-1}$

(14) $\ln XVA_i = f_o + f_1 \ln FA_i + f_2 \ln RXPA_i$

(14a) $FA_i = \sum_j sam_{ij} . MVA_j . A_j$

Fuels

(15) $\ln MVF_i = g_o + g_1 \ln QM_i + g_2 \Delta \ln QM_i + g_3 \ln RMPF_i + g_4 \ln(MVF_i)_{-1}$

Table 2 (continued). World Trade Model: Specification of the Volume Block for "Country i"

(i = 1 to 14 and all summations are from 1 to 14)

Definition of Variables 1/

Variables endogenous to the volume block

MVM_i	Import volume of manufactures for country i.
XVM_i	Export volume of manufactures from country i.
FM_i	Foreign market variable for manufactured exports from country i.
MVR_i	Import volume of raw materials for country i.
XVR_i	Export volume of raw materials from country i.
FR_i	Foreign market variable for raw materials exports from country i.
MVA_i	Import volume of agricultural goods for country i.
XVA_i	Export volume of agricultural goods from country i.
FA_i	Foreign market variable for agricultural goods exports from country i.
MVF_i	Import volume of fuels for country i.

Variables exogenous to the volume block

(Variables exogenous to the volume block but endogenous to the model are marked with an asterisk.)

A_i	Share of country i's imports of agricultural goods coming from the industrial countries, in value terms, in 1970.
AVG_i*	Weighted average of output in manufacturing (OM_i), and real final domestic demand for manufactures (DVM_i) both in index form, 1970=100, with the weights reflecting the share of manufactured imports going to intermediate and final demand, respectively.

$$AVG_i = (1-SH_i)\cdot OM_i + SH_i \cdot DVM_i$$

1/ Variables endogenous to the volumes block are listed in order of appearance while variables exogenous to the block are listed alphabetically.

Table 2 (continued). World Trade Model: Specification of the Volume Block for "Country i"

(i = 1 to 14, and all summations are from 1 to 14)

CC_i	Index of real personal consumption expenditure in country i, 1970=100.
LCD_i	Exchange rate variable for country i, calculated as the number of currency units of country i per U.S. dollar, expressed in index form, 1970=100.
M_i	Share of country i's imports of manufactured goods coming from the industrial countries, in value terms, in 1970.
MPA_i*	Index of import unit values of agricultural goods in country i, expressed in the currency of country i, 1970=100. (c.f. equation 8 of Table 1).
MPF_i	Index of import unit values of fuels in country i, expressed in the currency of country i, 1970=100.
MPM_i*	Index of import unit values of manufactures in country i, expressed in the currency of country i, 1970=100. (c.f. equation 2 of Table 1).
MPR_i*	Index of import unit values of raw materials in country i, expressed in the currency of country i, 1970=100. (c.f. equation 5 of Table 1)
$PFAD_i$*	Average of partner-country export unit value indices for agricultural goods, in U.S. dollars. (cf. equation 8a of Table 1.)
$PFMD_i$*	Average of partner-country export unit value indices for manufactures, in U.S. dollars. (cf. equation 2a of Table 1.)
$PFRD_i$*	Average of partner-country export unit value indices for raw materials, in U.S. dollars. (cf. equation 5a of Table 1.)
PY_i	Gross national product deflator for country i, expressed in the currency of country i, 1970=100.

Table 2 (continued). World Trade Model: Specification of the Volume Block for "Country i"

(i = 1 to 14 and summations are from 1 to 14)

QM_i Index of real value added in manufacturing in country i, 1970=100.

QMT_i Index of potential output in manufacturing in country i.

R_i Share of country i's imports of raw materials coming from the industrial countries, in value terms, in 1970.

$RMPA_i$* National product deflator relative to import price of agricultural goods, calculated as:

$$RMPA_i = PY_i/MPA_i$$

$RMPF_i$ National product deflator relative to import price of fuels, calculated as:

$$RMPF_i = PY_i/MPF_i$$

$RMPM_i$* Index of domestic prices of manufactures relative to import price of manufactures. This index is calculated as:

$$RMPM_i = PM_i/MPM_i$$

$RMPR_i$* National product deflator relative to import price of raw materials, calculated as:

$$RMPR_i = PY_i/MPR_i$$

$RQMT_i$ Index of potential output in manufacturing in country i relative to competitors' potential output in manufacturing.

$$\ln RQMT_i = \ln QMT_i - \sum_j smx_{ij} \cdot \sum_k smm_{kj} \cdot \ln QMT_k$$

$RXCU_i$* Average measure of capacity utilization in countries importing from country i, calculated as:

$$RXCU_i = \sum_j smx_{ij} X_i \cdot QM_j/QMT_j$$

where X_i is the share of country i's exports going to industrial countries, in value terms, in 1970.

Table 2 (concluded). World Trade Model: Specification of the Volume Block for "Country i"

(i = 1 to 14 and all summations are from 1 to 14)

$RXPA_i$* Index of export unit values of agricultural goods in country i relative to competitors' price index, calculated as:

$$\ln(RXPA_i) = \ln(XPA_i/LCD_i) - \sum_j sax_{ij} \ln(PFAD_j)$$

$RXPM_i$* Index of export unit values of manufactures in country i relative to competitors' price index.

$$\ln(RXPM_i) = \ln(XPM_i/LCD_i) - \sum_j smx_{ij} \cdot \ln(PFMD_j)$$

$RXPR_i$* Index of export unit values of raw materials in country i relative to competitors' price index, calculated as:

$$\ln(RXPR_i) = \ln(XPR_i/LCD_i) - \sum_j srx_{ij} \ln(PFRD_j)$$

skm_{ij} Share of commodity k imports from industrial countries in market j originating in country i, in value terms, in 1970, where k = a (agriculture), m (manufactures), and r (raw materials).

skx_{ij} Share of commodity k exports from country i to market j, in value terms, in 1970, where k = a (agriculture), m (manufactures), and r (raw materials).

XPA_i* Index of export unit values of agricultural goods from country i, in local currency, 1970=100.

XPM_i* Index of export unit values of manufactured goods from country i, expressed in the currency of country i, 1970=100.

XPR_i* Index of export unit values of raw materials from country i, in local currency, 1970=100.

Table 3. World Trade Model: Specification of Price and Volume Relationships for Aggregate Regions

(j = 1 to 14 and summations across i are from 1 to 14)

Export prices

(16) $\Delta \ln XPTD_j = a_1 \Delta \ln PPWDX_j + a_2 \Delta \ln PFWD + a_3 \Delta \ln PMWD$

Import prices

(17) $\Delta \ln MPTD_j = b_1 \Delta \ln PAWD + b_2 \Delta \ln PFWD + b_3 \Delta \ln PRWD + b_4 \Delta \ln MPMD_j$

where

(17a) $\ln MPMD_j = \sum_i smm_{ij} \ln(XPM_i/LCD_i)$

Import volumes

(18) $\ln MVT_j = c_0 + c_1 \ln XPP_j + c_2 \Delta \ln XPP_j + c_3 \ln(MVT_j)_{-1}$

(18a) $XPP_j = XVT_j \cdot XPTD_j/MPTD_j$

Export volumes

(19) $\ln XVT_j = d_0 + d_1 \ln OMIND_j + d_2 \ln(XVT_j)_{-1}$

Definition of variables 1/

Variables endogenous to the regions block

$XPTD_j$ Index of export prices (total) of region j, expressed in U.S. dollars, 1970=100.

$MPTD_j$ Index of import prices (total) of region j in U.S. dollars, 1970=100.

$MPMD_j$ Average of industrial partner-country export unit value indices, in U.S. dollars, for manufactures.

1/ Variables endogenous to the regions block are listed in order of appearance while variables exogenous to the block are listed alphabetically.

Table 3 (concluded). Regions: Price and Volume Relationships

MVT_j	Total import volume for region j.
XPP_j	Purchasing power of region j's exports in terms of its imports.
XVT_j	Volume of total exports of region j.

Variables exogenous to the regions block

(Variables exogenous to the regions block but endogenous to the model are marked with an asterisk.)

LCD_i	Exchange rate variable for country i calculated as the number of currency units of country i per U.S. dollar, expressed in index form, 1970=100.
PAWD*	Index of agricultural export unit value indices for the industrial countries in U.S. dollars, 1970=100.
PFWD	Index of fuel import unit value indices for the industrial countries in U.S. dollars, 1970=100.
PMWD*	Index of industrial country export unit value indices for manufactures in U.S. dollars, 1970=100.
$PPWDX_j$	Index of world spot prices for food and raw materials, weighted on the basis of the 1968-70 commodity structure of region j's exports in U.S. dollars, 1970=100.
PRWD*	Index of raw material import unit value indices for the industrial countries in U.S. dollars, 1970=100.
$QMIND_j$*	Index of output in manufacturing in industrial countries, where weights reflect the relative importance of industrial countries as export markets for region j in 1970.
smm_{ij}	Share of manufactured imports from industrial countries in area j originating in country i, in value terms in 1970.
XPM_i*	Index of export prices of manufactured goods from country i, expressed in the currency of country i, 1970=100. (c.f. equation 1 of Table 1).

Table 4. Fourteen Industrial Countries: Estimates of Export Unit Value Equations for Manufactures, Second Half 1962-Second Half 1979 1/

(See equation 1, Table 1)

Explanatory Variable 2/	Austria	Belgium/ Luxembourg	Canada	Denmark	France	Fed. Rep. Germany	Italy	Japan	Netherlands	Norway	Sweden	Switzerland	United Kingdom	United States
Domestic raw material prices	0.029 (1.42)	0.052 (2.89)	0.032 (2.27)	0.066 (4.48)	0.069 (8.03)	0.069 (5.36)	0.029 (2.85)	0.034 (5.62)	0.090 (5.71)	0.017 (2.11)	0.013 (5.19)	0.093 (6.51)	0.033 (3.60)	0.023 (7.86)
Normal unit labor costs	0.115 (1.42)	0.289 (2.89)	0.243 (2.27)	0.463 (4.48)	0.267 (8.03)	0.257 (5.36)	0.353 (2.85)	0.401 (5.62)		0.278 (2.11)		0.348 (6.51)	0.131 (3.60)	0.665 (7.86)
Normal unit labor costs (-1)									0.405 (5.71)		0.329 (5.19)			
Energy price	0.030 (1.42)	0.063 (2.89)		0.026 (1.88)		0.068 (5.36)		0.160 (5.62)	0.067 (2.94)	0.052 (2.11)	0.081 (5.19)			0.051 (2.62)
Energy price (-1)			0.053 (2.27)	0.033 (2.36)	0.104 (8.03)		0.045 (2.85)		0.041 (2.19)			0.096 (6.51)	0.052 (3.60)	0.056 (2.85)
Competitor prices	0.218 (1.02)	0.225 (1.01)	0.672 (4.66)	0.413 (3.15)	0.561 (10.24)	0.212 (2.10)	0.245 (2.23)	0.405 (3.83)	0.397 (3.76)		0.307 (3.50)	0.464 (5.63)	0.439 (3.32)	0.204 (2.02)
Competitor prices (-1)	0.608 (3.80)	0.371 (2.20)				0.394 (6.22)	0.329 (2.91)			0.653 (3.97)	0.271 (3.41)		0.346 (6.81)	
Cyclical unit labor costs						-0.248 (1.51)								
Seasonal dummy							-0.013 (2.25)		-0.010 (2.27)					
Rho										0.286 (1.68)		0.335 (1.94)	0.698 (5.10)	
SEE	0.025	0.019	0.026	0.014	0.016	0.013	0.022	0.027	0.017	0.031	0.014	0.022	0.013	0.017
$\bar{R}^2$ 3/	0.28	0.24	0.11	0.34	0.64	0.65	0.59	0.47	0.46	0.09	0.64	0.55	0.81	0.63
D.W.	2.48	2.00	1.89	2.24	1.89	1.72	2.15	1.87	1.46	1.87	1.90	1.69	1.81	1.86

1/ The t-statistics are in parentheses.
2/ Exact algebraic form of the equations and variable definitions are given in Table 1. All variables log first differences.
3/ As a result of coefficient restrictions imposed on these equations, $\bar{R}^2$ gives the proportion of explained variation in the difference between the rate of change in XPM and the rate of change in competitor prices.

Table 5. Fourteen Industrial Countries: Estimates of Import Unit Value Equations for Manufactures. First Half 1964-Second Half 1979. 1/

(See equation 2, Table 1)

Explanatory Variable 2/	Austria	Belgium/ Luxembourg	Canada	Denmark	France	Fed. Rep. Germany	Italy	Japan	Netherlands	Norway	Sweden	Switzerland	United Kingdom	United States
Partner country Export prices	0.841 (6.62)	1.016 (8.86)	0.651 (7.59)	1.0	1.0	0.862 (9.62)	0.788 (12.02)	0.883 (9.12)	0.518 (3.72)	0.740 (5.64)	0.884 (11.77)	0.803 (12.59)	0.894 (11.51)	0.733 (7.86)
Partner country Export prices(-1)	0.159 (1.25)		0.349 (4.07)			0.138 (1.54)	0.212 (3.24)	0.117 (1.21)	0.482 (3.46)	0.26 (1.98)	0.116 (1.55)	0.197 (3.09)	0.106 (1.36)	0.267 (2.87)
Dummies 3/ D74.1							-0.084 (4.43)							
D74.2						-0.071 (3.81)		-0.128 (3.78)						
D75.1				-0.043 (3.39)	-0.039 (2.14)									
D75.2	-0.039 (2.83)									-0.039 (2.90)				
DUMW 4/												0.041 (5.01)		
Rho	-0.283 (1.59)		0.270 (1.45)						0.232 (1.29)	0.459 (2.77)			0.280 (1.59)	
SEE	0.014	0.021	0.017	0.013	0.018	0.019	0.019	0.034	0.019	0.014	0.013	0.016	0.020	0.017
$\overline{R}^2$ 5/	0.38	0.58	0.33	0.25	0.10	0.32	0.48	0.31	0.29	0.33	0.42	0.58	0.11	0.18
D.W.	1.88	2.13	2.00	1.58	2.18	1.61	2.05	1.83	1.96	1.94	1.73	1.94	1.94	2.08

1/ The t-statistics are in parentheses.

2/ Exact algebraic form of the equations and variable definitions are given in Table 1. All variables log first differences (excluding dummies).

3/ The four dummy variables D74.1, D74.2, D75.1 and D75.2 all equal 1 in the period given, and zero elsewhere. These variables attempt to capture the effects of structural shifts in the country composition of import baskets which occurred in the wake of the first oil shock. Increases in the level and cross-country variance of manufactures prices at that time caused switches in demand patterns which in turn led to a general reduction in the level of import prices relative to export price indices based on traditional trade patterns. Accordingly, all of these variables carry negative coefficients.

4/ DUMW equals 1 in 78.1, 78.2 and -1 in 79.1, 79.2. This variable captures the effect of the lagged response of Swiss manufactured import prices to the rapid appreciation of the Swiss Franc in 1978.

5/ As a result of coefficient restrictions imposed on these equations, $\overline{R}^2$ gives the proportion of explained variation in the difference between the rate of change in MPM and the rate of change in WXPM.

Table 6. Fourteen Industrial Countries: Estimates of Equations for Domestic Wholesale Price of Manufactures. First Half 1963-Second Half 1979 1/

(See equation 3, Table 1)

Explanatory Variable 2/	Austria 3/	Belgium/ Luxembourg	Canada	Denmark	France	Fed. Rep. Germany	Italy	Japan	Nether-lands	Norway 3/	Sweden	Switzer-land	United Kingdom	United States
Export price of manufactures							0.436 (6.81)				0.598 (10.32)		0.376 (2.82)	0.169 (3.11)
Export price of manufactures (-1)													0.320 (2.74)	
Import price of manufactures	0.638 (8.44)	0.283 (5.01)	0.319 (4.38)	0.456 (3.90)	0.099 (2.01)		0.116 (1.93)		0.306 (3.74)	0.734 (3.13)				0.091 (1.62)
Import price of manufactures (-1)		0.249 (3.78)					0.153 (2.65)							
Normal unit labor costs		0.468 (6.19)	0.205 (5.06)	0.544 (4.65)	0.097 (2.66)	0.180 (1.24)	0.216 (3.80)	0.282 (3.82)	0.548 (6.28)			0.610 (18.23)	0.304 (2.94)	0.582 (3.03)
Normal unit labor costs (-1)					0.277 (2.38)	0.411 (3.51)								
Domestic raw material prices			0.213 (7.74)			0.409 (7.04)	0.079 (3.80)	0.342 (11.67)	0.146 (2.49)		0.402 (6.94)	0.375 (12.04)		0.064 (3.31)
Domestic raw material prices (-1)														0.047 (2.27)
Energy price					0.027 (2.59)							0.015 (3.27)		0.047 (4.82)
Energy price (-1)														
Domestic wholesale price of manufactures (-1)	0.362 (4.78)		0.263 (3.07)		0.500 (3.67)					0.266 (1.13)				
SEE	0.012	0.010	0.007	0.019	0.009	0.010	0.011	0.013	0.013	0.024	0.009	0.005	0.014	0.007
$\overline{R}^2$	0.32	0.61	0.82	0.30	0.74	0.59	0.83	0.89	0.41	0.26	0.76	0.84	0.57	0.82
D.W.	1.67	1.37	1.73	1.89	1.82	1.95	1.49	1.62	1.87	1.46	1.42	2.21	1.79	1.65

1/ The t-statistics are in parentheses.
2/ Exact algebraic form of the equations and variable definitions are given in Table 1. All variables log first differences.
3/ First half 1966-second half 1979.

Table 7. Fourteen Industrial Countries: Estimates of Export Unit Value Equations for Raw Materials. First Half 1963-Second Half 1979 1/

(See equation 4, Table 1)

Explanatory Variable 2/	Austria 3/	Belgium/ Luxembourg	Canada	Denmark	France	Fed. Rep. Germany	Italy	Japan	Nether-lands	Norway	Sweden	Switzer-land	United Kingdom	United States
Spot commodity prices	0.287	0.179	0.309	0.228	0.300	0.109		0.160			0.603	0.088	0.093	0.280
	(1.99)	(3.50)	(2.69)	(1.68)	(3.42)	(1.48)		(1.39)			(7.59)	(1.70)	(1.66)	(2.96)
Spot commodity prices (-1)			0.406	0.252	0.191	0.181	0.214	0.135		0.214	0.205		0.176	0.211
			(3.47)	(1.70)	(2.30)	(2.62)	(6.19)	(1.17)		(3.35)	(1.93)		(3.30)	(2.25)
Spot commodity prices (-2)											0.174			
											(1.94)			
Normal unit labor costs				0.883				0.559				0.837	0.264	0.231
				(1.55)				(1.18)				(3.06)	(1.66)	(0.76)
Energy price		0.104			0.180	0.160	0.155			0.112			0.072	
		(3.52)			(5.43)	(5.95)	(6.84)			(3.08)			(2.03)	
Energy price (-1)					0.082		0.073			0.129	0.060		0.106	0.210
					(2.07)		(2.30)			(3.52)	(1.67)		(2.72)	(5.20)
Export unit value raw materials (-1)	0.492	0.440		0.285		0.272	0.205	0.390						
	(3.13)	(3.95)		(1.82)		(2.05)	(2.10)	(1.99)						
Seasonal dummy 4/						-0.026						0.014		-0.031
						(2.21)						(1.22)		(2.49)
SEE	0.059	0.032	0.043	0.101	0.040	0.032	0.025	0.086		0.041	0.031	0.033	0.034	0.034
$\overline{R}^2$	0.27	0.64	0.27	0.45	0.77	0.73	0.87	0.34		0.52	0.77	0.25	0.64	0.78
D.W.	1.45	1.98	1.68	2.06	1.84	1.86	1.65	1.62		1.75	1.94	1.90	1.99	1.94

1/ The t-statistics are in parentheses.
2/ Exact algebraic form of the equations and variable definitions are given in Table 1. All variables in log first differences.
3/ Equation for Austria estimated over second half 1965-second half 1979.
4/ Seasonal dummy variable takes values which alternate between + 1/2 and - 1/2, so giving a mean effect of zero.

Table 8. Fourteen Industrial Countries: Estimates of Import Unit Value Equations for Raw Materials. First Half of 1962 - Second Half of 1979 1/

(See equation 5, Table 1)

Explanatory Variable 2/	Austria 3/	Belgium/ Luxembourg	Canada	Denmark	France	Fed. Rep. Germany	Italy	Japan	Nether-lands	Norway	Sweden	Switzer-land	United Kingdom	United States
Partner country export prices	1.017 (9.13)	0.990 (12.35)		0.997 (10.52)	0.883 (8.76)	0.802 (9.52)	0.596 (2.59)	0.449 (5.40)	1.096 (11.f2)	0.503 (2.29)	0.819 (7.06)	0.591 (8.01)	0.636 (9.20)	0.403 (2.20)
Partner country export prices(-1)			0.475 (3.95)							0.289 (1.74)		0.292 (3.92)		0.392 (2.02)
Spot commodity prices			0.199 (0.12)		0.095 (1.65)			0.429 (6.84)		0.228 (1.57)				
Spot commodity prices (-1)			0.223 (1.63)		0.176 (2.64)	0.296 (5.67)	0.458 (2.47)	0.244 (3.32)					0.356 (6.62)	
Seasonal dummy 4/			-0.047 (3.14)								-0.064 (4.68)			
Dummy 1 5/				0.181 (7.95)										
SEE	0.031	0.023	0.044	0.028	0.027	0.019	0.069	0.030	0.029	0.035	0.041	0.025	0.021	0.053
$\bar{R}^2$	0.73	0.81	0.52	0.92	0.89	0.88	0.58	0.88	0.79	0.60	0.85	0.76	0.92	0.29
D.W.	2.58	1.88	2.31	1.70	1.91	2.26	2.53	1.79	2.15	2.53	1.70	2.24	2.60	2.22

1/ The t-statistics are in parentheses.
2/ Exact algebraic form of the equations and variable definitions are given in Table 1.
3/ First half 1962-second half 1979.
4/ Mean effect of seasonal dummy term is zero.
5/ Dummy variable for Denmark equals 1 in 1974.1, -1 in 1975.2 and zero elsewhere.

Table 9. Fourteen Industrial Countries: Estimates of Equations for Domestic Wholesale Prices of Raw Materials. First Half of 1962 - Second Half of 1979 1/

(See equation 6, Table 1)

Explanatory Variable 2/	Austria	Belgium/ Luxembourg	Canada	Denmark	France	Fed. Rep. Germany	Italy	Japan	Netherlands	Norway	Sweden	Switzerland	United Kingdom	United States
Spot commodity prices, import weighted		0.311 (10.22)	0.342 (5.99)		0.409 (7.42)	0.122 (3.00)	0.280 (4.14)	0.399 (7.60)	0.088 (2.40)	0.404 (7.57)		0.512 (1.52)	0.226 (4.75)	
Spot commodity prices import weighted (-1)	0.211 (4.50)			0.263 (4.00)	0.196 (3.49)	0.180 (4.29)	0.202 (2.64)		0.146 (3.93)		0.125 (6.01)	0.146 (3.97)	0.166 (3.10)	
Spot commodity prices export weighted														0.648 (6.33)
Spot commodity prices export weighted (-1)														0.390 (3.81)
Normal unit labor costs	0.294 (3.62)	0.447 (4.41)				0.300 (2.73)			0.415 (4.45)		0.194 (2.22)	0.499 (2.98)	0.381 (5.32)	
Normal unit labor costs (-1)	0.271 (3.19)			0.331 (1.28)										
Energy price	0.097 (5.27)	0.048 (3.32)	0.066 (2.10)	0.365 (8.98)	0.123 (5.40)	0.078 (5.02)	0.408 (13.97)	0.259 (11.25)	0.133 (8.83)	0.084 (4.23)	0.126 (8.97)	0.061 (3.44)	0.195 (9.30)	
Energy price (-1)								0.141 (6.28)						
Domestic wholesale price of raw materials (-1)			0.445 (3.65)							0.459 (4.83)	0.335 (4.65)			
SEE	0.019	0.014	0.024	0.045	0.027	0.016	0.033	0.024	0.014	0.019	0.016	0.018	0.021	0.047
$\bar{R}^2$	0.71	0.85	0.76	0.79	0.84	0.76	0.92	0.93	0.89	0.77	0.86	0.73	0.90	0.74
D.W.	1.86	1.99	2.15	1.81	1.58	1.78	2.23	1.66	1.61	2.43	1.86	1.63	2.11	1.85

1/ The t-statistics are in parentheses.
2/ Exact algebraic form of the equations and variable definitions are given in Table 1. All variables in log differences.

Table 10. Fourteen Industrial Countries: Estimates of Export Unit Value Equations for Agricultural Goods. First Half of 1963 - Second Half of 1979 1/

(See equation 7, Table 1)

Explanatory variable 2/	Austria 3/	Belgium/ Luxembourg	Canada	Denmark	France	Fed. Rep. of Germany	Italy	Japan	Netherlands	Norway	Sweden	Switzerland	United Kingdom	United States
Spot commodity prices			0.185 (6.44)	0.129 (1.73)	1.118 (1.76)	0.081 (1.11)		0.105 (1.44)		0.293 (3.38)	0.131 (1.45)	0.060 (2.01)	0.093 (2.49)	0.461 (10.68)
Spot commodity prices (-1)			0.277 (6.69)		0.140 (2.02)	0.077 (1.04)	0.256 (2.81)			0.370 (4.27)	0.414 (4.68)		0.069 (1.70)	0.198 (4.31)
Spot commodity prices (-2)						0.052 (0.70)				0.201 (2.24)				
Normal unit labor costs	0.766 (1.80)	0.647 (3.95)		0.770 (3.64)				0.370 (0.94)	0.270 (1.09)		0.513 (2.22)		0.372 (3.38)	0.494 (2.70)
Normal unit labor costs(-1)					0.706 (3.66)				0.335 (1.36)					
Energy price			0.206 (8.04)									0.033 (1.32)		
Export unit value agricultural goods (-1)								0.272 (1.43)				0.153 (0.86)	0.307 (2.31)	
Seasonal dummy 4/						0.016 (1.25)								-0.022 (2.34)
SEE	0.097	0.027	0.021	0.042	0.040	0.038	0.074	0.071	0.019	0.050	0.050	0.030	0.023	0.027
$\bar{R}^2$	0.10	0.14	0.94	0.08	0.27	0.05	0.17	0.23	0.0.	0.40	0.44	0.12	0.59	0.88
D.W.	2.54	1.77	2.14	1.98	2.11	2.71	1.91	1.44	2.31	1.94	1.96	1.80	2.24	2.43

1/ The t-statistics are in parentheses.
2/ Exact algebraic form of the equations and variable definitions are given in Table 1.
3/ Estimated over second half 1965-second half 1979.
4/ Mean effect of seasonal dummy term is zero.

Table 11. Fourteen Industrial Countries: Estimates of Import Unit Value Equations for Agricultural Goods. First Half 1962-Second Half 1979 1/

(See equation 8, Table 1)

Explanatory Variable 2/	Austria 3/	Belgium/ Luxembourg	Canada	Denmark	France	Fed. Rep. Germany	Italy	Japan	Nether-lands	Norway	Sweden	Switzer-land	United Kingdom	United States
Partner country export prices		0.555 (1.93)		0.936 (5.74)	0.544 (3.71)	0.553 (2.91)	0.547 (4.77)	0.335 (2.30)	0.197 (2.4)	0.619 (3.50)	0.399 (3.33)	0.324 (3.25)	0.593 (6.71)	0.354 (2.11)
Partner country export prices(-1)	0.336 (1.34)	0.187 (0.75)					0.260 (2.83)							
Spot commodity prices	0.237 (4.02)		0.560 (8.89)		0.188 (3.24)	0.113 (1.74)	0.106 (1.84)	0.355 (3.49)		0.273 (4.58)	0.195 (6.10)	0.195 (4.98)		0.321 (4.30)
Spot commodity prices (-1)	0.109 (1.76)		0.148 (2.27)		0.103 (2.28)		0.097 (1.61)	0.279 (4.53)		0.206 (3.58)	0.090 (2.23)	0.176 (6.37)	0.239 (3.76)	0.114 (1.64)
Spot commodity prices (-2)			0.172 (2.67)											0.108 (1.57)
Import unit value, agricultural goods (-1)									0.578 (4.66)		0.355 (3.14)			
Seasonal dummy 4/										0.042 (3.81)				
SEE	0.035	0.054	0.040	0.037	0.028	0.032	0.024	0.039	0.016	0.032	0.023	0.017	0.028	0.046
$\bar{R}^2$	0.44	0.61	0.71	0.28	0.65	0.31	0.77	0.83	0.55	0.68	0.76	0.84	0.63	0.46
D.W.	1.84	1.72	1.53	1.57	2.32	2.49	2.33	2.26	1.91	3.02	1.99	1.92	1.90	1.80

1/ The t-statistics are in parentheses.
2/ Exact algebraic forms of the equations and variable definitions are given in Table 1. All variables in log first differences.
3/ Estimated over first half 1965-second half 1979.
4/ Mean effect of seasonal dummy term is zero.

Table 12. Fourteen Industrial Countries: Estimates of Volume Equations for Manufactured Imports, 1/ First Half of 1964-Second Half of 1979

(See equation 9, Table 2)

Explanatory variable 2/	Austria	Belgium/ Luxembourg	Canada	Denmark	France	Fed. Rep. of Germany 3/	Italy	Japan 3/	Netherlands	Norway	Sweden	Switzerland	United Kingdom	United States 3/
Demand relative to potential output	1.374	1.044	1.329	1.706	1.886	1.745	1.568	2.445	1.126	2.488	1.869	1.333	1.797	1.217
	(5.67)	(4.32)	(8.25)	(7.28)	(7.52)	(16.29)	(7.85)	(11.75)	(4.61)	(5.65)	(6.13)	(8.48)	(5.56)	(4.05)
Potential output 4/	1.12	1.50	1.42	1.84	1.226	1.663	2.00	1.856	2.00	1.68	2.00	1.94	1.226	1.75
					(2.43)	(14.00)		(5.67)					(2.86)	
Relative price 5/	0.802	0.696	0.715	1.137	0.595	0.765	0.942	0.973	1.216	0.839	0.940	0.251	0.753	1.056
	(1.24)	(3.17)	(4.18)	(2.08)	(3.39)	(6.75)	(4.04)	(3.62)	(2.84)	(1.73)	(1.77)	(1.04)	(3.59)	(2.92)
Constant	6.729	8.066	8.210	7.80	7.92	8.656	8.197	9.182	8.596	6.529	7.656	7.343	7.550	8.565
	(40.23)	(191.63)	(333.83)	(67.99)	(18.32)	(77.48)	(208.26)	(17.97)	(56.64)	(28.56)	(36.43)	(57.08)	(49.69)	(69.30)
Seasonal dummy	0.014	-0.040	-0.059	-0.025	-0.078				-0.025	-0.015	-0.035		-0.047	
	(1.85)	(6.37)	(5.41)	(3.00)	(10.37)				(3.63)	(2.04)	(4.79)		(3.30)	
Time trend	0.014	0.004	0.002	-0.015	0.022	0.013		-0.043	-0.008	0.014	0.004	0.012	0.031	0.017
	(2.48)	(3.10)	(3.34)	(4.28)	(1.63)	(3.80)		(2.74)	(1.89)	(2.47)	(0.82)	(3.44)	(5.92)	(3.59)
Dummy 1	0.078				0.083	-0.103	0.102	0.090	0.101			-0.177	0.048	0.029
	(4.49)				(2.89)	(5.39)	(2.41)	(2.95)	(2.83)			(6.54)	(2.31)	(2.87)
Dummy 2	-0.061	-0.067			-0.049		-0.065		0.027	-0.027			0.088	
	(2.30)	(4.64)			(2.80)		(1.86)		(1.01)	(0.76)			(1.91)	
Rho	0.504	0.482		0.666	0.267		0.198	0.268	0.773	0.854	0.847	0.807		
	(3.38)	(3.03)		(4.97)	(1.53)		(2.01)	(1.64)	(12.20)	(14.19)	(15.33)	(19.25)		
SEE	0.030	0.024	0.03	0.037	0.025	0.023	0.042	0.049	0.030	0.038	0.037	0.029	0.039	0.064
$\overline{R}^2$	0.98	0.92	0.87	1.00	1.00	1.00	0.92	0.99	0.96	0.90	0.93	0.89	0.99	0.90
D.W.	1.67	1.57	1.66	2.10	1.79	1.65	2.21	1.88	1.96	1.77	2.24	2.14	1.43	2.20

1/ Exact algebraic forms of the equations and variable definitions are given in Table 1. The t-statistics are in parentheses.
2/ All non-dummy variables in log levels.
3/ Estimated over first half 1962-second half 1979.
4/ Derivation of restriction values for coefficients without t values is given in the Appendix.
5/ Only the total long-run elasticity and its t value are given here. See Table 13 for the lag distribution of this effect.

Table 13. Relative Price Lag Distributions From Manufactured Imports Equations 1/

	Austria	Belgium/ Luxembourg	Canada	Denmark	France	Fed. Rep. Germany	Italy	Japan	Netherlands	Norway	Sweden	Switzerland	United Kingdom	United States
Time delay in six-month units														
t	0.029		0.715	0.546		0.574	0.942	0.159	0.708			0.251	0.595	
t-1	0.327			0.379	0.489	0.191		0.556	0.508				0.158	1.056
t-2	0.350	0.696		0.212	0.106			0.258		0.232	0.940			
t-3	0.096									0.342				
t-4										0.265				
Sum of weights 2/	0.802 (1.24)	0.696 (3.17)	0.715 (4.18)	1.137 (2.08)	0.595 (3.39)	0.765 (6.75)	0.942 (4.04)	0.973 (3.62)	1.216 (2.84)	0.839 (1.73)	0.940 (1.77)	0.251 (1.04)	0.753 (3.59)	1.056 (2.92)
Average lag length 3/	1.64	2.0	--	0.71	1.18	0.25	--	1.10	0.42	3.04	2.00	--	0.21	1.00
Degree of poly 4/	2	--	--	1	1	1	--	2	1	2	--	--	1	--
Test of poly restrictions 5/	CH2(1) = 1.70			CH2(1) = 3.16										

1/ Total weights only are shown in Table 12.
2/ Represents long-run elasticity. t value for total weight given in parentheses.
3/ Measured in six-month units.
4/ Note, no end point restrictions applied.
5/ Test is 2 ln(Lu/Lr) ~ $\chi^2(r)$ (or CH2(r)) where r = number of restrictions and Lu, Lr are unrestricted and restricted likelihood values, respectively. Because of the generally short length of the lag distributions, the polynomial restrictions are found to be binding in only 2 of the 14 equations. In both of these cases the validity of the restrictions cannot be rejected at the 5 percent significance level.

Table 14. Fourteen Industrial Countries: Estimates of Volume Equations for Manufactured Exports. 1/ First Half 1963-Second Half 1979

(See equation 10, Table 2)

Explanatory Variable 2/	Austria	Belgium/ Luxembourg	Canada	Denmark	France	Fed. Rep. Germany	Italy	Japan	Netherlands	Norway	Sweden	Switzerland 3/	United Kingdom 4/	United States
Foreign demand	0.611	0.908	0.369	1.521	0.532	1.075	0.910	0.806	1.333	1.101	0.746	1.138	0.846	0.655
	(5.92)	(5.79)	(4.31)	(12.06)	(4.37)	(54.95)	(9.35)	(4.65)	(7.28)	(5.28)	(3.81)	(4.43)	(54.15)	(7.32)
Foreign demand (-1)		0.275	0.318		0.402			0.467			0.518			
		(1.81)	(3.53)		(3.36)			(2.54)			(2.96)			
Potential output relative to competitors	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Relative price 6/	-1.372	-1.552	-0.708	-1.133	-1.245	-1.411	-0.638	-1.608	-0.885	-1.485	-1.594	-0.727	-0.306	-1.669
	(6.28)	(3.09)	(2.75)	(7.49)	(3.82)	(3.23)	(0.81)	(6.46)	(1.79)	(5.22)	(5.01)	(1.25)	(1.52)	(8.07)
Capacity utilization relative to competitors														0.649
														(2.62)
Constant	1.925	-0.958	2.250	-2.912	0.510	-0.832	0.633	-2.246	-2.102	-0.810	-2.182	-1.277	1.228	2.908
	(3.05)	(1.16)	(2.47)	(4.08)	(4.50)	(4.37)	(0.73)	(2.08)	(1.67)	(0.71)	(2.93)	(0.62)	(8.46)	(4.00)
Seasonal dummy	0.038	-0.039	-0.025		-0.068	0.015		0.087			-0.027	0.029	-0.044	-0.032
	(5.77)	(4.23)	(4.04)		(10.91)	(2.09)		(6.29)			(2.80)	(7.30)	(3.32)	(5.40)
Time trend 5/	0.020	-0.021	-0.003	-0.025		0.029		-0.018	-0.019	-0.006	-0.004			0.004
	(4.74)	(4.02)	(0.41)	(4.82)		(1.12)		(2.85)	(2.31)	(0.70)	(0.65)			(0.83)
Dummy 1	0.037	0.016	0.099			0.055	0.068					-0.213		
	(4.23)	(2.04)	(4.29)			(2.65)	(5.83)					(7.30)		
Dummy 2	0.088					-0.047								
	(3.82)					(2.75)								
Rho	0.314	0.313	0.664		0.314				0.263			0.774	-0.208	0.256
	(1.93)	(2.12)	(7.50)		(1.79)				(1.60)			(7.75)	(1.16)	(1.54)
SEE	0.022	0.026	0.028	0.036	0.021	0.019	0.041	0.038	0.036	0.047	0.027	0.033	0.029	0.021
$\bar{R}_2$	1.00	0.99	0.94	0.99	1.00	1.00	0.89	0.99	0.99	0.98	1.00	0.98	0.99	0.99
D.W.	1.58	2.03	1.76	1.79	1.59	1.79	2.46	1.90	2.10	1.94	1.66	2.01	1.98	2.11

1/ The t statistics are in parentheses.
2/ Exact algebraic form of the equations and variable definitions are given in Table 2. All variables log levels excluding dummies.
3/ Estimated over first half 1968 to second half 1979.
4/ Estimated over second half 1964 to second half 1979.
5/ The coefficient in this row for Germany corresponds not to a time trend, but to a third dummy variable.
6/ Only the total long-run elasticity and its t-value are given here. See Table 15 for the lag distribution of this effect.

Table 15. Relative Price Lag Distributions From Manufactured Exports Equations 1/

Time Delay in 6-Month Units	Austria	Belgium/ Luxembourg	Canada	Denmark	France	Fed. Rep. of Germany	Italy	Japan	Netherlands	Norway	Sweden	Switzerland	United Kingdom	United States
t	-0.549	-0.177	-0.075	-0.820	-0.204		-0.318	-0.594	-0.242	-0.401	-0.272	-0.263		-0.183
t-1	-0.384	-0.417	-0.327	-0.313	-0.274	-0.088	-0.192	-0.418	-0.249	-0.339	-0.454	-0.198		-0.296
t-2	-0.247	-0.484	-0.303		-0.297	-0.155	-0.096	-0.276	-0.216	-0.278	-0.477	-0.139		-0.353
t-3	-0.137	-0.377	-0.003		-0.271	-0.201	-0.032	-0.169	-0.144	-0.217	-0.342	-0.087		-0.354
t-4	-0.055	-0.097			-0.198	-0.226		-0.095	-0.033	-0.155	-0.049	-0.040	-0.009	-0.298
t-5						-0.231		-0.056		-0.094			-0.047	-0.185
t-6						-0.214							-0.069	
t-7						-0.177							-0.075	
t-8						-0.119							-0.066	
t-9													-0.041	
Sum of weights 2/	-1.372	-1.552	-0.708	-1.133	-1.245	-1.411	-0.638	-1.608	-0.885	-1.485	-1.594	-0.727	-0.306	-1.669
	(6.28)	(3.09)	(2.75)	(7.49)	(3.82)	(3.23)	(0.81)	(6.46)	(1.79)	(5.22)	(5.01)	(1.25)	(1.52)	(8.07)
Average lag length 3/	1.10	1.87	1.33	0.28	1.99	4.63	0.75	1.33	1.41	1.78	1.65	1.23	6.37	2.50
Degree of poly	2	2	2	1	2	2	2	2	2	1	2	2	2	2
End point zero restrictions 4/	far	none	none	none	none	near	far	none	none	none	none	far	far	none
Test of poly restrictions 5/	CH2(3) =5.22	CH2(2) =0.0	CH2(1) =0.2	—	CH2(2) =3.3	CH2(6) =18.78*	CH2(2) =1.78	CH2(3) =12.5*	CH2(2) =3.8	CH2(4) =18.2*	CH2(2) =0.2	CH2(3) =0.78	CH2(4) =1.2	CH2(3) =1.6

1/ Total weights only are shown in Table 14.
2/ Represents long-run elasticity. t-value for total weight given in brackets.
3/ Measured in six-month units.
4/ none: no restrictions; far: far end point restriction; near: near end point restriction.
5/ Test is 2 ln(Lu/Lr) ~ $X^2(r)$ or CH2(r) where r = number of restrictions and Lu, Lr are unrestricted and restricted likelihood values respectively. An asterisk indicates that the null hypothesis that the polynomial restrictions are valid; can be rejected at the 5 percent significance level.

Table 16. World Trade Model: Relative Price Elasticities for Trade in Manufactures 1/

Country	Imports			Exports		
	Impact elasticity	Short-run elasticity	Long-run elastitiey	Impact elasticity	Short-run elasticity	Long-run elasticity
Austria	0.03 (0.19)	0.36	0.80 (1.24)	-0.55 (2.44)	-0.93	-1.37 (6.28)
Belgium	--	--	0.70 (3.17)	-0.18 (0.75)	-0.59	-1.55 (3.09)
Canada	0.72 (4.24)	0.72	0.72 (4.18)	-0.08 (0.36)	-0.40	-0.71 (2.75)
Denmark	0.55 (2.29)	0.93	1.14 (2.08)	-0.82 (3.04)	-1.13	-1.13 (7.49)
France	--	0.49	0.60 (3.39)	-0.20 (1.11)	-0.48	-1.25 (3.82)
Fed. Rep. of Germany	0.57 (2.85)	0.77	0.77 (6.75)	--	-0.09	-1.41 (3.23)
Italy	0.94 (4.09)	0.94	0.94 (4.04)	-0.32 (0.41)	-0.51	-0.64 (0.81)
Japan	0.16 (0.73)	0.72	0.97 (3.62)	-0.59 (3.69)	-1.01	-1.61 (6.46)
Netherlands	0.71 (2.29)	1.22	1.22 (2.84)	-0.24 (0.92)	-0.49	-0.89 (1.79)
Norway	--	--	0.84 (1.73)	-0.40 (5.00)	-0.74	-1.49 (5.22)
Sweden	--	--	0.94 (1.77)	-0.27 (1.42)	-0.73	-1.59 (5.01)
Switzerland	0.25 (1.04)	0.25	0.25 (1.04)	-0.26 (1.65)	-0.46	-0.73 (1.25)
United Kingdom	0.60 (2.22)	0.75	0.75 (3.59)	--	--	-0.31 (1.52)
United States	--	1.06	1.06 (2.92)	-0.18 (1.00)	-0.48	-1.67 (8.07)

1/ The impact elasticity gives the response in the current semester, the short-run elasticity gives the response after 2 semesters (1 year) and the long-run elasticity gives the total response. t-values are given in parentheses.

Table 17. Volume of Auto Trade Between Canada and the United States

Canadian Imports (j = United States, i = Canada)

$$\ln XVC_j = \underset{(3.97)}{3.075} + \underset{(2.68)}{0.874}\ln AVG_i + \underset{(3.07)}{0.158}\ln XVC_i + \underset{(2.87)}{0.424}\ln (XVC_j)_{-1} - \underset{(1.82)}{0.160}\,D197002 - \underset{(2.38)}{0.077}\,SD$$

$\overline{R}^2 = 0.98$ S.E.E. = 0.081 D,W, = 2.09 h = -0.74

Sample: 1965:I - 1979:II

U.S. imports (j = Canada, i = United States)

$$\ln XVC_j = \underset{(116.00)}{7.551} + \underset{(3.49)}{1.009}\ln AVG_i + \underset{(1.45)}{0.489}\ln (AVG_i/AVG_j) - \underset{(6.86)}{0.099}\,SD - \underset{(2.26)}{0.123}\,D197002 - \underset{(3.14)}{0.211}\,D197902$$

$\overline{R}^2 = 0.77$ S.E.E. = 0.063 D.W. = 1.91 rho = 0.733 (56.15)

sample: 1965:I - 1979:II

Description of variables 1/

AVG_i* Index of domestic demand in country i, defined in Table 2.

D197002 Represents impact of U.S. auto workers strike in late 1970.
D197002 = 1 in 1970:II
= 0 elsewhere

D197902 Represents extraordinary slowdown in Canadian automotive exports in late 1979, due to general low level of productive activity combined with industrial disputes.
D197902 = 1 in 1979:II
= 0 elsewhere

SD Seasonal dummy variable
SD = 1 first semester
= 0 second semester

XC_i* Current US$ value of automotive exports from country i to country j (i, j = 111, 156).

XVC_i* Measure of import volume of autmotive products into country j from country i (i, j = 111, 156) in constant 1970 US$ prices. Current US$ value is deflated by dollar unit value index of manufactured imports, i.e.,
$XVC_i = XC_i/(MPM_j/LCD_j)$
where XC_i is defined above, and MPM_i, LCD_i are define in Table 1.

1/ Endogenous variables indicated by an asterisk.

Table 18. Fourteen Industrial Countries: Estimates of Volume Equations for Imports of Raw Materials 1/
First Half 1962-Second Half 1979

(See equation 11, Table 2)

Explanatory Variable 2/	Austria	Belgium/ Luxembourg	Canada	Denmark	France	Fed. Rep. Germany	Italy	Japan	Nether- lands	Norway	Sweden	Switzer- land	United Kingdom	United States
Output in manufacturing	1.508	0.290	0.145	0.278	0.828	0.280	0.600	0.212	0.303	0.060	0.189	0.409		0.343
	(16.93)	(3.58)	(1.53)	(2.55)	(8.50)	(1.76)	(4.01)	(2.63)	(4.34)	(0.36)	(2.70)	(3.22)		(2.96)
Output in manufacturing first difference		1.406	0.637	1.406	0.369	0.771	0.432	1.292	1.341	0.428	1.389	0.323	1.639	0.658
		(6.04)	(1.50)	(2.65)	(1.95)	(3.70)	(1.25)	(4.97)	(3.59)	(0.56)	(3.63)	(1.49)	(5.78)	(2.29)
Relative price				0.150									0.073	
				(2.08)									(1.31)	
Relative price(-1)					0.223	0.160			0.164	0.442		0.259		
					(2.58)	(2.20)			(1.56)	(2.66)		(2.73)		
Imports of raw materials(-1)		0.608	0.824	0.606		0.609	0.267	0.725	0.528	0.754	0.791		0.638	0.549
		(5.30)	(6.06)	(4.51)		(4.51)	(1.57)	(6.58)	(5.45)	(6.05)	(6.07)		(7.54)	(3.99)
Constant	5.171	2.541	1.018	1.995	7.040	2.965	5.260	2.179	2.985	1.268	1.027	5.202	2.643	3.347
	(208.4)	(3.38)	(1.27)	(2.92)	(271.7)	(2.75)	(4.33)	(2.47)	(4.77)	(1.98)	(1.48)	(186.6)	(4.27)	(3.25)
Seasonal dummy			0.041		-0.099	0.018	-0.050	-0.031	0.055		0.132	-0.022		0.039
			(0.75)		(2.58)	(1.27)	(1.86)	(1.84)	(1.49)		(4.01)	(2.03)		(2.37)
Dummy 1	0.065				-0.069				-0.152			-0.163	0.033	
	(2.77)				(3.44)				(2.95)			(5.87)	(2.07)	
Dummy 2	-0.102			0.134				-0.077						
	(2.44)			(1.28)				(1.47)						
Rho	0.465	-0.542	-0.525	-0.378	0.758	-0.218			-0.529	-0.620	-0.364	-0.483	-0.225	0.199
	(3.18)	(3.88)	(3.58)	(2.32)	(7.93)	(1.30)			(4.11)	(4.58)	(2.28)	(3.32)	(1.22)	(1.29)
SEE	0.043	0.041	0.077	0.088	0.035	0.032	0.077	0.050	0.052	0.093	0.060	0.044	0.044	0.056
$\bar{R}^2$	0.98	0.95	0.81	0.79	0.97	0.98	0.90	0.98	0.93	0.81	0.75	0.86	0.66	0.82
DW	1.94	1.68	1.65	1.75	2.06	2.09	1.89	1.40	2.02	2.11	1.85	2.03	1.85	2.04

1/ The t-statistics are in parentheses.
2/ Exact algebraic form of the equations and variable definitions are given in Table 2.

Table 19. Fourteen Industrial Countries: Estimates of Volume Equations for Exports of Raw Materials 1/
First Half 1962-Second Half 1979

(See equation 12, Table 2)

Explanatory Variable 2/	Austria	Belgium/ Luxembourg	Canada	Denmark	France	Fed. Rep. Germany	Italy	Japan	Nether- lands	Norway	Sweden	Switzer- land	United Kingdom	United States
Foreign demand	0.744	0.817	1.079	1.435	1.212	1.158	0.877	0.621	1.298	0.844	1.604	1.260	1.254	1.115
	(6.87)	(13.49)	(6.95)	(14.86)	(17.68)	(5.44)	(7.07)	(2.31)	(4.75)	(5.34)	(7.19)	(7.46)	(12.41)	(10.61)
Relative price			-0.854	-1.102		-0.780		-0.248		-0.649	-0.565	-0.723		-2.073
			(1.62)	(10.23)		(1.45)		(1.04)		(1.98)	(2.55)	(2.11)		(3.47)
Relative price(-1)		-0.359			-0.770	-0.929	-1.401							
		(1.26)			(3.80)	(1.60)	(3.83)							
Constant	1.214	0.976	-0.782	-2.035	-1.367	-1.037	0.592	2.046	-2.350	0.679	-3.347	-1.141	-1.573	-0.989
	(2.20)	(2.89)	(0.66)	(4.33)	(3.15)	(0.78)	(0.93)	(1.35)	(1.54)	(0.84)	(2.46)	(1.65)	(2.66)	(1.21)
Seasonal dummy		-0.037	0.053	-0.198	-0.052	0.033	-0.090	0.089	0.070	-0.043	0.095	-0.034	-0.090	-0.032
		(1.66)	(3.74)	(10.16)	(4.67)	(2.18)	(3.08)	(5.73)	(2.85)	(3.50)	(10.19)	(1.55)	(4.80)	(1.59)
Time trend									0.011		-0.024			
									(2.13)		(4.47)			
Rho	0.574		0.580	0.254	0.311	0.685		0.919		0.582	0.795	0.535	0.422	0.307
	(3.98)		(4.44)	(1.63)	(2.05)	(5.91)		(21.66)		(4.00)	(9.55)	(4.11)	(2.96)	(1.85)
SEE	0.065	0.067	0.065	0.071	0.043	0.070	0.086	0.086	0.074	0.056	0.049	0.095	0.078	0.078
$\overline{R}^2$	0.83	0.87	0.84	0.94	0.97	0.95	0.92	0.95	0.97	0.90	0.83	0.94	0.92	0.91
DW	2.02	1.53	2.10	2.07	2.07	2.05	1.49	2.48	1.58	2.14	2.05	1.81	2.18	2.08

1/ The t-statistics are in parentheses.
2/ Exact algebraic form of the equations and variable definitions are given in Table 2. All non-dummy variables in log-levels.

Table 20. Fourteen Industrial Countries: Estimates of Volume Equations for Imports of Agricultural Goods 1/
First Half 1962-Second Half 1979

(See equation 13, Table 2)

Explanatory Variable 2/	Austria	Belgium/ Luxembourg	Canada	Denmark	France	Fed. Rep. of Germany	Italy	Japan	Nether- lands	Norway	Sweden 3/	Switzer- land	United Kingdom	United States
Consumer expenditure	0.806	1.480	0.420	0.241	0.352	0.633	0.991	0.751	1.040	0.379		0.220	0.050	0.495
	(8.89)	(27.59)	(4.97)	(1.71)	(2.38)	(3.78)	(4.86)	(3.99)	(4.12)	(3.65)		(2.02)	(1.49)	(4.65)
Consumer expenditure(-1)											0.609			
											(8.75)			
Consumer expenditure, first difference							1.704					1.528		
							(3.02)					(3.35)		
Relative price		1.158	0.235			0.262		0.107		0.380				0.337
		(11.95)	(5.18)			(1.58)		(1.55)		(3.28)				(4.81)
Relative price(-1)											0.674		0.158	
											(7.00)		(3.66)	
Imports of agricultural goods(-1)			0.563	0.845	0.697	0.330	0.382	0.439	0.439	0.270		0.742		0.489
			(6.09)	(9.55)	(5.35)	(2.45)	(3.19)	(3.43)	(3.31)	(1.94)		(6.57)		(4.23)
Constant	5.054	6.491	2.647	0.878	2.228	5.238	4.417	4.071	3.860	3.645	5.819	1.551	7.813	4.119
	(233.4)	(349.2)	(4.56)	(1.81)	(2.420)	(4.95)	(5.14)	(4.48)	(4.28)	(5.45)	(446.0)	(2.26)	(513.5)	(4.44)
Seasonal dummy		0.021	0.207		-0.098	0.031		-0.045		-0.125	-0.027			
		(1.61)	(6.27)		(3.11)	(1.89)		(1.48)		(5.02)	(1.54)			
Dummy 1						0.140		0.054	-0.103				-0.029	-0.106
						(2.86)		(1.97)	(2.37)				(3.21)	(2.32)
Dummy 2								0.157						0.064
								(2.35)						(1.18)
Dummy 3														-0.142
														(3.08)
Rho	0.443	0.270	-0.478		-0.355		-0.384	-0.145				-0.533	-0.248	-0.574
	(3.10)	(1.62)	(3.25)		(2.56)		(2.69)	(0.85)				(3.65)	(1.55)	(4.08)
SEE	0.067	0.048	0.047	0.086	0.058	0.045	0.065	0.063	0.067	0.057	0.049	0.044	0.026	0.049
$\overline{R}^2$	0.89	0.98	0.96	0.91	0.96	0.97	0.96	0.98	0.98	0.91	0.80	0.90	0.42	0.84
DW	1.80	1.73	1.84	1.88	1.88	1.79	1.92	1.76	2.04	1.94	1.97	2.06	2.00	1.73

1/ The t-statistics are in parentheses.
2/ Exact algebraic form of the equations and variable definitions are given in Table 2. All non-dummy variables in log-levels.
3/ Estimated over first half 1964-second half 1979.

Table 21. Fourteen Industrial Countries: Estimates of Volume Equations for Exports of Agricultural Goods 1/
First Half 1962-Second Half 1979

(See equation 14, Table 2)

Explanatory Variable 2/	Austria	Belgium/ 3/ Luxembourg	Canada	Denmark	France	Fed. Rep. Germany 1/	Italy	Japan	Nether-lands	Norway	Sweden	Switzer-land	United Kingdom	United States
Foreign demand	1.398	1.366	0.631	0.733	1.686	1.945	1.222	0.501	1.761	1.069	0.877	0.735	1.551	0.947
	(14.01)	(24.78)	(4.36)	(3.90)	(17.46)	(15.49)	(19.28)	(1.46)	(26.95)	(5.84)	(8.74)	(2.86)	(25.79)	(6.54)
Relative price	-1.041	-0.829	-0.927	-0.415	-1.089	-1.279	-0.596	-0.723	-0.810	-0.518		-0.734	-0.334	
	(4.85)	(2.98)	(3.26)	(1.92)	(2.58)	(3.65)	(2.46)	(1.41)	(1.97)	(2.09)		(2.46)	(2.59)	
Relative price(-1)									-1.086					-0.769
									(2.63)					(1.64)
Constant	-1.773	-2.310	2.309	1.660	-5.024	-5.994	-1.567	2.447	-5.720	-5.579	0.540	1.043	-3.769	0.416
	(4.16)	(6.46)	(2.27)	(1.34)	(7.15)	(7.30)	(3.89)	(1.18)	(11.80)	(0.62)	(1.21)	(0.77)	(9.64)	(0.36)
Seasonal dummy			0.164	0.020	-0.075	-0.055	0.135		-0.033	0.038	-0.081	0.116	0.064	0.045
			(6.33)	(2.39)	(4.37)	(2.84)	(4.88)		(2.56)	(2.16)	(1.97)	(6.92)	(2.69)	(2.55)
Time trend														
Rho			0.377	0.794		0.326		0.509	0.352	0.432		0.838		0.699
			(2.42)	(7.71)		(1.51)		(3.45)	(2.37)	(2.99)		(11.56)		(5.95)
SER	0.119	0.041	0.105	0.045	0.072	0.053	0.081	0.195	0.052	0.073	0.123	0.080	0.071	0.083
$\overline{R}^2$	0.93	0.97	0.73	0.36	0.90	0.96	0.94	0.16	0.98	0.83	0.69	0.96	0.98	0.89
DW	1.52	1.53	2.03	2.07	2.07	1.85	1.56	2.66	1.67	2.19	1.50	2.35	2.28	1.95

1/ The t-statistics are in parentheses.
2/ Exact algebraic form of the equations and variable definitions are given in Table 2. All non-dummy variables are log-levels.
3/ Estimated over first half 1970-second half 1979.

Table 22. Fourteen Industrial Countries: Estimates of Volume Equations for Imports of Fuels
First Half 1964-Second Half 1979 1/

(See equation 15, Table 2)

Explanatory Variable 2/	Austria 3/	Belgium/ Luxembourg	Canada	Denmark	France	Fed. Rep. Germany	Italy	Japan	Nether-lands	Norway	Sweden	Switzer-land	United Kingdom	United States
Output in manufacturing	1.162 (18.70)	1.381 (14.32)	0.633 (16.46)	0.879 (15.85)	1.238 (40.40)	0.658 (3.50)	1.139 (21.57)	1.063 (18.04)	1.250 (2.70)	1.265 (4.08)	1.142 (6.22)	0.687 (9.00)	1.554 (11.20)	0.999 (3.10)
Output in manufacturing first difference		1.513 (2.85)												
Relative price	0.061 (1.28)	0.373 (5.86)	0.508 (2.28)	0.166 (6.75)	0.098 (5.22)	0.361 (6.69)	0.245 (9.10)	0.189 (3.22)	0.552 (4 97)	0.112 (1.11)	0.087 (1.61)	0.037 (1.17)	0.382 (1.08)	
Constant	4.799 (320.87)	6.140 (183.6)	5.872 (173.15)	5.363 (37.10)	7.029 (895.8)	6.296 (43.69)	6.941 (382.6)	7.529 (216.4)	5.396 (16.60)	4.869 (111.0)	5.749 (176.5)	5.138 (290.0)	7.038 (311.13)	6.312 (33.82)
Seasonal dummy	0.149 (8.11)	0.024 (1.47)	0.179 (2.78)			0.020 (2.78)	0.039 (2.05)				0.120 (7.22)	0.060 (3.14)		-0.025 (2.04)
Time trend						0.028 (6.29)			0.018 (1.62)					0.033 (5.77)
Embargo 4/		-0.061 (2.24)			-0.040 (1.07)	-0.051 (3.32)	-0.100 (2.68)		-0.117 (3.71)		-0.091 (2.45)			-0.073 (2.46)
Dummy 1		0.116 (3.06)		-0.106 (2.12)			-0.068 (1.86)					0.058 (2.67)		
Dummy 2	-0.166 (4.09)			-0.079 (3.29)		0.123 (4.69)						0.126 (2.52)		-0.166 (3.35)
Rho		0.377 (2.27)	-0.604 (4.30)		-0.322 (1.91)	0.505 (3.01)		0.742 (6.77)	0.571 (5.65)	0.604 (3.75)	0.414 (2.56)			0.739 (7.93)
SEE	0.049	0.053	0.075	0.047	0.038	0.027	0.050	0.046	0.061	0.077	0.063	0.047	0.083	0.060
$\overline{R}^2$	0.96	0.91	0.88	0.91	0.98	0.99	0.95	0.99	0.95	0.82	0.84	0.82	0.86	0.98
DW	1.41	1.91	1.69	1.98	2.14	2.11	1.91	2.02	1.57	1.85	1.41	2.12	1.23	1.70

1/ The t-statistics are in parentheses.
2/ Exact algebraic form of the equation and variable definitions are given in Table 2. All non-dummy variables in log-levels.
3/ Estimated second half 1965-second half 1979.
4/ The oil embargo dummy variable takes the values of 1 in 74.1, -1 in 74.2 and zero elsewhere for all countries except Norway, the United Kingdom and Belgium. For Norway and the United Kingdom the variable equals (1, -1) in 73.2, 74.1 and zero elsewhere. For Belgium, the variable equals (2, 1, -3) in 73.2, 74.1, 74.2 and zero elsewhere.

Table 23. Relative Price Lag Distributions From Imports of Fuels Equations 1/

Time Delay Six-Month Units	Austria	Belgium/ Luxembourg	Canada	Denmark	France	Fed. Rep. Germany	Italy	Japan	Nether-lands	Norway	Sweden	Switzer-land	United Kingdom	United States
t	0.019	0.243		0.045		0.093	0.071		0.341		0.087	0.037		
t-1	0.015	0.124		0.038	0.047	0.080	0.059		0.184	0.112			0.020	
t-2	0.012	0.005		0.031	0.033	0.067	0.047		0.027				0.080	
t-3	0.009		0.059	0.024	0.019	0.054	0.035	0.043					0.109	
t-4	0.005		0.152	0.017		0.041	0.023	0.057					0.105	
t-5	0.002		0.174	0.010		0.028	0.010	0.054					0.069	
t-6			0.123					0.035						
Sum of weights 2/	0.061 (1.28)	0.373 (5.86)	0.508 (2.28)	0.166 (6.75)	0.098 (5.22)	0.381 (6.69)	0.245 (9.10)	0.189 (3.32)	0.552 (4.97)	0.112 (1.11)	0.087 (1.61)	0.037 (1.17)	0.382 (1.08)	0.0
Average lag length 3/	1.56	0.36	4.71	1.77	1.72	1.87	1.63	4.44	0.43	1.0	0.0	0.0	3.32	--
Degree of poly	1	1	2	1	1	1	1	2	1	0	0	0	2	--
Test of poly 4/ restrictions	CH2(4) =1.76	--	CH2(2) =2.38	CH2(4) =5.58	CH2(1) =1.68	CH2(4) =12.62*	CH2(4) =5.90	CH2(2) =1.00	CH2(1) =0.06	--	--	--	CH2(3) =7.94*	--

1/ Total weights only are shown in Table 22.
2/ Represents "long-run" elasticity; t-values in brackets.
3/ Measured in six month units.
4/ Test is $2\ln(Lu/Lr) \sim \chi^2(r)$ (or CH2(r)) where r = number of restrictions, and Lu, Lr are unrestricted and restricted likelihood values, respectively. Asterisk indicates rejection at 5 percent level.

Table 24. Four Regions: Estimates of Equations for Aggregate Export and Import Unit Value Indices. First Half 1962 to Second Half 1979 1/

(See equations 16 and 17, Table 3)

Explanatory Variables 2/	Exports				Imports			
	Developed Primary Producing Countries	Centrally Planned Economies 3/	Major Oil Exporting Countries	Non-Oil Developing Countries	Developed Primary Producing Countries	Centrally Planned Economies 3/	Major Oil Exporting Countries	Non-Oil Developing Countries
Spot prices for raw materials and food	0.381 (8.26)			0.422 (14.23)				
Spot prices for raw materials and food (-1)				0.117 (3.28)				
World price of manufactures 4/	0.376 (3.03)	1.145 (28.65)		0.413 (6.13)				
Price of fuels 4/	0.096 (3.27)		1.223 (25.72)	0.083 (3.57)	0.133 (6.05)	0.235 (30.64)	0.016 (2.51)	0.184 (7.32)
Price of fuels (-1)	0.087 (2.54)				0.089 (4.22)			
World price of agricultural goods 4/							0.075 (4.22)	0.252 (3.81)
World price of raw materials 4/					0.312 (5.34)	0.123 (5.18)	0.034 (1.85)	0.169 (2.56)
Partner-country export prices					0.427 (5.37)	0.638 (23.22)	0.894 (39.81)	0.408 (5.13)
Rho		0.457 (2.84)		-0.767 (7.00)		0.340 (1.51)		-0.492 (3.26)
S.E.E.	0.021	0.008	0.045	0.020	0.014	0.005	0.004	0.018
$\overline{R}^2$	0.88	0.95	0.95	0.88	0.96	1.00	0.99	0.90
D.W.	2.02	1.84	2.29	1.99	2.65	1.39	1.91	1.74

1/ The t-statistics are in parentheses.
2/ Exact algebraic forms of the equations and variable definitions are given in Table 3.
3/ Export unit values for these countries are not available. Export prices are therefore defined by an equation based on the commodity structure of these countries' trade in 1974.
4/ Unit value basis.

Table 25. Four Regions: Estimates of Volume Equations for Aggregate Exports and Imports. First Half 1962 to Second Half 1979 1/

(See equations 18 and 19, Table 3)

Explanatory Variables 2/	Exports				Imports			
	Developed Primary Producing Countries	Centrally Planned Economies	Major Oil Exporting Countries	Non-Oil Developing Countries	Developed Primary Producing Countries	Centrally Planned Economies	Major Oil Exporting Countries	Non-Oil Developing Countries
Manufacturing output in industrial countries	0.334 (1.87)	0.312 (1.97)	0.318 (1.41)	0.203 (1.73)				
Export volumes (-1)	0.800 (7.50)	0.725 (5.66)	0.690 (4.08)	0.863 (10.42)				
Constant	1.817 (1.87)	2.646 (2.10)	2.802 (1.85)	1.422 (1.74)	0.378 (2.14)	-0.416 (1.56)	-0.120 (0.81)	0.024 (0.15)
Seasonal dummy	0.066 (4.39)	0.134 (6.99)		-0.074 (4.32)			0.051 (2.11)	0.063 (5.04)
Purchasing power					0.331 (4.61)	0.920 (11.40)	0.280 (5.25)	0.302 (2.55)
Purchasing power first difference								0.226 (1.61)
Import volumes (-1)					0.644 (9.35)	0.121 (1.65)	0.717 (12.38)	0.705 (6.15)
S.E.E.	0.043	0.049	0.084	0.050	0.038	0.043	0.072	0.033
$\bar{R}^2$	0.84	0.86	0.76	0.65	0.70	0.66	0.46	0.92
D.W.	2.61	2.69	1.78	2.84	2.09	1.88	2.32	2.15

1/ The t-statistics are in parentheses.
2/ Exact algebraic forms of the equations and variable definitions are given in Table 3.

APPENDIX I

Derivation of Restriction Values for Elasticities of Manufactured Imports With Respect to Potential Output

The objective here is to derive values for the potential output elasticities in the manufactured imports equations which will ensure that, under the base year pattern of trade, manufactures trade balances will be neutral with respect to a uniform shift in potential output across all of the 14 industrial countries.

First considering the manufactured exports and imports of the ith country, these are determined by equations (in Table 2) of the form:

$$\ln XVM_i = \beta_i \ln FM_i + ... \tag{1}$$

$$\ln MVM_i = \alpha_i \ln OMT_i + ... \tag{2}$$

where

$$FM_i = \sum_j s_{ij} MVM_j \tag{3}$$

Now if it is required that $d(XVM_i - MVM_i)=0$, then the potential output elasticity $\alpha_i = d\ln MVM_i / d\ln OMT_i$ may be written as:

$$\alpha_i = \frac{XVM_i}{MVM_i} \cdot \frac{d\ln XVM_i}{d\ln OTM_i} = \frac{XVM_i}{MVM_i} \beta_i \frac{d\ln FM_i}{d\ln OTM_i} \tag{4}$$

Expanding the derivative component of (4) using (3),

$$\frac{d\ln FM_i}{d\ln OTM_i} = \sum_j s_{ij} \alpha_j \frac{MVM_j}{FM_i} \cdot \frac{OTM_i}{OTM_j} \cdot \frac{dOTM_j}{dOTM_i}$$

Thus if it is assumed that initial rates of change in potential output are the same across countries, (4) may be written as:

$$\alpha_i = \beta_i \frac{XVM_i}{FM_i} \cdot \sum_j s_{ij} \alpha_j \frac{MVM_j}{MVM_i} \tag{5}$$

Setting levels of variables equal to base period values (superscript 0) and splitting out imports of the regions (MVM_r), this gives 14 simultaneous equations in α_i:

$$\alpha_i MVM_i^0 = \beta_i \left(\frac{XVM_i^0}{FM_i^0}\right)\left(\sum_{j=1}^{14} s_{ij} \alpha_j MVM_j^0 + s_{ir} \alpha_r MVM_r^0\right) \quad i = \overline{1,14} \tag{6}$$

The equations may be written in matrix form as:

$$MVM.\underset{\sim}{\alpha} = \phi.S.MVM.\underset{\sim}{\alpha} + \phi.\alpha_r MVM_r^0 \underset{\sim}{s}_r \qquad (7)$$

where MVM is the diagonal matrix made up from $(MVM_1^0, \ldots\ldots MVM_{14}^0)$

ϕ is the diagonal matrix made up

$$\text{from} \quad \left(\frac{\beta_1 \ XVM_1^0}{FM_1^0}, \ldots\ldots\ldots\ldots \frac{\beta_{14} \ XVM_{14}^0}{FM_{14}^0}\right)$$

$S = \{s_{ij}\}$

$\underset{\sim}{\alpha} = (\alpha_1, \alpha_2, \ldots\ldots, \alpha_{14})'$

$\underset{\sim}{s}_r = (s_{1r}, s_{2r}, \ldots\ldots, s_{14r})'$

The solutions to (7) is then:

$$\underset{\sim}{\alpha} = MVM^{-1}(I-\phi.S)^{-1} \ \phi.\alpha_r \ MVM_r^0 \ \underset{\sim}{s}_r \qquad (8)$$

Base year (1970) averages for XVM, MVM and FM, plus estimates of β_i from Table 14, were substituted into equation (8) to give an initial set of restriction values for the α_i. These were found to range between 0.85 and 3.0 except in the case of Japan where the value was close to 7.0. Such a high value for Japan is perhaps not too surprising given that country's major role as a manufacturing exporter; in a situation where world demand is expanding, Japan's manufactured imports must grow rapidly on a proportional basis if the manufacturing trade balance is to remain constant.

The rule of thumb adopted for actual restriction values was to make 2.0 a maximum, to use actual estimated potential output elasticities when these were sensible and well determined, and to use the derived restriction values in the remaining cases. Estimated values were used for Japan, the United Kingdom, France and Germany, the value of 2.0 was imposed for Italy, the Netherlands and Sweden, and values derived from equation (8) were used for Canada, the United States, Austria, Belgium, Denmark, Norway and Switzerland.

List of Dummy Variables

Most of the dummy variables used in the model have simple structures which may be conveyed through a system of mnemonics. The conventions of the system adopted are as follows:

DYS equals 1 in year Y semester S, zero elsewhere, e.g., D197201.

DY1Y2 equals 1 in second semester of year 1, -1 in the first semester of year Y2, e.g., D196768.

DY12 equals 1 in first semester of year Y, -1 in second semester of year Y, e.g., D196612.

CDYS equals 1 from year Y semester S onwards, zero elsewhere, e.g., CD196801.

SDY1Y2 alternates between -1 and +1 from first semester of year Y1 to second semester of year Y2, and equals zero elsewhere, e.g., SD196973.

Dummy variable definitions by country, by equation, are as follows:

Austria

Manufactured imports:

DUM1 = D197778. Advance purchases of manufactures caused by pre-announcement of VAT increases due in January 1978.

DUM2 = D197302 + D197401. Effects of trade liberalization between the EEC and Austria.

Manufactured exports:

DUM1 = 2 in 197202, -1 in 197301 and 197302. Distortion resulting from the introduction of value added tax.

DUM2 = D197401. Unusual increase in share of eastern block and OPEC markets due to particular commodity composition of Austrian manufactures.

Raw material imports

DUM1 = D196869. Stocking in anticipation of border tax measures by the Federal Republic of Germany.

DUM2 = CD197102. Effect of termination of bilateral payments arrangements with members of the Council for Mutual Economic Assistance.

Fuel imports

DUM1 = CD197101. As for raw material imports DUM2.

Belgium/Luxembourg

Manufactured imports

DUM2 = D196612. Effects of U.K. shipping strike.

Manufactured exports

DUM1 = SD196973. Shift in seasonal pattern of exports.

Fuel imports

DUM1 = D197576. Unusual buildup and subsequent depletion of oil stocks.

Denmark

Raw material imports

DUM2 = D197601. Effects of temporary tax measures.

Fuel imports

DUM1 = D197302. Effect of oil embargo.

DUM2 = SD197576. Shift in seasonal pattern of fuel imports.

France

Manufactured imports

DUM1 = CD196801. Effects of EEC tariff liberalization.

DUM2 = D197012. Anticipation of mid-1970 relaxation of tight monetary policies.

Raw material imports

DUM1 = D197502-D197602. Abnormal decline and subsequent recovery of inventories.

Federal Republic of Germany

Manufactured imports

DUM1 = D197302 + D197401. Reduction in imports in response to restrictive domestic policies.

Manufactured exports

DUM1 = D196802. Anticipation of imposition of border tax.

DUM2 = D197001 + D197002. Effect of imposition of border tax.

Agricultural imports

DUM1 = D196302. Poor harvest in 1963.

Fuel imports

DUM2 = D197602. Strong demand for oil in anticipation of price increases.

Italy

Manufactured imports

DUM1 = D197301. Acceleration of domestic demand coincided with a low level of inventories.

DUM2 = D196901 + D197001. Effects of strikes.

Manufactured exports

DUM1 = SD19[illegible]79. Shift in seasonal pattern of exports.

Fuel imports

DUM1 = D19751. Unusual rundown and subsequent recovery in oil stocks.

Japan

Manufactured imports

DUM1 = 1 in 1972[illegible], 2 in 1973Q1, 3 from 1973Q2 onwards, and zero elsewhere. Effects of trade liberalization.

Raw material imports

DUM2 = D196901. Effects of U.S. dock strike.

Agricultural imports

DUM1 = SD196973. Shift in seasonal pattern of imports.

DUM2 = D196501. Decline in domestic food production.

The Netherlands

Manufactured imports

DUM1 = CD197401. Effects of enlargement of EEC.

DUM2 = D197301. Probable error in deflator, owing to wide exchange rate variations over period.

Raw material imports

DUM1 = D197502. Unusually low levels of industrial production and inventory investment relative to total domestic demand.

Agricultural imports

DUM1 = D197101 + D197102 + D197201. Good crop yields in 1970 and 1971.

Norway

Manufactured imports

DUM2 = D197201 + D197202. Unusual rundown in stocks reinforced by depressed level of fixed investment.

Switzerland

Manufactured imports

DUM1 = D197502. Unusually low level of demand for capital goods relative to total domestic demand.

Manufactured exports

DUM1 = D197402. World recession and sudden lagged effect of 1973 devaluation.

Raw material imports

DUM1 = D197576. Unusual rundown and subsequent recovery of inventories.

Fuel imports

DUM1 = SD196567. Shift in seasonal pattern of imports.

DUM2 = D197101. Movement in deflator understates rapid increase in fuel prices.

United Kingdom

Manufactured imports

DUM1 = 1 in 197301 and 2 thereafter. Effects of entry into the EEC.

DUM2 = D197401. Fall in industrial production due to three-day work week.

Raw material imports

DUM1 = SD196671. Shift in seasonal pattern of imports.

Agricultural imports

DUM1 = SD196773. Shift in seasonal pattern of imports.

United States

Manufactured imports

DUM1 = zero up to 196702, increases from 1 to 7 from 196801 to 197101, and equals 7 thereafter. Effect of rapid increase in Japanese car imports.

Agricultural imports

DUM1 = D196901. Effect of dock strike.

DUM2 = D197401. Inventory increases due to anticipated price increases.

DUM3 = D197512. Sudden upward shift in inventories following a period of rapid decumulation.

Fuel imports

DUM2 = D196702.

Fuel imports

DUM1 = SD196567. Shift in seasonal pattern of imports.

DUM2 = D197101. Movement in deflator understates rapid increase in fuel prices.

nited Kingdom

Manufactured imports

DUM1 = 1 in 197301 and 2 thereafter. Effects of entry into the EEC.

DUM2 = D197401. Fall in industrial production due to three-day work week.

Raw material imports

DUM1 = SD196671. Shift in seasonal pattern of imports.

Agricultural imports

DUM1 = SD196773. Shift in seasonal pattern of imports.

nited States

Manufactured imports

DUM1 = zero up to 196702, increases from 1 to 7 from 196801 to 197101, and equals 7 thereafter. Effect of rapid increase in Japanese car imports.

Agricultural imports

DUM1 = D196901. Effect of dock strike.

DUM2 = D197401. Inventory increases due to anticipated price increases.

DUM3 = D197512. Sudden upward shift in inventories following a period of rapid decumulation.

Fuel imports

DUM2 = D196702.