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INTERNATIONAL FINANCE DISCUSSION PAPERS

TWO MULTI-LEVEL MODELS OF U.S. MERCHANDISE TRADE, 1958.I-1971.IV, AND POST-SAMPLE ANALYSIS, 1972.I-1973.II AN EVALUATION OF A WORKABLE FORECASTING SYSTEM

by

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I. Introduction

This paper is a joint presentation of two models of U.S. merchandise trade developed independently by Hooper (1974) and Wilson (1973). The models discussed here consist of import and export demand equations in aggregate form, and disaggregated by "End-Use" commodity category and geographical region. Particular attention is given to the issues of dynamic adjustment, shifting coefficients and aggregation error. We investigate several alternative techniques for estimating adjustment lags and for weighting disaggregate explanatory variables in aggregation. Post-sample simulation is emphasized in our analysis as we attempt to determine the predictive viability of the alternative specifications investigated.

Our study proceeds as follows. In Section II, we outline the common theoretical specification of the two models in a static framework and list the underlying assumptions. The next section outlines special features that distinguish the two models from each other, and from previous work in the field, including alternative lag specifications, aggregation procedures, and testing for variable coefficients. Section IV then summarizes the data requirements. In Section V we present and discuss parameter estimates of both models, followed in Section VI by in-sample and post-sample simulation results. Comments on optimal linear correction and ex-ante forecasting, as well as our conclusions and suggestions for further research are given in the final sections.

II. Model Specification

In this section we present a synthesis of the almost identical theoretical structures underlying the two models. The quantity of imports demanded is specified as a function of domestic income (or activity), import price and domestic substitute price. Exports are treated symmetrically, with the quantity demanded expressed as a function of foreign imcome, export price and foreign substitute price. In the regional equations, foreign substitute ("third country") prices are included, and all traded goods prices are adjusted for tariff and exchange changes. Finally, the basic demand specification is modified to allow for foreign and domestic nonprice rationing, and dummy variables are included to account for certain discontinuous exogenous factors.[1/]

In specifying our basic static models we make the following explicit assumptions:

1. Foreign and domestic goods, or goods originating in different countries, are imperfect substitutes -- hence, foreign price differs from domestic and third-country substitute prices, and all three must be included as determinants of trade demand. Thus, our models are distinguished from "excess demand" models in which domestic and foreign goods are assumed to be perfect substitutes, and in which only one market price term is included for the good in question.

2. Cross-price elasticities among different commodity (not regional) groups are zero -- hence other commodity prices can be excluded.

1/ The nonprice rationing variables represent a departure from neoclassical demand theory -- they are included to allow for price disequilibrium -- due to non-competitive market forces. That is, in certain markets, producers may have control over their prices and be unwilling to adjust them continually for market-clearing purposes in the face of cyclical sings in demand (or supply). Rather, as noted by Gregory (1971) they turn to nonprice rationing (changing length of delivery lags, availability of trade credit, availability of "extras", etc.). Because data are not available, cyclical proxy variables must be used.

As we shall note below, the end-use commodity classification scheme tends to minimize similarities among commodity groups, hence, cross price elasticities should in fact, be very low.

3. Consumers display the absence of money illusion, and thus, demand can be expressed as a function of real income and relative prices. It should be emphasized that the no-money-illusion assumption has recently been challenged by Leamer and Stern (1970), but for several considerations, we adopt the conventional zero-degree homogeneity assumption and specify our price terms as relatives. On the practical side, both models presented here have tried to capture third country influences, which requires a second price term in many equations. Dropping the no-money-illusion framework would require the use of a <u>third</u> price variable in regional equations, and problems of collinearity would surely become severe.

4. The adjustments of trade demand to equivalent tariff, exchange rate and price changes are identical. More will be said about this below.

5. Tariff and exchange rate changes are "passed through" completely into changes in the domestic market prices of imported goods. Assumptions 4 and 5 allow us to build up domestic market prices of traded goods from unadjusted foreign (local) price components, exchange rates and tariff indices.

6. Transportation and insurance costs are constant through time. This assumption is somewhat *ad hoc*, but reliable data on these costs are not available.[2]

2/ Richardson (1972) attempted to construct a data series for transportation costs on the basis of differences between F.O.B. and C.I.F. valuations of U.S. trade, but met with little success -- the series fluctuated widely from quarter to quarter and yielded poor trade equation estimation results.

7. Supply can be treated as perfectly elastic -- we invoke the "small country" assumption. This assumption is discussed further below.

Given the above assumptions, our static model can now be written in implicit form. Let "i" denote the commodity index, "j" the foreign region of origin (or destination), "d" domestic (U.S.) variables, and "j' " the foreign (third-country) competing region.

Also let:

M = F.O.B. $ value of imports;

X = F.O.B. $ value of exports;

E = Exchange rate index in dollars per unit of foreign currency;

P = Price term;

Y = Income or activity (current value);

T = Tariff index;

NP = Non-price rationing or cyclical proxy;

D = Dummy (Steel and dock strikes; Suez crisis, etc.)

w^m = import-share weight, w^x = export-share weight

<u>Import Equations (Wilson and Hooper Models)</u>:

1. By Commodity (i)

$$\sum_j \frac{M_{ij}}{w^m_{ij} E_j P_{ij}} = f_i \left(\frac{Y_{id}}{P_{id}} , \frac{T_{id} \sum_j w^m_{ij} E_j P_{ij}}{P_{id}}, NP_{id}, \sum_j w^m_{ij} NP_{ij} , D_i \right) \tag{1}$$

2. By Region (j)

$$\frac{M_j}{E_jP_j} = f_2\left(\frac{Y_d}{P_d}, \quad \frac{T_dE_jP_j}{P_d}, \quad \frac{T_d \sum_{j' \neq j} w^m_{j'} E_{j'}P_{j'}}{P_d},\right.$$

$$\left. NP_d, NP_j, \sum_{j' \neq j} w^m_{j'} \cdot NP_{j'}, D_j\right) \qquad (2)$$

3. Total Imports

$$\sum_i \sum_j \frac{M_{ij}}{w^m_{ij}E_jP_{ij}} = f_3\left(\sum_i w^m_i \cdot \frac{Y_{id}}{P_{id}}, \sum_i \sum_j w^m_{ij} \cdot \frac{T_{id}E_jP_{ij}}{P_{id}},\right.$$

$$\left. \sum_i w^m_i \cdot NP_{id}, \sum_i \sum_j w^m_{ij} \cdot NP_{ij}, D\right) \qquad (3)$$

<u>Export Equations (Hooper model)</u>:

1. By Commodity (i)

$$\sum_j \frac{X_{ij}}{P_{id}} = f_4\left(\sum_j w^x_{ij} \cdot \frac{Y_{ij}}{P_{ij}}, \sum_j w^x_{ij} \cdot \frac{T_{ij}P_{id}}{E_j P_{ij}}, NP_{id},\right.$$

$$\left. \sum_j w^x_{ij} \cdot NP_{ij}, D\right) \qquad (4)$$

2. By Region of Destination (j)

$$\frac{X_j}{P_d} = f_5\left(\frac{Y_j}{P_j}\ ,\ \frac{T_j\ P_d}{E_j\ P_j}\ ,\ \sum_{j'\neq j} w^t_{j'}\cdot\frac{T_j\ E_{j'}\ P_{j'}}{E_j\ \ P_j}\ ,\ NP_d\ ,\right.$$

$$\left.NP_j\ ,\ \sum_{j'\neq j} w^t_j\ NP_{j'}\ ,\ D_j\right) \qquad (5)$$

3. Total Exports

$$\sum_i\sum_j \frac{X_{ij}}{W^x_i\ \ P_{id}} = f_6\left(\sum_i\ \sum_j w^x_{ij}\ \frac{Y_{ij}}{P_{ij}}\ ,\ \sum_i\ \sum_j\ w^x_{ij}\ \frac{T_{ij}\ P_{id}}{E_j\ \ P_{ij}}\ ,\right.$$

$$\left.\sum_i w^x_i\ \ NP_{id}\ ,\ \sum_i\ \sum_j w^x_{ij}\ \ NP_{ij}\ ,\ D\ \right) \qquad (6)$$

The dependent variable in each of the above equations is a constant-dollar approximation of "quantity" -- current values deflated by the appropriate price index. The income or activity variables are also in real terms, and prices are expressed as relatives. Foreign currency prices are transformed into domestic dollar prices through exchange rate and tariff adjustments. The weighting procedures, and dynamic adjustment aspects of the Wilson and Hooper models will be discussed in detail below.

While the underlying theoretical structure of the two models are essentially the same (as presented above), the treatments of aggregation and adjustment lags differ somewhat and thus, warrant separate discussion. Before we discuss these issues however, we should note several possible problems that could arise in the empirical specification of the above model.

First is the possibility of simultaneous equation bias resulting from supply constraints facing U.S. trade demand. As noted by Orcutt (1950), inelastic supply will cause single equation estimates of price elasticities of trade demand to be biased downward. There are several reasons to believe, however, that the downward bias in our U.S. import price elasticity estimates may not be severe. One is an emphasis on fairly disaggregated commodity grouping. Another is that the supply capabilities of U.S. trading partners have rapidly expanded while the U.S. share of world trade has steadily diminished over the past twenty years. Thus it seems safe to say that the U.S. faced fairly elastic import supply over the estimation sample period 1958-I-1971-IV. Nonetheless, supply shortages in world commodity markets have become increasingly evident over the past year, and while our estimated coefficients may not be significantly biased for the sample period, the changing structure in the world supply and demand of traded goods may reduce the forecasting accuracy of those estimates. It may be even more tenuous to assume that U.S. domestic prices are unaffected by export demand, particularly in periods of peak demand and high capacity utilization. Exports of agricultural commodities and finished durable manufactures in particular, account for significant proportions of total U.S. production of those goods.[3/]

3/ In 1972, agricultural exports accounted for 27 percent of Gross Farm Product, and exports of finished durable goods for 11 percent of Final Sales of domestic durables goods producers.

The bias involved could be eliminated, in theory, if the supply side of trade flows were specified, and simultaneous equation estimation techniques employed. Unfortunately, however, we have little knowledge of supply relationships in trade. Attempts to specify supply functions have thus far been largely unsuccessful, and it seemed doubtful to both authors that the considerable effort required would significantly improve forecasting results.4/

We recognize that there is room for much improvement in this area, yet even if supply functions could be specified with some degree of statistical accuracy, the additional exogenous data requirements would be burdensome to a forecasting endeavor.

A second possible source of downward bias in the price coefficients is our assumption of complete pass-through. That is, for example, if foreign suppliers do not increase the dollar prices of their exports to the U.S. by the full amount of a dollar depreciation, the effects of a depreciation on import demand will be diminished, thus, to the extent that our foreign price data do not reflect the reduction in foreign currency export prices, our price coefficient estimates will be biased downward (toward zero). The realism of the stance taken here --

4/ In an earlier effort by Hooper (1972), supply functions were specified for U.S. imports and exports by commodity, and region and by both simultaneously. The supply functions were based on the production decision of the competitive profit maximizing firm, and included the following determinants: market price, wage rates, materials import prices, corporate tax rates, output capacities and time as a proxy for technological change. The trade demand equations were then estimated using two-stage least squares, with trade prices estimated in reduced form. In general, the simultaneous equation estimates were no better (on the basis of coefficient sign and in-sample statistical fit) than corresponding single equation estimates.

and its counterpart of no-pass through -- is still very much clouded in uncertainty, however, and we see no reason why one must be chosen over the other. The most probable case is a partial pass-through one, to which our estimated forms could easily be adapted if exact pass-through responses were specified.

Thirdly, the question of whether long run adjustments of trade demand to equivalent tariff, exchange rate and local price changes are identical is subject to inquiry. There is reason in theory to believe that they should be, but no proof. One difference between our two models is that in the Hooper model that assumption is retained -- local price and exchange rate terms are treated jointly in all of the equations. In the Wilson regional import equations, however, exchange rates enter as separate regressors. This allows for responses to local prices and rate changes which differ in both the short and long runs.[5/] The specification of equations (2) shown above is thus slightly different in the Wilson model.

Another issue that warrants clarification is the use of commodity-specific activity variables (i.e., domestic consumption, investment expenditure and industrial production) to explain imports of consumer, capital and intermediate goods, respectively. Both aggregate and

5/ Orcutt (1950) thought that long-run response to the elements of international price should be the same, while short-run effects could be quite different. If terms are treated separately in a distributed lag model, this implies equality of coefficients sums. A method by which this can be applied is outlined by Wilson (1973, Chapt. 3). Many investigators have omitted the tariff component of international price. If the tariffs are *ad valorem*, this is improper, since tariff collections on imported goods go up as foreign prices rise, *even if* there is no change in rate. This causes an understatement in duty-paid import price relations.

commodity-specific activity variables are used in the two models, and a necessary assumption underlying the use of the latter is that the level of domestic expenditure is determined prior to the level of imports (or, independently of import prices). The disaggregated activity variables are used in large part to reduce aggregation error (discussed below). For two reasons, we believe that the potential statistical problems involved are minor. First, the fact that the price regressors are expressed in ratio form will tend to diminish collinearity with activity terms which contain strong trend factors. Second, our disaggregated activity terms are in fact fairly aggregate themselves, and their import contents are relatively small.6/

A final problem in specifying the trade demand functions concerns the choice of functional form. Functional forms can, of course, be derived if hypotheses are set up concerning utility and profit functions. There are, however, well known problems associated with postulating even the <u>existence</u> of aggregate utility functions. Deriving a specific functional form from any given utility hypothesis says nothing about the plausibility of the hypothesis itself. Other forms can be derived from other starting points. Experience has shown that most of them can be made to fit the data well, which leaves the question of what is a "right" and what is a "wrong" functional form very much in limbo. Economic theory is much more helpful in suggesting variables which might be included or excluded from a relation than it is in telling us exactly what the shape of the estimating function must be.

6/ In 1972 for example, imports of Consumer Goods, Capital Goods, and Industrial Supplies and Materials each accounted for less than 4 percent of U.S. personal consumption expenditures, business fixed investment in durable equipment, and final goods output respectively.

On the matter of functional forms, therefore, we have preferred to work more intuitively. In both models we selected the double-log form for estimation. Our specification thus adopts the assumption that demand elasticities are constant through time over the premise (in a system which is arithmetically linear) that marginal propensities are constant. With strongly upward-trended trade flows, the linear system implies that price elasticities decline drastically over time.[7/] This implication we find somewhat dubious.

Given that log-linear forms were used, we may add a comment on the implications of equation (2) above. In the basic regional equation two relative-price terms are employed. The way they are entered has the effect of constraining the total foreign price effect (for regions j andj') to be algebraically equal to and opposite in sign from the domestic price elasticity. This is a logical consequence of the zero degree homogeneity assumption and consequent specification in terms of relative prices. But while preserving this symmetry, it also allows the multiple regression to "distribute" the foreign price effect across the two regions entered in the equation.

III. Special Features of the Hooper-Wilson Models.

At this point we should emphasize that despite the virtually identical static theoretical structures underlying the two models being examined in this study, there are some important differences. These differences should be carefully noted since they will clearly affect both

7/ See Leamer and Stern (1970, pp. 17-18).

the parameter estimates and simulation results presented below, and thus will form the basis for our empirical evaluation of the two models.

The essential specification differences are in the treatment of dynamic adjustment, the analysis of structural changes in trade elasticities and the weighting procedure used in aggregation. Minor differences in data usage are noted in the next section.

Dynamic Adjustment

Because of significant order-delivery lags involved in most trade flows, it seemed unreasonable to both authors that trade equations should be specified a priori without some allowance for lags in the adjustment of the flows to changes in their determinants. Three different distributed lag techniques were used, including Koyck and Almon lags in the Hooper model and Shiller lags in the Wilson model. The three lag models vary considerably in the degree of flexibility offered in the estimation of lag structures, with the Koyck technique ranked lowest and the Shiller highest in this regard.

As the Koyck and Almon models are fairly well known, our discussion can be brief. The Koyck lag model assumes a uniform lag pattern for all explanatory variables in a given equation, though this restrictiveness can be eased to allow for relatively longer lags in certain variables (i.e., prices) by including lagged values of those variables in the equation. The shape of the Koyck lag is restricted to a geometric decay, which is open to criticism. It may seem more reasonable that adjustment to a price change, for example, would build up slowly rather than decay immediately. The somewhat generalized and more flexible form of the Koyck model used in this study is outlined in Appendix A.

The Almon model is more flexible than the Koyck in that it allows for varying lag lengths on different explanatory variables, and for different shapes in the lag distributions. The model is restrictive in that it constrains the lag patterns (nonstochastically) to a polynomial shape, but the degree of the polynomial and the length of the lag can be varied in a search for the closest approximation to the actual lag patterns.

The Shiller lag, which affords an even greater degree of flexibility than the Almon model, is a more recently developed estimation technique, and we will consider it in somewhat greater detail here. It is discussed more extensively in Shiller (1971) and Wilson (1973).

Briefly this estimator's greater flexibility is based on the fact that it makes weaker assumptions on the shape of a lag distribution. As implemented in this particular model, it does impose conditions on the <u>smoothness</u> of the rate of slope change (coefficient 2nd differences) in such a lag distribution.[8/] The prior imposed takes the stochastic form

$$E\,[\,(\beta_i - \beta_{i-1}) - (\beta_{i-1} - \beta_{i-2})\,] = 0$$

which can be expressed in the linear form

$$r = R\beta + v, \quad E(v) = 0, \; E(vv') = W = \sigma_v^2\, I$$

This restriction can easily be implemented in the generalized least squares framework (see Goldberger (1963,) by "appending" the prior

8/ More generally it can be implemented as restraints on "dth" degree difference of the lag-coefficients. The choice of 2nd difference is thus a form of prior information analagous to the choice of a polynomical degree in Almon estimation. The Shiller procedure is, in fact, a stochastic Almon.

information the basic model. We thus have: $\begin{bmatrix} Y \\ r \end{bmatrix} = \begin{bmatrix} X \\ R \end{bmatrix} \beta + \begin{bmatrix} \varepsilon \\ v \end{bmatrix}$ or $\tilde{Y} = \tilde{X}\beta + \varepsilon^*$

We assume that $E(\varepsilon^* \varepsilon^{*\prime}) = \Sigma$ and further simplify this to the form

$$\Sigma = \left[\begin{array}{c|c} \sigma_\varepsilon^2 I & 0 \\ \hline 0 & \sigma_v^2 I \end{array}\right]$$

by assuming homoskedasticity in the error subvectors and zero covariance between the stochastic components in the basic structure and the prior restrictions.

By Aitken (GLS) estimation, coefficient estimates can be obtained as follows: $\tilde{b} = (\tilde{X}'\Sigma^{-1}\tilde{X})^{-1}\tilde{X}'\Sigma^{-1}\tilde{Y} = (\frac{1}{\sigma^2}X'X + R'W^{-1}R)^{-1}(\frac{1}{\sigma^2}X'Y + R'W^{-1}r)$

Since $R'r = 0$, and letting $k = \frac{\sigma_\varepsilon^2}{\sigma_v^2}$ the structure reduces to the relative simple form

$$\tilde{b} = (X'X + k^2 R'R)^{-1}X'Y$$

where the parameter value k is supplied in advance. Estimates can therefore be obtained by OLS with a simple adjustment to the moment matrix X'X prior to inversion. More extensive treatment of the form of R, the use of endpoint constraints ($\tilde{b}_{t-n} = 0$ in an n period lag) and the interesting relation between the Shiller and Almon techniques can be found in the references above. (See also the recent notes by Rappoport (1974) for the similarity between this and ridge-regression. Wilson (1973, Chapter 3) also includes an extension of the Shiller methodology which can be used when constraints may be applied as between distributed lags.[9/]

Like all other estimators which constrain the coefficients $\beta_i (i=o, n)$ in a lag distribution, the Shiller technique assists in overcoming

9/ Recall that in regional trade equations, price, tariff and exchange rate effects may be estimated with different lag structure. Still it may be desired to constrain the long-run elasticities of each such "price" term to be equal, while allowing for different shapes and lengths. This follows from discussions by Orcutt (1950), Liu (1954) and others.

collinearity in the regression matrix. Moreover, its flexibility rests on the fact that the shape it posits for the unknown distribution can be altered by the data. However, a value of the parameter k must be chosen, where "low" values, of course, imply looser stochastic restrictions on the bending properties of the coefficients in the estimated distributions. For all distributed lag forms in the Wilson results, a value of k = 1 was chosen.[10/]

One hypothesis extensively pursued in the Wilson model, was the possibility that U.S. import demand over the 1958-71 period was affected by structural changes in the underlying (elasticity) parameters. This was first suggested by the author's experience with post-sample testing of the Rhomberg-Boissoneault, Wharton and MPS models. All of these included one or more U.S. import relations estimated through the early to mid-1960's, and all, when extrapolated, tended to understate import values with increasing severity in the immediate post-sample years. The results, in fact, suggested (upward) changes in income elasticities or (downward) changes in the price parameters.

The results shown in Tables 3 to 6 for the Wilson model include a number of estimates in which searches were made for systematically shifting parameters. Models developed by Cooley and Prescott (1970) Swamy (1971) and others are adapted to search for parameters (e.g., intercepts) which may vary stochastically, but assume a constant mean. In contrast, the author's hypothesis was that the expectation of the income and price parameters was itself a function of time (or at least a function of trend income levels which could be approximated by using time as an instrument).

10/ A closer examination of "appropriate" values for k for medium-length lags (4-8 quarters) has been undertaken in a Monte-Carlo framework. See Wilson, "A Monte Carlo Comparison of Almon and Shiller Distributed Lag Estimators" (forthcoming).

For a variety of reasons it appeared to the author that such shifts in U.S. import demand appeared around 1965. The hypothesis was tested (crudely, we admit) using dummy variables in two forms:

D_{65} = 0 for periods prior to 1965.I

= 1 for periods after 1965.I

T_{65} = 0 for periods prior to 1965.I

= Quarterly time trend for periods after 1965.I

Both forms were used to test for intercept and slope changes in estimated parameters. The results obtained are discussed briefly in the section on our results.

Weighting in Aggregation

As shown in the equations presented in Section II, weights were used by both authors in the summation of commodity and regional specific explanatory variables. The weights used in the two models were somewhat different, and are described below. Because of the importance of aggregation to trade equation estimations, it would be worthwhile to digress briefly and consider the problem of aggregation error.

The essential problem is one of attempting to condense a collection of diverse demand responses into a single equation. To take a simple macroeconomic example, if the import content of consumption expenditures were twice as high as that of investment expenditures, an increase in consumption and a decrease in investment by the same amount would yield a net increase in imports, *ceteris paribus*, but an aggregate equation would predict no change in imports because the zero change in total expenditures.

Theil (1954) noted that there are two sufficient conditions for consistent aggregation: when all the disaggregate parameters are equal and when each disaggregate variable can be expressed as an exact linear function of the aggregate variable. In the absence of these conditions, he showed further, that consistent aggregation can be attained if the disaggregate parameters are known, and the aggregate explanatory variables are defined as averages of the disaggregate variables weighted by their respective parameters. Thus, in light of our above example, a weighted average of GNP expenditure components, using marginal propensities to import as weights, would be preferable to GNP as an aggregate explanatory variable. Unfortunately, the disaggregate trade parameters are unknown, and at best we have rough estimates -- often of poor quality because of the inadequacies in available disaggregate data. The use of uncertain estimates as weights in aggregation would cause an errors-in-variables problem, and ordinary least squares regression would yield inconsistent aggregate coefficient estimates.[11]

In the Hooper model Theil's optimal linear aggregation procedure was approximated (following the example of Leamer and Stern (1970, pp. 42-48) by assuming that the disaggregated parameters (marginal response) could be reasonably approximated by base period average responses. The assumed relationship can be expressed:

$$\frac{\partial M_i}{\partial Y_i} \approx \frac{M_{io}}{Y_{io}}$$

11/ We are grateful to P. Swamy for pointing this problem out to us.

where, M_i and Y_i are import and activity variables specific to commodity group i, and M_{io} and Y_{io} are actual base-period values. Using these weights, the weighted aggregate explanatory variable in period t, are defined:

$$Y_t = \sum_i \frac{M_{io}}{Y_{io}} Y_{it}$$

Multiplying through by the constant,

$$\frac{1}{\sum_i M_{io}}$$

we derive the trade-share weighted aggregate:

$$\frac{Y_t}{\sum_i M_{io}} = \sum_i \left(\frac{M_{io}}{\sum_i M_{io}} \cdot \frac{Y_{it}}{Y_{io}} \right)$$

where $\frac{M_{io}}{\sum_i M_{io}}$, the base period share of M_i in total imports, is the weight (w_i^m) used in equation (3) of Section II above.12/ Similarly, we have the regional weights:

$$w_j^m = \frac{M_{jo}}{\sum_j M_{jo}}$$

and the commodity-by-region weights:

$$w_{ij}^m = \frac{M_{ijo}}{\sum_i \sum_j M_{ijo}}$$

12/ One of the advantage of estimation in log linear form is that the constant $\frac{1}{\sum_i M_{io}}$ drops out of the weighted explanatory variable and is captured by the constant term in a regression equation. At the same time, however, the use of weighted aggregates in logarithmic form requires a specific assumption about the relationship between the average linear values and log-linear values. Consistent aggregation in log linear form requires the weighted averaging of log-linear disaggregate values, and the result would be equivalent to a weighted geometric mean. Geometric means are more difficult to interpret, however, and we prefer to explain trade flows in terms of linear sums or arithmetic means. Following the example of Klein (1953, p. 266) we assume that the geometric means and arithmetic means of the disaggregate variables generally move together through time.

The export weights (w_{ij}^{x} , etc.) used in equations (4)-(6) in Section II can be derived similarly with base period exports (X_o) replacing M_o. The base period used in the Hooper model was 1967-69, which places relatively greater weight on the latter part of the estimation sample period. All variables were weighted by region in the commodity and total import and export equations, and all activity and price variables were weighted by commodity shares in the total equation. The weights used in the aggregation of third-country variables in the export equation (w^t) were base-period regional share of world trade. Finally, separate aggregate equations were estimated using available aggregate data, i.e., GNP and the GNP deflator in place of trade weighted averages of their components.

The Wilson model employed current-trade shares rather than base period weights in calculating foreign price terms. The actual weights and procedures used in each model are available in Hooper (1974) and Wilson (1973).

IV. Data and Disaggregation

This section briefly summarizes the details of commodity and regional disaggregation as implemented in the two models. We will also summarize the data gathered by the authors for estimation and forecasting.

Table 1 presents the basic commodity and regional disaggregation scheme used by both authors. The essential classification differences between the two models (i.e., exceptions to Table 1) are as follows:

1. Wilson estimated Fuels and Lubricants imports and Imports N.E.S. as separate groups. Hooper combined them both with Industrial Supplies and Materials.

2. Wilson treated Canadian Automotive imports exogenously and estimated U.S. imports of Automotive from other sources only. Hooper combined passenger cars with Consumer Durables and other automotive (parts, etc.) with Capital Goods.

3. Wilson included unmanufactured Consumer Goods (nursery stock, gems, etc.) with Consumer Nondurables. Hooper included them with Consumer Durables.

4. The Wilson model treats Latin America and Rest-of-World as separate regions. In the Hooper model they are combined into one. Definitions for Canada and Japan are (we hope) the same. Countries included under Western Europe are also the same.

A brief synopsis of the types of data gathered for estimation and forecasting in the two models is given in Table 2. We should stress that with both models forecasting can be done at different levels of disaggregation, and exogenous data requirements vary accordingly.

Table 1

Commodity and Regional Trade Groups[a/]

End-Use Commodity Groups

Foods, Feeds and Beverages

Industrial Supplies and Materials

Fuels and Lubricants

Capital Goods

Automotive Products

Consumer Nondurables

Consumer Durables

Imports, N.E.S.

Regional Groups

Canada

Japan

Western Europe

Latin America

Rest-of-World

a/ Estimates were also made for U.S. imports and exports disaggregated by both commodity and region simultaneously. These results were found to be generally inferior to the more aggregate equations presented in this study. For further discussion see Wilson (1973) and Hooper (1972).

Table 2

Summary of Data Used in Hooper and Wilson U.S. Trade Models.

Hooper	Wilson
Domestic Activity	
GNP (excluding net exports) IP Personal Consumption Expenditures (and components) Fixed Business Investment	GNP IP Disposable Personal Income Automotive Expenditures
Domestic Prices	
GNP deflators, aggregate and disaggregate for the GNP components also for imports and exports WPI -- components to match End-Use groups	same, including some use of import unit-value indexes for aggregate equations
Domestic Non-Price Rationing and Cyclical Variables	
Unfilled orders scaled by Production Activity Cycle: deviation-from-trend IP	Unemployment rate Activity Cycle: trend/actual Inventory changes: Nonlinear capacity utilization term: [illegible] CU/(95-CU)
Foreign Activity	
GNP and components for Canada, Japan, U.K. IP -- Western Europe[a] Exports -- Rest-of-World	Foreign IP tried in several cases. Unsuccessful except in Japanese equations not shown here.
Foreign Prices	
WPI -- aggregate and by commodity groups where available for Canada Japan and Western Europe[a]	same -- including export prices denominated in local terms

[a] In the Wilson model, price terms, and in the Hooper model both activity and price terms for Western Europe were created by weighted averaging of data for seven countries: Belgium, France, Germany, Italy, Netherlands, Switzerland and United Kingdom.

Table 2 (continued)

Hooper	Wilson
ROW Prices a weighted average of data from Australia, Brazil, India Mexico, New Zealand, Philippines, South Africa, Taiwan, Venezuela, World Commodity prices for coffee, cocoa, sugar	LA and ROW prices derived from data in IFS and MBS, weighted by author for aggregate and FFB and ISAM groups

Other Data

Exchange Rates: Quarterly spot rates in both models, for all countries in which prices were obtained.

Tariff Rates: Both models use tariff series adjusted to the End-Use commodity framework and take Kennedy Round reductions (1968-72) into account. Hooper includes adjustments for the 1971 10-percent surcharge levied in the U.S.

Dummy Variables: Include adjustments for dock and steel strikes and the Suez Crisis. Hooper includes a dummy for U.S. Canadian Automotive Agreement (exogenous in Wilson Model). Wilson includes a dummy for surge of automotive imports in 1959-61 period, for large uranium imports in early 1960's and for tests of structural shift hypothesis.

Miscellaneous

Price, exchange rate and tariff data are based at 1963=100 in both models, and all data are seasonally adjusted.

NOTE: The specific activity, price and cyclical variables used depended on the type of equation. To save space, an exact description of each case is omitted from the paper, but can be had on request from the authors. Some are identified in the comments on results given in Section V.

V. Estimation Results

As we shall see in the two reviews of results which follow, the authors have obtained somewhat different estimates of U.S. trade parameters. These are surely due to the differences in the specific details in the two models, such as those in definitions of dependent variables, aggregation and weighting, and in some cases to types of data collected. We realize that this makes it difficult to present an integrated and uniform discussion, and have elected here and in the Simulation section which follows to present the two sets of conclusions separately. A brief discussion of points of comparison follows each analysis.

In interpreting the remarks which follow, the reader might bear in mind the ways in which these models are fundamentally the same, and in which ways different. As to similarities, both authors were interested in the question of multiple <u>types</u> of disaggregation for U.S. trade. So, both models include single and multiple equation experiments and are capable of generating trade predictions drawn from several levels of detail. The types of disaggregation, as described above, is in fact <u>very</u> <u>much</u> the same.

The most obvious difference between the models is that the Hooper work includes estimates of U.S. exports, while the Wilson work does not. On the import side, where the two models overlap, there is also a basic difference in emphasis in the authors' approaches. The main objective of the Hooper work was to explore the question of aggregation, particularly through the weighting of income/activity terms used in aggregate regressions. The two problems most extensively pursued in the Wilson model were the questions of parameter drift and the exploration of distributed lags. These differences make the models complementary on several points. The brief intramodel discussions which follow, therefore, emphasize the different approaches taken by each author. The comparative analysis of the two models at the end of this section outlines the similarities and attempts to reconcile the differences obtained in the empirical estimates, but we leave the task of critical evaluation to an analysis of the simulation results in Section VI.

Va. Estimation Results in the Wilson Model

In this section of the paper we will comment on the parameters obtained by one of the authors for three sets of U.S. imports' relationships. In the order treated, these are:

1) Total Imports less Canadian Automotive, and the same with the additional exclusion of Fuels;
2) Imports distinguished by types of commodities; and
3) Imports distinguished by region of origin, excluding Fuels in each case, as well as Automotive from Canada.

Our results under these three headings are tabulated in Tables 3 to 6 on the following pages.[13/]

13/ The author also has a complete set of U.S. import relations estimated by commodity and by region of origin. These are not reviewed here, but post-sample results drawn from this set are summarized in Tables 13 and 14 of Section VI.

TABLE 3

EQUATION ESTIMATES FOR TOTAL U.S. IMPORTS LESS

AUTOMOTIVE PRODUCTS FROM CANADA 1958.I-1971.IV

Variables	OLS (1)	OLS (2)	LAG (1)	LAG (2)
Constant	-7.487 (5.6)	-3.677 (-2.5)	-7.164 (-4.2)	-4.256 (-4.1)
GNP	1.626 (7.9)	1.025 (4.4)	1.475 -	1.114 (6.9)
PF/PD	-1.468 (-2.7)	- .964 (-1.8)	-2.637 ---	- .343 ---
DOCK	- .0716 (-7.7)	- .0714 (-7.0)	- .073 (-8.5)	- .076 (-7.6)
D65 * GNP		1.182 (3.1)		
D65		-7.646 (-3.1)		
T65 * GNP				.0017 (5.8)
$\bar{R}^2$	.987	.987	.989	.989
DW	2.07	1.89	2.119	1.82
$\hat{\rho}$	.87	.69	.90	.55
DF	52	50	52	51

Lag Structure		t-0	t-1	t-2	t-3	t-4	t-5	t-6
(1)	GNP	1.046 (5.8)	.525 (5.9)	.003 (.08)				
	PF/PD	-.855 (2.8)	-.705 (-2.7)	-.526 (-2.7)	-.350 (-2.6)	-.173 (-2.4)	.002 (.05)	
(2)	PF/PD	-.123 (-.65	-.095 (-.66)	-.068 (-.63	-.043 (-.56)	-.018 (-.39)	.0045 (.14)	

TABLE 4

EQUATIONS ESTIMATED FOR TOTAL U.S. GOODS IMPORTS, EXCEPT FUELS, LUBRICANTS AND CANADIAN AUTOMOTIVE PRODUCTS, 1958,I-1971.IV, OLS AND DISTRIBUTED LAG VERSIONS

Variables	OLS (1)	OLS (2)	OLS (3)	LAG (1)	LAG (2)	LAG (3)
CONSTANT	-8.532	-4.125	-4.619	-9.761	-4.905	-4.652
	(-5.2)	(-2.3)	(-3.7)	(-4.3)	(-1.6)	(-3.6)
Activity (Y)	1.769	1.077	1.154	1.954	1.206	1.158
	(7.0)	(3.8)	(5.8)	------	(2.4)	(5.8)
PF/PD	-1.463	-.815	-.342	-2.598	-2.619	-.161
	(-2.4)	(-1.4)	(-.60)	------	-------	-------
Dock	-.0805	-.0808	-.085	-.083	-.083	-.086
	(-7.9)	(-7.1)	(-8.1)	(-9.1)	(-7.9)	(-7.8)
Dsuez	-.076	-.061	-.074	-.077	-.065	-.053
	(-1.8)	(-1.5)	(-1.9)	(-2.0)	(-1.5)	(-1.3)
Other		D65*Y	T65*Y		D65*Y	T65*Y
		1.308	.0018		.519	.0019
		(3.0)	(4.0)		(.70)	(4.7)
		D65	STR	STR	D65	
		-8.462	-.0197	-.015	-3.356	
		(-3.0)	(-1.9)	(-1.6)	(-.71)	
$\bar{R}^2$	.986	.985	.987	.988	.985	.987
DW	2.21	1.85	1.86	2.11	2.19	1.87
DF	50	48	48	49	48	49
$\hat{\rho}$	.875	.675	.674	.917	.849	.607

TABLE 4 - continued

LAG DISTRIBUTIONS FOR U.S. IMPORTS EXCEPT FUELS,
LUBRICANTS AND CANADIAN AUTOMOTIVE PRODUCTS

	t-0	t-1	t-2	t-3	t-4	t-5	t-6
(1) Y	.986 (5.5)	.654 (5.6)	.322 (5.2)	-.008 (-2.4)			
PF/PD	-.754 (-2.3)	-.624 (-2.3)	-.495 (2.3)	-.368 (-2.2)	-.243 (-2.0)	-.118 (-1.7)	.003 (.08)
(2) PF/PD	-.757 (-2.2)	-.627 (-2.2)	-.498 (-2.2)	-.371 (-2.1)	-.245 (-1.9)	-.122 (-1.6)	.0008 (.02)
(3) PF/PD	-.065 (-.26)	-.048 (-.25)	-.031 (-.22)	-.018 (-.17)	-.0045 (-.07)	.006 (.17)	

Note:

Basic Variables used in these "total imports" equations are defined below:

Activity: Real U.S. GNP (GNP/PGNP)
PF: Published unit-value deflator for U.S. Imports (PM)
PD: Deflator for U.S. non-farm business product (PXBNF)
STR: Steel Strike Dummy

As noted above, one of the author's goals was to examine the distributed lag structure of U.S. import demand. Consequently, in Tables 3-6 two versions of most equations are presented: one with unlagged regressors only (OLS), and a version (LAG) with complete sets of distributed lag relations estimated by the Shiller method described in Section III. The motive for this dichotomy was purely empirical. It was to try to discern if the elaboration of such lag structures in fact contributes to improvement in the forecasting properties of such a model. This is a point which is not treated in the previous literature, though it might be assumed that a model with lags accounted-for would do better than a simpler version. By Occam's Razor, however, if this proves not to be the case, one should choose and use the simpler structure. Also, a great deal more complexity is introduced when full-blown lag relationships are specified, and more energy must be invested to find them. So to be as objective as possible, parallel forms were estimated, and both were subjected to the "horse-race" described in Section VIa. of this paper.[14/]

By and large the equations shown in Tables 3-6 (and the others not shown) were estimated independently of results obtained in other equations. A few exceptions to this rule were made to insure some "consistency" in findings concerning shifts in income or price parameters over the 1965-1971 period. Clearly, when the same model is treated at different levels of aggregation, there is an overlap between the dependent

14/ Marston (1971) also followed the procedure of estimating equations with and without lagged determinants, Ball and Marwah (1962), Grimm (1968), and Branson (1968) compared single-vs-multiple equation predictions but did not compare models with and without lag structures. None of these studies included post-sample tests of the empirical structure.

variables which are explained, and we must expect some agreement in findings at different levels. Thus, if evidence of income shifts were found in all the regional functions, it would be difficult to explain not finding some trace of a similar phenomenon in a single-equation aggregate. However, the number of cases in which any adjustments were made is very small. For the most part, results from the three types of functions shown here were compatible on the first round.

In both Tables 3 and 4 an important result which emerges is support for our hypothesis that in the late 1960's a structural change appeared to affect U.S. import behavior. Both versions of the aggregate equation sets show shifts in behavior which are significant at the .01 level. In each case where the shift hypothesis is tried, a rise in the income elasticity can be traced.[15/] With particular reference to use of the D65 dummy (one-time shift), the results would imply that the income elasticity of U.S. import demand suddenly "rose" from 1.077 to a value of 2.385. This result inspires certain natural reservations and is viewed as highly implausible. In all but a few cases results using the T65 trend term are clearly preferred. It should be noted that the 1965.I-1971.IV subsample comprises 28 quarters, so that an equivalent calculation (e.g., using eq. LAG(2) in Table 3) can be used to give a

15/ The author (1973, Chapt. IV) has noted that an aggregate equation which shows "evidence" of such shifts can sometimes lead to spurious conclusions. If the aggregate contains items with widely varying demand elasticities, over periods of rising income the "high elasticity items" will gain greater weight in the composite. No single item in the group need undergo a demand "shift" for the aggregate regression to give evidence of upward changing elasticity with respect to aggregate income. But since even our most highly disaggregated equations show signs of such effects, it is believed that the aggregate functions do represent legitimate, changing demand effects.

"total" estimated cumulative shift to end of period. Where such conflicts emerged, the simulation model described later in this paper was constructed using the trend-shift variant.[16/]

Aside from the important conclusion regarding the existence of measurable shifts in U.S. import behavior, these tables can also be used to illustrate some of the other general findings of several months of estimation effort. One of the most consistent results was that usually shifts in income elasticity have been found. Further, in practically all of the cases, such shifts have been in the upward direction. In a few instances, marginally significant shifts in price elasticities have been traced, and were in both directions. These occurred in double-disaggregates not shown in the accompanying tables.

A second consistent pattern of findings has been that, with one exception, the lag structure on the price response is much longer than the lag structure, if any, on income. For most product and regional groups, income/activity variables appear to have at most a one or two quarter lag structure, while some of the relations indicate a four to six quarter lag in changes in relative prices. Both sets of global equations clearly show this effect: the estimate of the long-run income elasticity is in the neighborhood, or only slightly higher than, the estimate for the current period only. Long-run price responses are often substantially higher than the current period effect. In Table 4 (eqns.

16/ Except for two cases of restricted samples, the estimates given here were made with around 50 degrees of freedom. For measures of significance, the t-statistics in parentheses must reach the following values: 1 percent level: 2.680; 5 percent level: 2.010; and 10 percent level; 1.678.

LAG (1) and LAG (2)), for instance, the estimate of the price elasticity moves up from around -1.5 to a long-run value of about -2.6.

Without speculating for the moment on the magnitude of these lag coefficients, it should at least be said that this type of behavior is entirely in accord with received theory. Current period imports are unlikely to be strongly affected by the level of economic activity in the past, except insofar as there are long order/delivery lags. Given the activity level, however, it is well accepted that the short-period price elasticity is likely to be low. This would be true in an excess demand framework or, more generally, in any case in which the short-run elasticity between domestic and imported goods is low. It is undoubtedly the case that a variety of psychological and technical "thresholds" are involved in this mechanism: reluctance to change suppliers, production bottlenecks, construction delays or outright domestic unavailability, all of which seem to work to lengthen the adjustment to changes in relative foreign and domestic prices.

There is yet a third consistent pattern of findings which can be observed in Tables 3 and 4, as well as in those that follow. When interaction terms are introduced, particularly in trend form, estimated price elasticities tend to diminish. In a few cases these become quite suspiciously small, and in some of the equations, (e.g., LAG (3)) the individual coefficients in the distribution fail to meet conventional significance tests.

The reasons for this anomalous performance are not entirely clear, but a conjecture might be made. The real-income/cum inflation boom in the United States of the late 1960's preceded the onset of serious inflation in U.S. trading partners by several years. Further, one finds several currency devaluations among such trading partners during the sample period, which tended to offset such foreign (local) price increases which did occur. The U.S. real-income and relative-price terms in our functions over the 1965-71 subsample would thus tend to have appreciable negative correlation, and there is the possibility that the results obtained here are to some degree deceptive. While this tends to somewhat undermine the structural shift hypothesis, the evidence from more disaggregated equations still tends to sustain the framework of our argument. As in all the equations discussed here and later sections, the regressions fit the data quite well and results were corrected for first order serial correlation by the Cochrane-Orcutt technique.

Turning briefly to the estimates made by End-Use Commodity groups, presented in Table 5, we note that the pattern of results is similar to that obtained in previous studies and the other author of this paper. For instance, a consistently low income and price elasticity is found in the Foods, Feeds and Beverages group, while the values tend to be much higher for Capital Goods and the two groups of Consumer Goods. No lag distributions were estimated for either the Imports, N.E.S. or Automotive categories.

In obtaining the results summarized here, by far the most intractable problems were encountered in trying to find acceptable estimates for Automotive imports, less the Canadian component. Several

TABLE 5

ESTIMATES OF U.S. IMPORTS BY END-USE GROUPS, 1958.I-1971.IV, OLS AND DISTRIBUTED LAG VERSIONS

	Foods, Feeds, Beverages		Industrial Supplies		Fuels & Lubricants	
	OLS	LAG	OLS	LAG	OLS	LAG
CONSTANT	-1.009 (-1.8)	-.728 (-1.2)	-2.621 (-3.7)	-3.584 (-9.7)	-6.511 (-8.3)	-7.622 (-10.3)
Activity (Y)	.383 (4.0)	.336 (3.4)	.995 (6.4)	1.208 ------	1.118 (9.2)	1.287 (11.3)
PF/PD	-.777 (-4.0)	-.740 ------	-1.960 (-3.8)	-2.934 ------	-.687 (-1.9)	-.650 -------
Dock	-.119 (-5.3)	-.122 (-5.3)	-.071 (-5.5)	-.069 (-5.5)		
Cyclic			.0044 (1.5)	.006 (2.3)		1.629 (2.9)
Other	T65*YD		T65	T65*PF/PD		
	.0012 (4.3)	.0013 (4.5)	.0036 (1.1)	-.096 (-2.4)	.161 DSUEZ (3.0) .017T69 (2.9)	.184 DSUEZ (3.2) .018T69 (3.8)
$\bar{R}^2$	.836	.832	.967	.972	.933	.938
DW	1.95	1.96	1.68	1.73	2.29	2.10
DF	51	51	50	50	51	50
$\hat{\rho}$	-.014	-.056	.653	.661	.459	.336

*Lag distribution coefficients are given on page following this table. t statistics in parentheses except for lag sums.

TABLE 5 --Continued

Variables	Capital Goods OLS	Capital Goods LAG	Automotive OLS (1)	Automotive OLS (2)[1]	Cons. Non-durables OLS	Cons. Non-durables LAG	Consumer Durables OLS	Consumer Durables LAG	Imports N.E.S. OLS
Constant	-12.701	-12.950	- 1.186	.392	-14.258	-14.445	- 9.256	- 9.446	- 8.308
	(-15.7)	(-13.6)	(- 1.8)	(1.4)	(-11.9)	(-14.5)	(- 2.7)	(- 2.3)	(- 6.6)
Activity (Y)	2.796	2.799	.244	-.383	2.455	2.471	1.655	1.679	1.271
	(15.7)	--	(1.2)	(- 4.2)	(13.0)	--	(2.9)	--	(6.5)
PF/PD	- .881	- 1.709	.791	.905	- 1.448	- 1.833	- .922	- .954	
	(- 1.5)	--	(.94)	(1.6)	(- 2.8)	--	(- 1.4)	--	
Dock	- .183	- .075	- .147	- .188	- .034	- .032	- .053	- .055	
	(- 3.5)	(- 3.4)	(- 4.6)	(- 4.1)	(- 2.6)	(- 2.5)	(- 3.5)	(- 3.5)	
Cyclic	- .138				- .208	- .159	- .301	- .272	
	(- 3.5)				(- 2.6)	(- 2.0)	(- 2.8)	(- 2.2)	
M_{-1}				.773					
				(11.8)					
D65	.256	.153	- .235						
	(3.5)	(2.0)	(- 1.9)						
Other			T65				T65*Y		DURAN
			.065	.019			.0037	.0037	.135
			(7.3)	(4.6)			(2.8)	(2.4)	(2.0)
			T59-61						
			- .026	- .028					
			(- 1.9)	(-3.1)					
$\bar{R}^2$	.987	.989	.967	.918	.992	.992	.990	.989	.883
DW	1.97	1.87	1.64	1.92	2.14	2.08	2.27	2.30	2.13
DF	50	51	49	49	51	51	50	50	53
$\hat{\beta}$	.499	.635	.797	- .214	.818	.759	.834	.826	.627

1/ In OLS(2) the dependent variable was ln [(MAUTO-MAC)/ECAUTO], where ECAUTO = Consumer expenditures on automotive products. The equation was also run in Koyck form. The short run elasticity of auto imports (in level form) with respect to ECAUTO is thus, .617, and by the properties of a geometric series the calculated long-run value is 2.84. Equation OLS (1) also excludes the Canadian component.

TABLE 5 --Continued

LAG DISTRIBUTION COEFFICIENTS FOR GLOBAL IMPORTS BY END USE GROUPS

Group		t-0	t-1	t-2	t-3	t-4	t-5	t-6
MFFB:	YDP							
	PF/PD	-.318 (-2.8)	-.223 (-3.4)	-.136 (-2.6)	-.067 (-1.2)	-.016 (-.31)	.023 (.44)	
MISAM:	IP	.611 (10.1)	.407 (12.8)	.199 (7.3)	-.0095 (-.25)			
	PF/PD	-.843 (-2.9)	-.699 (-3.0)	-.558 (-3.0)	-.418 (-2.9)	-.278 (-2.6)	-.139 (-2.1)	.001 (.03)
MFL:	PF/PD	-.443 (-1.8)	-.215 (-1.8)	.008 (.13)				
MKG:	IP	.945 (6.6)	.740 (9.6)	.543 (8.6)	.361 (5.1)	.190 (2.8)	.020 (.30)	
	PF/PD	-.689 (-2.1)	-.517 (-2.1)	-.343 (-2.0)	-.168 (-1.6)	.008 (.12)		
MCND:	YDP	1.649 (14.7)	.823 (15.4)	-.001 (-.01)				
	PF/PD	-1.221 (-3.4)	-.611 (-3.4)	-.001 (-.02)				
MCD:	YDP	.843 (2.5)	.559 (2.5)	.278 (2.4)	-.001 (-.001)			
	PF/PD	-.484 (-.87)	-.318 (-.86)	-.155 (-.81)	.0033 (.06)			

Note:

No lag distributions were calculated for MAUTO or MNES groups. The t-statistics are shown in parentheses below the coefficients. Lag lengths were found by estimation without endpoint constraints and "tightness" parameters of 1.0. Results shown here include endpoint constraints ($\hat{B}_{t-n}$~O) applies after the unconstrained results were examined.

dozen variants were tried, all of them unsuccessfully, and in fairness the results presented here are only the least objectionable of a bad lot. Attempts were made with a variety of price indexes, including the untranslated German D-mark price for road vehicles.[17] Several different behavioral hypotheses were also probed, including the notion of resistance functions based on the share of the U.S. market captured by foreign manufacturers. In its final form, the Automotive equation OLS(2) is the only estimate made in the ratio form used by Branson. The dependent variable is the ratio of automotive imports (except from Canada) to domestic auto expenditures, and the equation was also cast in Koyck form. Since the activity variable is also domestic auto expenditures and the equation is in logs, the negative sign on Y is not an implausible result. In a large number of attempts it proved almost impossible to "attain" a negative sign on the price term. The sharp but temporary break in the pace of auto imports in the 1959.II to 1961.II biennium was, frankly, fitted by a trend dummy over these 9 quarters.[18]

Turning for a moment to the evidence of structural shifts at the commodity level, some clear tendencies can be discerned. Some form of trend shift phenomenon seems also to have occurred in all the groups except in imports of KG, CND and Imports, N.E.S. In the ISAM group results, the income effect is weak (the regressor was IP), but there

17/ At the suggestion of L.R. Klein, who used this index in his Spring 1973 reestimation of U.S. imports for the Link project.

18/ Perhaps the most discomfiting aspect about the automotive function was that when it is broken into its two principal parts, for Western Europe and Japan, fairly acceptable results emerge. These results are not shown in this paper.

appears to be a strong price-trend relation -- the only one found in this section. Interestingly, the estimates suggest an increasing price elasticity of demand for these products. In contrast to the others, the trend term in the Fuels and Lubricants equation was set to begin in 1969. (The authors disclaim any responsibility for the unhappy events of late 1973.) Imports of both FFB and CD seem to have been markedly affected by rising income elasticities in the late 1960's, the former probably in connection with demand for European products and the latter with both European and Japanese durable goods. The contrast between Consumer Durables and Nondurables is especially interesting in this regard, since despite fairly extensive data rummaging it was impossible to find significant shifts in the latter. Finding such differences helps refute the possible conclusion that such "shifts" were merely a reflection of an increasing dollar overvaluation during the late 1960's.

As in the aggregate equations, the estimation of distributed lags also tended to distinguish sharply between the "long" and "short" price lag structures, as shown at the end of Table 5. In the former group we find price lags on FFB (5 quarters) and ISAM (6 quarters). The only instance of a long and significant <u>income</u> lag was the 5 quarter lag on IP in the function for imports of Capital Goods, which can be explained by a simple accelerator mechanism.[19] This result, incidentally, carries over to the KG import functions estimated under regional disaggregation. Shorter income lags do appear, however, for ISAM and CD and to a marginal extent for the CND groups.

19/ See, for instance, M.K. Evans, <u>Macroeconomic Activity: Theory Forecasting and Control</u> (New York: Harper and Row, 1969), pp. 80-85.

It is not our intention to assign inviolable attributes to the coefficient estimates shown in these tables, but a few further comments may be warranted. In two cases in Table 5 (FFB and FL) we have "found" a long-run price elasticity which is slightly lower than the short-run analogue. The margins between them are small, however, and it seems preferable to call the discrepancy a statistical artifact rather than tamper further, as we could surely have done. This result is probably just more evidence that there is only a small margin between the long- and short-run values. There is also the surprisingly high estimate for the price elasticity on ISAM, especially if the T65 x P_f/P_d trend shift is counted. One is perhaps too much accustomed to thinking of "Industrial Supplies" solely in terms of indispensable raw materials with low price elasticities. In fact, there is an enormous variety of intermediate goods in this group, ranging from unfabricated metals and ores to hides, textiles and semi-manufactures. Since there are extensive substitution possibilities between domestic and foreign supply sources for many products of this group, the high long-run estimate may be less startling than it seems at first glance.

Finally, we may add a few remarks about the cyclical influences which can be traced in these functions. With the exception of the FFB, AUTO and NES groups, statistically significant estimates for cyclical variables were often found. A great deal of experimentation was made with the appropriate concepts. In ISAM, for instance, either inventory changes or the nonlinear capacity utilization concept proved fruitful.

Where an effect could be found for the KG group, it was most often through the capacity term. On occasion, as in the FL equation, the semilog estimate of 1956-71 trend-to-current activity variable seemed most applicable. In the Consumer Goods categories the most consistent results were produced by introducing the unemployment level.

Although both current and once-lagged unemployment were significant in the CG regressions, there was an evident and persistent improvement when the lagged term was used, and these results are reported here. Even on theoretical grounds this cannot be viewed as a distasteful result. In the first place there are always order/delivery lags. Secondly, and more important perhaps, if shortsightedness (as the author believes) is a basic human characteristic, expectations may always be slightly out of phase with the march of events. In some sense we are all forced to take delivery tomorrow on the goods our slightly erroneous expectations induce us to order today. Except in the realms of theory, the author believes it is hard to find much perfect foresight in the social universe.

We may now turn briefly to Table 6, which presents estimates made for total U.S. imports (less FL in each case) made by regions of origin. Of necessity this involves re-aggregation by commodity. In some senses these were the least "interesting" or promising functions which were developed, at least for prediction of total U.S. trade. There is, nonetheless, great current interest in matters of "bilateral trade balance," so for predictive purposes a good case can still be made for developing such functions by region.[20/]

Beginning with the regional equations, our estimation procedure has tried to take into account both the exchange rate and competing-region effects outlined in earlier portions of this paper. For U.S. imports from any one region at the aggregate level shown in Table 6, it seemed best to consider all four other world regions as competitors in the U.S. market. In the highly disaggregated results not shown here, finer distinctions were made. This means that in each regression term in P_{f2}/P_{f1} are weighted averages of the prices of four world regions, adjusted for exchange rates. In the ordinary case the expectation would be for a positive coefficient estimate on this term, with a negative value expected on the basic regressor, P_{f1}/P_d. In addition, for Western Europe, Canada and Japan the tariff rate has been consolidated in the basic price term, but the regional exchange rate has been considered separately.

By and large the author's hopes for illuminating insights to be derived from treating exchange rate terms separately were only partially borne out by the regression results. In most cases it can at least be said that the sign expectations are met, and in the Canadian and Japanese results there is some statistical significance associated with

20/ In 1972 and early 1973, for instance, Japan was under great pressure to get its bilateral trade with the U.S. "back in balance," despite the fact that there is little support in economic theory for rigid bilateralism. Interestingly, no mention was then made of the traditional positive U.S. balance on trade account with Latin America. Recent events continue to raise ominous overtones of the trade wars of the 1930's.

TABLE 6

EQUATIONS ESTIMATED FOR U.S. IMPORTS FROM WORLD REGIONS, 1958.III-1971.IV, OLS AND DISTRIBUTED LAG VERSIONS (FUELS AND LUBRICANTS AND CANADIAN AUTOMOTIVE PRODUCTS EXCLUDED)

	Western Europe		Canada		Japan	
Variables	OLS	LAG	OLS	LAG	OLS	LAG
CONSTANT	-4.564	-5.043	-.798	-1.514	-20.080	-22.788
	(-1.9)	(-2.0)	(-1.0)	(2.8)	(-8.7)	(-8.4)
Activity (Y)	.935	1.001	.414	.605	3.215	3.644
	(2.4)	------	(2.3)	------	(8.8)	-------
PF1/PD	-4.104	-4.934	-1.052	-1.214	-1.015	-2.114
	(-2.9)	------	(-1.6)	------	(-1.0)	-------
PF2/PF1	.414	.801	.074	.093	-1.935	-2.968
	(.52)	------	(.22)	------	(-1.9)	-------
XR	.152	.100	-1.637	-2.099	-1.172	-1.191
	(.14)	(.08)	(-3.6)	------	(-1.1)	(-1.2)
DOCK	-.1017	-.1027	-.0539	-.053	-.064	-.061
	(-5.2)	(-5.6)	(-3.5)	(-3.6)	(-2.9)	(-2.8)
CYCLIC	.096	.135	.0734	.005	-------	
	(1.3)	(2.0)	(2.2)	(1.6)		
T65*Y			.003	.002	.002	
			(3.9)	(3.3)	(2.0)	
OTHER	D65		DURAN			
	.085		.033	.055		
	(1.3)		(1.2)	(2.0)		
$\bar{R}^2$	.972	.973	.972	.973	.990	.989
DW	1.85	1.96	1.96	1.95	2.14	2.07
DF	46	47	45	45	47	48
$\hat{\rho}$	.572	.631	.062	.058	.583	.674

TABLE 6 --Continued
EQUATIONS ESTIMATED FOR IMPORTS

FROM WORLD REGIONS

	Latin America		Rest of World	
Variables	OLS	LAG	OLS	LAG
Constant	-2.493 (-3.1)	-3.096 (-3.5)	-5.926 (-10.6)	-5.805 (-10.7)
Activity (Y)	.773 (4.3)	.905 -------	1.504 (12.7)	1.479 -------
PF1/PD	-1.080 (-2.5)	-.964 -------	-.691 (-1.5)	-1.216 -------
PF2/PD1	-.006 (-.01)	.288 (.61)	.696 (1.2)	.568 (1.1)
XR	-------	-------	-------	-------
Dock	-.075 (-3.4)	-.083 (-4.3)	-.056 (-2.3)	-.059 (-2.6)
Cyclic	-------			
D65	-.116 (-1.7)	-.139 (-2.1)		
Other			DURAN	
			.034 (.64)	.0063 (.11)
$\bar{R}^2$	.774	.786	.950	.955
DW	2.09	2.11	2.08	2.11
DF	48	48	48	48
$\hat{\rho}$	.49	.59	.470	.475

TABLE 6 --Continued

LAG DISTRIBUTIONS FOR IMPORT EQUATIONS ESTIMATED BY WORLD REGIONS[a]

	t-0	t-1	t-2	t-3	t-4	t-5	t-6
WE: Y	.668 (2.4)	.334 (2.4)	-.001 (-.02)				
PF1/PD	-1.985 (-3.2)	-1.487 (-3.2)	-.990 (-3.2)	-.494 (-3.0)	.022 (.04)		
PF2/PF1	.400 (.74)	.265 (.74)	.132 (.72)	.004 (.06)			
CAN: Y	.404 (4.6)	.202 (4.9)	-.0008 (-.02)				
PF1/PD	-.477 (-1.9)	-.362 (-2.0)	-.245 (-2.0)	-.126 (-1.8)	-.0044 (-.12)		
PF2/PF1	.043 (.25)	.029 (.26)	.016 (.27)	.005 (.13)			
XR	-1.052 (-4.3)	-.697 (-4.3)	-.343 (-4.1)	-.0076 (.20)			
JAP: Y	2.433 (8.4)	1.217 (8.6)	-.006 (-.009)				
PF1/PD	-1.072 (-2.24)	-.707 (-2.4)	-.346 (-2.2)	.011 (.16)			
PF1/PF1	-1.974 (-3.1)	-.989 (-3.1)	-.005 (-.07)				
LA Y	.600 (4.1)	.304 (4.5)	.001 (.01)				
PF1/PD	-4.37 (-1.9)	-.301 (-1.9)	-.175 (-1.5)	-.067 (-.90)	.016 (.27)		
ROW Y	.972 (9.3)	.494 (11.2)	.013 (.19)				
PF1/PD	-.402 (-1.8)	-.317 (-1.9)	-.238 (-1.9)	-.162 (-1.5)	-.087 (-1.1)	.010 (-.16)	

the estimates. The Canadian result, in contrast to the Japanese, is also significant at the .05 level. This strong result may in part be due to the fact that the Canadian dollar was allowed to float over part of our sample. Not only was there higher variance in the exchange rate, but U.S. importers would naturally tend to think both in terms of local Canadian prices and parity developments as components of a single "international price."21/

We have suggested above that there may be some uncertainty on the sign expectation for terms in $\ln(P_{f2}/P_{f1})$. In the "normal" case imports from one region should be viewed as competitive to those from another. Should there exist complementarity, however, this term could have a negative sign, but at the level shown in Table 6, this would seem to be an unlikely result.

One attractive aspect of these estimates is the sharp difference in income and price elasticities which seems to characterize U.S. demand for imports from the five world regions shown here. Both the sluggish U.S. demand for Canadian and Latin American bundles and the phenomenally high income elasticity for Japanese products come through sharply. For the most part, the long-run effects agree with previously described results, in that from the short to long run, relatively higher jumps are made by price than by income elasticities.

21/ Somewhat stronger exchange rate results were obtained by Peter B. Clark in his recent paper (1973), in which the estimation sample was designed to encompass the period following the Smithsonian and February, 1973, arrangements.

Vb. Estimation Results in the Hooper Model

In the interests of brevity and of focusing on our comparative analysis of the Wilson and Hooper forecasting models, the various alternative specifications of the Hooper model will not be presented here.[22/] Rather, we shall concentrate on a single set of equations for imports and exports (by commodity, regional and total groupings) and briefly summarize the aspects of specification and estimation that may pertain to the present effort. In order to avoid repitition with the subsequent joint discussion of the two models, our discussion in this subsection will be limited to a comparison of the import and export elasticity estimates, and of the unweighted and weighted aggregate equations obtained in the Hooper equations presented below.

The estimated equations are presented in Tables 7-11, including imports and exports by commodity and region, and total imports and exports, both unweighted and weighted. The coefficients are long-run elasticity estimates, and the number in parentheses to the right of certain coefficients indicate the number of lagged periods included in the long-run (Almon) estimates. The impact and lagged coefficients obtained in Almon equation of the commodity disaggregated equations are presented at the end of Tables 7 and 9. The statistics presented at the bottom of each table are the same as in previous tables, with the exception of "(D)", which is the adjusted Durbin Watson statistic for autoregressive equations. First-order serial correlation was assumed, and the Cochrane-Orcutt iterative procedure and Hildreth-Lu scanning technique (in the case of autoregressive equations) used to estimate rho values.

22/ We deviate slightly from this resolution in presenting both weighted and unweighted aggregate equations. Alternative specifications of the Hooper model have been presented and discussed in detail in Hooper (1972) and (1974).

The most surprising result with respect to prices is the extremely high value (-4.934) obtained for Western Europe.

Another slightly unexpected result is that a uniform negative sign was obtained for the DOCK dummy for all regions, including Canada and Japan. There seems to be no ready explanation for such a phenomenon, since except in 1971 the West Coast was little affected by U.S. dock strikes. Extremely strong assumptions would have to be made about a general slowdown in all U.S. import activity for the Canadian estimates to seem plausible. At the regional level a uranium products import dummy, DURAN, was included for both Canada and the Rest-of-World, since both of these areas were significant suppliers during the early 1960's, but only the former produced significant estimates.

For these aggregate regional equations, experiments with lag-distributions were somewhat less successful than for commodity groups. This is almost surely due to the enhanced commodity mixes involved. The longest estimated lags, as might be expected, appear in equations for regions with a fairly high share of industrial materials exports.

The above summaries of regression results have deliberately been somewhat perfunctory,since it assumed that the reader is familiar with such interpretations. We also have some ways to go before this written exercise is complete, and lengthy discussions of regressions is, after all, a rather colorless way to spend one's time. There is also a tendency to focus too strongly on real or imagined faults in the estimates.

In summary we might argue that on the whole the results given in Tables 3 to 6 are not at all unsatisfying,despite our focus on the unexpected or implausible in the text above. With the few exceptions shown, a fairly high degree of consistency can be found between the various levels of the basic functional form. Rather impressive differences in U.S. import behavior as between several world regions and commodity groups have been identified. There is also, as can be seen, some evidence to support the hypothesis that distinguishable types of structural shifts have taken place in the late 1960's. The commodity groups affected can be fairly sharply delineated from those in which no such effects were found for the 1965-71 subsample. Although the attempt to distinguish cross-elasticity effects in the regional regressions produced poor results, even this "failure" is not complete. The reason <u>may</u> reside in difficulties with the chosen price or weighting procedures; but it may <u>also</u> in fact reflect a lower level of substitutibility in U.S. import provenance that we had supposed at the outset of this study. Even negative results can be informative.

Finally, the estimates provide at least some information regarding exchange rate effects. The results for Canada are strong, but those for Japan and Western Europe fairly weak and inconclusive. Had the major parity realignments of December, 1971 and February, 1973, not occurred, this could be regarded as a minor pitfall. Within that span, however, the relation of the dollar to several foreign currencies changed by 10-20 percent, and by the end of 1973 there was evidence that these realignments were having a real impact on U.S. trade flows. How well such relatively weak estimates will "hold up" under the empirical tests of the post-sample is a question which will be examined more closely in following sections.

Table 7

Equations Estimated for U.S. Imports by End-Use Commodity Category
1958.I-1971.IV - PH Model
(t-ratios in parentheses)

Commodity Imports	Foods Feeds & Beverages	Industrial Supplies	Capital Goods	Consumer Non-Duras.	Consumer Durables
Constant	6.630 (128.77)	7.790 (108.82)	3.081 (4.10)	3.802 (22.58)	6.278 (125.51)
Activity	1.452 (11.52)	1.076(1) (12.50)	1.598 (4.40)	2.605(2) (15.61)	1.214(2) (9.56)
Relative Price	-0.752(3) (-4.04)	-1.269(2) (-1.69)	0.025(1) (0.02)	-2.953(3) (-5.27)	-2.653(3) (-5.49)
U.S. Nonprice Rationing	-- --	-0.007 (-0.051)	-- --	-- --	-- --
Foreign Nonprice Rationing	-- --	-- --	-0.154(1) (-1.25)	-- --	-- --
Lagged Dependent Variable	--	--	0.430 (3.56)	--	--
Dock Strike Dummy	0.168 5.03	0.080 (6.76)	0.095 (2.72)	0.061 (3.04)	0.084 (3.771)
Lagged Dock Strike Dummy	--	--	-0.030 (-0.080)	--	--
Other	--	Suez Dummy -0.061 (-2.35)	Canadian Auto Dummy 0.332 (3.71)		Canadian Auto Dummy 0.496 (12.52)
R^2	0.896	0.986	0.995	0.992	0.994
Standard Error of regression	0.064	0.031	0.063	0.051	0.049
Durbin-Watson (D)	1.397 --	1.923 --	2.068 -0.568	1.989 --	1.970 --
Degrees of Freedom	50	45	45	47	46
Rho Estimate	--	0.720	0.207	0.692	0.387

Table 7 (continued)

Almon Lag Coefficients for Commodity Import Equations - PH Model
(t-ratio in parentheses)

Time Period	t-0	t-1	t-2	t-3	t-4
Foods, Feeds & Beverages					
Activity	--	--	--	--	--
Relative Price	-0.520	-0.226	-0.041	0.034	--
	(-3.25)	(-4.05)	(-0.51)	(0.46)	--
Industrial Supplies					
Activity	0.738	0.338	--	--	--
	(3.65)	(1.74)	--	--	--
Relative Price	-0.956	-0.316	0.002	--	--
	(-1.85)	(-0.97)	(0.007)	--	--
Capital Goods					
Activity	--	--	--	--	--
Relative Price	--	--	--	--	--
Consumer Nondurables					
Activity	9.597	1.104	0.905	--	--
	(1.02)	(5.49)	(2.34)	--	--
Relative Price	-0.960	-0.886	-0.701	-0.406	--
	(-2.66)	(-5.27)	(-3.01)	(-2.05)	
Consumer Durables					
Activity	1.285	0.179	-0.249	--	--
	(6.65)	(2.03)	(-1.77)	--	--
Relative Price	-0.800	-0.796	-0.662	-0.396	--
	(-2.38)	(-5.49)	(-3.18)	(-2.20)	--

Table 8
Equations Estimated U.S. Imports by World Region
1958.I-1972.IV - PH Model
(t ratios in parentheses)

Regional Imports	Western Europe	Canada	Japan	Rest of World
Constant	6.094 (7.23)	3.434 (1.17)	4.975 (2.13)	6.793 (7.83)
Trend Activity	1.503 (5.62)	1.679 (5.15)	2.720 (2.07)	0.589 (4.01)
Deviation from trend Activity	0.122 (2.14)	0.155 (5.28)	0.280 (2.65)	
Relative Price	-2.720 (-5.28)	-0.184(-1) (-0.30)	-2.951 (-1.85)	-1.219 (-5.25)
U.S. Nonprice Rationing	0.140(-1) (1.27)	-- --	-- --	-- --
Foreign Nonprice Rationing	-1.226(-1) (-2.28)	-- --	-- --	-- --
Lag Dependent Variable	0.285 (2.77)	-- --	0.696 (7.14)	0.106 (0.93)
Dock Strike Dummy	0.184 (5.27)	-- --	0.023 (0.58)	0.073 (2.46)
Lagged Dock Strike Dummy	-0.046 (-1.10)	-- --	-0.112 (-2.61)	-0.003 (-0.08)
Other	Steel Strike Dummy 0.179 (3.87)	Canadian Auto Dummy 0.261 (8.02)	Steel Strike Dummy -0.002 (-0.04)	
R^2	0.975	0.985	0.990	0.950
Standard Error of Regression	0.062	0.062	0.070	0.052
Durbin-Watson (D)	1.963 0.220	1.447 --	1.919 0.443	2.010 -0.073
Degrees of Freedom	45	50	47	49
Rho Estimate	--	--	--	--

Table 9

Equations Estimated for U.S. Exports by End-Use Commodity Category
1958.I-1971.IV - PH Model
(t-ratios in parentheses)

Commodity Exports	Foods, Feeds & Beverages	Indus-trail Supplies	Capital Goods	Consumer Goods
Constant	6.631 (93.96)	8.264 (3.48)	7.761 (328.67)	6.683 (66.43)
Activity	0.426 (2.63)	0.562(2) (3.59)	1.190(4) (23.38)	1.231 (9.01)
Relative Price	-0.882 (-2.92)	-0.857(4) (-1.50)	-- --	-2.150(4) (-2.74)
U.S. Nonprice Rationing	-- --	-- --	-0.350 (-2.76)	-- --
Foreign Nonprice Rationing	-- --	0.756 (0.67)	-- --	-- --
Lagged Dependent Variable	-- --	-- --	-- --	-- --
Dock Strike Dummy	0.254 (10.59)	0.185 (9.24)	-- --	0.056 (2.05)
Lagged Dock Strike Dummy	-- --	-- --	-- --	-- --
Other	--	Steel Strike Dummy 0.059 (1.51)	--	Canadian Auto Dummy 0.096 (2.26)
R^2	0.880	0.940	0.979	0.975
Standard Error of regression	0.066	0.052	0.044	0.056
Durbin-Watson (D)	2.482 --	1.659 --	2.102 --	2.006 --
Degrees of Freedom	46	42	46	44
Rho Estimate	0.797	0.755	0.463	0.209

Table 9 (continued)

Almon Lag Coefficients for Commodity Export Equations-PH Model
(t-ratios in parentheses)

Time Period	t-0	t-1	t-2	t-3	t-4
Foods, Feeds & Beverages					
Activity	--	--	--	--	--
	--	--	--	--	--
Relative Price	--	--	--	--	--
Industrial Supplies					
Activity	0.104	0.246	0.212	--	--
	(0.15)	(1.11)	(0.47)	--	--
Relative Price	--	-1.953	-0.257	-.634	0.719
	--	(-2.03)	(-0.50)	(-1.07)	(1.49)
Capital Goods					
Activity	0.064	0.251	0.338	0.325	0.212
	(0.27)	(4.89)	(4.83)	(2.77)	(2.26)
Relative Price	--	--	--	--	--
	--	--	--	--	--
Consumer Goods					
Activity	--	--	--	--	--
	--	--	--	--	--
Relative Price	1.096	-0.211	-0.974	-1.193	-0.868
	(2.02)	(-1.12)	(-3.36)	(-3.27)	(-3.20)

Table 10

Equations Estimated for U.S. Exports by World Region
1958.I - 1971.IV - PH Model
(t-ratios in parentheses)

Regional Exports	Western Europe	Canada	Japan	Rest of World
Constant	0.875 (2.12)	4.394 (3.45)	-2.596 (-0.77)	0.017 (0.04)
Activity	1.359 (4.20)	1.051 (2.81)	.781 (4.71)	.790 (2.40)
Relative Price	0.073 (0.14)	-0.086 (-0.19)	-1.582 (-1.23)	-1.339 (-1.49)
U.S. Nonprice Rationing	-- --	-- --	-- --	-- --
Foreign Nonprice Rationing	-0.359 (-0.50)	1.806 (3.04)	-- --	-- --
Lagged Dependent Variable	0.314 (2.11)	0.510 (4.08)	0.448 (3.95)	0.797 (9.16)
Dock Strike Dummy	0.180 (3.84)	-- --	0.165 (4.44)	0.237 (5.75)
Lagged Dock Strike Dummy	-0.045 (-0.80)	-- --	0.034 (0.842)	-0.155 (-3.31)
Other		Canadian Auto -0.013 Dummy (-0.38)		
R^2	0.932	0.967	0.972	0.830
Standard Error of Regression	0.083	0.062	0.070	0.074
Durbin-Watson (D)	1.916 undefined	2.037 -0.309	2.040 -0.248	2.206 -0.966
Degrees of Freedom	45	44	44	44
Rho Estimate	--	-0.213	0.426	-0.537

Table 11

Equations Estimated for Total U.S. Imports and Exports, Weighted and Unweighted
1958.I-1972.IV - PH Model
(t-ratios in parentheses)

Total Imports and Exports	Import Equations		Export Equations	
	Un-Weighted	Weighted	Un-Weighted	Weighted
Constant	5.090 (5.75)	5.252 (6.48)	-2.292 (-1.26)	1.175 (1.52)
Activity	0.946 (3.34)	0.895 (4.827)	0.575 (4.51)	.990 (5.63)
Relative Price	-0.982 (-1.44)	-1.940 (-3.77)	-.834 (-1.59)(1)	-1.622 (-1.49)(1)
U.S. Nonprice Rationing	-0.034 (-0.38)	-- --	-0.692 (-0.12)	-0.134 (-1.40)
Foreign Nonprice Rationing	-- --	-- --	0.088 (0.33)	0.133 (0.391)
Lagged Dependent Variable	0.393 (3.65)	0.364 (3.65)	0.334 (2.32)	
Dock Strike Dummy	0.087 (6.77)	0.088 (7.56)	0.160 (7.83)	0.146 (7.70)
Lagged Dockstrike Dummy	-0.461 (-2.69)	-0.039 (-2.52)	-0.023 (-0.77)	.003 (-.10)
Other	Canadian Auto Dummy 0.127 (3.32)	Canadian Auto Dummy 0.126 (3.73)	Suez Canal Dummy -0.023 (-0.73)	Canadian Auto Dummy -0.037 (0.86) Steel Strike Dummy 0.040 (1.39) Suez Canal Dumm -0.002 (-0.06)
R^2	0.995	0.996	0.979	.984
Standard Error of Regression	0.026	0.024	0.036	.033
Durbin-Watson (D)	1.922 0.482	2.021 -0.118	1.876 1.185	1.906 Undefined
Degree of Freedom	45	46	40	38
Rho Estimate	0.55	0.612	-0.078	0.107

Considerable effort went into the final selection of the explanatory variables included in Tables 7-11, from among numerous alternative data series. Selection was made on the basis of in-sample statistical fit and expected sign of coefficient. Before discussing the activity and price elasticity estimates in particular, we can briefly describe the salient results of empirical specification as follows:

1. Disaggregate activity variables (consumer expenditure components, investment, industrial production) performed better than aggregate activity (GNP, IP, etc.) in the commodity import and export equations. The former results (presented in Tables 7 and 9) also exhibited coefficients that were generally closer to unity than the aggregate variable coefficients.[23/]

2. Commodity-trade-share-weighted explanatory variables did not yield significantly better results than unweighted aggregate data, such as GNP, IP, and aggregate WPI, in the regional trade equations. The unweighted estimates alone are reported in Tables 8 and 10, as it was felt that these would be more manageable for forecasting purposes.

23/ The estimated GNP elasticities of import demand for capital goods and consumer durables, for example, were both about 3.0. But, when more specific activity variables were used (including consumption and investment expenditures on durables good), the elasticity estimates fell to about 1.2, largely because these explanatory variables were more volatile (cyclically) than GNP. The movement towards unity was from the other direction for foodstuffs (using consumer expenditures on food as the activity), and there was little change in the case of industrial supplies (using IP). In the case of exports, the difference between aggregate and disaggregate activity coefficients was less pronounced, because foreign GNP components were not as well defined, and in many cases were unavailable.

3. In the unweighted regional equations, separation of the activity variable into trend and deviation-from-trend components yielded better results for imports, though not for exports.[24] The cyclical elasticity estimates, while significantly different from zero, were very small in magnitude relative to the trend elasticities, suggesting that cyclical factors may be relatively unimportant in determining U.S. trade flows.

4. Price coefficients were far less erratic when exchange rates were included directly in the price terms rather than as separate explanatory variables. The exchange rate coefficients (in equations not reported here) were generally insignificant, except for Canada, reflecting the lack of exchange rate variation over the sample period.

5. Price terms performed poorly when third-country prices were included in the regional equations. Considerable covariance between the price variables suggested severe problems of multicollinearity. The third-country price variables were excluded from the regional equations presented in Tables 8 and 10.

6. In support of our observation on cyclical factors under number 3 above, as well as results obtained by Richardson (1973), nonprice

24/ The same was done for total trade equations, with similar results, thought not reported here. See Hooper (1974, Ch. 5). This specification follows the example of Adams et al. (1969) who argued that an aggregate activity variable cannot capture cyclical differences among activity components and related trade flows. The separation of the aggregate activity terms into cyclical and trend components is designed to do this. The trend period used in this case was 1954.II-1972.IV.

rationing proxies were found to be generally insignificant. Among the numerous domestic and foreign proxies tried, only U.S. unfilled orders normalized by production, and foreign deviation-from-trend industrial production performed well in several of the durable goods equations.[25/]

7. Adjustment lags were very short for activity variables (1-3 quarters) and only slightly longer for price variables (3-5 quarters).[26/] In results not shown here, each of the equations was estimated using the Almon model with lags ranging from one to twenty quarters on both income and prices (using second and third-degree polynomials, with and without zero-end restrictions). The Almon estimates of income and price lags were found to be very similar in regional and aggregate equations, and the Koyck model yielded better results in those cases.[27/] The Koyck results are reported in Tables 8, 10 and 11, and the Almon in Tables 7 and 9. The modified Koyck model (including a lagged price term) was generally inferior in the same equations, thus supporting the Almon results, which suggest a similarity in the length of income and price lags.

Income and Price Elasticity Estimates

In general, the activity and price elasticity estimates were all highly statistically significant with the correct signs (positive

25/ Other proxies tried included U.S. and foreign unemployment rates, price changes, U.S. inventory change normalized by production, capacity utilization and various lags of each of these.

26/ Short lags could be anticipated for the expenditure activities used in certain commodity import equation -- the estimated lags in those cases are probably due largely to order-delivery delays.

27/ Both the price and income lags averaged about 3-4 quarters in length, and the shapes most often approximated linear decay.

and negative, respectively).[28] The only notable exceptions were in the price coefficients of the capital goods and Canadian import and export equations. Much of the problem in these cases can probably be blamed on simultaneous equation bias.[29]

Among the (long-run) activity elasticities, those of food and beverages and consumer goods were higher for imports than for exports, reflecting the relatively greater proportion of "luxury" items (alcoholic beverages, passenger cars, etc.) in U.S. imports. By region, activity coefficients were fairly similar between imports and exports, except for trade with Japan. In the Japanese case, the U.S. import elasticity was much higher than its export counterpart, reflecting the higher proportion of consumer durables and automotive products on the import side.

The commodity price elasticity estimates ranged from -.8 and -.9 for imports and exports of foods and beverages, to -3.0 and -2.2 for imports and exports of consumer goods. Price estimates for industrial supplies and materials were intermediate, though somewhat lower for exports than for imports. In the regional breakdown, import price elasticities were considerably higher than export elasticities, with the exception of the Rest-of-World region, where the two were fairly close. The import-export price elasticity difference was also obtained in the total trade equations, though less dramatically.

28/ The coefficients presented in Tables 7-11 are long-run elasticity estimates. In the Koyck equations, (Tables 8, 10 and 11) the t ratios are those of the impact coefficients. See Appendix A for the derivation long-run elasticities under the Koyck model.

29/ As evidence that supply problems could have been involved here, Canada's exports to the U.S. accounted for 20 percent of its GNP in 1972, and U.S. exports of machinery in the same year equaled nearly 12 percent of domestic sales in that commodity category.

The differences, obtained among disaggregated income and price elasticity estimates in Tables 7-10 suggest a considerable potential for aggregation error in the single equation estimation of total imports or exports. We can expect, in theory at least, that the commodity-trade-share weighted (as opposed to the unweighted) aggregate equations will yield elasticity estimates that are more consistent with the disaggregate estimates.[30/] To investigate this hypothesis briefly, we list the weighted and unweighted activity and price elasticity estimates, and trade-share weighted averages of the disaggregate elasticities in Table 12 below.

The results are mixed. In the cases of import price and export activity elasticities, the weighted aggregated estimates are consistent with the disaggregate averages, while the unweighted estimates are not. In the other two cases, however, the aggregate import activity elasticities are about the same, both somewhat below the disaggregate averages, and the aggregate export price elasticities are at two extremes above and below the disaggregate averages.

It would be difficult to draw any final conclusions on the efficacy of trade-shares weighting across commodities on the basis of these results, but there are several interesting observations that can be made. First, though the selection criteria are admittedly weak, the weighted estimates did exhibit slightly better in-sample fits, and were generally more consistent with the disaggregate estimates.

30/ Both the "weighted" and "unweighted" equations necessarily used weighted averages of data aggregated across foreign countries and regions.

Table 12

Estimates of Activity and Price Elasticities
for U.S. Imports and Exports - Hooper Model.

	Aggregate Elasticity Estimates		Weighted Average of Disaggregate[a] Estimates	
	Unweighted	Weighted	Commodity	Regional
Imports				
Activity	.95	.90	1.28	1.31
Price	-.98	-1.94	-1.61[b]	-1.98[c]
Exports				
Activity	.58	.99	.86	1.04
Price	-.83	-1.62	-1.08[b]	-1.39[c,d]

a/ The weights used are 1967-69 share of U.S. imports or exports by commodity and region. See Hooper (1974, p. 62).
b/ Capital goods excluded.
c/ Canada excluded.
d/ Western Europe excluded.

Post-sample simulation results should provide further evidence. Secondly, the income or activity elasticity of demand for U.S. imports appears to be somewhat higher than that for exports. This would tend to support Houthakker and Magee's (1969) conclusion that the U.S. trade balance is subject to secular deterioration if all countries grow at the same rate, ceteris paribus. At the same time however, the disparity between our import and export price elasticity estimates suggests the opposite result. Import demand appears to be more price elastic than export demand, which suggest that the U.S. trade balance will improve if all countries inflate at the same rate, ceteris paribus. Finally, our findings are clearly a setback to "elasticity pessimism". The estimates listed above suggest that the demand for U.S. imports and exports is indeed price elastic, even more so, since the estimates obtained may well be biased downwards (towards zero) because of simultaneous equation problems. We may conclude that the Marshall-Lerner condition is well met, and that a dollar depreciation would have a favorable impact on the U.S. trade balance in the long run. The dramatic improvement in the trade balance after mid-1973, following several major dollar depreciations, bolsters this view. We shall briefly reconsider these conclusions below in light of the import elasticity estimates obtained in the Wilson model.

Vc. Comparative Analysis of Estimation Results

Having summarized various aspects of the two models individually, we can now outline the similarities and differences obtained in the estimation results. Since we shall be stressing post-sample simulation results as the primary basis for evaluation of the two models, our discussion here willbe terser than usual.

It might be instructive to show, side by side, the estimates of long run activity and price elasticities of import demand obtained by each author. This is done below:

Category	Income/Activity		Relative Prices	
	JFW	PH	JFW	PH
Foods Feeds Beverages	.34	1.45	-.74	-.75
Industrial Supplies	1.21	1.08	-2.93	-1.27
Capital Goods	2.80	1.60	-1.71	--
Consumer Nondurables	2.47	2.61	-1.81	-2.95
Consumer Durables	1.68	1.21	-.95	-2.65
Western Europe	1.00	1.50	-4.93	-2.72
Canada	.61	1.68	-1.21	--
Japan	3.64	2.72	-2.11	-2.95
Latin America	.91	.59	-.96	-1.22
Rest of World	1.48		-1.22	
Total Imports	1.47	.90	-2.64	-1.94

At first glance, there appears to be very little common ground between the two sets of estimates. However, we should keep in mind the fact that these are point estimates, and that there is often considerable room for overlap when confidence intervals around these coefficients are considered. We find, on balance, that there are important similarities in the results above, as well as obvious explanations for some of the differences.

The most striking difference in the income estimates between the Hooper (PH) and Wilson (JFW) models, is in the FFB and KG equations. The PH equations used commodity-specific expenditure concepts as activity variables, so for reasons noted earlier, their coefficients may be biased toward a value of 1.0 relative to the JFW results, which used income and output measures. In the FFB group, for instance, the PH regression used Consumer Expenditures on Foods, while the JFW equation employed Disposable Income. Most of the other differences can be accounted for by commodity group definitions listed in Section IV (notably that petroleum and automotive products were treated separately in the JFW model, but were distributed among industrial supplies, capital goods and consumer goods in the PH model.

With these reasons for dissimilarity in mind, there still appears to be room for broad agreement on whether U.S. import demand can be described as "elastic" or "inelastic", and in some cases, there is remarkably close agreement, considering the independent nature of the projects. In particular, the JFW estimates suggest that U.S. import demand is even more price elastic than the PH estimates indicate, and this would tend to bolster our earlier observation that the U.S. trade balance should benefit from a dollar depreciation.

Before closing this section, there are several other areas of agreement that should be noted. First, it was found in the Hooper model that price terms perform better when exchange rates were included in the price regressor. Similar conclusions can be drawn from the Wilson model, based on these estimation results and the simulation performance discussed in Section VI below. The authors concur that this seems to be due to the low exchange rate variance over the specific sample. Somewhat stronger results are obtained in periods of rapid rate change, as illustrated by Clark (1973).

Another point of concurrence was that introduction of "third country" terms adds very little to the explanatory power of the functions. In neither model did the hoped-for "competitive effect" come through decisively.

Thirdly, in both cases we found price lags of only moderate length, with most of the results well-behaved in the sense that long-run parameter values do turn out to be higher (more elastic) than the short-run values. The activity lags were somewhat longer in the Hooper model, though in neither model were they longer than the price lags.

Fourthly, in both cases regressions run on a regional basis seem somewhat less attractive than those estimated by commodity group. This is in accord with standard theory but of course cannot guarantee inferior predictive performance, as will be seen below.

The final remark of this section should underscore our comments at the beginning of the paper. It concerns, if one will, the uncertainty of the world. The two sets of results reviewed in this section are taken from trade models which have a great deal in common. They are, in fact, probably the most extensive and conceptually "similar" U.S. trade studies yet undertaken. Both models fit the data extremely well (though others do, too) and are almost indistinguishable in this regard. Yet the point estimates presented in the tables and discussions above are often widely different; there are contrasts in our appraisal of distributed lags, and in general we must assume that apparently small differences in weighting, price collection, variable usage and lag assumptions have great effects on the results. We hope, therefore, that when phrases such as "the elasticity is..." were encountered above, they were read in the same spirit of skepticism with which they were written.

VI Simulation Results: Post-Sample Analysis

"The Past is Prologue...if the model works."

One of the hazards of the model-building trade - not always encountered in purely theoretical work - is the need to test the model against the world's numbers. It would be fortunate if the working-class econometrician could share the luxury of leaving his formulations untested by observations on the real world. Unfortunately this is not the case. Since an econometric exercise such as this also makes a pretense at describing the economic universe in more or less mathematical terms, by fitting the model analyzed above, it has thereby made certain assertions which can be examined further.

It has been our joint thesis since undertaking this project that he who undertakes to build a model shall also be obliged to test it. In particular, time series models should be examined for their behavior over periods which postdate the samples over which they were estimated; in other words, in the framework of post-sample simulation, or "forecasts" in which the actual values of the exogenous variables are known. This is especially so, as in the case of the two complete models described here, where there are only comparatively simple questions which might be asked over sample period simulations.31/

In the current section we turn our attention to the performance

31/ Such sample period simulations have in fact been performed for both the Hooper and Wilson models, but are not examined here. The principal points of interest lie in examining the behavior of the renormalized and exponentiated dependent variables of the behavioral equations, and the properties of the predictions produced by the identities which relate regional and commodity sums to total imports (or total imports less some component such as Canadian Automotive trade). The Hooper model also raises the question of dynamic stability.

of the various types and combinations of equations developed for U.S. imports and exports for the six quarters following the sample, that is, the 1972.I-1973.II forecast period. At the end of the analysis, we will show how practical application can be made of a procedure developed by Theil (1966) for optimal linear correction of systematic biases in the predictions generated over the post-sample tests. Applying such corrections has the effect of compensating for specification errors or aggregation problems which afflict the model's predictions when the equations are used later for actual <u>ex-ante</u> forecasting runs.

In an examination of the uncorrected and corrected simulation results there are several areas that deserve special attention. First is the issue of alternative static and dynamic specifications, which was considered at length within the Wilson model, and is also an area of major differentiation between the Hooper and Wilson models. While we have readily accepted the consensus that lagged relationships <u>do</u> exist in trade demand, it may still be an open <u>empirical</u> matter how much, in some quantitative sense, a fully elaborated lag model will contribute to predictive accuracy beyond the sample period. In this regard, the OLS and LAG formulations of the Wilson model, which showed comparable fits to the sample data, should yield interesting simulation comparisons.

In the Hooper model there is an additional element to the comparative dynamics, in as much as a number of equations included lagged dependent variables, and this gives us a choice between "single period" and "dynamic" simulation, using the actual and predicted values of the lagged dependent variables, respectively.32/

A second problem that merits review is the treatment of exchange rates as a component of the price term, and alternatively, as a separate variable. This issue is crucial to our simulation analysis because of the abrupt change in exchange rate behavior that began before the transition from our estimation to our simulation sample periods. While both authors found that the separate treatment of the exchange rate variable yielded dubious estimation results because of the lack of variance over the sample period, it will be interesting to determine how well the composite price term (including the the exchange rate) is able to predict trade flows in face of the upheaval in foreign exchange markets that took place during the simulation period.

Finally, since one of the basic reasons for making post-sample runs is to determine how "applicable" the estimated parameters continue to be for data beyond those which were used to estimate them, we shall want to determine the severity of parameter "drift" over time. A comparison of simulation bias between the two models should help to confirm or reject the hypothesis that structural shifts in coefficients have indeed taken place. That is, since the Wilson model made explicit allowance for structural shift in parameters during the sample period while the Hooper model did not, we can anticipate relatively more bias

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32/ In ex-ante forecasting, of course, only lagged predicted values of such variables can be used, and the forecast must be run dynamically.

in the Hooper predictions, if in fact, there were structural shifts in parameters. We should also note that to the extent that simulation bias is caused by such structural shift, simulation results after the Theil linear correction for bias may yield a useful basis for comparison of other aspects of the two models.

In what follows we first present the results of the Wilson model simulations, with emphasis on the static (OLS) versus dynamic (LAG) results, then the Hooper simulation results are summarized, followed by a comparative analysis, emphasizing the issues outlined above.

For the sake of convenience in the later comparative analysis, the summary statistics of the two model simulations are presented jointly at this point. These statistics are given in Tables 13 and 14 for the OLS and LAG version of the Wilson Model, and in the Table 15 and 16 for the single period and dynamic simulations of the Hooper model. The summary statistics include the mean of the actual value over the simulation period, the mean error of the prediction relative to the actual values (ME), Root Mean Squared Error (RMSE), and "bias proportion" (percentage of MSE attributable to prediction bias) statistics.

These performance statistics are presented for a partial in-sample simulation, over 1970.I-1971.IV, as well as for the 1972.I-1973.II post-sample run. This juxtaposition should give some idea of how predictive behavior changes at that point, or for example, whether simulation error was a continuation of an error trend that began within sample. A longer in-sample subset might have been chosen, except that most of the import values were strongly upward-trended in this period, and to preserve comparability -- particularly in the error variance statistics -- it seemed preferable to compare only the last eight quarters of the sample fit with the six quarters of post-sample results. In order to partially normalize the in-sample and post-sample set of results we have also calculated each RMSE as a percentage of the dependent variable mean over the respective simulation period, a step which also helps correct for definitional differences between solution variables in the two models.

To explain the other entries on these tables, the variable numbers refer to locations in the simulation model coded by the authors. variable types are explained in the table footnotes, and an "X" under the heading "Graph" indicates that specimens of the computer runs which produced the post-sample results are included in Appendix B. Finally, the last column in each table lists the percentage RMSE/MEAN for post-sample simulation after optimal linear correction (the elimination of consistent bias in the equations). This statistic is an important basis for comparison, as the correction procedure might be the last step taken before ex-ante forecasting. The rationale for this procedure is discussed in Section VII.

Table 13

1970.I-1971.IV In-Sample and 1972.I-1973.II Post Sample Simulation Statistics for JFW Static U.S. Import Demand Model

#	Variable	Type	Graph	1970.I-1971.IV Mean	ME	RMSE	RMSE/M(%)	1972.I-1973.II Mean	ME	RMSE	RMSE/M(%)	Theil Linear Correction: Bias Proportion (%)	(RMSE/M)* (%)
	-- Commodity Equations --												
2	MFFB*	E		6.260	.113	.528	8.43	7.751	.072	.254	3.28	8.0	3.03
3	MISAM1*	E		12.635	.028	.590	4.67	16.249	.262	.964	5.93	7.4	5.50
4	MFL*	E		3.374	-.009	.228	6.76	5.501	.421	.608	11.05	48.0	3.20
5	MKG*	E		3.938	.022	.160	4.06	6.048	.362	.410	6.78	78.0	1.34
6	MAUTO*-CA	E		2.889	.047	.277	9.59	4.286	-.637	.951	22.19	44.9	8.30
8	MCND	E		3.679	.090	.144	3.91	5.160	.279	.449	8.70	38.6	6.22
9	MCD*	E		4.368	.076	.452	10.35	6.691	-.029	.202	3.02	2.1	1.15
10	MNES*	E		1.492	.005	.102	6.84	1.823	-.046	.146	8.01	9.8	5.32
	-- Regional Equations --												
11	M1WE	E		11.836	.175	.696	5.88	15.992	.440	.660	4.13	44.4	2.30
20	M1C-CA	E		6.725	-.018	.428	6.36	8.618	.196	.527	6.12	13.9	5.27
29	M1J	E		6.557	.186	.560	8.54	9.252	-1.422	1.705	18.43	69.6	4.24
38	M1LA	E		4.225	.092	.281	6.65	5.398	.032	.268	4.96	1.4	4.91
47	M1ROW	E		5.919	.271	.430	7.26	8.739	.502	.557	6.37	81.1	2.58
	-- Total Imports - Single and Composite Equations --												
1	M$*-CA	E	X	38.636	.755	1.413	3.66	53.513	1.204	1.700	3.18	50.2	1.68
56	M*-CA	C	X	38.636	.372	1.202	3.11	53.513	.545	1.597	2.98	11.7	2.69
57	M1$*-CA	E	X	35.263	.025	.944	2.68	48.012	-1.024	1.831	3.81	31.3	2.73
58	M1$*-CA	C	X	35.263	.381	1.066	3.02	48.012	.124	1.473	3.07	0.7	3.05
59	M1$*-CA	R	X	35.263	.706	1.210	3.43	48.012	-.240	1.317	2.74	3.3	2.00
60	M1$*-CA	CR		35.263	.425	.941	2.67	48.012	-2.552	3.513	7.32	52.7	2.28

Note: Variable numbers shown refer to location in joint Wilson-Hooper U.S. trade model. Equation type indicated as follows: E = estimated function; C = commodity composite; R = regional composite; CR = composite of doubly-disaggregated equations not discussed in this paper. Basic variable units are $billions at annual rates.

Table 14

1970.I-1971.IV In-Sample and 1972.I-1973.II Post Sample Simulation Statistics for JFW Dynamic U.S. Import Demand Model

#	Variable	Type	Graph	1970.I-1971.IV Mean	1970.I-1971.IV ME	1970.I-1971.IV RMSE	1970.I-1971.IV RMSE/M(%)	1972.I-1973.II Mean	1972.I-1973.II ME	1972.I-1973.II RMSE	1972.I-1973.II RMSE/M(%)	Theil Linear Correction Bias Proportion(%)	Theil Linear Correction (RMSE/M)*
						-- Commodity Equations --							
2	MFFB*	E		6.261	.102	.541	8.64	7.751	-.122	.285	3.68	18.4	3.14
3	MISAM1*	E		12.635	.107	.510	4.04	16.249	1.669	2.218	13.65	56.7	8.20
4	MFL*	E		3.374	-.019	.227	6.73	5.501	.708	.925	16.82	58.7	3.78
5	MKG*	E		3.938	.131	.170	4.32	6.048	.661	.683	11.29	93.6	2.39
6	MAUTO*-CA	N.A.		2.889	-	-	-	4.286	-	-	-	-	-
8	MCND*	E		3.679	.081	.159	4.33	5.160	.405	.495	9.59	67.0	5.44
9	MCD*	E		4.368	.068	.460	10.53	6.691	-.066	.255	3.81	6.8	0.96
10	MNES*	N.A.		1.492	-	-	-	1.823	-	-	-	-	-
						-- Regional Equations --							
11	M1WE	E		11.837	.162	.685	5.79	15.992	.354	.600	3.75	34.9	1.85
20	M1C-CA	E		6.725	-.068	.443	6.59	8.618	.238	.497	5.72	23.0	3.98
29	M1J	E		6.557	.238	.564	8.60	9.252	-1.564	1.869	20.20	70.0	4.79
38	M1LA	E		4.225	.045	.281	6.65	5.398	-.404	.292	5.41	1.9	5.07
47	M1ROW	E		5.919	.243	.375	6.34	8.739	.312	.404	4.62	59.5	2.19
					-- Total Imports - Single and Composite Equations --								
1	M$*-CA	E	X	38.636	.701	1.275	3.30	53.513	2.516	3.052	5.70	70.4	2.57
56	M$*-CA	C	X	38.636	.521	1.153	2.98	53.513	2.576	3.330	6.22	59.8	3.34
57	M1$*-CA	E	X	35.263	.554	1.033	2.93	48.012	1.206	1.895	3.95	40.5	3.03
58	M1$*-CA	C	X	35.263	.540	1.033	2.93	48.012	1.867	2.609	5.43	51.2	3.63
59	M1$*-CA	R	X	35.263	.621	1.094	3.10	48.012	-.688	1.651	3.44	17.4	2.00
60	M1$*-CA	CR		35.263	.502	.906	2.57	48.012	-2.232	2.862	5.96	60.8	2.02

TABLE 15: 1970I-1971IV IN-SAMPLE AND 1972I-1973II POST SAMPLE (SINGLE PERIOD) SIMULATION STATISTICS FOR PH IMPORT-EXPORT MODEL

					1970I - 1971IV IN-SAMPLE					1972I - 1973II POST-SAMPLE					Post-sample RMSE% / MEAN (After Theil Optimal Linear Correction)
DESCRIPTION	#	VARIABLE	TYPE	GRAPH	MEAN	ME	RMSE	RMSE/M%	BIAS %	MEAN	ME	RMSE	RMSE/M %	BIAS %	
COMMODITY IMPORTS															
Foods, Feeds, Bev.	93	MFB	E		6.253	0.267	0.571	9.14	21.835	7.768	-0.226	0.344	4.43	43.188	3.16
Industrial Sup.	97	MISM	E		17.531	0.353	0.648	3.70	29.557	23.605	1,313	1.465	6.21	80.304	2.68
Capital Goods	96	MK	E		6.473	0.056	0.203	3.14	7.484	9.918	-0.028	0.297	3.00	0.871	2.62
Consumer Nonduras.	94	MCN	E		3.135	0.043	0.121	3.86	12.678	4.317	0.318	0.395	9.16	64.578	4.85
Consumer Duras.	95	MCD	E		9.330	0.155	0.322	3.46	23.042	13.504	1.877	1.959	14.51	91.849	4.05
REGIONAL IMPORTS															
Western Europe	91	MWE	E		11.801	0.204	0.416	3.52	24.102	16.405	3.228	3.418	20.84	89.196	6.56
Canada	89	MCA	E		11.911	0.069	0.641	5.38	1.170	15.781	0.226	1.685	10.68	1.795	8.99
Japan	90	NSA	E		6.556	0.247	0.824	12.56	9.009	9.178	0.309	0.629	6.86	24.054	2.26
Rest-of-World	92	MRW	E		12.405	0.410	1.179	9.50	12.078	17.719	3.333	3.740	21.11	79.413	8.89
TOTAL IMPORTS															
Unweighted	88	MMTP	E	X	42.728	0.133	0.846	1.98	2.487	59.110	2.292	3.100	5.24	54.661	3.42
Weighted	100	MMTS	E	X	42.728	0.544	0.930	2.18	34.154	59.112	4.451	4.940	8.36	81.187	3.04
Commodity composite	99	MMTC	C	X	42.728	0.789	1.198	2.80	53.804	59.112	3.255	3.485	5.90	87.252	2.03
Regional composite	98	MMTR	R	X	42.728	0.956	1.168	2.73	71.276	59.112	7.126	8.063	13.64	78.096	6.28
COMMODITY EXPORTS															
Foods, Feeds & Bev.	81	XFB	E		5.956	0.021	0.303	5.09	0.468	9.217	0.743	1.283	13.919	33.568	9.33
Industrial Sup.	84	XISM	E		14.767	-0.345	0.903	6.11	14.605	17.230	-0.258	1.918	11.13	1.805	7.15
Capital Goods	83	XKG	E		15.340	0.137	0.493	3.21	7.734	18.481	0.922	1.518	8.22	36.852	3.99
Consumer Goods	82	XC	E		6.245	-0.151	0.459	7.36	10.753	8.523	0.719	1.073	12.601	44.852	9.18
REGIONAL EXPORTS															
Western Europe	79	XWE	E		14.066	-0.327	1.421	10.10	5.295	16.819	-0.442	1.158	6.89	14.525	4.82
Canada	77	XCA	E		9.518	-0.282	1.112	11.68	6.419	13.390	0.318	0.634	4.74	25.075	3.73
Japan	78	XJA	E		4.340	-0.012	0.346	7.97	0.112	5.960	-0.249	0.523	8.77	22.603	7.70
Rest-of-World	80	XRW	E		15.816	-0.041	1.952	12.34	0.044	18.718	-1.034	1.297	6.93	63.520	4.18
TOTAL EXPORTS															
Unweighted	76	XIMTP	E	X	42.316	0.142	1.386	3.28	1.048	53.605	-1.689	2.850	5.32	35.120	3.33
Weighted	87	XIMTS	E	X	42.316	-0.199	1.245	2.94	2.562	53.605	1.327	3.511	6.55	14.287	5.08
Commodity Composite*	86	XIMTC	C	X	42.316	-0.332	1.698	4.01	3.822	53.605	2.271	3.932	7.34	33.35	5.80
Regional Composite	85	XMTR	R	X	43.740	-0.661	2.352	5.38	7.897	54.886	-1.406	2.243	4.09	39.296	2.31

Note: Variable numbers shown refer to location in joint Wilson-Hooper U.S. trade model. Equation type indicated as follows:
E = estimated function; C = commodity composite; R = regional composite.

TABLE 16 : 1970I-1971IV IN-SAMPLE AND 1972I-1973II POST SAMPLE (DYNAMIC) SIMULATION STATISTICS FOR PH IMPORT-EXPORT MODEL

DESCRIPTION	#	VARIABLE	TYPE	GRAPH	1970I - 1971IV IN-SAMPLE MEAN	ME	RMSE	RMSE/M%	BIAS %	1972I - 1973II POST SAMPLE MEAN	ME	RMSE	RMSE/M%	BIAS %	Post-sample RMSE% MEAN (After Theil Optimal Linear Correction)
COMMODITY IMPORTS															
Foods, Feeds, Bev.*															
Industrial Sup.*															
Capital Goods	96	MK	E		6.473	0.101	0.258	3.99	15.409	9.918	-0.201	0.259	2.61	0.600	2.30
Consumer Nondur.*															
Consumer Dur.*															
REGIONAL IMPORTS															
Western Europe	91	MWE	E		11.801	0.306	0.517	4.38	35.152	16.405	4.154	4.303	26.23	93.211	6.79
Canada*															
Japan	90	MSA	E		6.556	0.436	0.715	10.90	37.303	9.178	0.890	1.055	11.50	71.057	3.30
Rest-of-World	92	MRW	E		12.405	0.439	1.156	9.32	14.428	17.719	3.629	4.058	22.90	79.990	9.26
TOTAL IMPORTS															
Unweighted	88	MMTP	E		42.728	0.205	0.910	2.13	5.081	59.110	3.006	3.595	6.08	69.904	3.34
Weighted	100	MMTS	E		42.728	0.654	1.011	2.37	41.816	59.112	5.274	5.703	9.65	85.500	2.10
Commodity composite	99	MMTC	C		42.728	0.924	1.270	2.97	52.988	59.112	3.293	3.493	5.91	87.237	2.03
Regional composite	98	MMTR	R		42.728	1.307	1.464	3.43	79.615	59.112	8.929	9.880	16.71	81.664	7.15
COMMODITY EXPORTS															
Foods, Feeds, Bev.*															
Industrial Sup.*															
Capital Goods*															
Consumer Goods*															
REGIONAL EXPORTS															
Western Europe	79	XWE	E		14.066	-0.376	1.261	8.96	8.892	16.819	-0.726	1.351	8.03	28.904	4.61
Canada	77	XCA	E		9.518	-0.450	0.886	9.31	25.802	13.390	0.382	0.632	4.72	13.008	3.50
Japan	78	XJA	E		4.340	-0.024	0.386	8.89	0.400	5.960	-0.279	0.610	10.23	20.935	8.31
Rest-of-World	80	XRW	E		15.816	0.890	1.599	10.11	30.959	18.718	-5.967	6.850	33.66	75.871	2.47
TOTAL EXPORTS															
Unweighted	76	XIMTP	E		42.316	0.331	1.262	2.98	6.867	53.605	-2.763	3.692	6.89	56.032	3.35
Weighted	87	XIMTS	E		42.316	-0.200	1.150	2.72	3.011	53.605	1.467	3.847	7.18	14.533	5.13
Commodity composite*	86	XIMTC	C		42.316	-0.332	1.698	4.01	3.822	53.605	2.271	3.932	7.34	33.349	5.80
Regional composite	85	XMTR	R		43.740	0.039	1.433	3.28	0.075	54.886	-6.591	6.935	12.63	90.324	1.76

* These equations do not have a lagged dependent variable -- hence, dynamic simulations not run.

Note: Variable numbers shown refer to location in joint Wilson-Hooper U.S. trade model. Equation type indicated as follows:
E = estimated function; C = commodity composite; R = regional composite.

VIa. Summary of Wilson (OLS and LAG) Model Results

Referring to Tables 13 and 14, it can be seen that the post-sample results are quite varied and there is an admixture of both over- and under-estimates (ME <0 and ME >0, respectively) in individual equations. We should take into account, however, that no conclusion about aggregate import predictions should be drawn solely on this basis, due to the wide range in dependent variable magnitudes. Speaking solely of individual equations (on the ME criterion), it is discernible that there is a fairly constant tendency for the LAG versions of the model to overpredict less (or underpredict more) than the OLS structure. The central tendency of the LAG model, in fact, is toward understatement of import magnitudes. In particular, there are some striking differences which emerge between single-equation predictions and the several identity-related composites for the two principle aggregate variables. These two aggregates are M$*-CA (Total imports, less Canadian automotive, eqns. 1 and 56) and M1$-CA (the same, less the FL component, represented by eqns. 57, 58, 59 and 60).

One of these differences in predictions for M$*-CA and M1$*-CA is that in the OLS model all but one of the six equations (#60) generate very small mean prediction errors. If the proportional RMSE criterion is used, these same equations all perform as well or better in the 1972.I-1973.II post-sample as during the 1970.I-1971.IV in-sample period.

In contrast, the results from the LAG model must be described as disappointing. On the ME criterion only the single equation predictor (57) and regional composite (59) appear to be tracking as they should, and in terms of proportional RMSE, appreciable deterioration from the in-sample basis is shown by all but one of the predictions. The relative magnitude of the problem with the LAG model can be appreciated if we consider that for 1970.I-1971.IV its RMSE/M was, overall, better than in the OLS results. As can be seen in the tabulations of Appendix B, most of the LAG equations generate a pattern of increasing underprediction across the 6 post-sample quarters.33/

An interpretation of this tendency to underpredict might be based on the fact that income as well as price lags were estimated for each aggregate function or its component relations. It could be argued

33/ We should perhaps not view matters so harshly, but it is better to preempt a flogging from others by flogging oneself first. One should recall that the "misses" described here (on either criterion) are only a few per cent in the aggregate. Forecasters who work by other methods have often not done so well. Consider, for instance, the jubilation which followed the Smithsonian Accord over a turnaround in the U.S. trade balance which, sadly, failed to materialize until a second major party shift was implemented. By comparison our results -- over the same turbulent period -- are reliability incarnate. It should be stressed that at no time were any post-sample results used to respecify any equations in this paper. The model form and estimates were "frozen" beforehand.

that import adjustment with respect to income is, in fact, relatively instantaneous and that the only relevant lags are those on price or exchange rate variation. A LAG form equation with income lags would thus continually underpredict quarter-to-quarter import increases (in periods of rising income), due to the fact that part of the total estimated effect is attributed to income in prior quarters. In earlier sections we have actually made the opposite argument, and will present another possible explanation in Section VIc below. What actually vitiates this interpretation is the fact that, while several lag functions underpredict, two others - for which income lags were also estimated - do just the opposite.

Results for two of the major aggregates in the LAG model (equations 59 and 60) tend to bear out this impression. In both cases Imports less Fuels and Lubricants are somewhat overpredicted in the post-sample period. The single equation prediction of M1$*-CA does somewhat more poorly than the regional composite, an interesting result in the face of the rather erratic regional results discussed in Section Va above. The worst results in both models are turned in by the commodity-by-region composite, which had been expected to do better. The reasons for this are somewhat conjectural, but a good case can be made for assigning the blame to faulty exchange rate elasticities.34/ As partial

34/ Since exchange rate variation was "low" within the sample in comparison to post-sample parity changes, the (negative) effect of such changes on U.S. imports are probably understated. This in turn would lead to the tendency to overstate import values observed in some of the regional equations.

confirmation of this notion, we may note that the mean prediction error for Latin America and the Rest of World (#38 and #47) is quite small in both models. These are exactly the regions for which all regressor price terms were measured in dollars, with no exchange rate translation. It might also be concluded that the negative mean-errors in the regional composite (#59, both models), are due in large part to the fairly large error in both regional equations (#29) for Japan. At the same time the predictions for imports from Canada (#20) are pretty much on target. Both of these results are consistent with observations above on the weakness of exchange rate estimates for Japan, and the strength of those for Canada, and it was precisely the Japanese rate which varied most sharply in the immediate post-sample months. Hindsight clarifies one's vision remarkably.

We may now turn briefly to the import predictions drawn from the commodity equations #2-#10 in the OLS model. These are the results which underlie the evidently successful forecast of the composite equation 58 mentioned above. In scanning these results it is clear that the Automotive equation, as expected, is surely the poorest performer, since even in the normalized form it generates a 22% error. This underscores our already stated dissatisfaction with this relation.35/ Three of the other equations produce negligible mean overestimates, and

35/ Published reports following the two dollar devaluations suggested major difficulties for auto importers. This may help explain the tendency of this function to overestimate. In the wake of the oil crisis, the reverse may soon prove to be true. Since no LAG form equations were generated for either the AUTO or NES equations, the OLS results are shared by both models.

the remainder tend to underpredict in the forecast, though the percentage misses are smaller than we have seen in the regional equations. It may be recalled that since these import relations were formed on a "global" basis, exchange rate variation was built into the basic price term, so that the regional difficulties described above may not be so serious for the commodity series.36/

Taking into account the turbulence of the post-sample period, the forecasts for the commodity sector in the OLS model are quite remarkably good. Those drawn from the LAG model are in nearly every respect inferior. Both mean forecast errors and RMSE statistics deteriorate, as in consequence do all of the proportional errors for the six quarter period. Since this level of disaggregation is the one most nearly comparable to that used in previous studies of End-Use disaggregation,37/ the relative failure of the LAG model in the forecasting exercise must be viewed with some concern. A silver lining in this cloud is that at least two of these LAG equations (2 and 9) perform better over the 1972.I-1973-II period than over the 8 quarters preceding. But judging from the overall results, we would have little basis to choose the theoretically more satisfying but empirically disappointing LAG model over its simpler OLS cousin for predictive purposes.

36/ See, for instance, arguments by Junz and Rhomberg (1973) that it may not in fact be necessary to separate local price and exchange rate effects.

37/ See, for instance, Branson (1968) and Grimm (1968).

It is also possible to gain some insight into the behavior of the two Wilson models at identical levels of disaggregation. The forecast statistics may be compared to those obtained for the final eight quarters of the sample, using the RMSE or RMSE/M as the basic criterion. As a starting point it can be noted that in the eight quarter subsample the RMSE's of both the OLS and LAG relations are comparable, and that the post-sample deterioration of the latter is more extreme. The 1972.I-1973.II RMSE of the commodity aggregate (#58), for instance, is actually better by 19% than the single equation forecast (#57) in the OLS model, but is about 37% worse in the LAG model, despite the fact that the results represent comparable types of disaggregation in each model. The regional composites (#59) <u>improve</u> on the single equation prediction somewhat in both models. Yet if we consider the predictions formed from the doubly-disaggregated estimates (#60) there is a severe deterioration from single equation predictions in <u>both</u> cases. Obviously this worsening of the RMSE from the single to the full multiple equation composite cannot be laid entirely on estimation difficulties associated with exchange rates, since this difficulty should be most evident in aggregate <u>regional</u> equations, where independent exchange rate terms were used. It appears more likely that, in combination with the bias introduced by poor exchange rate estimates, error components in the most disaggregated equations failed to offset each other as hoped, and this caused the substantial rise in the RMSE of equation 60. Since <u>both</u> the OLS and LAG models are affected, the fault is probably also <u>not</u> due to misestimates of distributed lag relations.

In making the transition from single equation to multiple equation approximations to total imports, therefore, it cannot be argued that the only problems occur in the step from the OLS to LAG model structures. Regional composites, after all, perform well in both models. Basic difficulties are also encountered as one moves to decreasing levels of aggregation. There are thus two separate issues to be handled in further work with this model: one is the additional work that is needed to improve estimates of the lag structure of U.S. imports. Errors on this count, as we have seen, lead to the emergence of systematic biases in post-sample predictions. The second problem relates to errors in the finely disaggregated equations for each world region, these perhaps stemming from difficulties with exchange rate estimates.38/ Insights into pass-through questions, which can be derived from this predictive behavior, are taken up in Section VIc.

38/ Again, in the above section reference was made to the most disaggregated set of equations, which were not presented in the paper. Only the identity (#60) which relates these results to total imports is shown. In Wilson (1973) an analysis was also made of the estimates of aggregate U.S. imports by region which can be derived from this set of equations.

VIb. Post Sample Results of the Hooper Model

Since only one set of Hooper equations is presented in this paper, our separate discussions of the post-sample simulation results will be in brief summary form. The more interesting analytical aspects of the discussion are deferred to the following sub-section, where the Hooper and Wilson results are compared.

We should note first that several sets of test simulations were run for the Hooper regional and total trade equations (as well as capital goods imports), all of which used the Koyck lag model and thus included lagged dependent variables. The equations were first simulated dynamically (using predicted values of the lagged dependent variable) over the period 1958.III-1973.II, to determine whether they exhibited long-run dynamic stability. 39/ The results of these simulations showed that with two exceptions the equations were dynamically stable -- exhibiting less than 10 per cent RMSE/MEAN for the entire simulation, and no evidence of compounding error over time. For imports from Japan there was a slight compounding of error towards the end of the sixty-quarter simulation, and the RMSE/MEAN was 15 per cent. The Rest of World export (and Regional composite) equation, however, fell apart completely (overpredicting) almost from the beginning of the simulation. 40/

39/ Thanks go to Dick Berner and Sung Kwack for their suggestions concerning this test.

40/ This particular equation was the one that elicited the least confidence on the basis of in-sample fit. The $\bar{R}^2$ of .83 was low relative to others (see Table 10 above). The problem may have been due to the use of Rest of World exports as a proxy for income, or to the considerable price inflation and exchange rate depreciation in certain countries (i.e. Brazil) represented in the Rest of World regional price index. In any event, error would have been compounded more readily in this equation because its lagged dependent variable coefficient (.79) was the highest obtained among the equations estimated.

Secondly, dynamic simulations and single period simulations (using actual values of the lagged dependent variables) were run over the periods 1970.I-1971.IV, and 1972.I-1973.II. A comparison of these two sets of results, listed in Tables 15 and 16 shows that the dynamic simulations generally yielded slightly higher mean bias errors in the same direction, reflecting a compounding of the bias problem through errors in the lagged dependent variable. The bias problem was significantly worsened under dynamic conditions only for equations for imports of Capital Goods and total imports from Japan, and for exports to the Rest of World (and the Regional composite), much as the long-run dynamic simulation results would have suggested. With these differences in mind, we can now summarize the error bias obtained across the various equations in single period simulations.

As indicated by the mean error statistics in Table 15, for the aggregate, regional and three out of five of the commodity equations, there was a strong downward bias in post-sample simulations ($ME > 0$), that is, a continuation of consistent (though small) underprediction during the last eight quarters of the sample period. At first glance, results from the two commodity equations (post-sample overprediction of foodstuffs and capital goods imports) seem inconsistent with the regional and aggregate results. However, those two commodity groups accounted for only 30 per cent of total imports over the simulation period, and since the magnitude of upward bias was small in each case, it was clearly washed out by the rather large downward bias in the other commodity groups.

On the export side, bias was lower in magnitude and considerably more mixed in direction among the various equations. The commodity disaggregate and commodity-trade-share-weighted aggregate equations tended to underestimate exports, while the regional and unweighted aggregate equations overestimated them. This inconsistency could be explained, in part at least, by the presence of aggregation error.

Aggregation error, however, does not appear to be the problem in the import simulations. The bias in the weighted aggregate import equation is in the same direction and almost twice as great as in the unweighted. The persistence of this bias suggests that there may have been a structural (upward) shift in parameters over the sample period that was not captured in the Hooper estimates. It would be worth noting, however, that the downward bias in the Hooper commodity and aggregate predictions was about the same as in the Wilson lag equations, which had corrected for structural shift over the sample period. While these results may not be strictly comparable (due to different data, weighting, and lag techniques), there are other possible explanations for the severe downward bias, which we will consider in the next section.

To summarize, on the basis of ME and RMSE/M (for both dynamic and single period simulations), the commodity disaggregate and unweighted aggregate equations were superior for both imports and exports.[41/]

These results contradict our in-sample conclusions on the efficacy of trade-share weighting across commodities. We shall consider possible explanations for these results in the following comparative analysis with the Wilson results.

VIc Comparative Analysis of the Hooper-Wilson Simulation Results.

A comparison of the post-sample error statistics for import predictions in Tables 13-16 shows that the Wilson static (OLS) equations were clearly more accurate than either the Hooper model or Wilson LAG model in predicting imports over the period 1972.I-1973.II. Only in the capital goods commodity equation, and several of the regional equations did either dynamic model perform better.

At this point it would be useful to investigate these results more closely, and offer some possible explanations for the relatively better performance of the static model.

Predictive Misbehavior when Lagged Variables are Included

Why should simple, unlagged relations perform so much better in both of these models in spite of the fact that both authors

41/ The regional exports equations were most accurate for the single period simulations, but least accurate in the dynamic simulation, largely because of the dynamic instability in the ROW and Japanese equations noted earlier.

used fancy estimation techniques and actively searched for distributed lags?

One possibility, alluded to above, is that we have "over-estimated" the lag structure on the income/activity terms in the regressions. If such lags did not exist our results would show a lesser (positive) impact of current income changes than "actually" exists. This would have the effect of producing a downward bias in the distributed lag predictions. Since except for the few long lags on the Capital Goods equations, however, income lags seldom exceeded two or three quarters, it seems unlikely such a result should occur. Arguments in theory, moreover, tend to support the existence of income lags.

A more likely possibility is that both models suffer from inaccuracies in the estimates of price lags, specifically that true lag lengths may be longer than shown. If this were the case we would expect to find some exaggeration of the (measured) current period impact of relative price changes. This would also exert a systematic downward thrust to the predictions as the price-exchange rate regressor varies over the forecast. Some evidence for long lag relations was recently obtained by Junz and Rhomberg (1973) in a series of regressions of market shares on relative prices in past periods. Although the fit in their regressions is unimpressive, maximum correlation seems to have been obtained with an appreciable lag (in years).

This argument should be carefully construed only to mean that in the aggregate and perhaps for some commodity groups the lag estimates given in Tables 3 to 11 may be too short. It would be hard to tell with certainty which they are, though conjectures might be made on the basis of substitution elasticities and forecast performance.

Inferences about Pass-through Levels

Because of the abnormal exchange rate behavior that characterized much of the simulation period, certain comparative results in the Hooper-Wilson import predictions shed some light on the legitimacy of the full-pass-through assumption. In this we refer specifically to predictions obtained for Europe and Japan, recalling that Wilson treated exchange rates separately and Hooper consolidated them with local price terms.

For Western Europe the Wilson model obtained a low and insignificant exchange rate coefficient, but predicts accurately. The Hooper model underpredicts severely. These findings would be consistent with the hypothesis that pass-through for Western Europe was in fact much less than we had both assumed. The local price for WE is thus overstated in the Wilson model and the (negative) effect from this term seems to be roughly offset by the understatement of the exchange rate coefficient. In the Hooper case the local price term is also "too high", but there is no such offset, which causes the $3.2 billion average undeprediction.

These conclusions are almost reversed in the case of Japan. Here the Wilson (OLS) model overpredicts by about $1.4 billion while the Hooper model is about on target. Why the contrast between the Western European and Japanese results?

One possibility is that our assumption of full-pass through was in fact nearly correct for the Japanese case. This may have been due to U.S. pressure on Japanese authorities (tacit threats of trade-restriction, etc.) to "make the parity changes work" and reduce Japan's bilateral trade surplus.

Even if there were incomplete pass-through, another possibility is that the Japanese price data used in both models adequately reflected the relative decline in the yen price of Japanese exports. Both authors used Japanese export price indexes as the local term in this particular equation. Since well over one-third of Japanese exports went to the U.S. in this period, we can thus expect any lag in pass-through to show up fairly strongly in the export price series.

In either case the Wilson model would overpredict because of its low and insignificant exchange rate coefficient while the combined price/exchange rate term in the Hooper model produces an approximately correct prediction.

Unfortunately, not much can be said about pass-through in the Canadian case on the basis of a comparative analysis. Both authors predicted imports from Canada very accurately, despite major compositional and coefficient differences. 42/

The Hooper and Wilson commodity equations both used composite price terms, and the consistent downward bias in their simulation results (ME>0 in Tables 14 and 15) could also be explained

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42/ Hooper included automotive and petroleum imports (which accounted for about half of the total from Canada, while Wilson did not. Also, Wilson found significant price and exchange rate coefficients while Hooper did not.

by incomplete pass-through, even if lag structures are well specified. This phenomenon could also explain the relatively better performance of the weighted against the unweighted aggregate import equation in the Hooper model. The former used an aggregate (dollar) import price index, which would have accounted for incomplete pass-through, while the latter used foreign local prices and exchange rates, which would not have. Finally, as seen in Tables 15 and 16, the Hooper regional export equations tended to overpredict during the simulation period. This suggests that pass-through was also less than complete on the export side (i.e. U.S. exporters did not raise the foreign currency prices of their goods by the full amount of the dollar depreciation).[43/]

An Alternative Explanation for Dynamic Model Results

The above observations on pass-through effects suggest another interpretation of the relatively better simulation performance of the Wilson static (OLS) model against either the Hooper or Wilson dynamic models. We noted that equations which used composite price terms, (rather than treating the exchange rate separately) tended to under-predict imports if: a) pass through was less than complete, and b) the foreign (local) price data were too broad to reflect reductions in the foreign currency prices of U.S. imports. It stands to reason then, that somewhat by default, equations with downward biased price elasticities would suffer less from the problem of underprediction

43/ The only exception was for exports to Canada, in which a significant price term could not be found and was deleted from the equation.

caused by incomplete pass-through. The Wilson OLS price coefficients are, in fact, consistently downward biased estimates of the long run elasticities obtained in the LAG equations. As might be expected, Table 13 shows that commodity and total OLS import equations exhibit much less severe downward simulation error than their LAG counterparts in Table 14.[44/] More to the point, however, since a major dollar depreciation took place over most of the simulation period, we could expect the severity of the LAG model's underprediction to increase relative to that of the OLS model as the lagged price effects accumulated over time. The illustrations in Appendix B bear this out - the differential between Wilson's OLS and both sets of dynamic underpredictions tends to increase over successive simulation quarters.

In brief, it may well be that a static framework is the best way to handle periods of exchange rate turbulence in the prediction of trade flows, especially when the true lag structure is unknown. Alternatively, these same results might imply that our lags are nearly right, and that the dynamic equations performed poorly in the face of an unprecedented dollar depreciation only because of erroneous assumptions about complete pass-through. Had we simply adjusted the models for such pass-through dynamics (e.g., by delaying exchange rate changes within the price term "in stages" at some assumed rate), either of the lag models might well have performed better than the static model.

44/ The only notable case in which the static model did not yield more accurate predictions was in Wilson's regional equations. As we noted earlier, the complete pass-through assumption would not have caused underprediction in either the OLS or LAG regional equations because the exchange rate was included separately with generally weak coefficients.

At the outset of this study we professed a belief in the existence of lag dynamics, and see no reason to renounce that belief now. In light of the uncertainty concerning the "appropriateness" of a purely static model, at the least it would be a mistake at this point to abandon attempts to estimate more suitable lag-type models. Authors doing so might be well-advised to try to build in more explicit pass-through dynamics.

Finally, we should also note a particular advantage to using a lag-type model in <u>ex-ante</u> forecasting work. Since the degree of uncertainty about projections of exogenous variable increases the more distant the forecast period, a lag model has the practical advantage of relying more heavily on data relatively "closer" to the point at which the forecast is generated.

<u>Composition Effects and Intermodel Comparisons</u>

The intermodel comparisons we have made so far do seem to yield useful information concerning lag structures, pass-through assumptions and exchange rate treatment. Nonetheless, it is difficult to treat the models in truly parallel form, since they are not absolutely the same. This applies particularly to the commodity equations, due to differences in dependent variable composition. Since the two dynamic models are probably the most "comparable," however, let us focus for a moment on the results in Tables 14 and 15 and see what further conclusions may be drawn.

The most obvious contrast between regional predictions seems to be that, except for Japan, the degree of underprediction and proportional RMSE in the Hooper results seems to be larger than those obtained by Wilson. Although the reasons for this may be difficult to disentangle from problems of exchange-rates and pass-through, they may also reside partly in the composition of the dependent variables, specifically in the inclusion of fuels and Canadian automotive in the regional aggregates. Since U.S. fuels imports rose nearly 50 percent from mid-1971 to the end of the test, the predictions for Hooper's Rest-of-world aggregate might have been affected by this inclusion.

One might speculate that there are also compositional effects in relative predictions of Consumer Durables, due to the exclusion of automotive in the Wilson model. In both of these cases the equations which include volatile or unpredictable components tend to deteriorate fastest in prediction. How then might we explain the opposite finding for the relatively poor forecasting performance of the Wilson ISAM equation? This equation excludes the fuels component, but even the separate Fuels equation errs in the same (downward) direction. Together they underpredict by an average of $2.4 billion, against a $1.3 billion mean error in the Hooper results. We are tempted to refer back to our discussion on the "true" nature of lag structures for an explanation, but other reasons might be adduced as well, which at this point the reader is invited to provide.

Generally speaking, such findings underscore the need for the model-builder to carefully define the commodity categories with which he chooses to work in a disaggregated framework. There do seem to be practical consequences when the models are tested. For U.S. trade studies, our most likely candidates for "special consideration" seem to be Fuels and Canadian Automotive on the import side, and perhaps military items on the export side.

VII An application of Theil's Linear Correction Technique as a Preface to ex ante Forecasting

Throughout these extensive discussions of our models and post-sample predictive results, we have tried to stress the apparent reasons for the kinds of errors (particularly bias) which have emerged. Among these we have pointed to aggregation problems, possible misestimates of exchange rates and uncertainty over the time shape and lengths of lag distributions. To some extent these sources of difficulty lead to prediction errors which show consistent biases or other undesirable features. Bearing in mind that the objective of this exercise has been to produce a functioning forecasting model (actually models) for U.S. trade, a difficult question may now be faced.

With the understanding that the investigators (as we do) possess a working simulation model, there are basically two ways to proceed in forecasting exercises. One of them is to estimate the set of equations "right up to date" (e.g., currently to 1973.IV) and extrapolate the results from there to the future.[45/]

The second procedure, which is the one we have followed, is to terminate the basic data sample at some point lying further back in time (e.g. 1971.IV) than the most recent month or quarter. We feel that the advantage to this latter approach lies in permitting the investigators to become familiar with the post-sample error structure generated

45/ For models with simultaneity or lagged dependent variables, of course, this involves a dynamic structure and stability questions, as discussed above in connection with the Hooper simulation runs.

by their equations. A model which is estimated "right up to date" and extrapolated into the future is a most uncertain instrument. Not only are the future values of the exogenous variables for <u>any</u> forecast unknown, but the post-sample limitations of the model itself are uncertain, and these two sources of error will intermingle.

Once the post-sample error structure of the model is known, how then to proceed? The authors would agree that the most rigorous procedure would be to reestimate the model(s) in respecified form and apply the same test again, repeating until a "satisfactory" pattern of post-sample errors emerges. Unfortunately this process could go on indefinitely until that happy day arrives (especially for large-scale models such as reported here), and as a practical matter it may be necessary to "freeze" the model in some form which may not be entirely reliable.

Does it follow that using a model with - so to speak - "outdated estimates" is a better alternative? We believe so, since a procedure is available which can be used to compensate for the systematic error components which the model turns up in the interval between the sample termination and the latest data availability. In this we refer to the procedure for optimal linear correction developed by Theil (1966). Applying this method has the effect of greatly improving the tracking properties of any set of equation estimates and purging the results of systematic biases which may be due to the problems sketched above.

Theil's method is relatively simple to apply, and can be implemented in any standard computer program. The first step is to make a post-sample run of the model to generate a series of $\hat{Y}$ predictions and calculate the usual error statistics. 46/

The Theil procedure depends on recognizing the fact that there are several ways the MSE (error variance) can be decomposed. One of these is as follows

$$MSE = \frac{1}{n}\Sigma(Y_i-\hat{Y}_i)^2 = (\bar{\hat{Y}}-\bar{Y})^2 + (\sigma_{\bar{y}} - \sigma_y)^2 + 2(1-r)\,\sigma_{\hat{y}}\,\sigma_y$$

which in turn can be rewritten as

$$1 = \frac{(\bar{\hat{Y}}-\bar{Y})^2}{MSE} + \frac{(\sigma_{\hat{y}} - \sigma_y)^2}{MSE} + \frac{2(1-r)\,\sigma_y\,\sigma_y}{MSE}$$

$$= U^m \quad + \quad U^s \quad + \quad U^c$$

The error variance is thus decomposed into bias (or error in central tendency, U^m), an error due to unequal variation (U^s) and a component due to unequal covariation (U^c) between actuals and predicteds. In Theil's terminology these components are "inequality proportions" 47/ There are also other ways in which the same MSE can be decomposed; for an illustration of these, see Theil (1966, pp. 33-34).

46/ In such a run the historical levels of both dependent and independent variables are known. To insure some degrees of freedom in the MSE calculation, it should cover a minimum of 5 or 6 quarters.

47/ The post-sample computer runs in the Appendix to this paper include these three statistics for the "uncorrected" predictions of selected variables.

Consider now the bivariate regression of Y_i on $\hat{Y}_i$ of the form which yields a set of $\hat{Y}*$ estimates

$$\hat{Y}* = a + b\hat{Y}$$

Minimizing the sum of squared errors of this relation, basic regression theory shows that the following will hold:

$$b = \frac{r\,\sigma_y}{\sigma_{\hat{y}}} \qquad\qquad a = \bar{Y} - b\bar{\hat{Y}}$$

These parameters are easily calculated from the post-sample results given in the previous sections of this paper. It also follows from the property of the estimator that since $\bar{\hat{Y}}* = \bar{Y}$, the bias proportion of the corrected predictions, $\hat{Y}_i*$ is eliminated with respect to the actuals. The remaining error variance in the prediction system, $\frac{1}{n}\ \Sigma(Y_i - \hat{Y}_i*)^2$ is entirely due to U^S and U^C, the latter of which Theil regards as very difficult to eliminate.

The significance of this linear correction lies in the fact that it compensates for the prediction bias in a system which, for whatever reason, has been somewhat badly specified. The expectation of prediction error has thus been reduced to zero, and in Theil's words: (p. 27)

> if prediction error can be regarded as an independent random variable with zero mean and a certain RMS value, then we can use this result to formulate probability statements about future predictions, even if the forecaster himself refrains from doing so.

In this manner post-sample information can be used to "correct" the tracking properties of the system. It should then be possible to carry out actual _ex-ante_ forecasting with somewhat more confidence that any errors in the forecast results will be due either to false projections of the exogenous variables or to a purely random component affecting the relation between Y_i and $\hat{Y}_i*$. Systematic biases have been removed.

The same advantage cannot be claimed for a model which is estimated "up to date" and used for forecasting in uncorrected form. The fundamental problem, as both authors have stressed, is that there is _always_ some uncertainty as to correct specification and we feel it is better to take this element into account rather than assume it away. In the literature on the subject one often encounters the claim that the "predictive" properties of a model are "good", when in fact no "predictions" are generated at all. This is an invalid claim. Often times what is really meant is that the sample period _fit_ of the system is attractive. We hope we have now sufficiently made the point that these are two fundamentally separate issues.

Linear corrections of the form $\hat{Y}* = a + b\hat{Y}$ have been applied to the 1972.I-1973.II predictions of all the equations shown in Tables 13 to 16 and the results are shown in the final two columns of those tables. Given are the U^m bias proportions of total error variance of the unadjusted $\hat{Y}$'s and the new (percentage) $(RMSE/\bar{Y})*$ derived after the linear correction was applied.

It will readily be seen that a marked improvement occurs in the RMSE of the predictions with the elimination of this bias component. The gain, of course, is greater as the original U^m was larger. In the context of <u>comparative</u> evaluation of trade models, applying Theil-type corrections to simulation results also helps normalize different sets of results in such a way that residual variance can be analyzed apart from the question of prediction biases stemming from slightly different model specifications. Again the collection of results shown in Tables 13 to 16 for our two models may serve as an illustration of such a comparison.

Finally, this procedure suggests an interesting experiment which will be carried out in the near future. Our argument has been that the optimal linear correction helps compensate for specification problems. It should also do so, to some extent, for gradual structural change in the system, since this, too may cause systematic prediction bias to emerge.

Since we now have two alternative estimators of each dependent variable, $\hat{Y}$ and $\hat{Y}^*$, both of these could be applied to new data as they become available. We would hypothesize that the $\hat{Y}^*$ estimator should outperform the uncorrected version, but in any case the results should yield greater insights into the way U.S. merchandise trade is evolving.

VII. Conclusions

There are several points we might cover by way of summarizing the efforts which have gone into this exercise in model building. Perhaps the most important is that the authors are as acutely aware as anyone that we have designed, not so much a fusion of two U.S. Merchandise trade models, as a parallel presentation of separate models, each constructed independently of the other. We do not pretend that one synthetic model has yet come out of this work.

The primary differences in these systems, aside from matters of variable weighting and exchange-rate treatment, are in the development of lag structures, with the Koyck and Almon realms explored by one author and the Shiller method used by the other. But even these differences are informative.

We hope also to have showed that, despite the differences, the conceptual framework of each of these systems is remarkably similar; that is, in the use of similar End-Use commodity groups and regional definitions, in what the authors believe are the two most highly disaggregated U.S. trade models constructed to date. Sample periods used in both models have also been standarized, so that on most counts a solid basis has been laid for analyzing comparative predictive performance.

Our perhaps strident emphasis on model testing can be illuminated by backcasting a moment to the various sets of parameter estimates we have reviewed. Casual inspection shows that both models provide extremely close and comparable fits to the sample data, but each draws rather different conclusions about such important features of the system as short- and long-run elasticities, cyclical influences and price-responsiveness. In view of such disparate results, who can say which is "better" on the basis of sample features? Who, indeed, could fit a third model and venture to say that it is "better" than either of these, solely because it, too, fits the data? We hope to have made it clear that something more is required.

Thirdly, we have tried to show that the predictive properties of each of these models lends a good deal of insight into ways in which both of them might be improved. A surprisingly rich assortment of information about the character of distributed lags, pass-through, the advantages of different types of disaggregation and exchange-rate effects can be gleaned from such as analysis. We also recognize that much work is yet to be done in developing a supply side for such models. In attempts to be begun in the near future, this information can be incorporated into the specification of a revised system.

Fourthly, we have tried to put to practical use Theil's procedure for applying corrections to import and export predictions as a bridge between post-sample tests and *ex-ante* forecasting. Use of the Theil method also helps "normalize" predictive results for residual differences in model structure or peculiarities of the post-sample test period. Although our corrected results were not extensively discussed, we hope that data in tables above demonstrate the practical usefulness of this procedure.

Lastly, the authors would like to return for a moment to the genesis of this project: an attempt to develop a workable forecasting system for the U.S. Balance of Payments. The efforts in this paper have been confined to the two sides of the Trade Account only, but (with a little help from our friends), the work can be expanded to include other Current and Capital Account items. In fact, our data banks already contain much of the required material. Most importantly, we now have a set of specific equations which, if desired, can be immediately applied to true ex-ante forecasting efforts. The required computer programs have been prepared and tested, and all that remains is to select an appropriate set of forecast values for right-hand variables in one or more of our alternative formulations.

Model construction and refinement is an organic process which goes on (and on and on, usually forever). While the authors have every intention of applying what we have now learned to further improvements, it can at least be stated that one "generation" of this system is now complete and ready to go in the practical sense. The authors would more than welcome the chance to engage in a little friendly competition with others -- of whatever stripe or persuasion -- who also enjoy playing the balance of payments forecasting game!

Appendix A

Derivation of a Modified Koyck Lag Structure

The implicit dynamic structure is written:

$$M_t = a_o + \sum_{i=o}^{\infty} b_i Y_{t-i} + \sum_{i=o}^{\infty} C_i P_{t-i} \tag{A.1}$$

where M_t, Y_t, and P_t are, respectively, import, activity and price values in period t. We now assume that the geometrical decline in lagged response begins in period t-1 for the activity variable and in period t-2 for price. Thus, for $0<\lambda<1$, and $i = 1...\infty$,

$$b_i = \lambda^i b_o \tag{A.2}$$

and

$$c_{i+1} = \lambda^i c_1 \tag{A.3}$$

Hence, our assumption allows for $C_1 > C_o$ while we must have $b_1 < b_o$. In other words, the ratio of the steady-state to the impact response can be greater for price than for activity changes. From (A.1), (A.2) and (A.3), our long-run income and price coefficients ($b*$ and $c*$) are defined:

$$b* = \sum_{i=o}^{\infty} b_i = b_o \sum_{i=o}^{\infty} \lambda^i = \frac{b_o}{1-\lambda} \tag{A.4}$$

$$c* = \sum_{i=1}^{\infty} c_i = c_o + c_1 \sum_{i=o}^{\infty} \lambda^i = c_o + \frac{c_1}{1-\lambda} \tag{A.5}$$

The model used to estimate the parameters b_o, c_o, c_1 and λ is derived by first substituting (A.2) and (A.3) into (A.1):

$$M_t = a_o + b_o \sum_{i=o}^{\infty} \lambda^i Y_{t-i} + c_o P_t + \sum_{i=o}^{\infty} \lambda^i P_{t-i-1}, \qquad (A.6)$$

then lagging (A.6) one period, multiplying it by λ and subtracting the result from (A.6):

$$M_t - \lambda M_{t-1} = (1-\lambda)a_o + b_o Y_t + c_o P_t - \lambda c_o P_{t-1} + c_1 P_{t-1}, \qquad (A.7)$$

and finally, rearranging (A.7), to obtain:

$$M_t = (1 - \lambda)\ a_o + b_o Y_t + c_o P_t + c_1' P_{t-1} + \lambda M_{t-1} \qquad (A.8)$$

where,

$$c_1' = c_1 - \lambda c_o \qquad (A.9)$$

Hence, from (A.5) and (A.9), we have:

$$c^* = \frac{c_o + c_1'}{1 - \lambda}$$

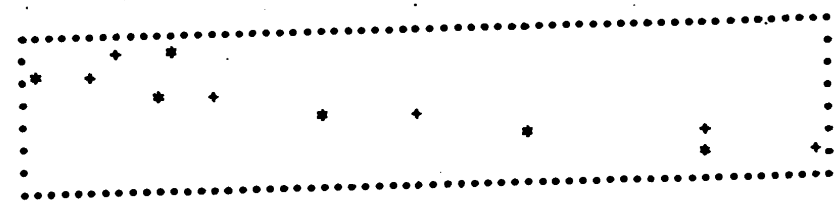
Appendix B:

Post-Sample Simulation Runs for Total Imports and Exports, Single and Multiple Equation Predictions

Graphs B1: Total U.S. Imports, less Canadian Automotive - Single Equation (Wilson Model)

OLS EQUATIONS RUN 72.1-73.2. THEIL DECOMPOSITION OF ERRORS AND CORRECTIONS
RANGE 47.34 TO 60.86

ACTUAL	SOLUTION	RESIDUALS	%ERROR	
M*-CA +	M*-CA *			
EQUATION	1	IN MODEL		
48.700	49.664	-0.964	-1.980	1972.1
48.208	47.338	0.870	1.805	1972.2
50.488	49.554	0.934	1.850	1972.3
53.928	52.416	1.512	2.804	1972.4
58.888	55.896	2.992	5.080	1973.1
60.864	58.984	1.880	3.088	1973.2



MSE= 2.888 RMS= 1.700 RHO= 0.750
MEAN ERR= 1.2040 MEAN= 53.5126

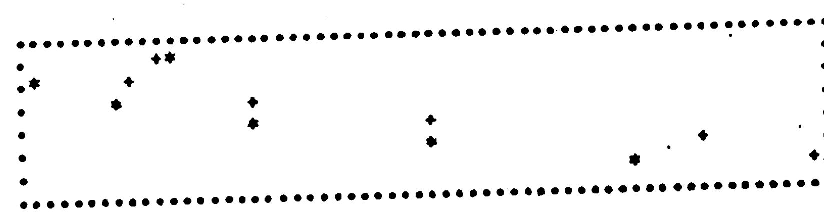
DECOMPOSITION OF ERROR VARIANCE

	ACTUALS	PREDICTEDS
MEAN	53.513	52.309
STD DEVIATION	4.892	4.015
CORRELATION	0.983	
% DUE TO BIAS=	50.182	
% DUE TO VARIANCE=	26.593	
% DUE TO COVARIANCE=	23.365	

OPTIMAL LINEAR CORRECTION OF FORECAST BY THEIL METHOD: YHAT* = A +B*YHAT
A= -9.118
B= 1.197

LAG EQUATIONS RUN 72.1-73.2. THEIL DECOMPOSITION OF ERRORS AND CORRECTIONS
RANGE 46.50 TO 60.86

ACTUAL	SOLUTION	RESIDUALS	%ERROR	
M*-CA +	M*-CA *			
EQUATION	1	IN MODEL		
48.700	49.078	-0.378	-0.776	1972.1
48.208	46.495	1.713	3.553	1972.2
50.488	48.090	2.398	4.750	1972.3
53.928	50.514	3.414	6.331	1972.4
58.888	53.881	5.007	8.502	1973.1
60.864	57.651	3.213	5.279	1973.2



MSE= 9.312 RMS= 3.052 RHO= 0.966
MEAN ERR= 2.5611 MEAN= 53.5126

DECOMPOSITION OF ERROR VARIANCE

	ACTUALS	PREDICTEDS
MEAN	53.513	50.951
STD DEVIATION	4.892	3.769
CORRELATION	0.959	
% DUE TO BIAS=	70.439	
% DUE TO VARIANCE=	13.545	
% DUE TO COVARIANCE=	16.059	

OPTIMAL LINEAR CORRECTION OF FORECAST BY THEIL METHOD: YHAT* = A +B*YHAT
A= -9.940
B= 1.245

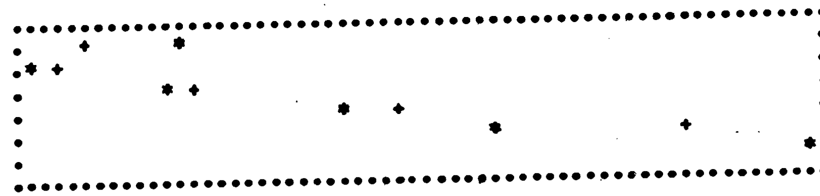
Graphs B2: Total U.S. Imports, less Canadian Automotive - Commodity Composite (Wilson Model)

GLS EQUATIONS RUN 72.1-73.2. THEIL DECOMPOSITION OF ERRORS AND CORRECTIONS
RANGE 47.84 TO 60.86

M*-CA + M*-CA *

EQUATION 56 IN MODEL

ACTUAL	SOLUTION	RESIDUALS	%ERROR	
48.700	50.419	-1.719	-3.531	1972.1
48.208	47.836	0.372	0.772	1972.2
50.488	50.165	0.323	0.639	1972.3
53.928	53.025	0.903	1.675	1972.4
58.888	55.528	3.360	5.706	1973.1
60.864	60.831	0.033	0.054	1973.2



MSE= 2.551 RMS= 1.597 RHO= 0.086
MEAN ERR= 0.5453 MEAN= 53.5126

DECOMPOSITION OF ERROR VARIANCE

	ACTUALS	PREDICTEDS
MEAN	53.513	52.967
STD DEVIATION	4.892	4.264
CORRELATION	0.955	
% DUE TO BIAS=	11.656	
% DUE TO VARIANCE=	15.463	
% DUE TO COVARIANCE=	73.063	

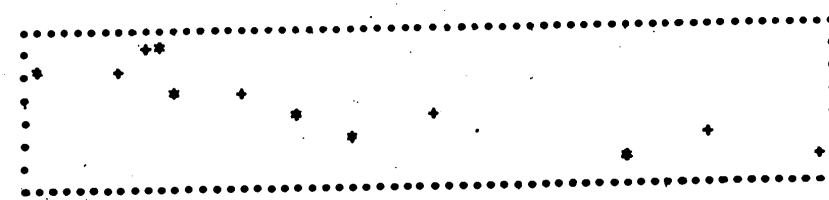
OPTIMAL LINEAR CORRECTION OF FORECAST BY THEIL METHOD: YHAT* = A +B*YHAT
A= -4.542
B= 1.096

LAG EQUATIONS RUN 72.1-73.2. THEIL DECOMPOSITION OF ERRORS AND CORRECTIONS
RANGE 46.65 TO 60.86

M*-CA + M*-CA *

EQUATION 56 IN MODEL

ACTUAL	SOLUTION	RESIDUALS	%ERROR	
48.700	48.843	-0.143	-0.293	1972.1
48.208	46.651	1.557	3.230	1972.2
50.488	49.099	1.389	2.750	1972.3
53.928	51.272	2.656	4.926	1972.4
58.888	52.288	6.600	11.208	1973.1
60.864	57.466	3.398	5.583	1973.2



MSE= 11.089 RMS= 3.330 RHO= 0.694
MEAN ERR= 2.5762 MEAN= 53.5126

DECOMPOSITION OF ERROR VARIANCE

	ACTUALS	PREDICTEDS
MEAN	53.513	50.936
STD DEVIATION	4.892	3.433
CORRELATION	0.931	
% DUE TO BIAS=	59.848	
% DUE TO VARIANCE=	19.197	
% DUE TO COVARIANCE=	20.998	

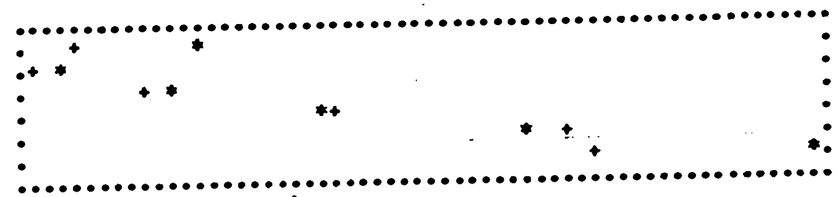
OPTIMAL LINEAR CORRECTION OF FORECAST BY THEIL METHOD: YHAT* = A +B*YHAT
A= -14.041
B= 1.326

Graphs B3: Total U.S. Imports, less CA and FL - Single Equation (Wilson Model)

OLS EQUATIONS RUN 72.1-73.2. THEIL DECOMPOSITION OF ERRORS AND CORRECTIONS
RANGE 43.42 TO 57.30

EQUATION 57 IN MODEL

ACTUAL M1-CA +	SOLUTION M1-CA *	RESIDUALS	%ERROR	
44.276	46.401	-2.125	-4.799	1972.1
43.424	43.893	-0.469	-1.080	1972.2
45.420	45.847	-0.427	-0.941	1972.3
48.684	48.517	0.167	0.343	1972.4
52.820	52.254	0.566	1.071	1973.1
53.448	57.302	-3.854	-7.210	1973.2



MSE= 3.353 RMS= 1.831 RHO= -0.417
MEAN ERR= -1.0237 MEAN= 48.0120

DECOMPOSITION OF ERROR VARIANCE

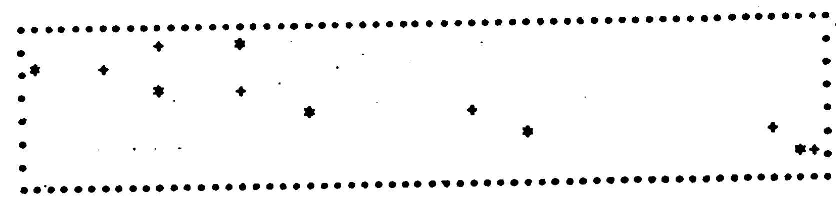
	ACTUALS	PREDICTEDS
MEAN	48.012	49.036
STD DEVIATION	3.976	4.519
CORRELATION	0.944	
% DUE TO BIAS=	31.256	
% DUE TO VARIANCE=	8.796	
% DUE TO COVARIANCE=	60.024	

OPTIMAL LINEAR CORRECTION OF FORECAST BY THEIL METHOD: YHAT* = A +B*YHAT
A= 7.285
B= 0.831

LAG EQUATIONS RUN 72.1-73.2. THEIL DECOMPOSITION OF ERRORS AND CORRECTIONS
RANGE 42.45 TO 53.45

EQUATION 57 IN MODEL

ACTUAL M1-CA +	SOLUTION M1-CA *	RESIDUALS	%ERROR	
44.276	45.432	-1.156	-2.611	1972.1
43.424	42.447	0.977	2.251	1972.2
45.420	44.112	1.308	2.879	1972.3
48.684	46.212	2.472	5.077	1972.4
52.820	49.448	3.372	6.384	1973.1
53.448	53.184	0.264	0.493	1973.2



MSE= 3.592 RMS= 1.895 RHO= 0.336
MEAN ERR= 1.2061 MEAN= 48.0120

DECOMPOSITION OF ERROR VARIANCE

	ACTUALS	PREDICTEDS
MEAN	48.012	46.806
STD DEVIATION	3.976	3.563
CORRELATION	0.931	
% DUE TO BIAS=	40.501	
% DUE TO VARIANCE=	4.744	
% DUE TO COVARIANCE=	54.820	

OPTIMAL LINEAR CORRECTION OF FORECAST BY THEIL METHOD: YHAT* = A +B*YHAT
A= -0.567
B= 1.038

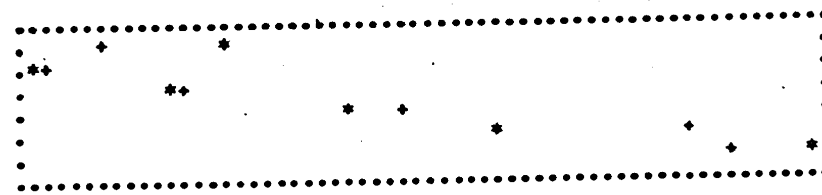
Graphs B4: Total U.S. Imports, less CA and FL - Commodity Composite (Wilson Model)

OLS EQUATIONS RUN 72.1-73.2. THEIL DECOMPOSITION OF ERRORS AND CORRECTIONS

ACTUAL	SOLUTION	RESIDUALS	%ERROR		RANGE 43.25 TO 54.73
M1-CA +	M1-CA *				

EQUATION 58 IN MODEL

44.276	46.054	-1.778	-4.015	1972.1
43.424	43.251	0.173	0.399	1972.2
45.420	45.317	0.103	0.226	1972.3
48.684	47.902	0.782	1.607	1972.4
52.820	50.070	2.749	5.205	1973.1
53.448	54.734	-1.286	-2.405	1973.2



MSE= 2.171 RMS= 1.473 RHO= -0.213
MEAN ERR= 0.1241 MEAN= 48.0120

DECOMPOSITION OF ERROR VARIANCE

	ACTUALS	PREDICTEDS
MEAN	48.012	47.888
STD DEVIATION	3.976	3.722
CORRELATION	0.929	
% DUE TO BIAS=	0.709	
% DUE TO VARIANCE=	2.974	
% DUE TO COVARIANCE=	96.402	

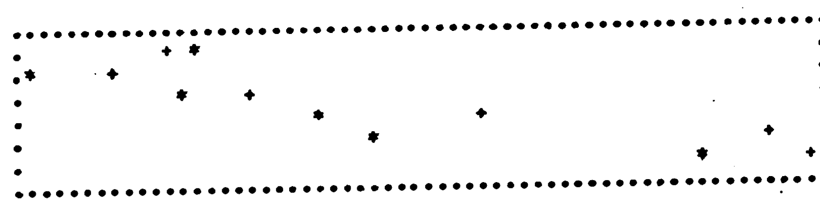
OPTIMAL LINEAR CORRECTION OF FORECAST BY THEIL METHOD: YHAT* = A +B*YHAT
A= 0.472
B= 0.993

LAG EQUATIONS RUN 72.1-73.2. THEIL DECOMPOSITION OF ERRORS AND CORRECTIONS

ACTUAL	SOLUTION	RESIDUALS	%ERROR		RANGE 42.24 TO 53.45
M1-CA +	M1-CA *				

EQUATION 58 IN MODEL

44.276	44.561	-0.285	-0.644	1972.1
43.424	42.243	1.161	2.720	1972.2
45.420	44.454	0.966	2.127	1972.3
48.684	46.416	2.268	4.659	1972.4
52.820	47.249	5.571	10.547	1973.1
53.448	51.942	1.506	2.819	1973.2



MSE= 6.809 RMS= 2.609 RHO= 0.364
MEAN ERR= 1.8679 MEAN= 48.0120

DECOMPOSITION OF ERROR VARIANCE

	ACTUALS	PREDICTEDS
MEAN	48.012	46.144
STD DEVIATION	3.976	3.041
CORRELATION	0.899	
% DUE TO BIAS=	51.239	
% DUE TO VARIANCE=	12.824	
% DUE TO COVARIANCE=	35.984	

OPTIMAL LINEAR CORRECTION OF FORECAST BY THEIL METHOD: YHAT* = A +B*YHAT
A= -0.196
B= 1.175

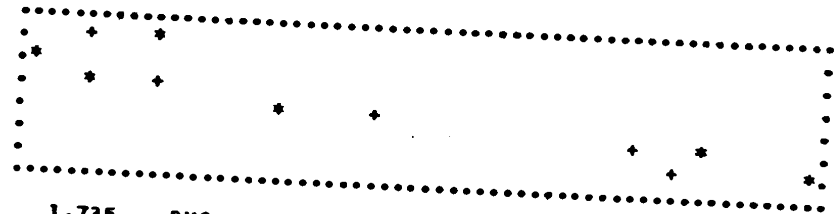
Graphs B5: Total U.S. Imports, less CA and FL - Regional Composite (Wilson Model)

OLS EQUATIONS RUN 72.1-73.2. THEIL DECOMPOSITION OF ERRORS AND CORRECTIONS

RANGE 43.42 TO 55.53

EQUATION 59 IN MODEL

ACTUAL M1-CA +	SOLUTION M1-CA *	RESIDUALS	%ERROR	
44.276	45.357	-1.081	-2.442	1972.1
43.424	43.419	0.005	0.011	1972.2
45.420	44.164	1.236	2.721	1972.3
48.684	47.166	1.518	3.119	1972.4
52.820	53.863	-1.043	-1.974	1973.1
53.448	55.526	-2.078	-3.888	1973.2



MSE= 1.735 RMS= 1.317 RHO= 0.398
MEAN ERR= -0.2405 MEAN= 48.0120

DECOMPOSITION OF ERROR VARIANCE

	ACTUALS	PREDICTEDS
MEAN	48.012	48.253
STD DEVIATION	3.976	4.723
CORRELATION	0.970	
% DUE TO BIAS=	3.336	
% DUE TO VARIANCE=	32.200	
% DUE TO COVARIANCE=	64.470	

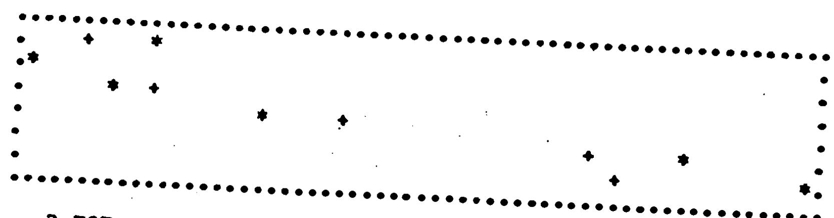
OPTIMAL LINEAR CORRECTION OF FORECAST BY THEIL METHOD: YHAT* = A +B*YHAT
A= 8.604
B= 0.817

LAG EQUATIONS RUN 72.1-73.2. THEIL DECOMPOSITION OF ERRORS AND CORRECTIONS

RANGE 43.42 TO 56.59

EQUATION 59 IN MODEL

ACTUAL M1-CA +	SOLUTION M1-CA *	RESIDUALS	%ERROR	
44.276	45.438	-1.162	-2.624	1972.1
43.424	43.456	-0.032	-0.074	1972.2
45.420	44.913	0.507	1.116	1972.3
48.684	47.278	1.406	2.088	1972.4
52.820	54.523	-1.703	-3.225	1973.1
53.448	56.590	-3.143	-5.880	1973.2



MSE= 2.727 RMS= 1.651 RHO= 0.558
MEAN ERR= -0.6879 MEAN= 48.0120

DECOMPOSITION OF ERROR VARIANCE

	ACTUALS	PREDICTEDS
MEAN	48.012	48.700
STD DEVIATION	3.976	5.011
CORRELATION	0.970	
% DUE TO BIAS=	17.354	
% DUE TO VARIANCE=	39.299	
% DUE TO COVARIANCE=	43.336	

OPTIMAL LINEAR CORRECTION OF FORECAST BY THEIL METHOD: YHAT* = A +B*YHAT
A= 10.518
B= 0.770

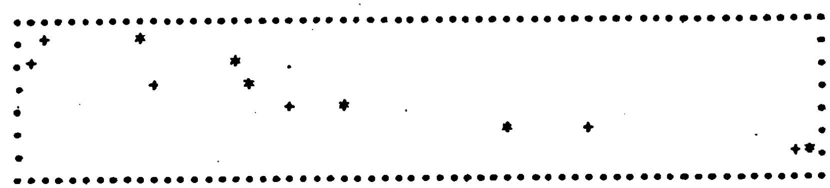
Graph B6: Total U.S. Exports, less Military Goods - Single Equation, Unweighted (Hooper Model)

POST-SAMPLE SIMULATION RUN OF HOOPER MODEL. SINGLE PERIOD SIM.

RANGE 45.99 TO 66.66

EQUATION 76 IN MODEL

ACTUAL XIMTP +	SOLUTION XIMTP *	RESIDUALS	%ERROR	
46.476	48.981	-2.505	-5.390	1972.1
45.988	51.321	-5.333	-11.597	1972.2
49.172	51.616	-2.444	-4.971	1972.3
52.744	54.492	-1.748	-3.314	1972.4
60.888	58.677	2.211	3.631	1973.1
66.364	66.676	-0.314	-0.474	1973.2



MSE= 8.123 RMS= 2.850 RHO= 0.308
MEAN ERR= -1.6891 MEAN= 53.6053 RMS/MEAN= 0.0532

DECOMPOSITION OF ERROR VARIANCE

	ACTUALS	PREDICTEDS
MEAN	53.605	55.294
STD DEVIATION	7.584	5.929
CORRELATION	0.972	
% DUE TO BIAS=	35.120	
% DUE TO VARIANCE=	33.724	
% DUE TO COVARIANCE=	31.258	

OPTIMAL LINEAR CORRECTION OF FORECAST BY THEIL METHOD: YHAT* = A +B*YHAT
A= -15.128
B= 1.243

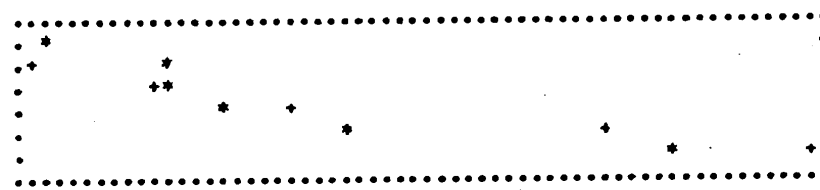
Graph B7: Total U.S. Exports, less Military Goods - Single Equation, Weighted (Hooper Model)

POST-SAMPLE SIMULATION RUN OF HOOPER MODEL. SINGLE PERIOD SIM.

RANGE 45.99 TO 66.26

EQUATION 87 IN MODEL

ACTUAL XIMTS +	SOLUTION XIMTS *	RESIDUALS	%ERROR	
46.476	46.293	0.183	0.393	1972.1
45.988	49.713	-3.725	-8.100	1972.2
49.172	49.563	-0.391	-0.795	1972.3
52.744	50.987	1.757	3.330	1972.4
60.888	54.174	6.714	11.027	1973.1
66.364	62.939	3.425	5.160	1973.2



MSE= 12.326 RMS= 3.511 RHO= 0.535
MEAN ERR= 1.3270 MEAN= 53.6053 RMS/MEAN= 0.0655

DECOMPOSITION OF ERROR VARIANCE

	ACTUALS	PREDICTEDS
MEAN	53.605	52.278
STD DEVIATION	7.584	5.303
CORRELATION	0.933	
% DUE TO BIAS=	14.287	
% DUE TO VARIANCE=	42.217	
% DUE TO COVARIANCE=	43.533	

OPTIMAL LINEAR CORRECTION OF FORECAST BY THEIL METHOD: YHAT* = A +B*YHAT
A= -16.174
B= 1.335

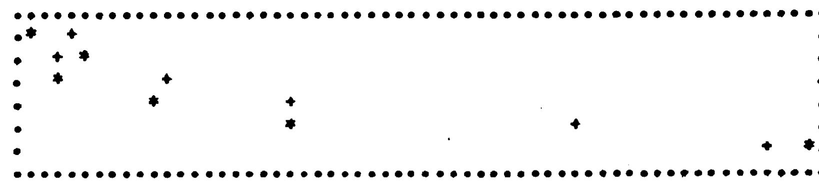
Graph B8: Total U.S. Exports, less Military Goods - Commodity Composite (Hooper Model)

POST-SAMPLE SIMULATION RUN OF HOOPER MODEL. SINGLE PERIOD SIM.

ACTUAL	SOLUTION	RESIDUALS	%ERROR		RANGE 45.36 TO 67.70
XIMTC +	XIMTC *				

EQUATION 86 IN MODEL

46.476	45.364	1.112	2.393	1972.1
45.988	47.125	-1.137	-2.472	1972.2
49.172	46.059	3.113	6.331	1972.3
52.744	48.840	3.904	7.401	1972.4
60.888	52.917	7.971	13.091	1973.1
66.364	67.702	-1.338	-2.016	1973.2



MSE= 15.464 RMS= 3.932 RHO= -0.177
MEAN ERR= 2.2709 MEAN= 53.6053 RMS/MEAN= 0.0734

DECOMPOSITION OF ERROR VARIANCE

	ACTUALS	PREDICTEDS
MEAN	53.605	51.334
STD DEVIATION	7.584	7.722
CORRELATION	0.912	
% DUE TO BIAS=	33.349	
% DUE TO VARIANCE=	0.124	
% DUE TO COVARIANCE=	66.549	

OPTIMAL LINEAR CORRECTION OF FORECAST BY THEIL METHOD: YHAT* = A +B*YHAT
A= 7.622
B= 0.896

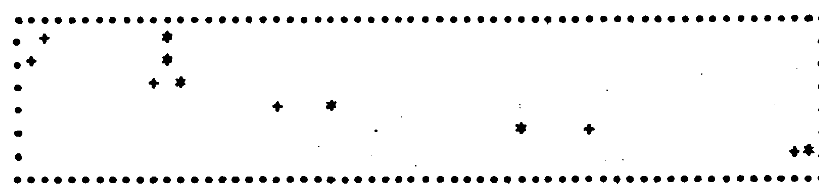
Graph B9: Total U.S. Exports, including Military Goods - Regional Composite (Hooper Model)

POST-SAMPLE SIMULATION RUN OF HOOPER MODEL. SINGLE PERIOD SIM.

ACTUAL	SOLUTION	RESIDUALS	%ERROR		RANGE 47.25 TO 68.29
XMTR +	XMTR *				

EQUATION 85 IN MODEL

47.612	50.842	-3.231	-6.785	1972.1
47.248	50.950	-3.702	-7.835	1972.2
50.408	51.479	-1.071	-2.125	1972.3
53.908	55.466	-1.580	-2.931	1972.4
62.208	60.699	1.509	2.425	1973.1
67.932	68.294	-0.362	-0.533	1973.2



MSE= 5.032 RMS= 2.243 RHO= 0.199
MEAN ERR= -1.4062 MEAN= 54.8859 RMS/MEAN= 0.0409

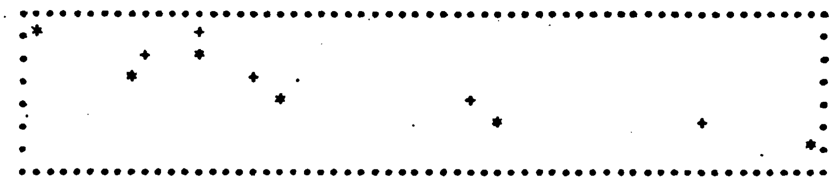
DECOMPOSITION OF ERROR VARIANCE

	ACTUALS	PREDICTEDS
MEAN	54.886	56.292
STD DEVIATION	7.704	6.397
CORRELATION	0.986	
% DUE TO BIAS=	39.296	
% DUE TO VARIANCE=	33.921	
% DUE TO COVARIANCE=	26.994	

OPTIMAL LINEAR CORRECTION OF FORECAST BY THEIL METHOD: YHAT* = A +B*YHAT
A= -11.968
B= 1.188

Graph B10: Total U.S. Imports - Single Equation, Unweighted (Hooper Model)

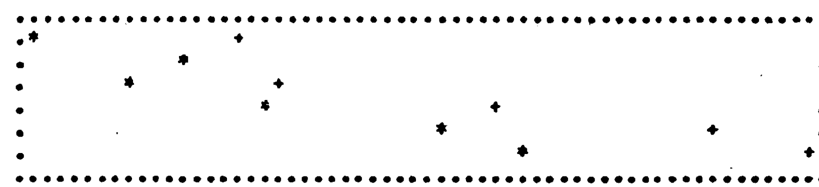
```
       POST-SAMPLE SIMULATION RUN OF HOOPER MODEL.  SINGLE PERIOD SIM.
        ACTUAL     SOLUTION  RESIDUALS    %ERROR              RANGE    50.51  TO    67.38
  MMTP  +        MMTP  *

              EQUATION    68   IN MODEL

        54.104     50.506     3.598     6.650  1972.1
        52.922     54.051    -1.129    -2.134  1972.2
        55.177     52.504     2.673     4.845  1972.3
        60.074     55.843     4.231     7.043  1972.4
        65.004     60.718     4.286     6.593  1973.1
        67.360     67.269     0.091     0.135  1973.2
```



```
                                 MSE=      9.607    RMS=      3.160    RHO=     -0.314
                                 MEAN ERR=   2.2916    MEAN=   59.1101   RMS/MEAN=    0.0524

              DECOMPOSITION OF ERROR VARIANCE
                 ACTUALS            PREDICTEDS
  MEAN              59.110              56.819
  STD DEVIATION      5.921               5.656
  CORRELATION                    0.930
      % DUE TO BIAS=              54.661
      % DUE TO VARIANCE=           0.189
      % DUE TO COVARIANCE=        45.184

OPTIMAL LINEAR CORRECTION OF FORECAST BY THEIL METHOD: YHAT* = A +B*YHAT
   A=        7.502
   B=        0.906
```

Graph B11: Total U.S. Imports - Single Equation, Weighted (Hooper Model)

```
       POST-SAMPLE SIMULATION RUN OF HOOPER MODEL.  SINGLE PERIOD SIM.
        ACTUAL     SOLUTION  RESIDUALS    %ERROR              RANGE    49.32  TO    67.38
  MMTS  +        MMTS  *

              EQUATION   100   IN MODEL

        54.104     49.317     4.787     8.848  1972.1
        52.922     52.627     0.295     0.179  1972.2
        55.177     51.384     3.794     6.875  1972.3
        60.074     54.727     5.347     8.900  1972.4
        65.016     58.857     6.159     9.474  1973.1
        67.380     60.853     6.527     9.687  1973.2
```



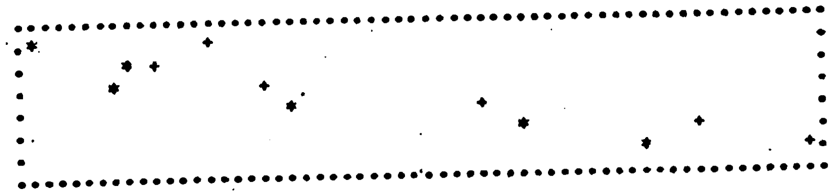
```
                                 MSE=     24.407    RMS=      4.940    RHO=      0.733
                                 MEAN ERR=   4.4514    MEAN=   59.1121   RMS/MEAN=    0.0836

              DECOMPOSITION OF ERROR VARIANCE
                 ACTUALS            PREDICTEDS
  MEAN              59.112              54.661
  STD DEVIATION      5.523               4.054
  CORRELATION                    0.946
      % DUE TO BIAS=              81.187
      % DUE TO VARIANCE=           8.837
      % DUE TO COVARIANCE=        10.000

OPTIMAL LINEAR CORRECTION OF FORECAST BY THEIL METHOD: YHAT* = A +B*YHAT
   A=      -11.291
   B=        1.[illegible]
```

Graph B.12: Total U.S. Imports - Commodity Composite (Hooper Model)

POST-SAMPLE SIMULATION RUN OF HOOPER MODEL. SINGLE PERIOD SIM.
RANGE 50.10 TO 67.38

EQUATION 99 IN MODEL

ACTUAL MMTC +	SOLUTION MMTC *	RESIDUALS	%ERROR	
54.104	50.101	4.003	7.399	1972.1
52.922	52.343	0.579	1.094	1972.2
55.177	51.908	3.269	5.924	1972.3
60.074	55.744	4.329	7.207	1972.4
65.016	61.163	3.853	5.926	1973.1
67.380	63.882	3.497	5.191	1973.2



MSE= 12.145 RMS= 3.485 RHO= 0.319
MEAN ERR= 3.2552 MEAN= 59.1121 RMS/MEAN= 0.0590

DECOMPOSITION OF ERROR VARIANCE

	ACTUALS	PREDICTEDS
MEAN	59.112	55.857
STD DEVIATION	5.523	5.061
CORRELATION	0.976	
% DUE TO BIAS=	87.252	
% DUE TO VARIANCE=	1.759	
% DUE TO COVARIANCE=	11.044	

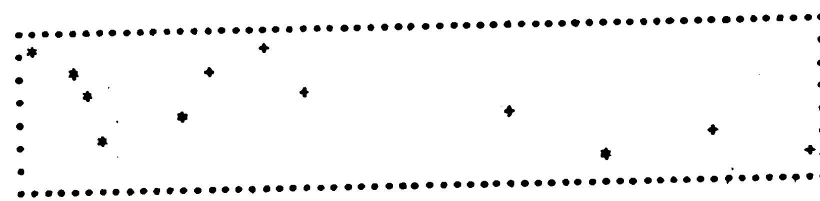
OPTIMAL LINEAR CORRECTION OF FORECAST BY THEIL METHOD: YHAT* = A +B*YHAT
A= -0.383
B= 1.0[illegible]

Graph B.13: Total U.S. Imports - Regional Composite (Hooper Model)

POST-SAMPLE SIMULATION RUN OF HOOPER MODEL. SINGLE PERIOD SIM.
RANGE 48.44 TO 67.38

EQUATION 98 IN MODEL

ACTUAL MMTR +	SOLUTION MMTR *	RESIDUALS	%ERROR	
54.104	48.444	5.660	10.462	1972.1
52.922	49.293	3.629	6.856	1972.2
55.177	49.721	5.457	9.889	1972.3
60.074	52.145	7.929	13.196	1972.4
65.016	49.943	15.073	23.184	1973.1
67.380	62.372	5.008	7.432	1973.2



MSE= 65.020 RMS= 8.063 RHO= 0.322
MEAN ERR= 7.1258 MEAN= 59.1121 RMS/MEAN= 0.1364

DECOMPOSITION OF ERROR VARIANCE

	ACTUALS	PREDICTEDS
MEAN	59.112	51.986
STD DEVIATION	5.523	4.779
CORRELATION	0.741	
% DUE TO BIAS=	78.096	
% DUE TO VARIANCE=	0.852	
% DUE TO COVARIANCE=	21.058	

OPTIMAL LINEAR CORRECTION OF FORECAST BY THEIL METHOD: YHAT* = A +B*YHAT
A= 14.612
B= 0.[illegible]

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