Measurement of Aid in International Trade: An Empirical Study

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1. Introduction

Foreign trade demand functions have been well explored and widely discussed (see, for example, studies reviewed by Cheng [1] and Learner and Stern [2]) because of the inherent interest in the movement of resources from one nation to another and an indispensable aid in correcting imbalances in world payments. Everyone recognizes the importance of income and price changes on a country's balance of payments, and this paper has something to contribute in this respect. Very little attention is paid to the role of aid in world trade. Only one study by Handakker and Magee [6] recognizes the influence of aid and incorporates credit considerations in the U.S. export equations. The nature of aid and its effect on the balance of payments is of great interest, especially on the availability of grants and aid. Such a variable will play an important role in linking the current and capital accounts of the balance of payments (see Learner and Stern, p. 16).

More formally, this model can be specified:

\[
M_{it} = A0 + A1(Y_{it}) + A2(P_{it}) + A3(\text{G}_{it}) + (U_{it})
\]  

where,

\(M_{it}\) is the \(i\)th country's imports in constant dollars during year \(t\),

\(Y_{it}\) is the \(i\)th country's economic activity during year \(t\),

\(P_{it}\) is the \(i\)th country's relative price measured by a ratio of \(i\)'s domestic price to the import price during year \(t\),

\(G_{it}\) is grants and aid of the rest of the world to the \(i\)th country during year \(t\),

\(U_{it}\) is an error term,

\(A0, A1, A2, A3\) are the parameters to be estimated,

\(A0, A1, A2 > 0\) and \(A3 < 0\).

2. The Model

The basic hypothesis of an import demand function is that the volume of imports depends on a country's economic activity and relative price measured by a ratio of the domestic price to the import price. The selection of the activity variable depends on the nature of imported commodities. In the case of consumer goods, real income is an appropriate activity variable, whereas, in the case of imports of raw materials, the industrial production variable is important, because raw materials are destined to be used as inputs in further production. The import function of a developing economy is also influenced by the giants and aid variable since the demand for imports is limited by the country's foreign exchange earnings capability. Import controls are used to cope with the international reserves-accreditation situation. The severity of these controls depends, to a great extent, on the availability of grants and aid. Such a variable will play an important role in linking the current and capital accounts of the balance of payments (see Learner and Stern, p. 16).

More formally, this model can be specified:

\[
(M_{ij}h) = A0 + A1(Y_{ij}h) + A2(P_{ij}h) + A3(G_{ij}) + A4(P_{ij}h) + (U_{ij})
\]  

where,

\(M_{ij}h\) is the \(i\)th country's imports in constant dollars during year \(t\),

\(Y_{ij}h\) is the \(i\)th country's economic activity in the production of \(k\)th product in the year \(t\),

\(P_{ij}h\) represents the \(i\)th country's relative price competitiveness measured by the ratio of the \(i\)th country's domestic price of \(k\)th product to the \(i\)th country's import price of \(k\)th product or the \(i\)th country's export price of \(k\)th product during year \(t\),

\(G_{ij}\) is country \(i\)'s grants and aid to country \(j\) in the year \(t\).
3. Empirical Results

The empirical results of the Indo-U.S. import demand equations for the major groups and subgroups of commodities classified by the SITC and the total imports are presented in Table 1.

Several equations warrant comments:

(i) Import Demand for Food (SITC 0 & 1) - Food imports of a low income country like India are, ceteris paribus, strongly influenced by agricultural production. When the grain output rises, the demand for imported foods and vice versa. The income variable may be used in lieu of agricultural production because the income elasticity of demand for food in the low income countries is considerably higher than in the advanced countries. Thus even a small rise in income will have a stronger impact on the demand for foodstuffs. India’s imports of food from the United States are also influenced by the availability of U.S. rice.

The lagged imports of food variable has been included in the function, implying a geometrically declining lag pattern. The estimated relationship is shown in Table 1.

The relative price and the population variables have not been included in Equation 2 since one cannot expect a significant influence of relative price on imports of food as these have been “stress” imports. The trial equations are in Table 1.

The coefficient of relative price variable in

*On an anonymous referee’s suggestion, an alternative specification was tried in which \( Y = f(\text{agricultural output, time, and U.S. grants and aids})\). The estimated equation is shown in Equation 2b in Table 1. The significance of the activity variables improved, whereas M2 dropped slightly.

Notes:
(1) Numbers in parentheses are t-ratios.
(2) \( R^2 \) is the coefficient of determination adjusted for degrees of freedom.
(3) S is the standard error of estimate for each equation.
(4) (D) is the Durbin-Watson statistic for serial correlation.
* Equation (1b) is divided by the population of India to derive per capita food demand.
* The import price index of chemicals is in the denominator and thus the coefficient of \( P2 \) has a negative sign.
† Time period 1951-1968. All variables use in 1963 prices of 100 millions of U.S. dollars except where otherwise noted. A complete data appendix may be obtained from the author.

Source [27]:

Equation 2a is statistically insignificant as expected. We have divided Equation 2 by the population of India to derive per capita food demand which takes into account the influence of population on food imports. Per capita income variable has been replaced by per capita food production. The coefficients have the expected signs. However, the standard error of the coefficient of \( Y \) is rather high. Therefore, Equations 2a and 2b are preferred.
(ii) Import Demand for Manufactured Goods (SITC 5 to 8).—Imports of chemicals (SITC 5), machinery and transport equipment (SITC 7) have been included in this broad category of manufactured goods.

In analyzing the import demand for manufactured goods, one would expect real income and relative prices to be the prime explanatory variables; competitors' export prices and U.S. aid are also important. Since the United Kingdom is the main competitor to the United States in the Indian Market, her export price index of manufactured goods has been introduced in lieu of the composite price index of major competitors. The estimated equation is shown as Equation 4 in Table 1.

(iii) Import Function for Chemicals (SITC 5).—Imports of chemicals deflated by its import price index is the dependent variable. Since the major portion of the imported chemicals is an input by the industrial sector, the index of industrial production is an appropriate activity variable. To obtain the U.S. price competitive variable, the U.S. export price index of chemicals was deflated by India's Import Price Index of Chemicals. Lagged import is another explanatory variable which serves as a link with the past import behavior. The estimated equation is shown as Equation 5 in Table 1.

It appears that the coefficient of the activity variable is statistically significant and that of \( \frac{\alpha}{\alpha} \) is significant at the 90 per cent confidence level.

(iv) Imports of Machinery and Transport Equipment (SITC 7).—Imports of machinery and transport equipment accounted for about 50 per cent of the total imported nonfood goods from the United States during the period under study. For imports of capital goods such as the one in question, total domestic expenditure on machinery and equipment is the appropriate activity variable. Unfortunately, the data are not available on capital goods for the SITC group. Therefore, India's real national income has been chosen to explain the machinery and transport equipment function.\(^4\)

A priori, one would not expect to find a significant effect of relative price variable on machinery imports since these were "maintenance" imports to feed the industrial sector. Therefore, it has not been included in our equation. The influence of U.S. price competitiveness terms of relative prices appears to be insignificant. This could be due to the dominance of the United States in the total imports of capital goods of India. Another important variable in explaining the import demand for machinery and transport equipment from the United States is U.S. aid and grants. The lagged imports and a time trend variable have also been included. The estimated relationship is shown as Equation 6 in Table 1.

Imports of machinery and transport equipment were further disaggregated into (i) imports of machinery (SITC 71 + SITC 72) and (ii) imports of transport equipment (SITC 73).

(v) Import Demand Equation for Machinery.—The import demand equation for machinery is quite similar in general structure to that of Equation 6. In other words, India's real national income, U.S. grants and aid, and time trend are the primary determinants of import demand for machinery. The lagged import variable has also been included which represents the past import behavior pattern and appears to be highly significant in the disaggregated import functions. The estimated relationship is shown in Equation 7 in Table 1.

(vi) Import Demand Equation for Transport Equipment.—In the equation of imports of transport equipment from the United States, the activity variable is represented by the index of industrial production of transport equipment since most of these imports are used as inputs by this industry. A time trend and U.S. grants and aid are the two other explanatory variables. The estimated equation is shown in Equation 8 in Table 1.

The coefficient of $c$ merits a comment. It is negative in Equations 6, 7, and in 8, which can be interpreted as the long run import substitution effect, and it tends to support the declared policy of the Indian government. The trend coefficient is significant in Equation 8 and marginally significant in Equation 6, whereas it is insignificant in Equation 7. Similarly, the coefficient of the import variable is insignificant in Equations 6 and 7 while it is significant in Equation 8. As explained earlier, it could be due to the lack of a meaningful explanatory variable such as domestic expenditures on machinery and transport equipment. The performance of the U.S. grants and aid variable is as expected.

Considering these results, decomposition of machinery and transport equipment did not improve the results statistically.\(^5\) Therefore, turned out to be lower, as is not unexpected when disaggregation is carried on to a higher order. However, it provides some insight into the behavior of the individual variables. It should be noted that all coefficients in the above three equations have proper signs suggested by economic theory.

(vii) Imports of Manufactures (SITC 6).—The major portion of imports of manufactures from the United States were basic metals and metal products such as iron and steel, copper, aluminum, etc. The demand equation for imports of this category is similar to that of machinery and transport equipment. India's income originating in the nonagricultural sector is the activity variable. Lagged imports and U.S. aid are the remaining explanatory variables. The estimated equation is presented as Equation 9 in Table 1.

(viii) Import Demand Function for Metals (SITC 6).—Since the major portion of manufactures imported from the United States consisted of basic metals and metal products, an effort is made to estimate the import demand function for this category. As in Equation 9, India's income originating in the non-agricultural sector, lagged imports and U.S. aid are the primary determinants of the import function. The regression equation is presented as Equation 10 in Table 1.

It can be seen that there is not much variation in the adjusted coefficients of multiple determinations in Equations 9 and 10, which is hardly surprising in view of the dominance of metals and metal products in the imports of manufactures. However, the magnitude of the regression coefficients may provide further insight into the import behavior of this group.

(ix) Import Demand for Raw Cotton (SITC 26).—The bulk of raw materials imported from the United States consists of raw cotton which accounts for about 70 per cent of total imports. The remainder of the group includes rubber, pulp, and paper.

The import function of raw cotton is fairly simple. The index of textiles production is the prime demand indicator. The relative price variable, i.e., a ratio of home and import prices of cotton, has significant influence on import demand as vigorous attempts have been made to grow the long staple varieties of raw cotton. The U.S. competitiveness in terms of relative prices is represented by a ratio of Sudanean export price index of raw cotton to that of United States, since Sudan is a major competitor. The estimated equation is given in Equation 11 in Table 1.

Statistically, the price coefficients are highly significant, which points out two types of substitution effects: 1. Between imported raw cotton and domestic raw cotton and 2. Between United States and Sudanese raw cotton. But the coefficient of TP appears to be too small and its sampling error is unusually high, showing some evidence of multicollinearity.

A final comment concerns the credit variable. The credit variable in Equation 11 is included aid under PL 480 sales and associated
TABLE 2
Some Measures of Elasticities

<table>
<thead>
<tr>
<th>Equation</th>
<th>Dependent Variable</th>
<th>Explanatory Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>SITC No.</td>
<td>Y</td>
</tr>
<tr>
<td>1</td>
<td>0-9 M</td>
<td>1.20</td>
</tr>
<tr>
<td>2</td>
<td>0-1 M</td>
<td>0.65</td>
</tr>
<tr>
<td>3</td>
<td>2-9 M</td>
<td>1.06</td>
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<td>4</td>
<td>3-8 M</td>
<td>1.73</td>
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<tr>
<td>5</td>
<td>5-8 M</td>
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<tr>
<td>6</td>
<td>7,9 M</td>
<td>1.18</td>
</tr>
<tr>
<td>7</td>
<td>10 M</td>
<td>0.60</td>
</tr>
<tr>
<td>8</td>
<td>6, 8 M</td>
<td>1.40</td>
</tr>
<tr>
<td>9</td>
<td>6, 8 M</td>
<td>1.74</td>
</tr>
<tr>
<td>10</td>
<td>23 M</td>
<td>0.32</td>
</tr>
</tbody>
</table>

The import price index of chemicals is in the denominator and the elasticity coefficient is negative. (See Table 2 and Table 1 of this paper.)

5The import price index of chemicals is in the denominator and the elasticity coefficient is negative. (See Table 2 and Table 1 of this paper.)

4. Measurement of Elasticities
One of the main objectives of economicometric study of international trade is to measure the trade elasticities with respect to various explanatory variables since policy implications depend, to a great extent, on their magnitude. In this section, an effort has been made to estimate the elasticity coefficients relating to India's imports from the United States. The elasticities are computed at sample means and are presented in Table 2.

Some of our estimated elasticities are "impact elasticities" due to the presence of lagged imports in various functions. In other words, the elasticity coefficients exhibit the effects of changes in the regressors in the year during which these changes occur. Therefore, allowance must be made for the influence of lagged imports. The long run elasticities\(^1\) can be computed using the following formula (See Paterson [22, p. 63]).

\[
E_{LP} = E_{LV} \left( \frac{1}{1 - c} \right)
\]

where,

- \(E_{LP}\) = the long run elasticity coefficient
- \(E_{LV}\) = the short run elasticity coefficient
- \(c\) = the coefficient of the lagged lag variable.

The long run elasticity estimates are presented in Table 3.

5. Policy Implications of the Results and Conclusions
A set of trade elasticities and properties relating to the disaggregated Indo-U.S. import trade has been presented. To evaluate the estimated equation Standard Statistical Criteria such as \(R^2\), DW, h, and t-test are provided. A word of caution is in order. The Durbin-Watson test is inappropriate for those equations in which the lagged dependent variable appears as a regressor. Thus a new Durbin's test known as "h" test has been developed by J. Durbin (28). We have computed the h-statistic wherever it is warranted. The new test is based on asymptotic properties and must be interpreted accordingly.

The results seem very encouraging. The coefficients have anticipated signs; appear to have statistical significance in many cases; and the serial correlation tests exhibit no significant serial correlation in the residuals indicating that the model is properly specified. The following implications and conclusions may be drawn from these findings:

a. The Role of Credit: The role of the credit variable is found to be quite significant. (See Table 4). Everyone of the aid elasticities is significantly different from zero (i.e., greater than zero) at the 5% level except in Equations (3) and (4) where its significance dropped to the 10% and the 5% level respectively; and every one is significantly different from unity (i.e., less than 1) at the 5% level. It appears that the role of the aid variable is quite appealing.

The magnitude of aid elasticities evaluated at the appropriate means in various equations are of importance since they show additional light on the contribution of this variable in disaggregated trade (see Table 2). The aid elasticity for major groups and subgroups of commodities varied from 0.22 to 0.64. Of particular interest within a broad category of SITC 7 are the aid elasticities for transport equipment (Equation 8) and machinery (Equation 7).

TABLE 3
Measures of Long-run Elasticity Estimates

<table>
<thead>
<tr>
<th>Equation</th>
<th>Dependent Variable</th>
<th>Explanatory Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>SITC No.</td>
<td>Y</td>
</tr>
<tr>
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<td>0-9 M</td>
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</tr>
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<td>1.84</td>
</tr>
<tr>
<td>10</td>
<td>23 M</td>
<td>1.56</td>
</tr>
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</table>

Sources: [27] and Tables 1 and 2 of this paper.

TABLE 4
Role of Credit Measured by its Statistical Significance

<table>
<thead>
<tr>
<th>Equation</th>
<th>Aid</th>
<th>Elasticity</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>0.53</td>
<td>6.79</td>
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<td>0.56</td>
<td>5.32</td>
<td>5.77</td>
</tr>
<tr>
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<td>0.60</td>
<td>1.90</td>
<td>4.43</td>
</tr>
<tr>
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<td>0.44</td>
<td>2.15</td>
<td>2.81</td>
</tr>
<tr>
<td>5</td>
<td>0.44</td>
<td>2.50</td>
<td>7.00</td>
</tr>
<tr>
<td>6</td>
<td>0.52</td>
<td>4.57</td>
<td>9.71</td>
</tr>
<tr>
<td>7</td>
<td>0.50</td>
<td>15.63</td>
<td>15.63</td>
</tr>
<tr>
<td>8</td>
<td>0.42</td>
<td>9.13</td>
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<tr>
<td>9</td>
<td>0.64</td>
<td>13.61</td>
<td>7.66</td>
</tr>
</tbody>
</table>

\(^{1}\)Significant at the 0.01 level.
\(^{2}\)Significant at the 0.05 level.

5They are based on the assumption that the model properly specifies the form of the distribution of lag and the lag patterns of all regressors are the same (24, p. 385).

6They are based on the assumption that the model properly specifies the form of the distribution of lag and the lag patterns of all regressors are the same (24, p. 385).

\(^{2}\)Significant at the 0.05 level.

\(^{2}\)Significant at the 0.01 level.

\(^{*}\)Significant at the 0.05 level.

\(^{2}\)Significant at the 0.01 level.

\(^{2}\)Significant at the 0.05 level.

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\(^{2}\)Significant at the 0.05 level.

\(^{2}\)Significant at the 0.01 level.

\(^{2}\)Significant at the 0.05 level.

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\(^{2}\)Significant at the 0.01 level.

\(^{2}\)Significant at the 0.05 level.

\(^{2}\)Significant at the 0.01 level.

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\(^{2}\)Significant at the 0.05 level.

\(^{2}\)Significant at the 0.01 level.

\(^{2}\)Significant at the 0.05 level.

\(^{2}\)Significant at the 0.01 level.

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\(^{2}\)Significant at the 0.01 level.

\(^{2}\)Significant at the 0.05 level.

\(^{2}\)Significant at the 0.01 level.

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\(^{2}\)Significant at the 0.05 level.

\(^{2}\)Significant at the 0.01 level.
results should be expected since economic growth, among other things, depends on the availability of capital goods. It is interesting to note that the long-run income elasticity for food is also elastic. It means that as the income of a developing country rises, expenditures for food items and especially for nourishing food items will likely rise faster than the per capita food consumption is far below the required balanced food consumption level.

The influence of the income variable on Indo-U.S. import trade appears to be stronger than those on Indo-U.S. export trade (see Narang [17, p. 141]). Therefore, our analysis indicates that, other things being equal, India's trade balance with the United States will probably deteriorate over time. However, attention must also be focused on the effects of price on trade.

c. The Impact of Disaggregation on Trade Parameters: The empirical and theoretical importance of disaggregation on trade parameters is beyond dispute. The disaggregated trade models will provide further insight into the role of the explanatory variables. One of the reasons for "elasticity parsimony" appears to be the lack of disaggregation of trade. And Occurs's [21] warning in this respect is quite noteworthy. We hope that the present study is a step in the right direction.

To sum up, we have the role of aid in world trade is significant. Its inclusion in the trade functions provides further information on the behavior of income and price variables. Further research on the impact of trade on certain restrictions, such as the tying of aid, may be fruitful. Further disaggregation of trade by three (or more) digit ISIC level and by trading partners may yield useful information on policy matters.

References

Merger Illusions and Externalities

JANUSZ A. ORDOVER* and ANDREW SCHOTTER*

Introduction

In this note we hope to accomplish two objectives. First, to alert policymakers to the importance of historical considerations when contemplating corrective taxes as a policy used to handle externalities. Second, to elucidate once more the usefulness of the core concept in the study of economics containing externalities.1

The "Tree Game"

Let us consider the following community consisting of three agents or players situated as follows:

<table>
<thead>
<tr>
<th>Player C</th>
<th>Player A</th>
<th>Player B</th>
</tr>
</thead>
</table>

Assume that the economy faces the following problems: Player A bestows a beneficial externality on Player B and a harmful externality on Player C. (The reader may think of Player A as planting trees to grow apples, Player B as a beekeeper, and Player C as the owner of a swimming pool which is polluted by falling tree leaves.) Now obviously because of the externality, the problem faced is that Player B wants Player A to increase his production (grow more trees), but Player C wants the production reduced (i.e., he wants some trees to be cut down).

Let us say that Player A, the apple grower, can sell his apples in a perfectly competitive apple market and that the optimal number of trees he would plant if acting alone is \( T \). In addition, assume that Player B is willing to offer Player A a payment to plant a number \( r^* \geq T \) trees. Similarly, Player C is willing to pay a reduction of the number of trees planted by Player A from \( T \) to \( r \leq T \). It follows, then, that Player B, acting alone can guarantee himself only the utility associated with \( T \) trees, while Player C, if acting alone, can guarantee himself only the utility associated with \( r^* \) trees. For the sake of argument, let us assume all of the proper convexity assumptions hold, and that B is willing to offer more to A for the addition of the \( T - 1 \)st tree than C is willing to offer for the destruction of the \( T \)th. Also assume that all the players' utility functions are linear in money so that side payments can be affected.

With these assumptions, the characteristic function \( v \) of the "tree game" is:

\[
\begin{align*}
V(A) &= U_B(T) \\
V(B) &= U_A(T) \\
V(C) &= U_C(T^*) \\
V(AB) &= \max \{ U_B(T) + U_A(T) \} \\
V(AC) &= \max \{ U_A(T) + U_C(T^*) \} \\
V(ABC) &= \max \{ U_A(T) + U_B(T) + U_C(T^*) \}.
\end{align*}
\]

We will assume that trees grow instantaneously and produce a fixed number of apples and that it is possible to plant a fraction of a tree, etc. Consequently, the marginal cost of an apple is the marginal cost of planting that fraction of the tree needed to produce that apple, measured in labor cost, if you wish.

We will assume that the game is played only in tree strategy space since it may be, or often is, underwhelming, that the true Pareto optimal solution would be to move Player C to the other side of Player B, but we will ignore this. See R. Coase, "The Problem of Social Cost," The Journal of Law and Economics (October 1960).