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**IMPORT ELASTICITY WITH GOVERNMENT INTERVENTION:
A TIME SERIES CROSS SECTION ANALYSIS OF
SEVENTY-TWO COUNTRIES**

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by

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ABSTRACT

The impact of government intervention on the behavior of a country's import market is investigated by focusing on the departure this intervention induces between excess and import demand functions. A formal model of government behavior is posited where government preferences are embodied in a country's import demand function. This function is related to its corresponding excess demand function through the domestic price to border price transmission elasticity. A pooled cross section data on 72 countries is used to estimate these functions for wheat and rice. The results suggest that import demand elasticities are larger than their corresponding excess demand elasticities and that price transmission elasticities are less than unity. Differences in elasticities over time, regions and levels of nominal protection are also reported.

Key Words: Import elasticities, government intervention, international trade, wheat and rice markets.

IMPORT ELASTICITY WITH GOVERNMENT INTERVENTION

I. Introduction

This paper addresses the issue of the impact of government intervention on a country's import market for rice and wheat. Price policy and the responsiveness of countries' imports to changes in border prices have a long tradition in the literature. Illustrations are the work of D. Gale Johnson (1975) on the effect of country's price policy and international price stability, the effects of domestic price policy on excess demand for agricultural imports (Abbott 1979) and more recently, Sarris and Freebairn's (1983) article on how the interaction of national policies can lead to a lowering and instability of both international and domestic prices. However, the literature on the estimation of import demand elasticities for agricultural commodities has invariably employed the assumption that parameters underlying import demand elasticities are unaffected by government intervention.

Under this formulation (Tweeten (1967, 84), Johnson (1977) and others), the direct import elasticity ($E_{I_{ij}}$)¹ is the sum of direct domestic demand ($E_{D_{ij}}$) and supply ($E_{S_{ij}}$) elasticities weighted by import shares ($I_{D_{ij}} \equiv Q_{D_{ij}}/Q_{I_{ij}}$ and $I_{S_{ij}} \equiv Q_{S_{ij}}/Q_{I_{ij}}$). However, when domestic and border prices differ it is easily shown that import elasticity must be further weighted by the price transmission elasticity ($E_{P_{ij}}$).² In this case, the direct import elasticity of demand can be expressed as:

$$(1.0) \quad E_{I_{ij}} = (E_{D_{ij}} \cdot I_{D_{ij}} - E_{S_{ij}} \cdot I_{S_{ij}})E_{P_{ij}}$$

where $(E_{D_{ij}} \cdot I_{D_{ij}} - E_{S_{ij}} \cdot I_{S_{ij}})$ is the direct excess demand elasticity. The approach employed by Tweeten (1967, 84), Johnson (1977) and others to

obtain import demand elasticities does not take account of government interventions. This fact was noted by Bredahl, Meyers and Collins (1977) where they argue:

"In cases where governments insulate internal production and consumption from world markets, the E_p ... [price transmission elasticity] ... will be at or near zero." [1977, p. 58]

However, they do not incorporate a theory of government behavior. Rather, somewhat like a dummy variable approach, they posit a system where the import elasticity is zero or near zero if governments intervene and otherwise the free trade elasticity prevails.

Estimates of the direct import and excess demand elasticities can differ for reasons other than government intervention in foreign trade markets. It can be easily shown that divergence in elasticity estimates can occur when the domestically produced commodity (e.g., wheat) is not identical to the imported commodity because of differences in variety, moisture content, impurities and other attributes, and when domestic prices are reported for a different level in the market channel than border prices. These subtle differences are often empirically difficult to take into account. Price data often are not adjusted for commodity attributes nor is it often possible to adjust reported prices to account for the difference in transport and handling costs between domestic wholesale and port warehouse facilities.

While these differences surely exist, it is also clear (4, 5, 21) that governments intervene in their foreign trade markets for agricultural commodities. A recent study (13) found that 19 of the 21 developing countries studied exercised direct control on imports and/or exports of

cereals either through a government export-import monopoly, import licenses, export tax or quotas. In economies with government intervention, it is not necessarily the domestic forces of supply and demand that are reflected in the country's foreign trade behavior. If governments intervene to attain specific economic objectives, the excess demand elasticity can depart from the import demand elasticity.

In addressing this issue, two contributions are made. The first consists of the use of a formal model of endogenous government behavior. It is posited that governments intervene in their trade sectors purposefully by choosing levels of policy instruments to impact upon consumer and producer welfare and the treasury.³ Hence, this approach departs from the traditional excess demand model.

The second contribution involves the use of pooled cross-section time series data on 72 countries to estimate import demand and price transmission elasticities for wheat and rice.⁴ And then, by construction, to derive their corresponding excess demand elasticities. Overall, the results suggest that estimates of import demand elasticities under government intervention are smaller in absolute value than the elasticities that would prevail if only the domestic forces of supply and demand prevailed in country's import demand for these commodities.

The paper flows as follows. The government intervention model is developed in the next section, followed by the empirical model and a discussion of the results. Then, the import demand, excess demand and price transmission elasticities are presented for 3 five-year intervals over the period 1967-80, on a grouped country basis and by the level of nominal protection.

II. THE GOVERNMENT INTERVENTION MODEL

Within a partial equilibrium context, a government's motivation for intervening in a particular market is specified as a function of only two arguments: (1) the area under the excess demand function (A), representing the tradeoff of consumer and producer welfare and (2) the net revenue position of the government (NR) via import marketing. Let us assume further that the government exercises, through whatever mechanism, direct control over net trade (Q_I).⁵ This criterion function (U) can be written as follows:

$$(2.0) \quad U = U(A, NR; \Gamma(z))$$

where $\Gamma(z)$ denotes the parameters Γ of U which are determined by unknown political variables. The function $U(\cdot)$ is assumed to be a concave, monotonically increasing function in both A and NR . Here we posit that the government chooses the level of its policy instrument, net trade, as though it sought to optimize (2.0). Implicitly, the government is assumed to know the underlying supply and demand relationships embodied in A .

Assuming no stock holdings and market clearance at a single price, the quantity imported (Q_I) equals excess demand (Q_E), i.e.,

$$(2.1) \quad Q_I = Q_E \equiv Q_D(P_d) - Q_S(P_d)$$

where domestic demand Q_D and supply Q_S are expressed as a function of domestic price P_d . Income and all other prices, in the sense of partial equilibrium, are treated as parameters. Hence the arguments of (2.0) are defined as:

$$(2.2) \quad A = -P_d Q_I + \int_0^{Q_I} P_d(Q_I) dQ_I$$

$$(2.3) \quad NR = P_d Q_I - P_w Q_I$$

where P_w is the border price and $P_d(Q_x)$ is the price inverse excess demand function. The government's problem is to choose Q_x to maximize U . Suppose the ratio of marginal weights $(\partial U/\partial A)/(\partial U/\partial NA)$ is unity. The first order necessary and sufficient conditions characterizing a maximum to (2.0) in this case is:

$$(2.4) \quad \partial U/\partial Q_x = P_d - P_w = 0.$$

Thus, when the ratio of the marginal weights is unity, net trade levels are chosen which equate the domestic and the border price. In this case, the government may be said to be unbiased. Hence, our model does not, by construction, prevent a free trade solution.

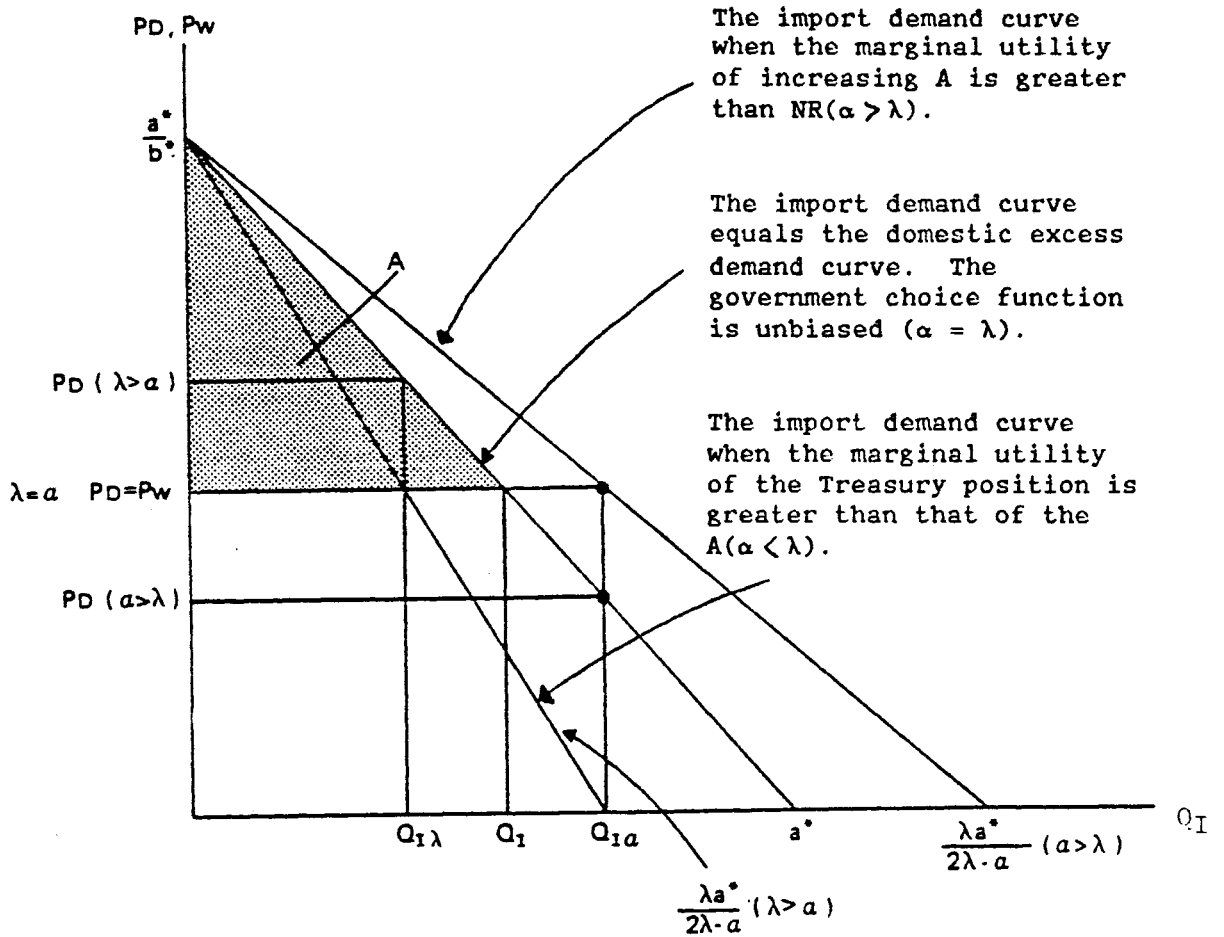
Now suppose that the ratio of marginal utility weights is different from unity so that the government has a biased preference. Letting $\alpha = \partial U/\partial A$ and $\lambda = \partial U/\partial NR$, the first order condition yields:

$$(2.5) \quad P_d - P_w = ((\alpha - \lambda)/\lambda)(\partial P_d/\partial Q_x)Q_x.$$

Thus if at the optimal choice Q_x^* the marginal weight α is greater than the marginal weight λ , P_d is less than P_w , while the converse is true if α is less than λ .

Assuming linear functions, the import and excess demand functions appear in (figure 1).⁶ The line a^*/b^* , a^* denotes the excess demand function. This function is identical to the import demand function when the weights α , λ are equal. In this case, domestic and border prices are equal and quantity Q_x is imported. Note that a change in bias ($\lambda \neq \alpha$) implies a departure (rotation) of the import demand function from the excess demand function and a departure of domestic price (P_d) from the border price (P_w).⁷

Figure 1
**Import Demand Function Under
 Government Intervention**



It follows from the implicit function theorem that the government's decision rule (i.e., the import demand function) can be obtained by solving (2.5) for Q_I . Let

$$(3.0) \quad Q_I = Q_I(P_w; \Gamma(z)).$$

denote this result. The inverse excess demand function is derived from (2.1) and denoted as:

$$(3.1) \quad P_d = P_d(Q_E).$$

The price transmission equation is obtained by substituting (3.0) into (2.5). Denote this result by

$$(3.2) \quad P_d = P_d(P_w; \Gamma(z)).$$

Equation (3.1) is not dependent on government preferences. These equations are not independent; knowledge of any two permits the derivation of the other.

A two commodity model which, for our purposes here, does not distinguish among producers or among consumers of the two commodities but does distinguish between producers and consumers amounts to a slight generalization of the previous model. In this case, the government's criterion function corresponding to (2.0) can be expressed as

$$(2.0') \quad U = U(A_c, NR_c; \Gamma(z)).$$

The market clearing, "consumer" surplus and government expenditure equations are:

$$(2.1') \quad Q_{I1} = Q_{E1} \equiv Q_{D1}(P_{dI}, P_{dW}) - Q_{S1}(P_{dI}, P_{dW})$$

$$(2.2') \quad A_c = \sum_1 (-P_{d1} Q_{I1} + \int_0^{Q_1} P_{d1}(Q_{I1}, Q_{Iw}) dP_{d1})$$

and

$$(2.3') \quad NR_c = \sum_i (P_{d_i} Q_{I_i} - P_{w_i} Q_{I_i}),$$

where the index $i = r, w$ denotes rice and wheat respectively. Conditions (2.4) to (2.6) remain unchanged for each commodity. The import demand functions

$$(3.0') \quad Q_{I_i} = Q_i(P_{wr}, P_{ww}; \Gamma(z)),$$

follow from the implicit function theorem where P_{wr} and P_{ww} denote the border price for rice and wheat respectively. The inverse excess demand functions

$$(3.1') \quad P_{d_i} = P_{d_i}(Q_{Er}, Q_{Ew})$$

and the price transmission equations

$$(3.2') \quad P_{d_i} = P_{d_i}(P_{wr}, P_{ww}; \Gamma(z))$$

are derived in a manner analogous to (3.1) and (3.2).

The derivation of the import and excess demand and the price transmission elasticities for rice and wheat along the lines of (1.0) can be simply stated as:

$$(4.0) \quad (\partial Q_{I_i} / \partial P_{w_i} P_{w_i} / Q_{I_i} = [(\partial P_{d_i} / \partial Q_{E_i})(Q_{E_i} / P_{d_i})]^{-1} (\partial P_{d_i} / \partial P_{w_i})(P_{w_i} / P_{d_i})$$

where it is easily shown that the right-hand term in brackets is equivalent to the first right hand term in (1.0). If the price transmission elasticity is unity, then the import and excess demand elasticities are equal. In the case of linear demand and supply (see footnote 6), at $Q_{I_i}^*$, λ less than (greater than) α implies a transmission elasticity less than (greater than) unity, and hence, a relative preference for this period's consumers. Contrary to the univariate linear model, equal direct excess and import demand elasticities do not imply unbiasedness. Biasedness is provided by border relative to domestic prices as (2.5) suggests.

III. EMPIRICAL MODEL

The model developed could be applied to a single country during a period over which the parameters $\Gamma(z)$ of (2.0) are constant. However, in general, we would not expect these parameters to be constant across countries or through time. The empirical model must be specified to take into account this problem of parameter non-constancy and the fact that we estimate the model using pooled cross-section time series data for 72 countries over 14 years. The empirical model chosen to approximate the import demand (3.0') and price transmission elasticities (3.2') is

(E3.0)

$$Q_{i,j,t} = a_{0,i,j,t} (P_{w,r,t})^{a_{r,i,j,t}} (P_{w,w,t})^{a_{w,i,j,t}} \Pi_k (P_{k,j,t})^{a_{i,k}} \epsilon_{i,j,t}$$

and

(E3.2)
$$P_{d,i,j,t} = c_{0,i} (P_{w,i,j,t})^{c_{i,j,t}} v_{i,j,t}$$

respectively, for rice and wheat where the indices $i = r$ (rice), w (wheat), k is the indice for other variables, j is the country index and t is time. The exponential terms are coefficients and $\epsilon_{i,j,t}$ and $v_{i,j,t}$ are disturbance terms. The explanatory variables are the j^{th} country's border price for rice ($P_{w,r,t}$), wheat ($P_{w,w,t}$), feedgrains ($P_{f,j,t}$), oilseeds ($P_{o,j,t}$), petroleum ($P_{p,j,t}$), and per capita total exports of goods and services ($P_{x,j,t}$). Properties of the coefficients, disturbance terms and exogenous variables are discussed subsequently. Only two of the three equations (3.0' - 3.3') need to be estimated. Hence, we have chosen the import demand and the price transmission equations; we omit the excess

demand equations (3.1') and estimate their direct price elasticities as a residual from the other two directly estimated elasticities.

Variables appearing in the applied welfare measure A_c , equation (2.2'), and in the government's treasury position (2.3'), also appear in the import demand function (3.0'). If feed grains and oilseeds are complements or substitutes in consumption and/or production and if they are tradeable commodities in the countries under consideration, then even in the presence of intervention, the domestic prices of these commodities should be correlated with their border market counterparts. This is the rationale for their appearance as explanatory variables in (E3.0). Excess demand is also a function of income. However, in the case of an import demand function and government intervention, one would expect the availability of foreign exchange, which we measure by total exports per capita ($P_{x,t}$), to be correlated with disposable income and to provide the equivalent of an income constraint for import demand through the government's treasury position, equation (2.3'). Petroleum price was also chosen because of its relatively large share of import expenditures in many countries.

Recall that government choices may also be influenced by political forces such as those mentioned by Bates (1980) and denoted by (z) in (2.0'). These forces are complex and difficult to quantify; in some countries they may vary over a ten year period, in others they may remain fairly unchanged. Moreover, many of the political forces discussed by Bates and others which influence government choices are in turn related to, and affected by, the structure and economic situation of a particular country. In general, our estimates will reflect an interaction of these

factors. Nonetheless, it should be possible to identify variables which will be associated with differences in these parameters across countries and time.

While it is beyond the scope of this study to model political behavior, it is nevertheless important to identify explanatory variables, within the context of this model and data constraints, that account for country differences. These variables serve as indices of structural economic differences among countries while at the same time, they should be associated with factors influencing government choices.

Three factors are chosen to reflect country differences in the coefficients of the first three components of the RHS of equations (E3.0):

$$(E3.3) \quad a_{0,j,t} = b_{01,j} + b_{02,j}PC_{j,t}$$

$$a_{r,j,t} = b_{11,j} + b_{12,j}ER_{j,t} + b_{13,j}NCRA_{j,t} + b_{14,j}PC_{j,t}$$

$$a_{w,j,t} = b_{21,j} + b_{22,j}ER_{j,t} + b_{23,j}NCRA_{j,t} + b_{24,j}PC_{j,t}$$

where (b) are coefficients and the j^{th} country's explanatory variables are the real exchange rate (ER), the relative trade share (NRCA) and the food production to consumption self-sufficiency ratio (PC). The exchange rate is chosen to reflect the policy environment. Inward looking countries (Belassa, 1981) are often characterized by over valued real exchange rates relative to their major trading partners. The trade share (NRCA)^a provides a measure of how important a commodity is to a country's total agricultural trade relative to other countries. This variable should be a proxy for the importance of a commodity (rice and wheat) in trade and for the openness of the agriculture sector to world markets relative to other countries. Finally, the ratio of food production to consumption (PC) is included to measure a country's relative dependence on food imports.

In the case of the price transmission equation, these same variables are used to capture changes in parameters across countries and time, thus:

$$C_{1jt} = b_{31,1} + b_{32,1}ER_{jt} + b_{33,1}NCRA_{1jt} + b_{43,1}PC_{1jt}$$

Our approach is to employ the small country assumption, namely, that the level of imports for the j^{th} country in the t^{th} year has a negligible affect on world prices. While this assumption is reasonable for most countries in the sample, it is almost surely violated for others. To treat the problem otherwise, is to significantly complicate the fitting of the model to available data.

The conceptual framework assumes that governments choose the level of net imports Q_1 in period $t-1$, so that these quantities actually enter the market during period t . It is further assumed that the government has perfect knowledge of the supply and demand conditions prevailing in the economy. In reality, this is not likely to be the case. Instead, governments probably form expectations of next periods demand and supply conditions. To incorporate an expectation formation mechanism for each country in the sample will quickly exhaust the degrees of freedom of the 14 year time series for each country. Thus, we continue to employ the assumption that governments have perfect foresight so that the variables specified on the RHS of equations (E3.0) and (E3.2) are treated as exogenous. While the residual terms may still not be independently distributed, no evidence of simultaneous equations bias was revealed in the empirical results. Since, the potential for heteroscedasticity exists, a GLS procedure was chosen where country population over world population was used as a weighting factor.

Our sample includes 72 countries over the period 1967-80 of which 70

countries are wheat importers and 56 are rice importers. Three specific data problems must be addressed before the data can be meaningful pooled. These are: (1) scale, (2) common units and (3) consistent real valuations. Scale problems were handled by simply defining variables in per capita terms. Many of the variables are initially defined in local currency units. A systematic approach to converting these into common units is required. This is particularly important since more than one method is available. The most common technique is to convert the nominal local currency values into current U.S. dollars through the current exchange rate. However, this has the problem that the new value, although in common units, is now a function of both the original series and changes in exchange rates.

Our approach is to convert each series into real valued local currency units first and then apply a fixed base year exchange rate. The variations will now reflect the underlying changes in the base series and not that of exchange rates. Exchange rates can be brought in as a separate variable. The exchange rate variable presents particular problems for pooled data analysis. To overcome this problem, we convert the real exchange rates into an index with a common 1973 base year. Since our concern is with import behavior, we want our variables to reflect as much as possible real rather than nominal valuations. The commodity production, consumption and trade figures are thus converted to wheat equivalent units through FAO calorie conversions. The macro variables, GNP and total exports are converted first into real local currency values through the use of GNP price deflators from the World Bank's World Tables series and then

converted to constant 1973 U.S. dollar through the use of the 1973 fixed exchange rate.⁷

IV. EMPIRICAL ESTIMATION, WHEAT AND RICE

The results from fitting (E3.0) to data for rice and wheat appear in Table 1 and Table 2. The results generally adhere to prior conditions of excess demand functions. The sum of the mean own price (-.510), cross price (.071), and income elasticity (.435) is almost zero in the wheat equation. They are marginally negative in the rice equation. The cross price elasticities of the two equations are surprisingly close to being equal (.071 and .092, bottom of tables 1 and 2). The most significant variable in the equations is per capita total exports. A one percent increase in per capita exports implies an approximate increase for both wheat and rice imports of almost .44 percent.

In no case, is a coefficient associated with the rice and wheat import price variable significant at less than the 99 percent level. In the rice case, only the base value of the import price elasticity is not significantly different from zero. The goodness of fit, measured by the adjusted R^2 , (.87 and .83) are reasonably large for pooled data results.

Several alternatives were available for estimating the price transmission elasticities. A pooled data GLS estimate was carried out using a varying parameter model similar to that used for import equations, but of a simpler kind. Only relative net trade shares, exchange rates, and the production-food consumption ratio were used as shifters (Table 3). The results are encouraging. The coefficients are significant at the one percent level and the adjusted R^2 exceeds .99 for both wheat and rice. The

transmission elasticity for wheat is more than twice as large as the rice elasticity. These results need to be interpreted with some caution for reasons mentioned in the introduction to this paper. These departures from our framework will likely give rise to lower price transmission elasticity estimates than would otherwise occur and hence to an overestimate of excess demand elasticities. Moreover, the data embody all the complexities and dynamics of an economy as well as unknown measurement deficiencies. The model is a fairly simple, partial equilibrium and static construct which focuses on a narrow though important dimension of government intervention. While this level of abstraction has its virtues, it is not surprising that the interpretation of the empirical results is not entirely without some ambiguity. The results seem most plausible when elasticities are interpreted at their mean values over the period 1967-1980.

To obtain insights into the stability of the estimated coefficients of these equations the parameters were reestimated with the food production-consumption variable omitted. The results for the price transmission equations only are reported in Table 4. The change in the estimated elasticities and other equation characteristics were minor. The price transmission elasticity declined somewhat, but the t-statistics and adjusted R^2 remained virtually unchanged.

Since the expected price transmission relationship appears straightforward, equation (E3.2) was fit to individual country as opposed to pooled data. This had the advantage of reducing cross-country impacts on individual price transmission estimates. Even under this procedure, the estimated mean price transmission elasticities were quite close to mean values reported in Table 4. The wheat elasticity declined somewhat from .512

to .458, while the rice elasticity increased from .201 to .221. Similar small changes also occurred in the import demand equation.

The direct import elasticity for wheat compares favorably with those obtained in recent studies (8,12). No recent studies for rice were found to compare with the results obtained here. Other studies have not distinguished between import, price transmission and excess demand elasticities, and hence no comparison is possible.

V. ELASTICITY ESTIMATES: IMPLICATIONS OF THE EMPIRICAL RESULTS

The implications of the empirical results are discussed, first, on the basis of their mean estimates over all countries for the period 1967-1980, and then on the basis of their five year mean estimates for the period year 1967-1980. Next, the estimated elasticities are viewed from a regional basis for the period 1967-1980, followed by the relationship of the elasticities to nominal levels of protection.

The direct elasticities of import demand over all countries for the entire period 1967-1980 are $-.51$ for wheat (Table 1) and $-.66$ for rice (Table 2). The corresponding price transmission elasticities are $.51$ and $.2$ for wheat and rice respectively (Table 3). Hence, the implied excess demand elasticities are approximately minus one for wheat and approximately -3.3 for rice. These results suggest that import demand elasticities are less than unity and that these elasticities are less than, in absolute value, their corresponding excess demand elasticities. The results are in general agreement with the model posited which leads to the conclusion that over all countries for the 1967-1980 period, government intervention in markets for imported wheat and rice has given rise to a departure of direct import demand elasticities from their corresponding

excess demand elasticities; and the nature of this intervention has served to isolate domestic markets from variation in border market prices.

The results obtained for variables (NRCA,ER,PC) which serve to reflect country differences in the direct and cross price import demand elasticities, also support the conclusion that government behavior in wheat markets is different from government behavior in rice markets. Moreover, the rice economy, on average, appears to be more isolated from variation in border prices than in the case for wheat. These results seem plausible since, given the relative magnitude of the rice and wheat excess demand elasticities, equal variation in rice and wheat border prices will induce a larger per capita variation in the rice component of the applied welfare measure A_c , equation (2.0'), than in its wheat component. Hence, governments appear to respond by isolating rice relative to wheat markets. This difference in behavior is also suggested when the pattern of elasticities are viewed over time, and regions.

The coefficient of the trade shifter variable associated with the price of wheat in the wheat equation is positive (.375) and in the rice equation the corresponding coefficient is negative (-.118). These results suggest in the case of wheat that as a country's relative net import share in world trade (NRCA) of wheat increases, the direct price elasticity increases in absolute value because NRCA becomes a larger negative number; in the case of rice, the sign of the corresponding coefficient is negative so that import demand elasticity decreases in absolute value as the country's relative net import share in world rice trade increases. Hence, on average, rice imports become less responsive to changes in their border price as a rice importer's dependence on imports increase, while wheat

importers become more responsive to changes in border price as their dependence on wheat imports increase.

The coefficients of the trade shifter variable is positive in the price transmission equations for both wheat and rice. Greater relative dependence on trade in these commodities tends to decrease the price transmission elasticities.

The coefficients of the real exchange rate variable associated with wheat price in the wheat import demand equation, rice price in the rice import demand equation and in both price transmission equations have, universally, negative signs. A depreciation of a country's currency in real terms tends to cause rice and wheat import levels to be more sensitive to border prices. However, the results from the price transmission equations suggest that on average a real devaluation of a currency relative to the dollar yields less responsiveness of changes in domestic prices to changes in border market prices, i.e., while a nominal depreciation may increase domestic prices, a depreciation in real terms tends to dampen domestic price changes relative to changes in their border market counterparts.

The sign of the coefficients associated with the ratio of food production to consumption variable also differ between equations. In the case of wheat (rice), as the ratio increases, the direct price elasticity increases (decreases) in absolute value. Results from the price transmission equations, indicate that as the ratio of food production to consumption increase, wheat price becomes more responsive to changes in a border wheat prices. The reverse occurs in the case of rice. Unfortunately, our model does not provide any insights into political

behavior so that no rational for these differences cannot be inferred from the model.

We now focus on the patterns of elasticities over time, regions, and level of protection. There is a very clear time trend underlying the elasticity estimates for both wheat and rice (Table 5). The import price elasticity and the excess demand elasticity both declined significantly over the period 1967-80 while the price transmission elasticities tend to increase.

The import price elasticities remain less than one for both wheat and rice (and declining) over the entire period. This again tends to support the notion that import demand is inelastic. However, the implied five year mean excess demand elasticities are greater than one for wheat through 1975 and greater than one for rice over the entire period. Hence, on average, government intervention is characterized by a "slower" adjustment of import levels to world market prices than would prevail in the absence of intervention.

There are significant differences in elasticities over regions. For the case of wheat (Table 5), the import and excess demand elasticities increase moving from Africa south of Sahara, to Asia, to Latin America to North Africa. The price transmission elasticity is largest in Asia and Latin America. The pattern for rice changes somewhat from that of wheat (Figure 5). Africa south of Sahara has the highest excess demand elasticity and the lowest price transmission elasticities. Otherwise, the pattern resembles the pattern for wheat.

A correspondence also seems to exist between the nominal levels of protection and import elasticities. Wheat import and excess demand

elasticities clearly tend to decline as the protection coefficient increases, i.e., the elasticities decline as governments tax their food surplus producing households (Table 5) and subsidize food deficit producing households. This pattern is less pronounced in the case of rice, but none-the-less the pattern still seems to hold.

There appears to be less correspondence between the price transmission elasticity and the ratio of prices. Although this is somewhat surprising, there is no a priori reason for price levels and changes to be automatically related.

VI. CONCLUSION

It is a stylized fact that governments intervene in their foreign trade sectors. The framework utilized to model import behavior which explicitly accounts for government intervention provides one basis for empirical estimation of elasticities. The model posits that governments, like private agents, respond rationally to the forces they face. This behavior may result in significant departures from the import behavior characterized by free market conditions. In general, import elasticities tend to be substantially lower than what they would otherwise be. Significant insight into the debate on the question of whether import elasticities are elastic or inelastic can now be made. Excess demand elasticities for both wheat and rice (rice more than wheat) tend to be elastic supporting the contention of Tweeten and Schuh. However, because governments intervene the import demand elasticities are inelastic.

Over the period studied (1967-80), there was a substantial tendency for both wheat and rice import and excess demand elasticities to fall. This was associated with increases in the price transmission elasticity

implying a tendency over time to permit world price variation to be reflected in the domestic economy. Regional differences were also substantial. Countries with lower incomes and more reliance on trade for their consumption (Africa south of Sahara), tended to have lower price and import demand elasticities.

An important explanatory variable of import growth was a country's foreign exchange earnings. Obviously a country with growing exports can afford to import while one with stagnant or declining exports faces a foreign exchange constraint.

Table 1. Pooled Data Per Capita Wheat Import Demand Equation

Independent Variables	Coefficient	T-Statistic	Mean Value
Intercept	4.461324	6.1806	--
Prod./Food Consumption Shifter	1.097934	6.0557	.6719
<u>Wheat Import Price Variable</u>			
Base Value	1.536104	3.4428	--
Trade Share Shifter	.374773	6.1284	-.5137
Exchange Rate Shifter	-.013254	-3.0311	101.5462
Prod./Consumption Food Shifter	-.755431	-4.3596	.6719
<u>Rice Import Price Cross Variable</u>			
Base Value	-1.739350	-4.1806	--
Trade Share Shifter	-.398571	-7.3053	-.5137
Exchange Rate Shifter	.010461	2.7158	101.5462
Prod./Food Consumption Shifter	.488835	2.9643	.6719
Feed Grain Border Price	-.267497	-4.9297	158.110
Oilseed Border Price	-.241467	-4.7693	223.007
Petroleum Border Price	.002557	3.3578	8.6607
Per Capita Total Real Exports	.435372	16.7148	442.0603

Adjusted RSQ = .8785
 No. of Observations = 980
 Degree of Freedom = 964
 Standard Error of the Estimate = 24.785
 Dependent Variable = PER CAPITA WHEAT IMPORT QUANTITY
 Weighting Factor = COUNTRY POPULATION/WORLD POPULATION

Form of the equation--Log-log with varying parameters on wheat import price and rice import price.

Data Coverage--70 countries over 1967-80.

Direct Price elasticity estimate at mean variable values = -.50998

Cross price elasticity at mean variable value = .07094

Table 2: Pooled Data Per Capita Rice Import Demand Equation

Independent Variables	Coefficient	T-Statistic	Mean Value
Intercept	5.364787	7.7011	--
Prod./Food Consumption Shifter	-1.955932	-4.1147	.8271
<u>Rice Import Price Variable</u>			
Base Value	-.041256	-.1174	--
Trade Share Shifter	-.117753	-4.8347	-1.1307
Exchange Rate Shifter	-.012365	-3.6938	102.9551
Prod./Consumption Food Shifter	.629491	5.7877	.8271
<u>Wheat Import Price Cross Variable</u>			
Base Value	-.725832	-1.8743	--
Trade Share Shifter	.070447	2.7888	-1.1307
Exchange Rate Shifter	.011663	3.1510	102.9551
Prod./Food Consumption Shifter	-.366803	-3.6227	.8271
Feed Grain Border Price	-.113700	-2.4451	162.9835
Dilseed Border Price	-.295057	-6.2329	222.6139
Petroleum Border Price	.004085	6.3319	8.6607
Per Capita Total Real Exports	.441707	14.4860	562.7990

Adjusted R² = .8259
 No. of Observations = 784
 Degrees of Freedom = 786
 Standard Error of the Estimate = 20.064
 Dependent Variable = PER CAPITA RICE IMPORT QUANTITY
 Weighting Factor = COUNTRY POPULATION/WORLD POPULATION

Form of the equation--Log-log with varying parameters on rice import price and wheat import price.

Data Coverage--56 countries over 1967-80.

Direct price elasticity estimate at mean variable values = -.66055
 Cross price elasticity estimate at mean variable values = .091884

Table 3: Pooled Data Price Transmission Equation Wheat and Rice

Independent Variables	Coefficient	T-Statistic	Mean Value
Intercept (Wheat)	2.32567	22.1295	
<u>Wheat Price Transmission Variable</u>			
Base Value	.600036	33.4129	--
Trade Share Shifter	+.010620	+7.1947	-.5138
Exchange Rate Shifter	-.001038	-8.7063	101.5462
Prod./Consumption Food Shifter	.019759	5.0877	.6029
Intercept (Rice)	4.08660	38.5104	--
<u>Rice Price Transmission Variable</u>			
Base Value	.50209	26.8041	--
Trade Share Shifter	.00165	3.1214	-1.12837
Exchange Rate Shifter	-.00287	-22.4813	102.8368
Prod./Food Consumption Shifter	-.00482	-4.0842	.8292

	Wheat	Rice
Adjusted RSQ =	.9921	.9927
No. of Observations =	980	784
Degrees of Freedom =	975	779
Standard Error of the Estimate =	8.235	9.402
Dependent Variable = Log of Producer Price of Wheat and Rice		
Weighting Factor = COUNTRY POPULATION/WORLD POPULATION		

Form of the equation--Log-log with varying parameters on Pw shifters

Data Coverage--70 and 56 countries over 1967-80.

Wheat price elasticity estimates at mean variable values = .51244

Rice price elasticity estimates at mean variable values = .2015

Table 4: Pooled Data Price Transmission Equation Wheat and Rice

Independent Variables	Coefficient	T-Statistic	Mean Value
Intercept (Wheat)	2.32421	22.8390	--
<u>Wheat Price Transmission Variable</u>			
Base Value	.600083	33.0212	--
Trade Share Shifter	+ .00996	+ 6.6875	-.5138
Exchange Rate Shifter	-.00099	-8.2537	101.5462
Prod./Consumption Food Shifter	--	--	--
Intercept (Rice)	4.1778	39.8543	--
<u>Rice Price Transmission Variable</u>			
Base Value	.48069	26.4639	--
Trade Share Shifter	+ .000783	+1.5995	-1.12837
Exchange Rate Shifter	-.002912	-22.7010	102.8368
Prod./Food Consumption Shifter	--	--	--

	Wheat	Rice
Adjusted RSQ =	.9919	.9926
No. of Observations =	980	784
Degrees of Freedom =	976	780
Standard Error of the Estimate =	8.3395	9.4958
Dependent Variable = Producer Price of Wheat and Rice		
Weighting Factor = COUNTRY POPULATION/WORLD POPULATION		

Form of the equation--Log-log with varying parameters on Pw shifters

Data Coverage--70 and 56 countries over 1967-80.

Wheat price elasticity estimates at mean variable values = .50513

Rice price elasticity estimates at mean variable values = .1803

World Wheat and Rice Import Demand, Price Transmission, and Excess Demand Elasticities
Five-Year Average, Selected Countries and by Level of Protection, 1967-80

	Wheat			Rice		
	Import Demand Elasticity	Price Transmission Elasticity	Excess Demand Elasticity	Import Demand Elasticity	Price Transmission Elasticity	Excess Demand Elasticity
Five Year Average						
1967-70	-0.550	0.402	-1.388	-0.817	0.160	-5.104
1971-75	-0.497	0.427	-1.164	-0.685	0.207	-3.305
1976-80	-0.339	0.437	-0.715	-0.511	0.283	-1.808
Selected Countries (1967-1980)						
Africa, South of Sahara	-0.074	0.391	-0.190	-0.445	0.144	-3.097
North Africa						
Middle East	-1.006	0.446	-2.255	-1.005	0.365	-2.754
Asia	-0.332	0.550	-0.603	-0.275	0.380	-0.723
Latin America	-0.642	0.552	-1.164	-0.695	0.438	-1.585
By level of protection ($P_{w,t}/P_{a,t}$)(1967-1980)						
Price ratio ≤ 1	-0.630	0.448	-1.406	-0.670	0.228	-2.942
Price ratio > 1 , < 1.2	-0.630	0.448	-1.406	-0.806	0.285	-2.827
Price ratio > 1.2	-0.155	0.394	-0.39	-0.595	0.190	-3.136

FOOTNOTES

¹ The approach to these derivations can be found in Orcutt (1950). The subscripts I, D and S refer to import, demand and supply while the ij subscript refers to the ith commodity in the jth country. For the remainder of the analysis the ij subscript will often be assumed but for convenience not written, i.e. read $E_I = E_{I,ij}$. Also there is an implicit time subscript (t) associated with each variable.

² $E_{P_{i,j}} = (\partial P_{i,j} / \partial P_{w,i,j}) / (P_{w,i,j} / P_{i,j})$, where $P_{i,j}$ is the domestic price of the ith commodity in the jth country and P_w is the respective border price.

³ In a multiperiod model, a positive (negative) Treasury position can be viewed as a subsidy (tax) on consumers and producers in later periods. In a single period model, it is assumed that these concerns are embodied in the utility the government obtains from the Treasury's position.

⁴ Of the 72 countries, 70 imported wheat and 56 imported rice. Countries with zero imports were not included in the estimates. Individual estimates for each country would be ideal. However, sufficient data to estimate elasticities for a reasonably large set of individual countries is very limited. With appropriate normalization of variables, the pooling of cross-section time series data should provide the best overall consistent results across countries provided account can be taken of individual country characteristics.

⁵ There are, of course, numerous instruments which the government can control. These include domestic consumer and producer prices, exchange rates, taxes, tariffs and subsidies of various kinds. Moreover, the government is almost surely concerned with economic activity in other sectors. The solution of the more general problem requires a general equilibrium statement of the problem which would unnecessarily distract from the focus of this paper. It can be shown, however, that if taxes or subsidies were the policy instrument rather than Q_I , the problem can be redefined within this optimization structure so that the choice of tax-subsidy level will yield a Q_I level identical to that given in equation (3.0). The advantage of (3.0) is that data on import taxes subsidies is generally not available. Hence the use of (3.0) is simply the tax or subsidy equivalent.

⁶ In the case of linear supply and demand functions, it is easily shown that: import demand, inverse excess demand and the price transmission equation can be expressed as:

$$Q_I = ((\lambda / (2\lambda - \alpha)) (a^* - b^* P_w),$$

$$P_d = (a^* - Q_E) / b^*,$$

and $P_d = (\alpha - \lambda) a^* / b^* \alpha + (\lambda / \alpha) P_w$, respectively where a^*

(which embodies other price and income effects) and b^* are parameters and $2\lambda - \alpha \neq 0$ is assumed. If $\alpha > \lambda$, then the absolute value of the import demand elasticity is less than the excess demand elasticity, and the price transmission elasticity is less than unity. It should be kept in mind that the weights λ , α are, in general, functions of A and NR .

⁷ The linear univariate model is a special case. In general the import demand function will shift and rotate with changing utility weights. Note that we make a clear distinction between the import demand function which depends in part on government preferences and the excess demand which reflects domestic forces of demand and supply. The distinction between these has not been brought out in the literature. Furthermore, this distinction clearly separates allocative interventions which distribute the benefits to different groups from scale intervention which serves to separate the domestic and international markets. For the problem of import demand, it is clearly the latter which is most important. It should also be kept in mind that $U(\cdot)$ contains the parameters $\Gamma(z)$ which, over time, may vary as a function of social and political factors (z).

⁸ See Appendix for definition.

⁹ A further discussion of data sources and variable definitions is provided in Appendix.

¹⁰ The major countries with large average NRCA.s over the 1967-1980 period for wheat include Bangladesh, Chile, Pakistan, Peru, Egypt, Ethiopia and Brazil. In the case of rice, the countries are Indonesia, Sierra Leone, Sri Lanka, Bangladesh, Senegal, Tanzania, Malaysia and the Ivory Coast.

APPENDIX . DATA SOURCES AND VARIABLE DEFINITIONS

1. DATA SOURCES

The data for the study is derived from the following sources:

International Monetary Fund, International Financial Statistics Data Tapes, Washington, D. C., 1985.

World Bank, World Tables Tapes, Washington, D. C., 1984.

Food and Agricultural Organization, Food Balance Sheet Tape, Rome, 1985, Production Year Book Tape, Rome 1985, and Trade Yearbook Tape, Rome, 1985.

United States Census, Population Estimates, 1985.

2. DATA DEFINITION

$Q_{1,i}$ = Per capita import quantity, wheat and wheat flour and rice measured in wheat equivalent kilograms based on FAO caloric conversion, from the Food Balance Sheet Tape, $i = r, w$. These values are then divided by country Census population estimates.

ER_j = Real exchange rate index with a 1973 dollar base in dollars;

Calculated as $(XR_{j,t}/XR_{j,1973}) CPI_{us}/CPI_j$.

$XR_{j,t}$ = Exchange rate for country j , year t .

$XR_{j,1973}$ = Exchange rate for country j , 1973.

CPI_{us} = Index of U.S. consumer prices, 1973 = 100.

CPI_j = Index of country j consumer prices, 1973 = 100.

$P_{d,i,j}$ = Producer price series taken from FAO; Producer Price Tape, aggregated using production weights in wheat equivalent units and converted to U.S. dollars through real exchange rate series with a 1973 base.

$P_{w,k,j}$ = International price of crude oil measured in U.S. dollars per barrel times the real exchange rate index, 1973 base.

$P_{x,j}$ = Per capita total exports of goods and nonfactor services converted into constant 1973 local currency units and then transformed into U.S. dollars at 1973 exchange rate base.

$NRCA_{i,j}$ = Wheat and rice net revealed competitive advantage ratio, i.e., revealed comparative supply ($RCS_{i,j}$) of exports of wheat or rice minus revealed comparative demand ($RCD_{i,j}$) of imports of wheat or rice compared with total agricultural exports and imports or:

$$(X_{ij}/X_j)/(X_i/X) - (M_{ij}/M_j)/(M_i/M)$$

where: i = commodity, j = country, X = exports, M = imports.

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