IMF WORKING PAPER

WP/86/11

INTERNATIONAL MONETARY FUND

Research Department

Foreign Exchange Constraints and Imports in Developing Countries 1/

Prepared by Rüşdü Saracoglu 2/ and Iqbal Zaidi

Authorized for Distribution by Anthony Lanyi

November 4, 1986

Abstract

This paper estimates a disequilibrium model of developing country imports that incorporates determinants of private sector import demand as well as the foreign exchange rationing of the authorities. The parameters of the model are estimated using a full information maximum likelihood estimator, and the model provides an estimate of the probability of import rationing for each observation in the sample. Estimation results conform with the notion that there was regime switching, that is, periods of both import rationing and nonrationing were observed for the developing countries included in the study.

1/ The authors are grateful to Youkyong Kwon for providing computational assistance.

2/ Rüşdü Saracoglu is Deputy Governor, Central Bank of Turkey.

Table of Contents

Summary

The role of import restrictions in developing countries has been noted and discussed in a number of articles, but there is as yet little formal modeling work that is capable of explaining rigorously the observed levels of imports and their interactions with variables such as exports, output, and international reserves. This paper attempts to fill some of the gaps by estimating a disequilibrium model of developing country imports that incorporates determinants of private sector import demand as well as the foreign exchange rationing of the authorities. The disequilibrium model operates in two distinct modes, a rationing mode with import supply less than import demand, and a nonrationing mode with import supply greater than import demand. In the rationing mode, there are quantitative restrictions on imports and the desired imports of the private sector are greater than actual imports permitted by the authorities. Conversely, in the nonrationing mode, there are few or no quantitative restrictions and the private sector is able to import the desired volume of goods and services. The parameters of the model are estimated using a full information maximum likelihood estimator.

Statistical evidence in support of the model was obtained from time series data for five developing countries, and the results point to the necessity of explicitly taking government import restrictions into account when estimating import flows of developing countries. In all cases, estimation results conform with the notion that there was regime switching, that is, periods of both import rationing and nonrationing were observed for the developing countries included in the study. The periods of rationing tended to be more prevalent in the early years of the sample, and the authorities varied import restrictions inversely with the country's capacity to import, where this capacity was measured by real export earnings. The estimated price elasticities of import demand were negative and most were statistically significant.

I. Introduction

A recent development in macroeconomics is the effort to describe the government's reaction to economic fluctuations and to build this behavior into the model. This approach is particularly relevant for developing countries because one characteristic that many of these countries share is the substantial government participation in the economic development process through the setting of output growth targets, which involves taking into account a number of conditions such as the availability of foreign exchange resources. The aspect of the government's behavior that is the focus of this paper is the interaction between the availability of foreign exchange resources and the rationing of imports in developing countries. To this end, a simple disequilibrium model of imports, which includes both the private sector import demand equation and the authorities import rationing equation, is estimated for five developing countries. The parameters of the model are estimated using a full information maximum likelihood estimator. The results indicate that, in general, imports are price elastic and import rationing is more extensive in the early periods of the sample.

In sharp contrast to the traditional econometric analysis of developing country imports that uses single equation models, the model presented here consists of simultaneous supply, demand, and market rationing relationships. The inclusion of the market rationing relationship makes it possible to test the hypothesis that there has been excess demand for imports in developing countries. A model that assumes equilibrium obviously cannot be used to test whether there has been any excess demand or excess supply. Once the assumption of continuous market equilibrium is dropped, each observation reflects either equilibrium or excess demand. 1/ If supply and demand are not always equal, and the short side of the market determines the quantity transacted, then one needs to utilize the techniques developed in disequilibrium econometrics to estimate the structural parameters. The disequilibrium model contains two regimes, import rationing and nonrationing. In the import rationing regime, importers encounter quantity constraints such as import quotas and what is observed is the authorities' import supply function, whereas in the nonrationing regime, there are no quantity constraints and what is observed is the private sector import demand function. The advantage of the disequilibrium procedure is that it does not assume either equilibrium or excess demand in the market for imported goods, but instead derives the joint probability density functions for the demand and supply equations and tests whether there is disequilibrium.

The justification for studying the disequilibrium model for imports in the developing country context is twofold. First, quantitative restrictions on imports have been used for allocating scarce foreign

---

1/ Excess supply can be represented as negative excess demand.

exchange resources in many developing countries. 1/ Furthermore, the incidence of import restrictions has varied over time because of changing foreign exchange constraints. For example, reliance upon import restrictions for balance of payments adjustment is reduced in periods of exchange rate reforms. Therefore, to obtain consistent estimates of import elasticities for these countries, the model must take account of the evolution of exchange control regimes and the switching of regimes between import rationing and nonrationing. From the point of view of macroeconometric modeling, the possibility of switching regimes also helps in establishing more stable structural relationships, because the demand and supply equations are not forced to accommodate observations that do not apply to them.

Second, it is difficult to assess the incidence of import restrictions because changing supply or demand conditions can over time reduce or increase the restrictiveness of a given nontariff barrier. Because the disequilibrium model estimates the demand and supply equations simultaneously, it sheds new light on the incidence of import rationing in developing countries. The model provides an estimate of the probability of import rationing for each observation in the sample.

The plan of the paper is as follows. Section II contains a brief discussion of estmating developing country import equations when there are quantitative restrictions on imports. Section III discusses the disequilibrium model of developing country imports that is estimated. Section IV presents the results of the estimation. A description of the data base is provided in an Appendix. Section V provides a discussion of the results and suggestions for extending the analysis. Finally, Section VI presents some concluding observations.

II. The Restriction of Imports

Although import restrictions are employed frequently in developing countries, most empirical studies relating to developing country imports mention the importance of rationing in passing, while doing very little to take these effects into account. Estimation of an import demand equation by ordinary least squares would be the correct procedure to

---

1/ The analysis is not intended to imply that quantitative import restrictions are an appropriate policy, because to determine the optimality of import restrictions one must take account of the long-run costs that arise from resulting distortions in the allocation of resources. Short-run macroeconomic analysis, of the sort presented in this paper, is not suited to this purpose. The paper estimates import elasticities and addresses only the narrow question of testing for import market disequilibrium and does not consider what its broader welfare implications may be.

follow only if it is assumed that supply conditions play no part in determining the relative price of imports. This is the case if the supply of imports is perfectly elastic at some exogenously determined world price (the small country assumption) and there are no government restrictions on imports. However, if the price elasticity of import supply is not infinite, the single-equation estimate of the demand elasticity is biased toward zero. This is because the relationship between import prices and quantities may be due to supply factors or to demand factors, and the estimated price elasticity by ordinary least squares method is a weighted average of a negative demand elasticity and a positive supply elasticity. Moreover, if there are extensive quantitative restrictions on imports in part of the sample period, then these data trace the authorities' import rationing equation rather than the demand relationship, and single-equation estimation would again be inappropriate.

Researchers have typically dealt with these problems by ad hoc adjustments to empirical equations for developing country imports. Proxy variables such as international reserves are inserted into the empirical import demand equations; in this instance the reserve position is considered indicative of the strictness of controls affecting imports. No attempt is made to incorporate the government's restrictions on imports in the underlying theory of import demand. However, an import equation that has real income, relative prices, and international reserves as explanatory variables is neither the private-sector import demand equation nor the authorities' import supply equation, but some combination of the two that is misspecified. Consider a country that had import restrictions but then implemented a program of trade liberalization, and suppose that the trade restrictions were binding, so that the data on imports before the trade liberalization period did not measure private-sector import demand but rather the quantity of imports allowed by the authorities. To describe the behavior underlying such data would require, first, specification of a rule describing the authorities' short-run adjustment of imports in relation to its long-run trend and estimated for the data prior to the trade liberalization, whereas the standard import-demand equation would need to be used for estimating for the data after the trade liberalization. If the entire sample consisting of both the rationing and nonrationing periods is used to estimate the standard import-demand equation, there will be specification error bias. As the estimated equation does not take account of rationing, movements in the volume of imports caused by rationing would be attributed to the price variable. This leads to an overstatement of the price effect and an upward bias in the estimated price elasticity of import demand. Furthermore, even if the allocation of the sample of imports into demand and supply functions is known, these equations cannot be estimated separately by ordinary least squares. The residuals of these equations would be correlated with the exogenous variables of the model, because they are derived from truncated samples and do not have zero means.

Some of the issues involved in using foreign exchange availability as a major determinant of developing country imports were discussed in a study by Hemphill (1974). He emphasized the need for an alternative specification for developing country import equations because for many of these countries, imports consist largely of producer goods--capital equipment, maintenance items, and imported components--and often there are no adequate domestic substitutes. Thus, if restrictions are used to limit imports, there will be a tendency for imports to determine output, rather than the reverse, as is the case in the standard import-demand equation. A distinguishing feature of his study is that the behavioral relation between a developing country's imports and its foreign exchange receipts is derived from an optimizing model of government behavior that determines how the short-run external imbalance is divided between changes in international reserves and in imports. Hemphill estimated the reduced form import equations for a number of developing countries, and the empirical results were found to be generally consistent with the hypothesized behavior. However, a major shortcoming of his approach is that the demand determinants of imports are given only a sketchy treatment, and it is not suitable for economies that have experienced periods of import liberalization as well as restriction.

Zaidi (1984) emphasized the application of symmetric treatment of demand and supply in developing country import models. Although the developing countries are conventionally viewed as supply constrained economies in which many markets are in persistent excess demand, the demand side should be included in the model because disequilibrium might affect variables such as capital accumulation, saving, and labor supply and concern over such effects might in turn influence the authorities' allocation policies. By allowing either excess demand or excess supply, in the estimation procedure, the effects of macroeconomic disequilibria on the private sector's and government's behavior can be analyzed. The strength of the disequilibrium approach lies in its possibilities for the modeling of alternative import regimes and for the specification of import rationing as an important endogenous component of the model. Zaidi estimated the model using Philippine data and the results were generally acceptable, giving reasonable identification of rationing and nonrationing periods.

III. Disequilibrium Model of Imports

The above discussion leads one to question the validity of a strictly demand-side or supply-side model for developing country imports. A complete model of demand and supply of imports must be estimated, in which an import-supply equation for the authorities and the import-demand equation for the private sector jointly determine the observed quantity of imports. The model presented here operates in two distinct modes, a rationing mode with import supply less than import demand, and a nonrationing

mode with import supply greater than import demand. In the rationing mode, there are quantitative restrictions on imports and the desired imports of the private sector are greater than actual imports permitted by the authorities. Conversely, in the nonrationing mode, there are few or no quantitative restrictions and the private sector is able to import the desired volume of goods and services. In other words, it is assumed that the observed quantity of imports is given by the minimum of supply and demand (the "min condition"). The min condition derives its justification from the principal of voluntary exchange; that is, importers cannot be forced to buy more than they demand for given levels of income and relative prices. This formulation has the advantage of taking explicit account of the possibility of rationing and of permitting simultaneous estimation of import-demand and-supply equations for developing countries.

The econometric model is the following:

$$(1) \quad M_t^d = \alpha' x_{1t} + \varepsilon_t$$

$$(2) \quad M_t^s = \beta' x_{2t} + \eta_t$$

$$(4) \quad M_t = \min (M_t^d, M_t^s)$$

The M_t^d term denotes the demand in period t for the volume of developing country imports, M_t^s is the real supply of developing country imports permitted by the authorities, and M_t is the actual quantity transacted. The vector of explanatory variables in the import demand equation is x_{1t} and in the import supply equation is x_{2t}, and ε_t and η_t are stochastic error terms, where $(\varepsilon_t, \eta_t) \sim N(0, \Sigma)$ and are drawn independently with respect to t. The variance-covariance matrix Σ is assumed to be diagonal.

The import demand equation estimated is of the following form:

$$(4) \quad \log(M_t^d) = \alpha_0 + \alpha_1 \log(Y_t/P_t) + \alpha_2 \log(PM_t/P_t) + \alpha_3 \log(M_{t-1}) + \varepsilon_t$$

In equation (4), Y_t is an index of GDP of the developing country, P_t is an index of the GDP deflator of the developing country, and PM_t is an

index of import unit values of the developing country. The parameters α_1 and α_2 represent the short-run or impact real-income and relative-price elasticities of import demand, respectively. The parameter α_1 is expected to be positive, because an increase in income raises demand, whereas the parameter α_2 is expected to be negative, because when

import prices increase faster than domestic prices, there will be substitution away from imports to domestic goods.

The lagged dependent variable is included in the equation because current imports are related not only to current income and prices but upon lagged functions of these variables as well. Lags in the import equation arise from several sources, such as delays between the planning of orders and actual delivery, and the influence of expectations on the decision to order foreign goods. The combination of delivery lags and lags representing the influence of recent levels of income and prices on expectations gives a complicated lag structure for the import-demand equation to be estimated. However, we use the Koyck form, which achieves a major simplification in that only one parameter in relation to the lagged dependent variable is estimated instead of a string of coefficients for lagged independent variables. The Koyck form has been employed in most previous studies of imports, and this makes it easier to evaluate the disequilibrium modification to the import model that is introduced in this paper.

The import-supply equation is specified in the form of a behavioral rule describing the authorities' short-run adjustment of imports from the long-run trend. The equation describes import rationing in relation to official reserve holdings, export earnings, relative price, and domestic output. 1/ Suppose that the foreign exchange authorities of a country face balance of payments disturbances that are randomly distributed. When there is an adverse balance of payments disturbance, the authorities may either finance the disturbance to the extent of their reserves, or they may undertake adjustment measures, such as contractionary monetary and fiscal policies, exchange rate changes, and import restrictions, to reduce the requisite movements in their reserves. Adjustment carries a cost in terms of departures from equilibrium income growth, whereas holdings of international reserves earn a smaller return than alternative investments. The authorities choose their rules of adjustment and their average reserve levels in such a way as to minimize the sum of these costs. In the estimation, the long-run determination of imports is represented

---

1/ See Zaidi (1984) for a similar specification of an import supply equation that is derived from the minimization of a quadratic loss function for the authorities.

by fitting time trends to the observed values of imports and the short-run adjustment by deviations from these trends.

The import-supply equation is of the following form:

$$(5)\quad \log(M_t^s) = \beta_0 + \beta_1 \log(R_{t-1}/PM_t) + \beta_2 \log(EX_t/PM_t) + \beta_3 (VIM_t^*) + \beta_4 (VIMYX_t) + \beta_5 \log(PM_t/P_t) + \eta_t$$

Where R_{t-1} is international reserves at the beginning of the period, EX_t is nominal exports, VIM_t^* and RY_t^* are second order exponential time trend fits to the observed values of real imports and real GNP, respectively, and $VIMYX_t$ is defined to be $(VIM_t^*/RY_t^*)(RY_t - RY_t^*)$. The hypothesis is that the authorities vary the supply of imports around its trend value, taking into account their holdings of real international reserves, real export earnings, the relative price of imports, and deviations from trend of real imports. The parameters β_1 and β_2 are expected to be positive, because when international reserves and foreign exchange earnings from exports rise, the foreign exchange constraint is less severe for the authorities. The parameters β_3 and β_4 are expected to be positive, because they represent the trend and cyclical increases in gross domestic product and imports. The sign of the parameter β_5 is ambiguous, because a rise in the relative price lowers import demand and therefore the welfare loss due to rationing in the import market, which indicates a negative sign. But if domestic prices are rising rapidly because of excess demand the authorities may want to increase the supply of imports along with reduction in aggregate demand to control inflation, which indicates a positive sign.

The econometric problem is to estimate the coefficients of the demand and supply functions and the probability of import market disequilibrium for each observation in the sample. The model was estimated by maximum likelihood methods, and the derivation of the likelihood functions is provided in Maddala and Nelson (1974) and Goldfeld and Quandt (1975). The disequilibrium likelihood function allocates sample observations to the demand and supply equations. Although the data points provide some information about both demand and supply, the weights in the likelihood function are associated with the probability of observing excess demand or supply.

IV. Estimation Results

In this section, we report the results of estimating the disequilibrium model for developing country imports. We first report the results of estimating the import-demand and-supply equations by ordinary least squares. The estimated coefficients from this method were used as starting values for the iterative process for the maximum likelihood estimation. The results of the maximum likelihood estimation of the demand and supply equations with the min condition imposed are discussed next. Finally, we report the disequilibrium classification probabilities for observing import demand less than import supply for the developing countries.

The estimation was performed for countries selected largely on the basis of data availability; these were El Salvador, Greece, India, Korea, and Thailand. Other countries were omitted because certain essential series were missing or were not continuously available for a sufficient number of years. The data are quarterly for Korea and annual for the other countries because quarterly data were not available for them. A dummy variable for the two rounds of oil price increases was included in all of the equations. The dummy variable was zero for all years except 1973, 1974, 1979, and 1980. The sample periods of estimation for each country are shown in Chart 1.

The results from the ordinary least squares estimation of the demand and supply equations are presented in Table 1. Coefficient estimates, their t-values, and goodness-of-fit statistics are reported for each country. As was noted in Section II, when there is import rationing, some observations will not lie on the demand schedule, and excess demand can therefore be properly observed only when the complete model--consisting of a demand function, a supply function, and the min condition--is estimated by disequilibrium techniques. The preliminary ordinary least squares estimation on the entire data set for each country was done merely to obtain starting values for the disequilibrium estimation.

The maximum likelihood estimates of the import demand and supply equations are presented in Table 2. Several features in this table merit note. First, most of the coefficients are of expected sign and magnitude. Second, the corresponding asymptotic standard errors are fairly low; with few exceptions the 5 percent level of significance for testing whether the coefficients are equal to zero is exceeded. Third, the view that there is a tendency for imports to persist is verified by the significant coefficient of the lagged dependent variable in the import demand equation.

In the demand equations, the coefficients on the income variable are all positive and all but one are statistically significant. The income coefficient for India is implausibly small but because it is insignificant, the true value may well be considerably larger. The coefficients on the

Table 1. Ordinary Least Squares Estimates 1/

Import Demand						Import Supply						
Constant	Income	Relative Price	Lagged Imports	$\bar{R}^2$	Country	Constant	Reserves	Exports	VM Trend	VMYX	Relative Price	$\bar{R}^2$
1.17	1.10	-0.52	0.19	0.96	El Salvador	-0.61	-0.01	0.50	0.60	0.95	0.07	0.98
(1.97)	(4.76)	(-2.81)	(1.08)			(-0.62)	(-0.30)	(2.58)	(2.31)	(1.57)	(0.26)	
0.20	1.22	-0.38	0.13	0.99	Greece	1.33	0.06	0.15	0.79	0.70	-0.29	0.99
(0.36)	(5.66)	(-3.09)	(0.82)			(1.69)	(1.55)	(1.04)	(4.89)	(1.77)	(-1.85)	
0.27	0.39	-0.05	0.59	0.82	India	-0.07	-0.09	0.19	0.74	-0.07	0.14	0.79
(0.31)	(2.25)	(-0.34)	(3.57)			(-0.06)	(-1.24)	(0.67)	(2.41)	(-0.08)	(0.65)	
0.27	0.26	-0.13	0.82	0.98	Korea	2.87	-0.002	0.22	0.71	0.22	-0.57	0.98
(0.51)	(4.91)	(-1.19)	(19.84)			(3.59)	(-0.03)	(2.46)	(7.94)	(3.10)	(-3.78)	
2.14	0.92	-0.60	0.20	0.99	Thailand	3.03	-0.22	-0.20	1.34	2.99	-0.57	0.99
(6.95)	(7.11)	(-7.11)	(1.75)			(3.08)	(-2.49)	(-1.15)	(7.01)	(5.89)	(-3.12)	

1/ Figures in parentheses are t-values.

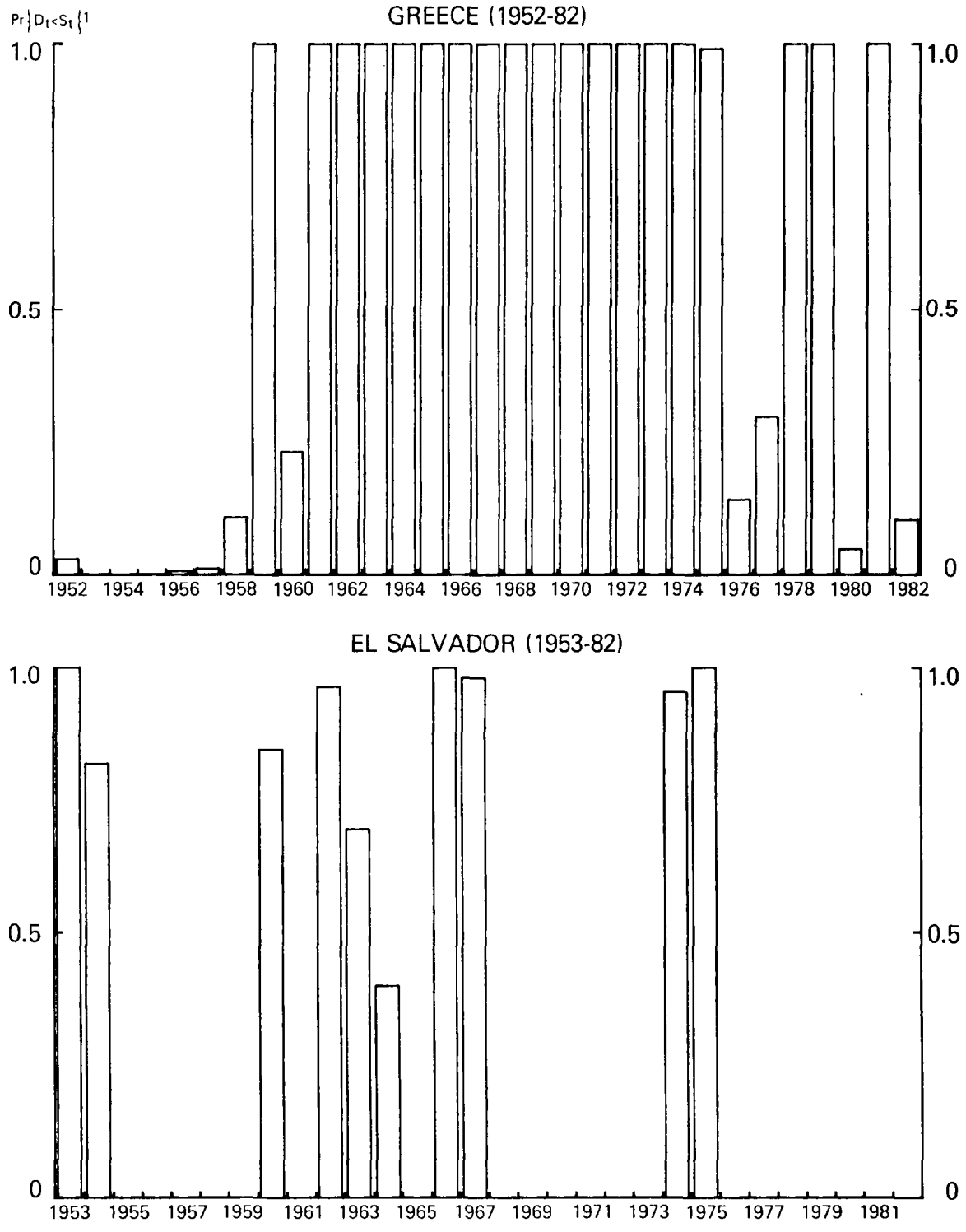
Table 2. Maximum Likelihood Estimates 1/

Import Demand						Import Supply						
Constant	Income	Relative Price	Lagged Imports	Variance of Error Term	Country	Constant	Reserves	Exports	VM Trend	VMYX	Relative Prices	Variance of Error Term
6.05	0.46	-2.18	1.50	0.0001	El Salvador	-1.81	-0.02	0.34	0.57	1.66	0.52	0.004
(0.36)	(0.08)	(0.12)	(0.11)	(0.00006)		(1.29	(0.05)	(0.18)	(0.25)	(0.61)	(0.38)	(0.001)
-1.32	1.54	-0.09	-0.15	0.003	Greece	3.38	0.08	-0.04	0.96	0.72	-0.74	0.00008
(0.77)	(0.29)	(0.14)	(0.21)	(0.001)		(0.17)	(0.01)	(0.05)	(0.05)	(0.13)	(0.04)	(0.00004)
1.61	0.06	-0.24	0.83	0.009	India	-3.49	-0.31	0.94	0.18	-0.96	0.91	0.012
(0.72)	(0.21)	(0.15)	(0.19)	(0.004)		(1.86)	(0.09)	(0.39)	(0.38)	(0.94)	(0.35)	(0.004)
1.00	0.26	-0.21	0.73	0.01	Korea	-2.33	0.13	1.18	-0.14	-0.07	0.40	0.013
(0.50)	(0.06)	(0.10)	(0.04)	(0.002)		(1.31)	(0.07)	(0.18)	(0.18)	(0.11)	(0.25)	(0.004)
2.01	0.69	-0.56	0.43	0.001	Thailand	2.95	-0.35	0.43	0.69	5.75	-0.38	0.004
(0.32)	(0.14)	(0.08)	(0.12)	(0.0005)		(1.43)	(0.15)	(0.31)	(0.33)	(1.58)	(0.26)	(0.002)

1/ Figures in parentheses are asymptotic standard errors.

CHART 1

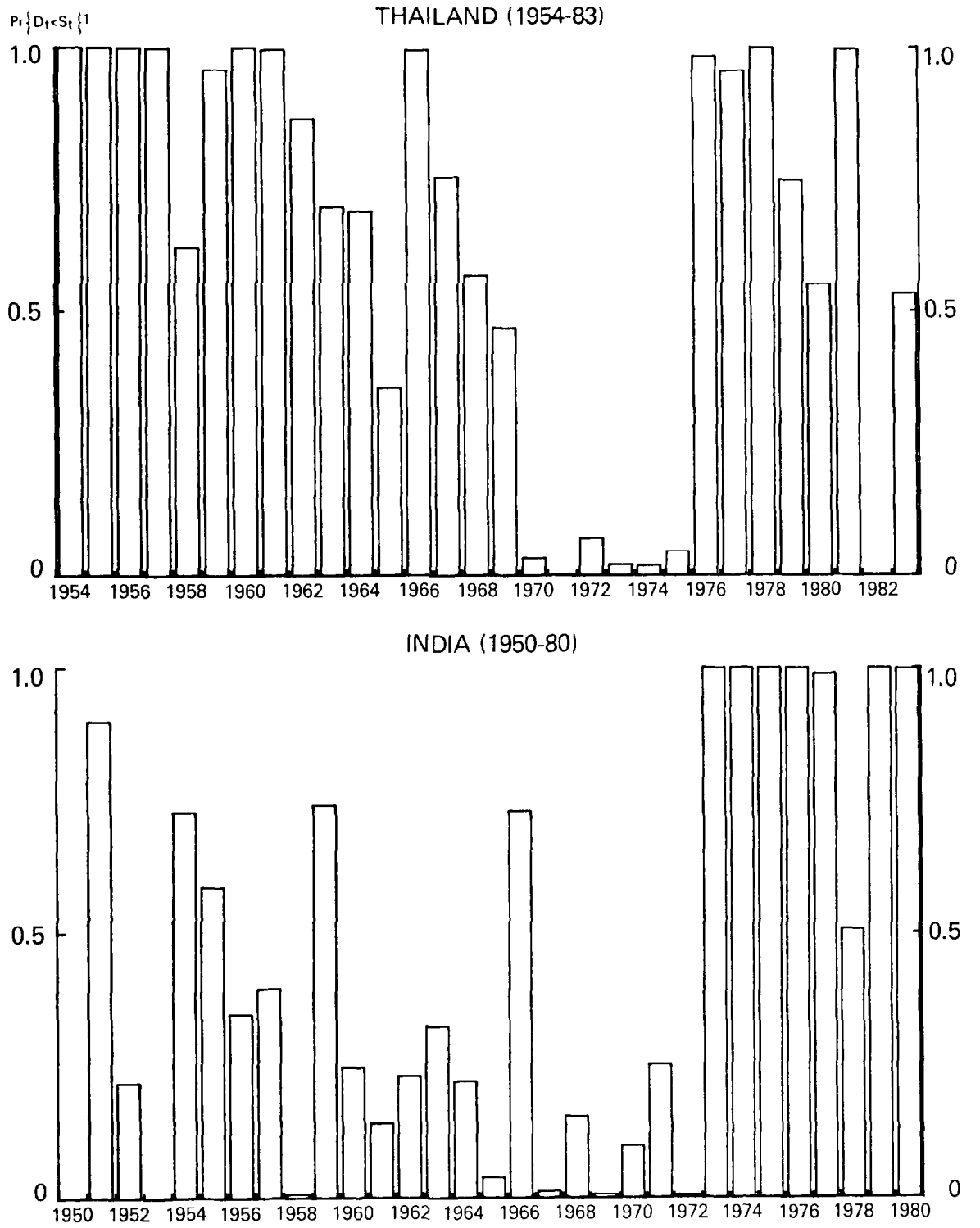
DISEQUILIBRIUM CLASSIFICATION PROBABILITIES



[1] $Pr\{D_t<S_t\}$ is the probability that import demand is less than import supply.

CHART 1 (continued)

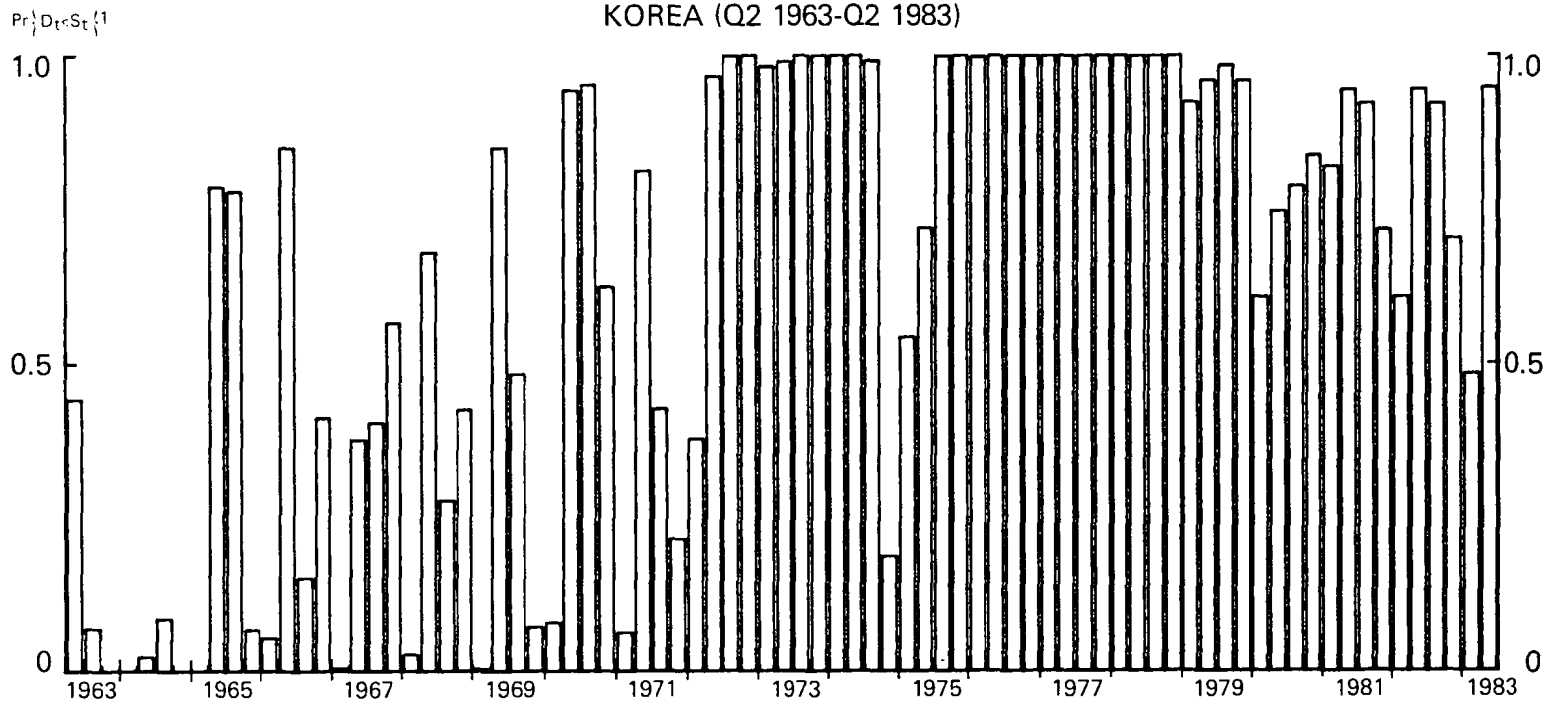
DISEQUILIBRIUM CLASSIFICATION PROBABILITIES



[1] $Pr\{D_t<S_t\}[1]$ is the probability that import demand is less than import supply

CHART 1 (concluded)

DISEQUILIBRIUM CLASSIFICATION PROBABILITIES



[1] $Pr\{D_t<S_t\}$ is the probability that import demand is less than import supply.

relative price variable are negative as expected from demand theory, and most of these are significant. Note that there are some differences in the magnitudes of the income and price elasticities for the individual countries.

In the supply equation, the authorities' behavior is viewed as consisting of two components: namely, a natural level and fluctuations around that level that are themselves due to movements with respect to foreign exchange receipts, output growth, and international reserve holdings. The estimated coefficient of the export variable is positive for four of the countries (the exception being Greece, where it is negative but statistically insignificant) indicating that higher foreign exchange earnings lead the authorities to increase the supply of imports. The coefficient of the international reserves variable is negative for three countries, whereas the expected sign was positive. One explanation for this could be that a reserve demand equation is not estimated in our model. Therefore, the increase in international reserves may be reflecting an endogenous adjustment of actual to desired reserves, rather than the movement of an exogenous variable that determines imports.

The coefficient of the trend imports variable is positive as expected, with the exception of Korea (where it is also insignificant). The cyclical variable is positive in all of the cases when it is statistically significant, indicating that when output is above its natural level, the authorities attempt to reduce demand pressures by increasing the supply of imports.

The effects of an increase in relative price on the import supply function are complicated. First, the import price rise will reduce the demand for imports; and second, because import supply is a determinant of the aggregate price level in periods of rationing, there will be two distinguishable but simultaneous influences on the import supply function. The first of these is that the reduction in the demand for imports will tend to reduce the import market disequilibrium. Because the authorities combine policy instruments in such a way as to minimize costs arising from the various imbalances, the reduced demand implies a lower import supply, which indicates a negative coefficient for the relative price term. On the other hand, however, aggregate prices rise following an import price increase, both from the effects on finished goods and from price mark-up in relation to imported intermediate goods. Thus, concern over price increases may induce the authorities to increase the supply of imports, which indicates a positive coefficient for the relative price term. Which of these effects dominate will depend on the coefficients of the loss function and the structure of the economy. In particular, the sign depends on the relative weights of the policy targets in the loss function and the inflationary impact of import price increases. In our estimation result, we find that three countries have positive and two

countries have negative coefficients for the relative price term in the import supply equation.

Turning to the problem of testing the hypothesis of excess demand in developing country imports, we present the disequilibrium classification probabilities in Chart 1. The chart depicts the probabilities for each observation that the developing country import demand is less than import supply. The specification of the disequilibrium model itself defines the probabilities with which each observation belongs to the demand equation or the supply equation. The statistical theory underlying this method is set out in Maddala and Nelson (1974), Gersovitz (1980), and in the appendix in a companion paper that we have written on developing country exports (see Saracoglu and Zaidi (1985)). Briefly, the probability that $M_t^d < M_t^s$ can be computed from the estimated model, because the disequilibrium likelihood function allocates sample observations to excess demand and excess supply regimes. Although each data point contains some information about both regimes, the weights in the likelihood function are associated with the probability of observing excess demand or excess supply. If these weights indicate a high probability of one particular regime, a low weight is given to the alternative regime. Thus, when most of the observations come from only one regime, then the alternative regime is in effect estimated on a small subset of the sample, and the estimates of the parameters associated with this regime will be relatively poorly determined.

Examination of the chart reveals that both import rationing and nonrationing regimes were present in all of the countries studied. When there is excess demand, the probability that demand is less than supply is close to one, and when there is excess supply, this probability is close to zero. In comparing the probabilities of import rationing across countries, one finds that for the five countries in the sample, import rationing was extensive in El Salvador and India, moderate in Thailand, and sporadic in Greece and Korea. It is interesting to note that import rationing is more extensive in the earlier periods of the sample.

A somewhat more concrete background for the import market disequilibrium may be provided by relating the estimated disequilibrium classification probabilities with the historical record on the nature of the exchange restriction regime in individual countries. We limit our discussion to two countries and provide brief accounts of the pattern of trade restraints in India and Korea. We made use of the Bhagwati and Srinivasan study, Foreign Trade Regime and Economic Development: India, and the Krueger study on Korea, The Developmental role of the Foreign Sector and Aid. The specific aim of these studies was to quantify and analyze the experiences with exchange control regimes and attempts at liberalizing those regimes.

The sample period for India was 1950-80, and the disequilibrium classification probabilities indicate that except for a few years there was excess demand for imports from 1950-72. The Bhagwati-Srinivasan study covers the period 1950-70, and they write that imports were licensed throughout the period: "the licensing has varied in degrees of restrictiveness. It was rather light during the First Plan, intensely severe during the Second, somewhat less so during the Third (except in the last two years), and perhaps equally so since then." 1/ Although imports were liberalized with the 1966 devaluation of the rupee, a bad harvest and price increases had an adverse effect on traditional exports and "by 1969-70, the liberalization appeared to have been largely reversed. The import premium was back to 30 to 50 percent on the average, export subsidies were reinstated and were up to high levels, industrial de-licensing had amounted to little (especially because of continuing QRs), automatic protection with QRs was still the order of the day, and the picture looked very similar to (though marginally better than) that obtaining during 1962-65." 2/

The sample period for Korea was 1963-83 and there are a relatively small number of observations from the excess demand regime. The observations that do come from the excess demand regime are generally before 1972. Krueger (1978) notes that liberalization of import controls proceeded rapidly in Korea after 1964. Quantitative restrictions on imports continued to play a role in determining the commodity composition of imports, but their relative importance diminished as foreign exchange receipts grew. In 1967, an important move in the direction of import liberalization was the shift from a positive-list to a negative list system for controlling imports. Under a positive-list system, import licenses are granted automatically only when an authorized official can find the item specifically listed on the approval list, whereas under the negative-list system, an official grants the license unless he finds the item on the restrictive list. A positive-list system is more restrictive because there are so many commodities that complete itemization is extremely difficult. "In sum, the trade and payments regime from 1967 onwards was much more liberalized than that which had prevailed in the 1950s or even the early 1960s." 3/

V. Extensions: Import Rationing and Multimarket Disequilibrium

The analysis of this paper has been focused on the import market and predicated on the assumption that output, prices, and exports are exogenous

---

1/ Bhagwati and Srinivasan (1975), p. 18.
2/ Ibid, p. 30.
3/ Krueger (1978), p . 130.

variables. Although the analysis provides new insights relating to import rationing in developing countries, it is clear that interactions with other markets have been neglected. This consideration leads directly into the topic of "spill-over effects," which is beyond the scope of this paper. Nevertheless, it seems useful at least to hint at the issues it raises within the context of the present model.

Before proceeding, there is one qualification of the results that warrants further discussion. This paper has followed previous research in disequilibrium econometrics by using the assumption that aggregate imports switch in discrete steps between being on the supply function and on the demand function. However, with developing countries restricting imports selectively, this assumption is arguable. There is likely to be some continuity in the market for total imports when some import categories are restricted, while others are not. Therefore, the formulation and estimation of a smoothed version of the disequilibrium model, probably along the lines of Muellbauer and Winter (1980), would be desirable. Their disequilibrium estimation technique is based on a theory of aggregation over markets in which the aggregate min condition does not hold, and there can be both rationed and nonrationed buyers in the aggregate. However, in the Muellbauer-Winter technique, data on several other variables is required and the number of parameters to be estimated is increased, because intermarket influences are important.

In analyzing interrelationships among markets when disequilibrium exists, the demand and supply functions in one market depend on excess demands or supplies in other markets. For example, the individual consumer's demand is a function of prices and realized or effective income--the amount actually received--rather than of notional income or the amount that would be recieved in an equilibrium situation. Since effective income in one market is determined by realized transactions in other markets, the discrepancies between an individual's planned and realized transactions will cause spillover from one market to another. Suppose that import demand is greater than import supply, so that households are rationed in the consumption goods market and firms in the intermediate and capital goods market. Because households are unable to purchase as much as they demand, they substitute both leisure and future consumption for the unobtainable present consumption, that is, reduce labor supply and increase savings. Firms that are unable to import the intermediate goods would produce less than their notional supply if there is high complementarity between imported inputs and domestic inputs, thereby reducing their demand for labor. In order to estimate these spillover effects from the import market to the labor and output market, a multimarket disequilibrium framework is required.

The likelihood functions for multi-market disequilibrium models have been derived by Gourieroux, Laffont, and Manfort (1980) and Ito (1980). These likelihood functions that incorporate rationing schemes and spill-over effects are highly nonlinear and involve multiple integrals, so that they have to be evaluated numerically. The computational problems are formidable but small-scale rationing models have been built for some industrial countries (see Artus, Laroque, and Michel (1984), Kooiman and Kloek (1985), and Sneessens (1983)). Because quantitative adjustments in lieu of price adjustments tend to be much more common in developing countries than in industrial countries, applications of the multi-market disequilibriums model should be high on the agenda for future research in empirical macroeconomics for developing countries.

VI. Conclusions

The role of import restrictions in developing countries has been noted and discussed in a number of articles, but there is as yet little formal modeling work that is capable of explaining rigorously the observed levels of imports and their interactions with variables such as exports, output, and international reserves. This paper has attempted to fill some of the gaps by estimating an econometric model of developing contry imports that incorporates determinants of private sector import demand as well as the foreign exchange rationing of the authorities. Statistical evidence in support of the model was obtained from time series data for five developing countries, and the results point to the necessity of explicitly taking government import restrictions into account when estimating import flows of developing countries.

The main findings can be briefly summarized as follows. First, in all cases, estimation results conform with the notion that there was regime switching, that is, periods of both import rationing and nonrationing were observed for the developing countries included in the study. Second, the periods of rationing tended to be more prevalent in the early years of the sample. Third, the authorities vary import restrictions inversely with the country's capacity to import, where this capacity is measured by real export earnings. Fourth, the estimated price elasticities of import demand were negative and most were statistically significant.

To conclude, while the disequilibrium estimation technique has led to some interesting results, the methodology used implies that the results are only suggestive. The results are limited because the sample sizes are relatively small. Furthermore, the data set was for aggregate imports, and the min condition generates aggregation problems in a macroeconomic context. Thus, conclusive results await the more detailed research effort referred to above. Nevertheless, the estimation results provide preliminary evidence regarding import market disequilibrium in developing countries. Further research might be aimed at incorporating particular institutional features present in individual developing countries, such as characteristics of their trade structure and the extent of international financial integration.

APPENDIX

Data Sources and Variables

The data for estimating the import demand and supply equations are from the International Financial Statistics tapes of the International Monetary Fund.

Definitions of the Variables in the Model

M	=	Volume of developing country imports.
Y	=	Nominal gross domestic product (GDP) of developing country.
RY	=	Real GDP of developing country.
P	=	Index of GDP deflator of developing country.
PM	=	Import unit value index.
R	=	International reserves.
EX	=	Nominal exports.
VIM^*	=	Trend real imports.
RY^*	=	Trend real GDP.
VIMYX	=	Cyclical variable that is derived as $(VIM^*/RY^*)(RY-RY^*)$

References

Artus, P., Laroque, G. and G. Michel, "Estimation of a Quarterly Macroeconomic Model with Rationing," Ecnometrica, Vol. 52 (November 1984), pp. 1387-1414.

Bhagwati, Jagdish, Foreign Trade Regimes and Economic Development: Anatomy and Consequences of Exchange Control Regimes (Cambridge, Massachusetts: Ballinger, 1978).

Bhagwati, Jagdish and T.N. Srinivasan, Foreign Trade Regimes and Economic Development: India, National Bureau of Economic Research, New York (1975).

Branson, W.H., "A Disaggregated Model of the U.S. Balance of Trade, Staff Economic Studies No. 44, Board of Governors of the Federal Reserve System (February 1968).

Chu, Ke-young, E.C. Hwa, and K. Krishnamurty, "Export Instability and Adjustment of Imports, Capital Inflows and External Reserves: A Short-Run Dynamic Model," in Exchange Rate and Trade Instability: Causes, Consequences, and Remedies, ed. by D. Bigman and T. Taya, (Cambridge, Massachusetts: Ballinger Publishing Company, 1983), pp. 195-214.

Dutta, M., "A Prototype Model of India's Foreign Sector," International Economic Review, Vol. 5 (January 1964), pp. 82-103.

Fair, R.C., and D.M. Jaffee, "Methods of Estimation for Markets in Disequilibrium," Econometrica, Vol. 40 (May 1972), pp. 497-514.

_____, and H.H. Kelejian, "Methods of Estimation for Markets in Disequilibrium: A Further Study," Econometrica, Vol. 42 (1974).

Gersovitz, Mark, "Classification Probabilities for the Disequilibrium Model," Journal of Econometrics, Vol. 14 (1980), pp. 239-46.

Goldfeld, S.M. and R.E. Quandt, "Estimation of a Disequilibrium Model and the Value of Information," Journal of Econometrics, Vol. 3 (1975).

Goldstein, Morris and Mohsin S. Khan, "The Supply and Demand for Exports: A Simultaneous Approach," Review of Economics and Statistics, LX (May 1978), pp. 275-86.

_____, "Income and Price Effects in Foreign Trade" in Handbook of International Economics, edited by P.B. Kenen and R.W. Jones, North-Holland, Amsterdam (1985).

Gourieroux, C., J.J. Laffont and A. Monfort, "Disequilibrium Econometrics of Simultaneous Equation Systems," Econometrica, Vol. 48 (1980), pp. 75-96.

Hemphill, William, "The Effects of Foreign Exchange Receipts on Imports of Less Developed Countries," International Monetary Fund, Staff Papers, Vol. 21 (November 1974), pp. 637-677.

Houthakker, H.S., and S.P. Magee, "Income and Price Elasticities in World Trade," Review of Economics and Statistics, LI (May 1969), pp. 111-25.

Islam, Nurul, "Experiments in Econometric Analysis of an Import Demand Function," Pakistan Economic Journal, Vol. 11 (September 1961), pp. 21-38.

Ito, Takatoshi, "Methods of Estimation for Multimarket Disequilibrium Models," Econometrica, Vol. 48 (1980), pp. 97-126.

Khan, M.S., "Import and Export Demand in Developing Countries," Staff Papers, International Monetary Fund (Washington, November 1974), pp. 678-93.

Kooiman, P. and T. Kloek, "An Empirical Two Market Disequilibrium Model for Dutch Manufacturing," European Economic Review, Vol. 29 (1985), pp. 323-354.

Krueger, Anne O., Foreign Trade Regimes and Economic Development: Liberalization Attempts and Consequences (Cambridge, Massachusetts: Ballinger, 1978).

_____, The Development of the Foreign Sector and AID, (Cambridge, Massachusetts: Harvard University Press, 1982).

Lipschitz, Leslie, "Domestic Credit and Exchange Rates in Developing Countries: Some Policy Experiments with Korean Data," International Monetary Fund, Staff Papers, Vol. 31 (December 1984), pp. 595-635.

Maddala, G.S. and F.D. Nelson, "Maximum Likelihood Methods for Models of Markets in Disequilibrium," Econometrica, Vol. 42 (1974), pp. 1013-30.

Magee, S.P., "Prices, Income and Foreign Trade: A Survey of Recent Economic Studies," in P.B. Kenen (ed.), International Trade and Finance: Frontiers for Research, Cambridge University Press, Cambridge (1975).

Muellbauer, J., and D. Winter, "Unemployment, Employment, and Exports in British Manufacturing: A Non-Clearing Markets Approach," European Economic Review, Vol. 13, (1980), pp. 383-409.

Orcutt, G., "Measurement of Price Elasticities in International Trade," Review of Economics and Statistics, XXXII (May 1950), pp. 117-32.

Portes, R. and D. Winter, "Disequilibrium Estimates for Consumption Goods Markets in Centrally Planned Economies," Review of Economic Studies, Vol. XLVII (1980), pp. 137-59.

Quandt, R.E., "Tests of the Equilibrium vs. Disequilibrium Hypothesis," International Economic Review, Vol. 19 (1978), pp. 435-52.

Sneessens, H., "A Macroeconomic Rationing Model of the Belgian Economy," European Economic Review, Vol. 20 (1983), pp. 193-215.

Stern, R.M., J. Francis, and B. Schumacher, Price Elasticities in International Trade - An Annotated Bibliography (Macmillan, London: 1976).

Sundararajan, V., "Exchange Rate versus Credit Policy: Analysis with a Monetary Model of Trade and Inflation in India," Journal of Development Economics, Vol. 20 (1986), pp. 75-105.

Saracoglu, Rüsdü and Iqbal M. Zaidi, "Disequilibrium Estimation of Developing Country Exports," DM/85/83, International Monetary Fund, December 1985.

Zaidi, Iqbal M., "A Rationing Model of Imports and the Balance of Payments in Developing Countries: Theoretical Framework and an Application to the Philippine Economy," DM/84/62, International Monetary Fund, October 1984.