nology matrix of that period embody domestic prices that reflect the distortions created or the "tariffs" implied by the non-equilibrium exchange rate. Let us call this matrix for later purposes:

(7) $[A_o] = //a_{ij}//$

If the exchange rate is in equilibrium, then domestic price pd will equal foreign price P_f. If the exchange rate is not in equilibrium, as it is not under exchange control, then domestic price will equal foreign price <u>plus</u> the "tariff" implied by the non-equilibrium exchange rate, i.e., $P_d = P_f(1+e)$, where e is the implied percentage tariff. If we define the "tariff" inclusive price at the base period as equal to unity, then $1 = P_f(1+e)$, and $P_f = 1/(1+e)$, which means that, in the absence of distortions, domestic price will equal foreign price or $1/(1+e)$.

Since the model requires the calculation of the optimal national income under a set of domestic prices that approximate international prices, the technology matrix of the base period must be redefined to reflect free trade prices. Operationally, this involves the calculation of free trade prices given by $P_f = 1/(1+e)$. The set of P_f prices so calculated will then serve as an approximation to domestic prices that will prevail if foreign exchange is not under control and the exchange rate is in equilibrium. Then the coefficients in the technology matrix of the base period must be expressed in terms of the calculated free trade total supply of foreign exchange generated by exports and non-trade sources.

The objective function is given below.

$$(5) \quad \overset{1x1}{[V^*]} = \text{Max } \overset{1x1}{[Y]}$$

The objective function calls for a solution that will make national income as large as possible given the various constraints.

Finally, we have the non-negativity requirements, viz.:

$$(6) \quad \overset{nx1}{[X]} \geq \overset{nx1}{[0]}, \quad \overset{nx1}{[M]} \geq \overset{nx1}{[0]}, \quad \overset{nx1}{[E]} \geq \overset{nx1}{[0]}, \quad \overset{nx1}{[Y]} \geq \overset{nx1}{[0]},$$

Slack variables which are not shown are also required to be non-negative.

The Role of Prices

Prices play a central role in the model. If, in the technology matrix of a given period, we define X_{ij} as the output of industry i used as input of industry j, and Xj as the output of industry j, then $X_{ij} = a_{ij}X_j$, that is, the demand of an industry for intermediate input, X_{ij}, is a linear function only of the level of its output, X_j. Here the levels of inputs and outputs, i.e., the X_{ij}'s and X_j's, are all expressed in value terms (price times quantity), hence, the coefficients a_{ij}'s, which are equal to X_{ij}/X_j, are also expressed in value terms. Since the base period used is one where the exchange rate is not in equilibrium, then the coefficients a_{ij}'s that define the techindustries and rigidities in the economic environment, the overall capital constraint is supplemented with exogenously specified sectoral constraints defining the upper and lower bounds of capital available for each particular industry, thus:

$$(3.1)\quad \overset{n\times n}{[f_k]}\ \overset{n\times 1}{[K]} \leq \overset{n\times 1}{[K^u]}$$

$[K^u]$ is a vector of exogenously specified upper bounds for capital available for the various industries.

$$(3.2)\quad \overset{n\times n}{[f_k]}\ \overset{n\times 1}{[X]} \geq \overset{n\times 1}{[K^b]}$$

$[K^b]$ is a vector of exogenously specified lower bounds for capital available for the various industries.

The upper bounds for capital are intended to encompass idle or underutilized capacity which can be put into operation in the short-run. On the other hand, the lower bounds are intended to allow for increased underutilization, depreciation, or disinvestment, also in the short-run.

Finally, the balance of payments constraint is specified.

$$(4)\quad \overset{1\times n}{[P_m]}\ \overset{n\times 1}{[M]} - \overset{1\times n}{[P_e]}\ \overset{n\times 1}{[E]} \leq \overset{1\times 1}{[F]}$$

$[P_m]$ is a row vector of prices of imported commodities where prices are in domestic currency.

$[P_e]$ is a row vector of prices of exported commodities where prices are in domestic currency.

$[F]$ is an exogenously determined amount of foreign exchange receipts, expressed in domestic currency, from such sources as loans, donations from abroad, or some previous foreign exchange reserves.

This constraint states that the total demand for foreign exchange going into imports at the most should not exceed the

$$(2) \quad \overset{1xn}{[f_1]}\ \overset{nx1}{[X]} \overset{}{\leq} \overset{1x1}{[\bar{L}]}$$

$[f_1]$ is a row vector of labor-output coefficients where both labor and output are expressed as unit flows per year.

$[\bar{L}]$ is the exogenously specified quantity of labor in man-years available in the economy.

The total number of labor units being the specified constraint, the implicit assumption is that various types of skills required by an output expansion are available in the economy. This implicit assumption, made necessary by the absence of data showing the breakdown of the labor force into skill groups, is not as unrealistic as it appears since output expansion, if it occurs, and consequently the increase in the demand for labor of some skill types, is not likely to be substantial given the short-run horizon of the model.

The capital constraint is expressed as follows:

$$(3) \quad \overset{1xn}{[f_k]}\ \overset{nx1}{[X]} \leq \overset{1x1}{[\bar{K}]}$$

$[f_k]$ is a row vector of capital-output coefficients where both capital and output are expressed as unit flows per year.

$[\bar{K}]$ is the exogenously specified number of capital units available in the economy.

The inequality states that the number of capital units that can be used for production in the various industries cannot exceed the total number available in the economy.

To take account of the short-run time period covered and the presence of idle or underutilized capacities in the various

[b] is an n dimensional column vector of proportionality coefficients, defived as follows:

$$b_i = y_i / \sum_{i=1}^{n} y_i$$

where y_i is output of industry i consumed by households. The formulation assumes that the proportional distribution of final demand or national income among the different industries is maintained, hence the line OH in Figure 1. This assumption permits the analysis of the industrial origin and welfare implications of national income. Also,

$$\sum_{i=1}^{n} b_i = 1$$

[0] is an n dimensional vector of zeros.

The inequalities state that the total supply of "commodities" should at least be equal to the total final demand for "commodities". In conventional macro-economic aggregates, final demand or national income is broken down as follows:

$$\text{(1.1)} \quad \underset{1x1}{[Y]} = \underset{1xnnx1}{[\hat{1}][C]} + \underset{1xnnx1}{[\hat{1}][K]} + \underset{1xnnx1}{[\hat{1}][G]}$$

[C] is a column vector of industry output that goes into household consumption.

[K] is a column vector of industry output that goes into investment.

[G] is a column vector of industry output that goes into government.

$[\hat{1}]$ is a vector of ones, to indicate that a column sum is to be taken.

In addition, the model is constrained by the available supply of labor, specified as follows:

of internal and external economies and diseconomies which are only too ubiquitous in the real world. However these benefits and costs can be regarded as mutually offsetting so that their absence does not destroy the precision of the optimal solutions.

Finally, the model does not include terms of trade effects of domestic output expansion and contraction. While this deficiency may be crucial when the model is applied to large trading countries, it is not so in the present context in view of the smallness of the country being studied. These shortcomings must be kept in mind when we come to the evaluation of the results of the application of the model to the problem at hand.

Specification of the Model

The model is structurally specified below in linear programming form, starting with the technological and supply and demand inequalities.

$$(1)\quad -\overset{n\times n}{[I-A]}\,\overset{n\times 1}{[X]} - \overset{n\times n}{[I]}\,\overset{n\times 1}{[M]} + \overset{n\times n}{[I]}\,\overset{n\times 1}{[E]} + \overset{n\times 1}{[b]}\,\overset{1\times 1}{[Y]} \leqq \overset{n\times 1}{[0]}$$

[I-A] is a technology matrix defining the production relations existing in the economy, where [A] is a square matrix of input coefficients, the a_{ij}'s, and [I] is a conformable identity matrix.

[X] is an n dimensional column vector of production levels of various industries.

[M] is an n dimensional column vector of import levels of various industries.

[E] is an n dimensional column vector of export levels of various industries.

[Y] is a scalar denoting total final demand (or national income) of the household "industry".

the model the optimal production level is also optimally distributed among producing industries.

The introduction of importation and exportation as distinct and separate economic activities and the treatment of imported and exported commodities as variables whose levels must be determined also make it possible to identify industries that have comparative advantage in international trade and industries that can be developed to produce import substitutes.

On the other hand, the model suffers from several weaknesses. Since it works on the basis of a given technology, it implicitly assumes fixed coefficients of production or zero elasticity of substitution among productive factors. However, as Leontief has pointed out,[6] input substitution is a feature only of highly aggregated models using only one all-embracing variable for consumption or production. Here any change of the proportion in which different individual commodities are consumed will bring about a change in the aggregated proportions employed in production, but not necessarily a change in the proportions used in production in individual industries. In more highly disaggregated models as those using input-output classifications of many sectors, input substitution is minimal.

The assumption of linearity in the production of functions is yet another source of weakness. It prevents the calculation

[6] Leontief [13], pp. 38-40 .

in order to more certainly encompass the "true" free trade state. The model is consequently defined for three regimes, namely, one where prices reflect the actual controlled non-equilibrium exchange rate, another where prices reflect a moderately adjusted exchange rate, and a third where prices mirror a liberally adjusted exchange rate.[5] The last two situations, as has just been said, are intended to represent separate approximations of a free trade regime.

Since production cost is measured in terms of national income, national income will be maximized in each version of the model. The difference between the optimal national income under each of the two free trade situations and the optimal national income under the controlled situation, expressed in appropriate free trade prices, will then be taken to generate an approximation of the production cost of exchange control.

The model has several outstanding features. As a general equilibrium model, it describes comprehensively the interrelations of producing, trading, and consuming units in the economy too numerous to be adequately dealt with by partial equilibrium analysis. Thus, it avoids some of the problems of aggregation and simplification that are inevitable in the latter type of work. In addition, it determines explicitly not only the level of national income but also its sectoral distribution. Thus, in

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[5]The precise differences among these three situations and the way by which the last two are derived will be spelled out on pp. 10-22.

production. However, the model assumes the existence of idle or underutilized capacity and allows for the increased utilization or underutilization of this capacity. This means that it permits changes in operating capacity rather than in capacity itself.

To generate a basis for the approximation of the production cost of exchange control, the model specifies the free trade and the controlled states of the economy and then focuses on the difference in national output between them. The free trade state is of course that state where there is no exchange control, where the exchange rate is in equilibrium, and where domestic prices equal international prices. In contrast, the controlled state is that state in which there is exchange restriction as a consequence of which the exchange rate is not in equilibrium and prices reflect the distortions created by the restriction.[4]

In the context of the Philippines to which the model will be applied, two estimates of the extent of adjustment that is necessary to approximate the free trade situation will be made,

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[4] Foreign exchange control is implemented either by the issuance of import licenses, the prohibition of capital movements, or the outright imposition of quotas. Whatever the device used, it has a definite tariff equivalent. For this reason, the theoretical concepts that deal explicitly with the measurement of the economic cost of tariffs and quotas can be employed in the calculation of the economic cost of exchange control. See, among others, Bhagwati [2], Krueger [10], and Jurado [9], pp. 6-11].

production of good X is less than is required to meet intermediate demand, i.e., there is net importation of good X, equal to X_1. At q_3, the value of output is greater than the value of output at q_2, both reckoned in terms of the international price ratio P_3, i.e., the value denoted by P_3 is greater than the value denoted by P_3'.

This case of the possibility of greater specialization is the basis for the argument that the production cost of any trade restriction is likely to be greater when intermediate products are included than when they are not.

3. The Model

Features of the Model

In view of the non-availability of data that will permit the measurement of the consumption component, the present study will be concerned with the approximation only of the production cost of exchange control. The model presented for making this approximation is a short-run, comparative static, input-output linear programming model. Production functions are of the conventional Leontief type, i.e., linear in both intermediate products and primary factors, implying constant returns to scale. As s short-run instrument, the model operates on the basis of a given technology and a given capital stock. This is because the implicit time period covered by the model is too short to allow for changes in the physical input structure of

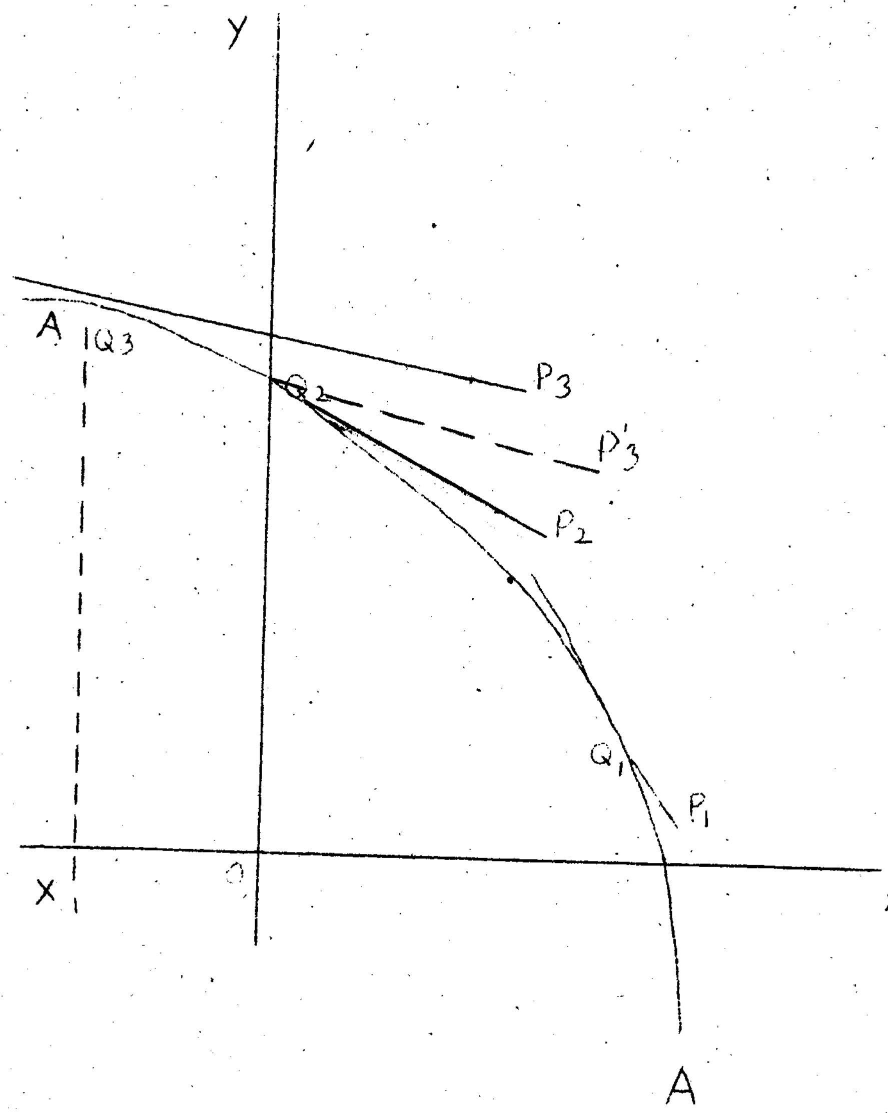

Figure 2. Product Transformation Curve with Intermediate Products.

goods may result in greater specialization and therefore in a higher production cost than when these goods are not included, we consider Figure 2. Goods X and Y can both be used as final goods and as inputs in each other's production. The line AB is the net product transformation curve, that is, the curve showing domestic production after use of the goods for intermediate production has been taken into account. For instance, any production point on the first quadrant indicates that gross domestic production of the two goods exceeds the use of the goods as intermediate inputs for each other. On the other hand, a production point on the second or fourth quadrant indicates that gross domestic production of one good is greater and of the other is less than the quantity required domestically for intermediate use.

How is the actual production point on the transformation curve determined? Assuming optimizing behavior among firms, production would always take place at that point on the curve at which the marginal rate of substitution is equal to the international price ratio. Thus, if the international price ratio is given by the slope of P_1 the optimal production point would be q_1. For the same reason, if the international price ratio is given by the slope of P_2, production would be at q_2, a position signifying positive net output of good Y and zero net output of good X. The crucial question arises when the international price ratio is given by the slope of, say, P_3. Then clearly, the optimum production point would be q_3, showing that gross domestic of Z_1 instead of Z_0, to do so. This difference between C''' and C, expressed in terms of the country's national income, is Z_1Z_0. This is called the consumption cost of the restrictions.

The sum of these two effects constitute the economic cost of the restrictions. If one had information on consumers' utility functions, it will be possible to express this economic cost in terms of utility levels. This economic cost is equal to the difference between C', the utility level that could be attained under unhampered trade, and C'''.

This analysis assumes that the country's terms of trade are not affected by the volume of its trade. This assumption is true only with respect to small countries the volume of whose exports and imports is not so substantial as to affect the prices of these goods. Otherwise, the cost of the restrictions would be smaller or, in the extreme case, even negative.

Production Cost with Intermediate Products

The foregoing analysis takes into consideration final consumption goods only. If goods that can serve as both final and intermediate products are taken into account, the analysis must be modified to allow for the possibility of greater specialization in the economy and therefore the possibility of higher production cost.[3] To see how the inclusion of intermediate

[3]McKinnon [14].

exist. Then the country's point of production will be P and its point of consumption will be C. Because of the restrictions, the domestic marginal rates of substitution in production and consumption, given by the slope of the tangent at points P and C, respectively, differ from the international terms of trade, given by the slope of the line CP. The country's exports of good X are represented by QP and its imports of good Y by QC. The country's national income or output, expressed in terms of its exportable product at international prices, is Z_0.

Now assume that trade restrictions were removed. Producers would respond by adjusting levels of output, producing at that point where the domestic marginal rate of substitution between the two goods is equal to the international price ratio of these goods. Producers would produce at point P' on the transformation frontier, implying a national income or output valued at Z_2 at international prices. In cost terms, this difference between the value of output under free trade and the value of output under restrictive conditions, i.e., Z_0Z_2, represents what is called the production cost of the restrictions.

The output Z_0Z_2 is not the only cost paid for the restrictions, however. On the consumption side, consumers who were consuming at point C when restrictions were in effect, on indifference curve U_1, would, if they had access to a domestic price ratio equal to the international price ratio, consume at point C"', on the same indifference curve U_1, requiring only a national income

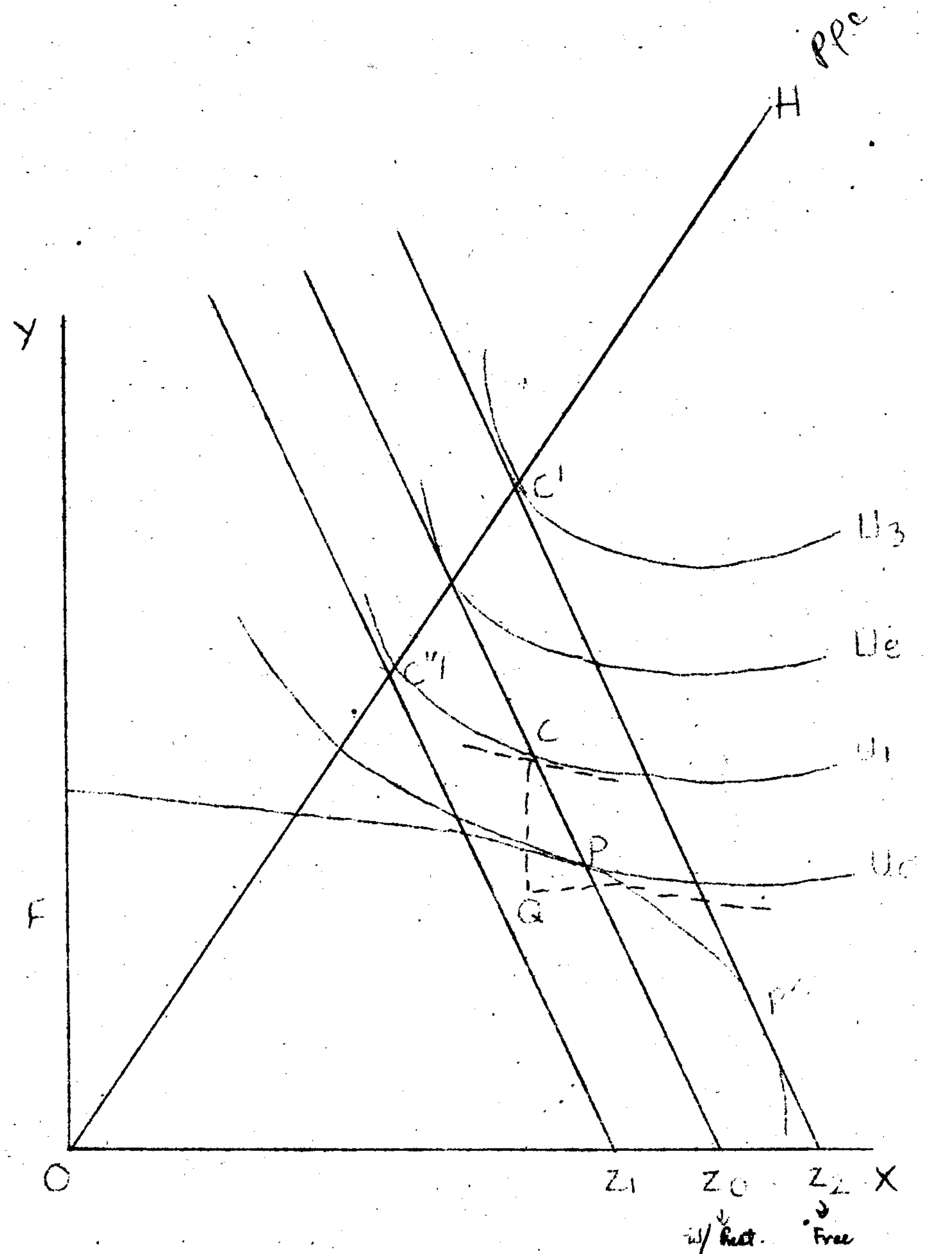

Figure 1. Production and Consumption Costs of Trade Restriction.

The meaning of production cost will be clarified in the next section. Then the model for estimating it will be presented. The data describing the Philippine economy in 1961 will then be introduced. Subsequently, estimates of the production cost of exchange control in the Philippines in 1961 will be presented. Some conclusions will be summarized in the last section.

2. The Definition of Production Cost

Production Cost as a Component of Economic Cost

As a preliminary discussion, it is necessary to clarify the meaning of production cost and how it arises from a given economic restriction.[2] The economic restriction in this study is of course exchange control.

In Figure 1, the horizontal axis measures the quantity of an exportable good X and the vertical axis the quantity of an importable good Y. The line FF is the transformation curve and the lines U_o, U_1, U_2, and U_3 are community indifference curves. The line OH, drawn from the origin, is a line of constant proportion between the two goods, reflecting a special assumption of the model which will be employed here. Without trade, the country's point of production P will also be its point of consumption, on indifference curve U_0. With trade the situation will be different. Assume that restrictions on foreign trade

[2] See Johnson [7] and Corden [5].

THE PRODUCTION COST OF EXCHANGE CONTROL IN THE PHILIPPINES, 1961*

By Gonzalo M. Jurado#

1. Introduction

This is an attempt to estimate the production cost of exchange control in the Philippines in 1961. The Philippines was under a regime of exchange control from the end of 1949 to early 1962. At one time or another, exchange control was accompanied by direct quantitative restrictions of imports, multiple exchange rates, tax exemptions and tariffs. The purpose of exchange control was, initially, to balance imports against exports at a fixed exchange rate and, subsequently, to accelerate the transformation of the economy to an industrialized one by encouraging import-substituting industries. Whether the restrictions contributed to the rapid expansion of the economy and the development of the desired economic structure has remained an interesting question to the present time.[1]

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*Based on Chapters III and V of the author's A Linear Programming Analysis of the Economic Cost of Exchange Control: The Philippine Case, unpublished Ph.D. dissertation, University of Wisconsin, 1970.

#I am indebted to Professors Fredrick Golladay, Robert E. Baldwin, Jeffrey G. Williamson, and Gerriet Muller for their valuable comments and criticisms. They are not, however, responsible for any weaknesses in the argument. Responsibility for these is solely mine.

[1]The literature on this problem has become considerable in recent years. Included in this body of written works are Legarda y Fernandez [12], Treadgold and Hooley [19], Power [16], Sicat [18], Ruprecht [17], Williamson [20], Castro [4], and Mijares and Valdepenas [15].

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By

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TABLE 6

COMPUTED OPTIMAL VALUES OF FINAL DEMAND
(In 1000 pesos)

RHS	Under Matrix A_o	Under Matrix A_1	Per Cent Increase Due to Exchange Rate Adjustment
0	16,036,433*		
1	16,949,405	16,980,440	0.18
2	18,137,468	18,262,721	0.69
3	18,336,900	18,514,613	0.97
4	18,867,858	19,134,522	1.42
5	21,778,179	22,434,161	3.00

RHS	Under Matrix A_o	Under Matrix$_2$	
0	15,801,035**		
1	16,703,762	16,748,392	0.27
2	17,874,606	19,010,439	0.76
3	18,071,147	18,261,134	1.05
4	18,594,411	18,900,082	1.65
5	21,463,384	22,220,301	3.53

*This is the actual national income of 1961 expressed in the prices of Matrix A_1.

**This is the actual national income of 1961 expressed in the prices of Matrix A_2.

TABLE 5

CHANGES IN TRADING STATUS OF INDUSTRIES

R H S	1			2			3			4			5		
Matrix	A_0	A_1	A_2	A_0	A_1	A_2	A_0	A_1	A_2	A_0	A_1	A_2	A_0	A_1	A_2
1 Agriculture	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
2 Mining	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
3 Food Manufactures	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
4 Beverages	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
5 Tobacco Products	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
6 Textile Products	M	M	M	M	M	M	M	M	M	E	E	E	E	E	E
7 Footwear	M	M	M	E	E	E	E	E	E	E	M	M	M	M	M
8 Wood Products	M	M	M	M	M	M	E	E	E	E	E	E	E	E	E
9 Furniture and Fixtures	M	N	N	N	N	N	N	N	N	N	N	N	N	N	N
10 Paper Products	M	M	M	M	M	M	M	M	M	N	N	M	N	N	N
11 Printed Materials	M	M	M	M	M	M	N	N	M	N	M	M	N	N	N
12 Leather Products	M	M	M	M	M	M	E	E	E	M	N	E	E	E	E
13 Rubber Products	M	M	M	N	M	M	N	N	N	N	N	N	N	N	N
14 Chemicals	M	M	M	E	E	E	E	E	E	E	M	E	E	E	E
15 Petroleum Products	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
16 Non-Metallic Products	M	M	M	M	M	M	M	M	M	N	M	M	N	N	N
17 Ferrous-Metal Products	M	M	M	E	M	M	E	M	M	E	M	M	E	M	M
18 Non-Ferrous Metal	N	M	M	N	M	M	N	M	M	M	M	M	N	N	M
19 Non-Electrical Machinery	M	M	M	N	N	N	N	N	N	N	M	M	N	N	N
20 Electrical Machinery	M	M	M	M	M	M	M	M	M	N	M	M	N	N	M
21 Transport Equipment	M	M	M	M	M	M	N	N	M	N	M	M	N	N	N
22 Miscellaneous Manufactures	M	M	M	M	M	M	M	M	M	M	M	M	E	E	E
23 Construction	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24 Wholesale & Retail	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25 Transport Services	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26 Communication	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27 Electricity, Gas, Water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28 Banking, Insurance, Real Estate	E	E	E	E	E	E	E	E	E	N	N	N	N	N	N
29 Other Services	E	E	E	E	E	E	E	E	E	M	E	E	E	E	E

Symbols: E - net exporting; M - net importing; N - neutral; and -- non-trading or home industry.