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ON THE CHOICE OF A SHADOW PRICE

FOR

FOREIGN EXCHANGE

by

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DEVELOPMENT ADVISORY SERVICE
Center for International Affairs,
Harvard University,
Cambridge, Massachusetts.

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In most countries, the exchange rate, be it a market or an official one, does not alone maintain equilibrium in the balance of payments; some form of import restriction is used in addition. Such a situation implies a continuous disequilibrium in the foreign exchange market and causes the exchange rate to be a poor indicator of the scarcity of foreign exchange. In consequence, its use in the evaluation of investment projects will lead to misallocation of resources.

The following sections of this paper will develop a more appropriate price for foreign exchange and compare it with previously suggested derivations of such a shadow price. 1/

II

Consider a country called Banania which exports bananas and imports radios and washing machines. The exchange rate is pegged at 5 bananos to the dollar and there is an ad-valorem import duty of 50% on all imports.

Banania now studies the desirability of domestic radio production. This will require the import of capital equipment and radio parts but will substitute the import of radios completely. In order to evaluate the costs and benefits of the project, Bananian economists establish the physical availability of commodities with and without the radio factory. These are as follows:

Availability of Goods & Services (monthly)

	Without factory	With factory
Bananas	1000 ts.	1000 ts.
Radios	50 units	50 units
Washing Machines	20 units	25 units
Haircuts (Services)	300 man/hrs.	300 man/hrs.

From this analysis they conclude:

(1) the output of the factory is radios, however, the net addition to the economy consists of foreign exchange which is used to import washing machines.

*I would like to thank Dr. Gustav Papanek and Professor Richard E. Caves for their very valuable and incisive comments.

1/ J. Tinbergen, The Design of Development; H. B. Chenery, "Development Policies and Programmes," Economic Bulletin for Latin America, March 1958; S. Chakravarty, "The Use of Shadow Prices in Programme Evaluation" in Capital Formation and Economic Development, P. N. Rosenstein-Rodan, ed.; G. F. Papanek and M. A. Qureshi, "The Use of Accounting Prices in Planning," U. S. Papers for U. N. Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas, Vol. VIII, p. 95.

(2) the cost of radio production is also foreign exchange, which could have been used to import even more washing machines.

(3) both costs and benefits are foreign exchange and should be assigned the value of imports (i.e., washing machines) foregone or made possible.

The Bananian analysis can be generalized as follows: the value of foreign exchange is equal to the value of goods or services into which it is embodied. Furthermore, the marginal utility of foreign exchange is equal to the marginal utility of the goods or services on which it is spent; and, the shadow price of foreign exchange is equal to the price of the goods or services in which it is embodied.

Applying these generalizations to radio-producing Banania again, we have: (i) the value of a dollar to Banania is equal to the value of a dollar's worth of imported washing machibes; (ii) the marginal utility of a dollar is equal to the marginal utility of a dollar's worth of washing machines; and (iii) the shadow price of a dollar is equal to the price of a dollar's worth of washing machines.

With these conclusions we can easily calculate the shadow price of the dollar in Banania. Imported washing machines sell to the consumer for a price made up of:

(1) Price CIF Bananian import port

(2) +50% ad-valorem duties

(3) +port charges, etc.

(4) +importers' costs and profit.

Assuming that items (3) and (4) represent real costs, the price of a dollar's worth of washing machines in Banania is equal to its CIF price plus 50% ad-valorem duties. The CIF price of a dollar is 5, thus the chadow price is 7.50.

III

In section II we have argued that the shadow price of foreign exchange is equal to the marginal utility of the goods and services on which it is spent. If the consumer is in equilibrium, marginal utility of consumption goods is measured by price. Thus the price of a dollar's worth of imports is the shadow price of foreign exchange. Furthermore, if there is competition among importers, the price of imported goods will equal their CIF price plus the tariff. Hence if there is a uniform ad-valorem tariff, this tariff will represent exactly the adjustment necessary to convert eh market exchange rate into the shadow rate.

In this section, we will extend this reasoning to cover (i) differentiated tariff rates; (ii) intermediate and capital goods; (iii) foreign expenditure on other than commodity account; (iv) disequilibrium in other factor markets; and, (v) domestic indirect taxation.

(i) Differentiated tariff rates:

Let us assume that Banania imports automobiles in addition to washing machines, and that on the margin these are imported in a proportion of 1 to 4. Let us also assume that the ad-valorem duty is 100% on cars and 50% on washing machines. A marginal dollar in Banania will now be embodied 20% in additional automobiles and 80% in additional washing machines. The former generate a marginal utility equal to 10 bananos per dollar and the latter equal to 7.50 per dollar.2/ Weighting these prices by their share in marginal imports we find an average marginal utility per dollar of 8 bananos, which constitutes the shadow price of the dollar for this situation.

(ii) Intermediate and capital goods:

The marginal utility of foreign exchange embodied in intermediate goods will be correctly estimated by the price of these goods provided the economy concerned is perfectly competitive. In that case, the price of inputs is equal to the value of their marginal product. If market imperfections exist, the price of inputs will be below the value of their marginal product and thus the marginal utility of foreign exchange derived from these prices will be an underestimate.

The marginal utility of foreign exchange embodied in capital goods will be correctly estimated by the price of these goods provided the economy concerned is perfectly competitive and no excess profits are being made. In contrary cases, the shadow exchange rate derived by the use of these prices will be an underestimate.

(iii) Foreign expenditure on other than commodity account:

Marginal foreign exchange expenditure takes place on non-commodity items as well as commodities. These payments may be for services imported or for interest on the foreign debt or they may represent capital transfers. In all cases, these payments can be treated as a purchase of final goods since services and interest are directly akin to commodities and capital transfers can be regarded as the import of foreign bonds. The marginal utility of a dollar's worth of these items is then the price at which they sell domestically.

(iv) Disequilibrium in other factor markets:

In most underdeveloped economies, the labor and capital markets are out of equilibrium concurrently with the foreign exchange market. The prevalent view is that labor is overpriced whereas capital is underpriced. This causes the factor mix used in production to deviate from the optimum. As a consequence, the marginal productivities of other inputs, the prices of inputs and the prices of outputs all deviate from the values that would be found under full equilibrium. When

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2/ It should be pointed out that consumer equilibrium requires that marginal utility per unit of domestic currency expenditure be equal in all commodities. Since a dollar's worth of imports corresponds to different amounts of domestic expenditure in different commodities, the marginal utility per dollar is not subject to the same equality.

these market prices are used, as we suggest, to derive the shadow price of foreign exchange, the value obtained does not reflect the marginal utility of foreign exchange in a full equilibrium situation. It reflects, rather, what this marginal utility is, given the other factor disequilibria. This is the appropriate value for project evaluation except in the unlikely case that the economy moves to full equilibrium concurrently with the application of the shadow price for foreign exchange, since it is this price which reflects the marginal utility in fact derived from an additional dollar.

(v) Domestic indirect taxation:

Domestic indirect taxation affects the valuation of inputs and outputs by creating a difference between the supply and demand prices for all goods and services. As a consequence, the demand prices for imports (which result from derived demand curves based on supply prices) understate the marginal utility of their contribution to output (or consumer welfare) by the proportion of the tax. The shadow price for foreign exchange must therefore be calculated by adding the relevant indirect taxes onto the tariff.

The necessity of this adjustment can be seen from the following examples. Assume Banania has a sales tax of 10%. A dollar's worth of imported washing machines will now sell to the consumer for:

			Bananos
(1)	Price CIF Banania port		5
(2)	+ 50% ad-valorem duties		2.50
(3)	+ port charges, etc.	say	1.50
(4)	+ importer's cost and profits		0.90
(5)	+ 10% sales tax		
		Total sales price	9.90

The marginal utility of an import dollar worth of washing machines is given by the sales price (9.90) less the domestic inputs(1.50) and their share of the sales tax (0.15). This comes to 8.25 bananos. The demand price for imports of washing machines, however is only items (1) and (2), i.e., 7.50 bananos, thus underestimating the marginal utility by 10%.

Consider now the case of radio parts imported into Banania. The relevant demand price will be equivalent to the marginal physical productivity of radio parts valued at the sales price of radios less the tax, i.e.

$$P_d = MPP \times 0.909\ P_r$$

where P_d is the demand price for parts, MPP is the marginal physical productivity of parts in radio production and P_r is the price of radios. The marginal utility generated by the parts is equal to

$$MU = MPP \times P_r = 1.1\ P_d$$

Thus again the demand price understates marginal utility by the proportion of the tax.

In summary we can state that the marginal utility of foreign exchange and hence its shadow price is reflected at any point in time by the average demand price adjusted for domestic indirect taxes of the goods, services, and financial assets on which the marginal unit of foreign exchange is spent. This average price will be the exact shadow price in a competitive economy and will be an underestimate in an economy with market imperfections.

It should further be noted that the shadow price of foreign exchange will vary over time with changes in the composition of foreign exchange expenditure and in import restrictions.

IV

In this section we will briefly take up the arithmetic of calculating the shadow price for foreign exchange for any point in time.

The basic building blocks are two: (i) the composition of marginal foreign exchange expenditure; and (ii) the demand prices for one dollar's worth of these imports. Weighting each element of (ii) (marginal utilities) by (i) (share in imports) we obtain the desired price:

$$U = \sum_i m_i P_i \qquad (1)$$

where U is the shadow price for foreign exchange, m_i is the marginal import share of commodity i, and P_i is the demand prices for one dollar's worth of commodity i.

If the binding import restrictions are tariffs and there is competition between importers, the domestic demand price for one dollar's worth of each commodity will equal the market exchange rate plus the tariff rate. In this case we can therefore transform the average of demand prices into an average of tariffs as follows:

Define:

t_i = ad-valorem tariff on commodity i
r = market-exchange rate[3]

then,

$$P_i = (1 + t_i)\, r \qquad (2)$$

Hence:

$$U = \sum_i m_i (1 + t_i) r = r(1 + \sum_i m_i t_i) \qquad (3)$$

3/ If there is more than one import exchange rate, the appropriate base of measurement is the average import exchange rate derived by using the marginal import shares, m_i, as weights.

If we now assume further that for small changes the marginal composition of imports is equal to the average, $\sum m_i t_i$ is the ratio of tariff collections [4] to outpayments of foreign exchange as can be seen from the following:

$$\sum_i m_i t_i = \sum_i \frac{M_i}{\sum M_i} t_i = \frac{1}{\sum_i M_i} \sum_i M_i t_i = \frac{\text{tariff revenue}}{\text{For. Exch. Expenditure}} \qquad (4)$$

It follows with this assumption, therefore, that for countries relying on tariffs, the shadow price of foreign exchange exceeds the market exchange rate by the ratio of tariff revenue to outpayments of foreign exchange.

For countries relying on quota or other restrictions a direct analysis of demand prices and import shares must be made and (1) above can be applied.

Formulas (1), (3) and (4) can be used with historical data to provide the starting point of a time series of the shadow price for foreign exchange. Later values can be built up from information on the intended policy to be followed. The simplest case of this kind would be one in which trade policy consists of (a) maintaining the real import exchange rate constant, and (b) having a 50% across the board tariff. As long as this policy is adhered to, the shadow price of foreign exchange will be 50% above the import rate. More complex policies would in theory require estimating the change in the composition of imports. This can be avoided, however, by estimating the tariff revenue directly. It may thus often be possible to define a usefully narrow range for the time profile on the basis of intended or likely policy.

Both the direct price calculation and the tariff calculation require adjustment for internal indirect taxes as discussed in the previous section. An estimate of this adjustment can be derived from aggregate indirect tax revenue and figures on gross national product and imports at landed prices (i.e. including duty) as follows:

Define: w_i = proportion of final demand spent goods sold by sector i

r_{ji} = direct and indirect requirement coefficient of sector i for inputs from sector j

v_i = gross value added coefficient of sector i (at factor cost).

m_i = import coefficient of sector j (at landed prices).

d_i = indirect tax coefficient of sector i.

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[4] In this context transfer taxes on capital items should be considered as tariffs.

Now, one banano of final demand of sector i's goods breaks down into primary inputs as follows:

$$1_i = \sum_j r_{ji}(m_j + v_j + d_j) \tag{5}$$

and one banano of final demand breaks down as follows:

$$1 = \sum_i \sum_j w_i r_{ji}(m_j + v_j + d_j) \tag{6}$$

reordering, we obtain

$$1 = \sum_j \sum_i w_i r_{ji}(m_j + v_j + d_j) \tag{7}$$

$$1 = \sum_j (m_j + v_j + d_j)\sum_i w_i r_{ji} = \sum_j (m_j + v_j)(1 + \frac{d_j}{m_j + v_j})\sum_i w_i r_{ji} \tag{8}$$

If we now think of each $m_j + v_j$ as one commodity and of $\sum_i w_i r_{ji}$ as the expenditure weights, we can conclude that the divergence between marginal utility and net demand price in each sector j is equal to $\frac{d_j}{m_j + v_j}$

The average understatement of the marginal utility of imports by the respective average demand price can now be written as

$$D_m = \frac{\sum_j \sum_i w_i r_{ji} m_j \frac{d_j}{m_j + v_j}}{\sum_j \sum_i w_i r_{ji} m_j} \tag{9}$$

Defining as estimator the ratio of indirect tax revenue to aggregate supply of goods, we have

$$\hat{D}_m = \frac{D}{M + V} = \frac{\sum_j \sum_i w_i r_{ji} d_j}{\sum_j \sum_i w_i r_{ji}(v_j + m_j)} \tag{10}$$

where D is indirect tax revenue, M is total imports at landed prices and V is domestic value added at factor cost

$\hat{D}_M$ will be an exact measure of D_M if the tax incidence is identical for all sectors, as in the case of a pure sales tax. Then

$$\frac{d_j}{m_j + v_j} = \frac{d_i}{m_i + v_i} = \frac{d}{m + v} \tag{11}$$

$$D_M = \frac{d}{m + v} \quad \frac{\sum_j \sum_i w_i r_{ji} m_j}{\sum_j \sum_i w_i r_{ji} m_j} = \frac{d}{m + v} \tag{12}$$

$$\hat{D}_M = \frac{d}{v + m} \quad \frac{\sum_j \sum_i w_i r_{ji}}{\sum_j \sum_i w_i r_{ji}} = \frac{d}{m + v} \tag{13}$$

Otherwise $\hat{D}_M$ will diverge from D_M, in a direction and amount dependent on the difference between each sectors contribution to imports and its contribution to total supply[5/] and the variance of the incidence.

Table 1 presents the ratio of the shadow rate of foreign exchange to the average import rate calculated for 48 countries[6/] on the basis of the following assumptions:

(i) tariffs are the binding constraint;

(ii) the marginal composition of imports is equal to the average.

(iii) $\hat{D}_M$ is a good estimator of D_M.

(iv) The fiscal data tabulated in the UN Statistical yearbook accurately reflects total government revenues from tariffs and indirect taxes and correctly classifies them as such.

Since in many countries quotas are binding, assumption (i) implies that the calculated figures are lower bounds. This is reinforced by assumption (iii) which implies assuming away revenue accrueing to other than the Central Government

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5/ For D_M, each incidence $\frac{d_j}{m_j + v_j}$ is weighted by $\frac{\sum_i w_i r_{ji} m_j}{\sum_{ji} \sum w_i r_{ji} m_j}$,

for $\hat{D}_M$ the weight can be written as $\frac{\sum_i w_i r_{ji} (m_j + v_j)}{\sum_j \sum_i w_i r_{ji} (m_j + v_j)}$

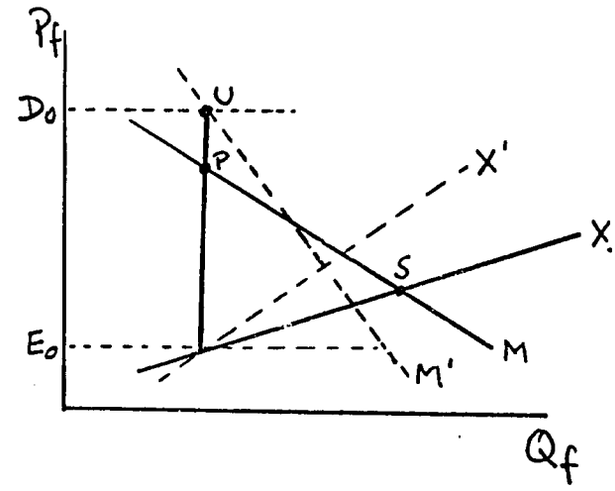
6/ The countries were selected on the basis of data availability.

and thus not tabulated in the Statistical Yearbook. Assumptions (ii) and (iii) can produce error in either direction but the magnitude is unlikely to reverse the consequences of the other two.[7]

In this section we will compare the shadow price just derived with the methodology suggested or used previously in the literature.

Shadow prices have variously been defined as prices at which supply is just sufficient to meet demand and as prices that correspond to the value of the marginal products of the resources in a perfect allocation situation. [8]

In the case of the shadow price of foreign exchange these definitions lead us to find the price that will equate supply and demand under free trade. With concurrent perfect internal allocation this can be graphically portrayed as follows:



In a two dimensional space relating Pf, the exchange rate, and Qf, the quantity of foreign exchange demanded or supplied, define M as the perfect allocation demand curve for imports and X as the perfect allocation supply curve of exports, and M' and X' as the respective curves given the disequilibria of the other factor markets. The prices of imports and exports can be assumed fixed without loss of generality.

Let us call E_o the official (overvalued) exchange rate, and let us assume that balance of payments equilibrium is maintained by levying an import duty of size E_oD_o.

7/ Some notion of the magnitude of understatement for countries relying heavily on quotas can be derived from results for Pakistan obtained by M.L. Pal (Pakistan Development Review, Winter 1964) who estimates the scarcity value of quotas at 40-50% of the landed price.

8/ Tinbergen, Op. Cit., p. 40; Chakravarty, Op. Cit., p. 50; Chenery, Op. Cit., p. 62.

The free market exchange rate would be S and hence that is the shadow rate of exchange that we are advised to use.

Due to the difficulty of calculating S it has been suggested that we use P instead, although recognising that this is a simplification that can be dispensed with in a more complicated computing algorithm whenever supply and demand elasticities are important. 9/

It is also generally accepted that the choice of a set of projects in period one will cause the demand and supply curve to shift and a different S to be applicable in period two, etc. ad infinitum. 10/ All these points S, however, share the property of clearing the market of foreign exchange in the absence of restrictions.

The approach we have adopted differs from the above in two essential respects:

(i) we assume full free trade will not be achieved during the relevant planning horizon

(ii) we recognize that perfect internal allocation will not be achieved for a considerable time, which in all likelihood exceeds the planning horizon.

The first of these differences implies that the demand and supply prices of foreign exchange will diverge during the planning period. As a consequence the equilibrium free-market clearing exchange rate becomes irrelevant both as a determinant of the volume of foreign exchange receipts and as an indicator of the marginal utility of imports.

The second difference implies that the relevant demand curve of foreign exchange is not the perfect allocation one, but one derived under the constraints of the prevailing factor market disequilibria.

In terms of the graph used earlier, we will find the shadow price of foreign exchange by reading off curve M' at the point corresponding to the amount for foreign exchange available. This point is denoted by U.

It should be noted that programming formulations operating with a fixed level of exports differ from our approach in their assumption of perfect domestic allocation. As a result, they lead to point P rather than U and imply import restrictions which differ from the ones actually in force.

9/ Chakravarty, Op. Cit., p. 57; H.B. Chenery and H. Uzawa, "Non Linear Programming in Development Planning," Arrow, Hurwicz & Uzawa, Studies in Linear and Non-Linear Programming.

10/ Chakravarty, Op. Cit., p. 51; Papanek and Qureshi, Op. Cit. p. 102.

VI

In this section we shall explore the implication for the import tariff structure of the close link between the shadow price of the foreign exchange and the level and structure of the duties included in such a tariff.11/

In sections II, III, and IV we have established that abstracting from capital flows, assuming tariffs are the binding import restrictions and marginal propensities to import equal the respective average propensities, the shadow price of foreign exchange is given by the market price adjusted for the average nominal import duty computed with own import weights.

On the other hand, under these assumptions, the domestic resource cost of earning a unit of foreign exchange in an activity is equal to the market exchange rate adjusted by the effective rate of protection. This can be seen from the following analysis:12/

The domestic cost of foreign exchange in an activity is defined as

$$B_{ii} = \frac{W_i}{P_i - M_i} \qquad (5)$$

Where W_i is the domestic value added under protection, P_i is the world market price of the commodity, M_i is the direct materials input at world market prices.

The effective rate of protection, in turn, is defined as

$$Z_i = \frac{W_i - V_i}{V_i} = \frac{W_i}{V_i} - 1 \qquad (6)$$

where V_i is domestic value added at world market prices.

By definition, the value of production under free trade is

$$rP_i = rM_i + V_i \qquad (7)$$

hence substituting (6) and (7) into (5) we obtain

$$B_{ii} = r\frac{W_i}{V_i} = r(1 + Z_i) \qquad (8)$$

If the market prices of domestic factors correctly represent opportunity cost, a uniform tariff will assure that the shadow price or marginal utility of foreign exchange be equal to the cost of producing foreign exchange in import substitution. This is the consequence of two factors:

11/ In this section nominal tariffs are taken to mean rates on the value of the product and effective tariffs are defined as rates of protection on value added.

12/ For a more extensive treatment Cf. Balassa and Schydlowsky, "Effective Tariffs, the Domestic Cost of Foreign Exchange, and the Equilibrium Exchange Rate," Journal of Political Economy, (forthcoming).

(i) with a uniform rate, the weighting of imports becomes irrelevant;

(ii) with a uniform rate, all effective rates are equal to the nominal rate. 13/

If the nominal rate is not uniform, however, we tend to find:

(i) imports concentrating on lower tariff items and hence a relatively lower marginal utility of foreign exchange.

(ii) domestic production concentrating on the higher tariff items which have an effective rate above their nominal rates. In consequence, we tend to have a cost of production of foreign exchange above its marginal utility.

If capital flows are considered, the shadow rate of exchange is affected by outpayments with zero import duties (i.e. interest, purchase of foreign securities, etc.). As a result, even with a uniform tariff, the shadow rate would be below the domestic resource cost of foreign exchange at market prices.

Counteracting the apparent waste of resources noted in the preceding paragraphs is the difference between market and shadow prices for domestic inputs. To the extent that domestic value added at shadow prices is smaller than domestic value added at market prices, the effective rate of protection overstates the domestic resource cost of foreign exchange. It follows that a differential tariff does not necessarily imply a welfare waste. The probability of such an undesirable result, however, is stronger the greater the differentiation of the tariff, and the greater the proportion of imports that come in under low or non-existent duties.

13/ Using an alternative and equivalent definition of the effective rate we have:

$$Z_i = \frac{t_i - \sum_j a_{ji} t_j}{1 - \sum_j a_{ji}}$$

where a_{ji} is the input coefficient of commodity j into commodity i under free trade. If $t_i = t_j$ for all j, then

$$Z_i = \frac{t_i - t_i \sum a_{ji}}{1 - \sum a_{ji}} = \frac{t_i(1 - \sum a_{ji})}{1 - \sum a_{ji}} = t_i$$

Table 1

Shadow Prices of Foreign Exchange

for Year 1965 1/

Country	Premium over Average Import Rate
Argentina	29.1%
Australia	11.3
Austria	16.6
Belguim	10.9
Bolivia	*13.9
Brazil	12.0
Canada	9.3
Ceylon	*25.2
Chile	21.3
Colombia	14.4
Costa Rica	15.7
Denmark	12.2
Dominican Republic	*31.2
Ecuador	26.9
El Salvador	13.2
Finland	16.9
Germany	12.6
Ghana	27.7
Greece	28.2
Honduras	16.8
India	41.5
Ireland 2/	20.0
Israel	17.6
Italy	*15.6
Japan	10.6
Kenya	13.6
Korea	11.3
Malaysia	12.9
Mexico	8.7
Netherlands	10.2
New Zealand	13.8
Norway	11.8
Pakistan	24.0
Panama	*10.4
Philippines	10.0
Portugal	* 9.9
South Africa	8.6
Spain	*16.7

Table 1 (cont.)

Country	Premium over Average Import Rate
Sudan	*26.9%
Sweden	14.1
Syria	15.7
Switzerland	11.0
Thailand	19.9
Turkey	28.5
United Kingdom	31.2
United States	7.9
Venezuela	5.2
Zambia	5.9

1/ Starred figures are for 1964.

2/ 1963 data used

Sources: United Nations Statistical Yearbook 1966
United Nations Yearbook of Trade Statistics 1966
United Nations Yearbook of National Accounts Statistics 1965
International Monetary Fund, Balance of Payments Yearbook, Vol. 18, 1965.