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Estimates of the Trade Effects of Tariff Preferences for Less Developed Countries

AID Summer Research Project

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December 1968

Estimates of the Trade Effects of Tariff Preferences for Less Developed Countries

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I. Introduction*

In this paper we attempt to estimate the trade effects of a fifty-per cent tariff preference extended by developed countries to all less developed countries. It should be recognized at the outset that any such estimate is subject to a wide margin of error. Given the state of our ignorance, however, estimates of the range of probable outcomes are useful, even if the upper and lower points of the range differ by a factor of, say, four.

The reasons for the large margin of error can be briefly sketched. In addition to the usual problems encountered in estimating the effects of most-favored-nation (MFN) tariff cuts, there are several special problems involved in the present attempt. First, since the tariff cut is preferential, we have to be concerned not merely with the displacement of domestic production by imports, but also with the substitution of one group of imports for another. We know even less about elasticities of substitution between different classes of imports than we do about import demand elasticities. Second, export supply elasticities are probably lower for less developed countries than for developed countries. The trade effects of tariff cuts become more sensitive to the precise value of supply elasticities as these elasticities become smaller. Investigators studying the effects of MFN tariff cuts (on

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trade in manufactured goods) have frequently assumed (long-run) supply curves to be perfectly elastic, an assumption which causes little error if supply elasticities are high relative to demand elasticities. Such an assumption would be dangerous in the case of LDC exports. Thirdly, in underdeveloped countries, shifts in supply curves (due to changes in technology, management, or government policies) are probably more important than they are in developed countries.

I have found no satisfactory solutions to these problems. Although I have developed a model which incorporates the substitution among different classes of imports as well as the substitution between imports and domestic production, I have to admit that the values assumed for the various elasticities of substitution are only very loosely grounded in empirical investigation. Furthermore, I have no empirical information on supply elasticities in less developed countries and can do no more than illustrate the implications of arbitrary assumptions. Finally, I can say nothing about the likely effects of preferences on shifts in the supply curves of LDC exports.

In section II of this paper, we present a brief look at the trade flows (in 1965) likely to be affected by a preference scheme. Section III is by far the longest section of the paper; it contains a theoretical discussion of the model employed to estimate the effects of trade preferences, a justification for our selection of particular values of the elasticity of substitution, and a sensitivity analysis of the model. The

special case of nonferrous metals is discussed in section IV and our numerical estimates of the effects of a 50-per cent tariff preference are presented in section V. Finally, there is a data appendix.

Parts of this paper are quite theoretical and will not be of interest to readers who merely want to know what the likely effects of preferences will be. I will offer this guide to the hurried reader. Section II is short and essential. In section III, the heart of the analysis is contained in sections A, B, C, F, and H. Sections D, E, G, I, and J are theoretical qualifications on the analysis. I'm afraid that even the central sections (A, B, C, F, and H) will be pretty tough going for non-economist readers; consequently I have added a section K which summarizes the absolutely essential points which the reader must have in mind when he reads the empirical results in section V. The section on nonferrous metals (section IV) is full of numbers but should not be difficult to understand.

II. A Brief Look at the Trade Flows

The f.o.b. value of all imports by the developed countries from less developed countries was $25.6 billion in 1965.[1] According to the UNCTAD definition of manufactures and semi-manufactures, developed country imports of these products were

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[1]Hal B. Lary, Imports of Labor-Intensive Manufactures from Less Developed Countries (New York: NBER, 1967), pp. 4-17 (in manuscript). Total LDC exports were around $8 billion higher (see UNCTAD Document TD/B/C.2/30/Add.1, 22 June 1967, p. 61).

$7.38 billion, valued c.i.f. (see Table 1). Of that 7.38 billion, 1.7 billion is petroleum products, which would probably not be included in a preference scheme. Another .678 billion is in processed agriculture, an area which might be included in a preference scheme and therefore needs investigation, but which has been omitted from the present study. There remains about 5 billion in products which will be included in this paper. 1.8 billion of that is in nonferrous metals, which because of the very large flows of trade in individual items and because of the distinguishing features of these products (notably the high degree of product standardization) will be treated in a separate section (section IV). The remaining 3.16 billion will be analyzed with a model which we shall develop in section III.

The present study includes imports of 2096 million out of the 3160 million in Table 1; in nonferrous metals we include 1506 million out of 1802 million. The reasons for the discrepancies are, first, our omission of importing countries other than the U.S., the U.K., the E.E.C., and Japan and second, our omission of certain products because either tariff or import data were not available on a four-digit SITC level.

An idea of the share of the U.S., the U.K., the E.E.C., and Japan in total developed country imports from LDC's can be obtained from some data on the imports of labor-intensive manufactures (see Table 2). These data differ from ours in being fob instead of cif and in being labor-intensive manufactures (as defined by Lary) instead of the UNCTAD definition

Table 1. Imports of Manufactures and Semi-Manufactures by Developed Countries from Less Developed Countries, 1965 (thousands of U.S. dollars, imports valued c.i.f.)

1.	Total manufactures and semi-manufactures	7380
2.	Processed agriculture (in SITC 0 and 1)	678
3.	Manufactured petroleum products (in SITC 3)	1740
4.	Nonferrous metals (SITC 68)	1802
5.	Total, less items 2, 3, and 4 above	3160

Note: The UNCTAD list of items regarded as manufactures and semi-manufactures has been used. The list is contained in Document TD/B/C.2/3, 2 July 1965.

Source for the above figures: UNCTAD Document TD/12/Supp.2, 13 October 1967, p.2 and Table 1.

Table 2. Imports of Labor-Intensive Manufactures from Less Developed Countries, by Importing Country, 1965 (thousands of U.S. dollars, imports valued f.o.b.)

Importing Country	
U.S.	1010
U.K.	429
E.E.C.	580
Japan	66
Total of above	2085
Total of Developed Countries	2427

Source: Hal B. Lary, op.cit., pp. 4-21 (in manuscript).

Note: Labor-intensive manufactures are defined by Lary in his book. Petroleum products and nonferrous metals are excluded but certain processed agricultural items are included.

of manufactures. The point of Table 2 is that the four listed developed areas account for 85% of the imports of labor-intensive manufactures from LDC's. Probably they account for a similar percentage of the 3.16 billion of manufactures in Table 1.

To round out the picture of LDC manufactured exports, mention should be made of the 2022 million (f.o.b.) of LDC exports to other LDC's, of which 1761 million corresponds (approximately) to the 3160 million of Table 1 and the remaining 261 million is nonferrous metals.[2]

III. The Model

A. Introduction

In order to predict the effects of tariff discrimination, as well as to understand other phenomena in international trade, it is important to relax the assumption, frequently made in partial equilibrium models of international trade, that imports and domestic consumption are one homogeneous commodity. While the homogeneous good assumption is not universal, I think it is fair to say it is the normal assumption in empirical work. For example, this assumption is employed by Balassa[3] when he derives his formula for expressing the import demand elasticity in terms of domestic supply and demand elasticities and market shares (of imports and domestic production). (Balassa is, however, quite aware of the lack of realism of this assumption;

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[2]These figures are from UNCTAD Document TD/B/C.2/30/Add.1, 22 June 1967, p. 61.

[3]Bela Balassa, Trade Liberalization among Industrial Countries (New York: McGraw-Hill, 1967), p. 59.

in one place, he makes allowance for product differentiation by adjusting the market shares. See pp. 189-190 in Trade Liberalization among Industrial Countries.)

When the price of an imported good declines, imports expand but the increase is limited by two factors: (a) the decline in price of the domestically produced good, and (b) the limited substitutability (if in fact imports and the domestic product are not identical in the eyes of consumers) between imports and domestic production. Models which rely on the homogeneous good assumption direct our attention to the supply elasticity of domestic production. And if we decide that this elasticity is very high then we can see no reason why a small decline in the import price should not lead to imports taking over a large share of the domestic market. Yet this does not seem in accord with our observations of the behavior of imports.

We shall now develop a model which explicitly considers the degree of product differentiation, or the elasticity of substitution between different goods. We shall first consider a two-good model, in which there is substitution between imports and domestic production. Later we shall introduce a third good, to allow for substitution between different sources of imports.

B. The Two-Good Case

All of our models start from the Slutsky equation, which in the case of two goods is as follows:[4]

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[4] Henderson and Quandt, Microeconomic Theory, p. 26, give the Slutsky equation in this form:

$$\frac{\partial q_1}{\partial p_1} = \left(\frac{\partial q_1}{\partial p_1}\right)_{u = \text{const.}} - q_1\left(\frac{\partial q_1}{\partial y}\right)_{\text{prices} = \text{const.}}$$

$$n_1 = h_2 s_{12} + h_1 \mu_1$$

where n_1 = the elasticity of demand for good 1 (a positive number)

---

[4](Cont.) We shall convert this into elasticity form. I define the price elasticities to be positive. We set all prices equal to 1 initially.

$$\frac{\partial q_1}{\partial p_1}\frac{p_1}{q_1} = \left(\frac{\partial q_1}{\partial p_1}\right)_{\bar{u}} \frac{p_1}{q_1} - q_1\left(\frac{\partial q_1}{\partial y}\right)_{\bar{p}} \frac{p_1}{q_1}$$

$$-n_1 = -\bar{n}_1 - \frac{\partial q_1}{\partial y}$$

where n_1 is the ordinary price elasticity of demand and $\bar{n}_1$ is the compensated elasticity.

$$n_1 = \bar{n}_1 + \left(\frac{y}{q_1}\frac{\partial q_1}{\partial y}\right)\frac{q_1}{y}$$

$$n_1 = \bar{n}_1 + u_1 \cdot h_1$$

Now we can show that, if p_1 changes while p_2 remains constant, $\bar{n}_1 = h_2 s_{12}$.

We have $\bar{n}_1 = -\dfrac{\partial q_1}{\partial p_1}\dfrac{p_1}{q_1}$

and $s_{12} = -\dfrac{\partial(q_1/q_2)}{\partial(p_1/p_2)}\dfrac{p_1/p_2}{q_1/q_2}$

Hence $\dfrac{s_{12}}{\bar{n}_1} = \dfrac{\partial(q_1/q_2)}{\partial q_1}\dfrac{\partial p_1}{\partial(p_1/p_2)}\dfrac{q_2}{1}$

If p_2 is constant, the term $\partial p_1/\partial(p_1/p_2)$ equals 1.

$$\frac{s_{12}}{\bar{n}_1} = \frac{q_2 - q_1\dfrac{\partial q_2}{\partial q_1}}{(q_2)^2}\frac{q_2}{1}$$

s_{12} = the elasticity of substitution between good 1 and good 2 (a positive number). (This elasticity is explained in footnote 5 below.)

μ_1 = the income elasticity for good 1 (usually positive).

h_1, h_2 = the shares of goods 1 and 2 in consumption. $(h_1+h_2=1)$.

In this two-good model, we shall be considering two goods, M (imports) and Y (domestic production). Their prices are P_m and P_y, and the elasticities in the Slutsky equation are n_m, n_y, μ_m, μ_y, and s_{my}, and the market shares are h_m and h_y. We shall express percentage changes in M and P by small letters:

$$\frac{\Delta P_m}{P_m} = p_m, \quad \frac{\Delta P_y}{P_y} = p_y, \quad \frac{\Delta M}{M} = m, \quad \frac{\Delta Y}{Y} = y$$

The Slutsky equation in this new notation is:

$$n_m = h_y s_{my} + h_m \mu_m$$

Now n_m is the percentage change in quantity divided by the percentage change in price, or

$$n_m = \frac{m}{-p_m}$$ (We write $-p_m$ to make n_m a positive number.)

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[4] (Cont.) Now the increase in expenditure on one product is equal to the decline in expenditure on the other. Since both prices are 1 initially, $\partial q_2/\partial q_1 = -1$.

Thus $$\frac{s_{12}}{\bar{n}_1} = \frac{q_2+q_1}{q_2} = \frac{1}{h_2}$$

Hence $\bar{n}_1 = h_2 s_{12}$.

and $n_1 = h_2 s_{12} + u_1 h_1$, which is the formula in the text.

Thus the Slutsky equation can be re-written:

$$m = -p_m h_y s_{my} - p_m h_m \mu_m$$

(Heuristic note: If P_m declines, $-p_m$ is a positive number. The increase in imports, m, is composed of a positive substitution effect and a positive income effect.)

This equation, expressing the change in imports as a function of a change in P_m, assumes that P_y has remained constant. P_y is likely to fall, however, as a result of the increased volume of imports.

If P_y changes, the effect on M can be expressed as follows:

$$m = +p_y h_y s_{my} - p_y h_y \mu_m$$

(Heuristic note: A negative p_y reduces m through a substitution effect and increases it through an income effect.)

Adding together the effects of changes in P_m and P_y, we have:

$$m = -p_m h_y s_{my} - p_m h_m \mu_m + p_y h_y s_{my} - p_y h_y \mu_m$$

Now this equation needs to be modified because it assumes that all of consumption is divided between M and Y, whereas the situation we have in mind is that M and Y are two varieties of a product (say shoes) which is itself only a small share of total consumption. In modifying the equation, we need to introduce some additional notation.

H_m, H_y = the shares of M and Y in total consumption.

H_o = the share of all other products in total consumption. $(H_m + H_y + H_o = 1)$.

h_m, h_y = these now refer to the shares of M and Y in the consumption of shoes. $(h_m + h_y = 1)$.

σ = the elasticity of substitution between shoes and all other goods.

p^* = the percentage change in the price of shoes. It is a weighted average of p_m and p_y; specifically $p^* = h_m p_m + h_y p_y$. (Since we shall assume that the price of all other products is unchanged, p^* also represents the relative change in the price of shoes.)

The equation can now be written:

$$m = -p_m h_y s_{my} - p_m H_m \mu_m + p_y h_y s_{my} - p_y H_y \mu_m - p^* H_o \sigma$$

In the income effect terms, h_m and h_y have been changed to H_m to H_y. For individual commodities, H_m and H_y are so small that we can safely ignore the income effect terms. They will be dropped from the equation.

We have added a term $-p^* H_o \sigma$, which represents the substitution of shoes for all other products. We are assuming that the two types of shoes have the same elasticity of substitution against all other products.

There is an equation for y analagous to the equation for m. The two are as follows:[5]

$$m = -p_m h_y s_{my} - p^* H_o \sigma + p_y h_y s_{my} \qquad (1)$$

$$y = -p_y h_m s_{my} - p^* H_o \sigma + p_m h_m s_{my} \qquad (2)$$

---

[5]Some readers are probably not familiar with the concept of elasticity of substitution. s_{my}, the elasticity of substitution between imports and domestic production, indicates the percentage change in the ratio M/Y resulting from a 1% change in the ratio P_m/P_y. Now if P_y stays constant, p_m, the percentage change in P_m, measures the percentage change in the ratio P_m/P_y. Consider an example. If P_m falls by 10% (p_m = -.10), and s_{my} is 5, then M/Y will rise by 50%. If initially M/Y=20/80=.25, then M/Y will rise to .375, which implies that M=28 and Y=72.

Now it can be shown that the percentage increase in M is $(-p_m)h_y s_{my}$. In the above example, we have (.10) (.80) (5) = 40%. Increasing 20 by 40% gives 28, as above.

These are the two demand equations. Let us suppose that the price changes are brought about by a tariff cut. We can then write equations for the price changes in terms of supply elasticities.

$$p_m = \frac{\Delta t}{1+t} + \frac{m}{(1+t)e_m} \qquad (3)$$

$$p_y = \frac{y}{e_y} \qquad (4)$$

The second equation follows immediately from the definition of the supply elasticity ($e_y = y/p_y$). The first can be explained with the aid of a graph (see Fig. 1).

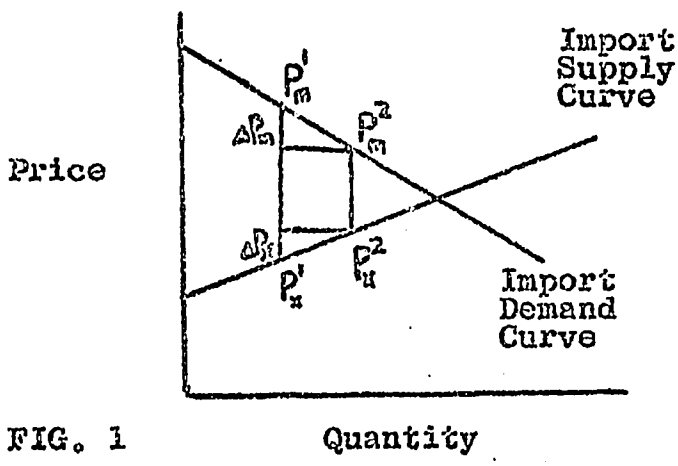

FIG. 1

P_m^1 represents the initial import price, P_x^1 the price received by exporters, and $P_m^1 - P_x^1$ is the initial tariff. P_m^2 and P_x^2 represent the situation after the tariff cut. The change in the tariff equals the reduction in the import price plus the rise in export price.

$$-\Delta P_m + \Delta P_x = -\Delta t \qquad (5)$$

---

[5](Cont.)Now if both P_m and P_y change, it is permissible to consider their effects separately. The percentage increase in M resulting from a decline in P_m is $(-p_m)h_y s_{my}$ and the percentage increase in M resulting from a rise in P_y is $(p_y)h_y s_{my}$. [See equation (1).] If $p_m = p_y$, the two expressions will cancel and M will be unchanged. This is the same answer we get when we multiply s_{my} by the change in P_m/P_y: If $p_m = p_y$, P_m/P_y is unchanged, and so, therefore, is M/Y.

($-\Delta P_m$ and $-\Delta t$ are positive numbers.) We arbitrarily set $P_x^1 = 1$, so $P_m^1 = P_x^1(1+t) = 1+t$. We divide equation (5) through by P_m^1.

$$-\frac{\Delta P_m}{P_m^1} + \frac{\Delta P_x}{P_x^1(1+t)} = \frac{-\Delta t}{P_x^1(1+t)}$$

$$-p_m + \frac{p_x}{1+t} = -\frac{\Delta t}{1+t}$$

$$p_m = \frac{\Delta t}{1+t} + \frac{p_x}{1+t}$$

Now $p_x = \frac{m}{e_m}$. Hence:

$$p_m = \frac{\Delta t}{1+t} + \frac{m}{(1+t)e_m}$$

We substitute the supply equations (3) and (4) into the demand equations (1) and (2). After some algebraic manipulation (which will not interest most readers), we obtain the following:[6]

$$a_{11}m + a_{12}y = W_1$$

$$a_{21}m + a_{22}y = W_2$$

where the a's and the W's can all be expressed in terms of the parameters s_{my}, σ, the h's, the e's, and the tariff changes. With two equations we can solve for the two unknowns m and y.

---

[6]For interested readers, the coefficients are as follows:

$$a_{11} = 1 + \frac{h_y s_{my} + h_m H_o \sigma}{(1+t)e_m}$$

$$a_{12} = -\frac{h_y s_{my} - h_y H_o \sigma}{e_y}$$

C. The Estimation of the Parameters

In using the equations we have just derived, we can assume that m is known and let one of the items which we have called paramters be an unknown. (We shall let the unknown parameter be either s_{my} or e_y.) We shall in effect assume that m is known by assuming that we know the elasticity of import demand and the size of the tariff cut (e.g. a $\Delta t/(1+t)$ of -.10 and an elasticity of 4 determines m at .40). Following Balassa, who has reviewed the literature on this subject, we shall assume the U.S. elasticities are 4.12 for finished manufactures and 1.63 for semi-manufactures.

Finished manufactures. The h_m and h_y can in principle be calculated for each commodity. Let us suppose that h_m for the finished manufactured commodity we are considering (we'll call it shoes) is 0.20. The elasticity of substitution, σ, between shoes and all other commodities will be assumed to be 0.5. H_o, the share of all other products in total consumption, will be assumed to be .99. $H_o\sigma$, which for practical purposes is the same as σ, is the elasticity of demand for shoes.

Given these assumed values, we can calculate pairs of values of s_{my} and e_y which will be compatible with the elasticity of import demand of 4.12. Table 3 gives some

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[6] (Cont.)

$$a_{21} = -\frac{h_m s_{my} - h_m H_o \sigma}{(1+t)e_m}$$

$$a_{22} = 1 + \frac{h_m s_{my} + h_y H_o \sigma}{e_y}$$

$$W_1 = \frac{-\Delta t}{1+t}(h_m s_{my} + h_m H_o \sigma)$$

$$W_2 = \frac{\Delta t}{1+t}(h_m s_{my} - h_m H_o \sigma)$$

Table 3. Alternative Estimates of the Elasticity of Substitution (s_{my}) between Imports and Competing Domestic Production -- Finished Manufactures

(The elasticity of import demand is assumed to be 4.12.)

			Values of s_{my} if e_y equals			
$H_o\sigma$	h_m	h_y	1.0	2.0	4.0	∞
.5	.20	.80	11.91	7.59	6.16	5.03
.2	.20	.80	26.93	9.04	6.59	5.10
.5	.25	.75	23.96	9.71	7.08	5.32

examples of acceptable pairs of s_{my} and e_y. Two such pairs are (e_y=2.0, s_{my}=7.59) and (e_y=4.0, s_{my}=6.16).

We really don't have a very precise idea of what e_y might be. But for finished manufactures, there is good reason to think it is large. And as long as e_y is large, it turns out that s_{my} is not very sensitive to its precise value. For example, in the case we are considering, if e_y varies between 2.0 and infinity, s_{my} must lie between 7.59 and 5.03. As will become clear in subsequent sections of this paper, s_{my} is the crucial variable for determining the trade effects of tariff preferences.

We have explained how one could derive estimates of s_{my} for a single commodity if its elasticity of import demand were known. In fact, we don't have estimates of import demand elasticities for individual commodities, but only for broad aggregates--finished manufactures and semi-manufactures.

We shall make the assumption that s_{my} is the same for all finished manufactured commodities. To estimate this common s_{my}, we need the average h_m for finished manufactures. I have calculated the average b_m (weighted by imports) to be .201 (methods are given in the Data Appendix). Thus the example we have been considering contains the appropriate numbers for the average of finished manufactures. We shall pick e_y=4.0, which gives s_{my}=6.16. Table 3 shows how our estimated s_{my} would be altered if the underlying parameters were changed.

Semi-Manufactures. In principle we could follow the same procedure in semi-manufactures as we did in finished manufactures--pick an e_y and derive the s_{my} compatible with the e_y and Balassa's figure for the import demand elasticity, which is 1.63 for semi-manufactures. I did not follow this procedure because in the case of semi-manufactures the value of s_{my} is very sensitive to the assumed value of e_y.

Instead I simply assumed that s_{my} for semi-finished is the same as for finished manufactures, namely 6.16. I think this is an underestimate, since semi-manufactures are more standardized than finished manufactures, but this procedure provides a reasonable minimum estimate of s_{my}. I can see no way of picking another number without being completely arbitrary.

With s_{my}=6.16, and assuming σ, the elasticity of substitution between the commodity in question and all other commodities, to be 0.2, and employing Balassa's figure of 1.63 for the import demand elasticity, and using the fact that the average h_m for semi-manufactures was calculated (see Data Appendix) to be .27, we can derive the implied e_y. This turns out to be .59, which seems to be a reasonable value for e_y. Alternative assumptions about h_m and σ lead to different values of e_y, as shown in Table 4.

In the case of one semi-manufactured product, nonferrous metals, we adopted the homogeneous product assumption because it seemed to fit the nature of the commodity. This product, which forms a substantial fraction of LDC exports of manufactures and semi-manufactures, will be treated in a separate section.

Table 4. Alternative Estimates of the Elasticity of Supply of Domestic Production (e_y) -- Semi-Finished Manufactures

(The elasticity of import demand is assumed to be 1.63)

H_o^σ	h_m	h_y	s_{my}	Values of e_y
.2	.27	.73	6.16	.590
.1	.27	.73	6.16	.765
.2	.22	.78	6.16	.382

Parameters for other countries. The parameters assumed for the developed countries other than the U.S. are given in the table below. The values assumed for the U.S. are listed for comparison.

	U.S.	E.E.C., U.K., and Japan
Semi-Manufactures		
s_{12}	6.16	4.0
$e_2=e_3=e_4$	1.5	1.5
e_5	.59	.30
Finished Manufactures		
s_{12}	6.16	4.0
$e_2=e_3=e_4$	6.0	6.0
e_5	4.0	2.0

Information on the shares of imports in domestic consumption for the E.E.C., U.K., and Japan are not available on a systematic basis. The United States has undertaken a considerable statistical effort in this field which we have been able to employ, but the other developed countries have yet to do the basic statistical work. As a substitute procedure, I tried estimating the import share for SITC groups for each of the other areas by assuming that domestic consumption of each article bore the same relation to GNP in each area. That is, if textile consumption in the U.S. were x times as large as U.S. GNP, the same relationship would hold in the U.K. Since imports of textiles by the U.K. are known, the import-consumption ratio could be calculated. This procedure had to be abandoned, because in a large fraction of

the cases (I believe nearly half) the estimated consumption turned out to be smaller than imports. I'm inclined to believe that the main reason the technique breaks down is that the import categories of the United States are not fully comparable with those of other countries. Of course there are in addition differences in consumption patterns among industrial countries, but I think that these differences are insufficient to account for the failure to obtain reasonable values for the import shares.

In the absence of any other information, I followed Balassa in assuming the import-consumption ratios to be .40 for the United Kingdom and .333 for the Common Market and Japan. These were assumed to be the same for all commodities.

These import shares, together with the values given earlier, imply the following import demand elasticities:

	Finished	Semi-Finished
U.K.	1.85	.76
E.E.C. and Japan	2.11	.94

D. Compatibility of Our Estimates of the Elasticity of Substitution with Econometric Estimates in the Literature

We have decided to use s_{my}=6.16 for both finished and semi-finished manufactures. Actually our reasoning could be used in support of the contention that s_{my} is even higher for semi-finished manufactures and hence the weighted average for all manufactures would be above 6.16. Since there is no reason to suppose that s_{12}, the elasticity of substitution between imports from two different sources, is any smaller than s_{my}, we have assumed s_{12} to be 6.16 also.

Yet the available econometric estimates of s_{12} are generally below 6.16. Table 5 gives some recent estimates of the average elasticity of substitution between alternative sources of imports for all manufactures for the major industrial countries.

The incompatibility, however, is only apparent. The estimates given in the table are for all manufactures together. But we are interested in elasticities for commodities on quite a disaggregated level (4-digit SITC). Because there is a substantial downward aggregation bias, an s_{12} of 6.16 on the 4-digit SITC level is compatible with a considerably lower elasticity for all manufactures.

The aggregation bias can be explained most easily with an example, which we shall take, with minor modification, from MacDougall.[7] Consider the substitution between American and British exports in third markets. Assume for expositional convenience that the combined exports of the two countries are constant. There are only two products: Britain exports 99 yards of cloth and 1 radio, while the U.S. exports 99 radios and 1 yard of cloth. Suppose both British prices fall by 1%, and that s_{12} for each product separately is 6. What happens to the volume index of British exports? It increases very little because cloth exports rise only from 99 to 99.06 (the ratio of British to American exports rises by 6%, from 99/1

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[7]G. D. A. MacDougall, "British and American Exports: A Study Suggested by the Theory of Comparative Costs, Part II," Economic Journal, Vol. 62, No. 247 (September, 1952), p. 493 and Appendix C.

Table 5 Elasticities of Substitution between Imports from Alternative Sources of Supply, All Manufactures, Averages for Major Industrial Countries

Author	Adjustment Period	Elasticity
Junz & Rhomberg 1965	4 yrs.1/	5.5 (third set of equations)3/
	4 yrs.1/	3.0 (second set of equations)3/
	2 yrs.2/	3.3 (third set of equations)
	2 yrs.2/	1.9 (second set of equations)
Kreinin, 1967	2 yrs.2/	2.6

1. These estimates are based on changes occurring between periods whose midpoints are about 4 years apart.
2. These estimates are based on changes occurring between periods whose midpoints are 2 years apart.
3. There is a difference in specification between the second and third set of equations in the Junz and Rhomberg article.

Sources: H.B. Junz and R.R. Rhomberg, "Prices and Export Performance of Industrial Countries, 1953-63," IMF Staff Papers, July 1965, pp. 224-271; Mordechai E. Kreinin, "Price Elasticities in International Trade," Review of Economics and Statistics, vol. 49 no. 4 (Nov. 1967), pp. 510-516.

to 99.06/0.94). British radio exports rise from 1 to 1.06, but since cloth dominates British exports, the export volume index rises by only 0.12%.

What happens to the volume index of U.S. exports? It decreases very little because radios dominate U.S. exports and they decline very little. Thus the ratio of the two volume indexes changes very little, and the elasticity of substitution for aggregate exports is much smaller than 6, the elasticity for each product.

The relationship between the elasticity of substitution for aggregate exports (S) and the elasticity for each product (s) can be expressed with MacDougall's formula:

$$S = s\left[\frac{\Sigma V_a^i B}{\Sigma V_a^i} + \frac{\Sigma V_b^i A}{\Sigma V_b^i}\right]$$

Where

V_a^i, V_b^i = Value of American (a) and British (b) exports.

A, B = proportion of market (in terms of quantity) held by American (A) and British (B) exports.

The term in brackets is called the Index of Similarity of Exports. If the pattern of exports is identical in the two countries the index is unity; if the patterns are completely different, it is zero. The derivation of this formula is given in MacDougall's Appendix C.

I am not prepared to make any estimates of the probable magnitude of the downward aggregation bias. Therefore I

cannot use the Junz and Rhomberg figures to make estimates of s_{12} at the 4-digit level. The purpose of this section has been merely to show that the Junz and Rhomberg figures are not necessarily inconsistent with our assumed s_{12} of 6.16.

E. Digression on Effective Protection

We shall be using nominal tariff rates instead of effective rates to estimate the effects of tariff preferences. In view of all of the attention that has recently been focused on effective rates, our use of nominal rates may seem to be a serious shortcoming of the study. However, the calculation of effective protective rates is less important for our study than for certain other studies. Preferences will probably have only a limited impact on product prices in the developed countries. This is partly because of the small share of LDC products in developed country markets. But it is also because we are dealing with differentiated products. In a differentiated product market, the price of the LDC article in the developed country may fall by the full extent of the tariff cut, but the weighted average of product prices will hardly change.

This has important implications for effective protection. It means, for example, that a preference on leather will not have much effect on the effective rate of protection for shoes.

If we can ignore the changes in the leather tariff in analyzing the effects of a preference scheme on shoes, then it is no longer necessary to calculate effective rates of protection; the impact of tariff changes can then be correctly analyzed with the nominal tariff rate.

Let us see why this is so. Effective protection theory[3] says that the response of domestic producers to a tariff change is given by the percentage change in the price of value added (p_v) multiplied by the elasticity of supply of value added (e_v), or (p_v) (e_v). Effective protection theory assumes that inputs are available in perfectly elastic supply; on this assumption the elasticity of supply of the product (e_y) equals e_v/v, where v is the value added share.

If input tariffs (and hence input prices) do not change, p_v equals the percentage change in the product price (p) divided by v. Thus we can replace

$$(p_v)(e_v) \text{ by } (\frac{p}{v})(e_v) \text{ or } p(e_y)$$

Since we don't have to deal with the price of value added, we don't have to calculate effective rates of protection.

There are certainly some products for which it is very important to know the tariff structure in order to predict the effects of preferences. These would be commodities for which the input prices in the developed countries would be significantly affected by a preference scheme; such commodities would tend to be homogeneous products or products in which the LDC's have a substantial share in developed country markets. Both these descriptions fit nonferrous metals and in the section on them we do look at tariffs on inputs. In all other commodities we have ignored the tariff structure.

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[3]See B. Balassa, "Tariff Protection in the Industrial Countries: An Evaluation," Journal of Political Economy, Vol. 73, No. 6 (Dec. 1965), pp. 573-94.

F. The Three-Good Case

In order to employ our model to predict the effects of trade preferences, we need to include at least three goods--imports from the preference-receiving countries (M_1), imports from other countries (M_2), and domestic production (M_3). The extension from two to three goods is quite straightforward. The demand equations are as follows:

$$m_1 = -p_1(h_2s_{12}+h_3s_{13}) - p^*(H_o\sigma)+p_2h_2s_{12}+p_3h_3s_{13}$$

$$m_2 = -p_2(h_1s_{12}+h_3s_{23}) - p^*(H_o\sigma)+p_1h_1s_{12}+p_3h_3s_{23}$$

$$m_3 = -p_3(h_1s_{13}+h_2s_{23}) - p^*(H_o\sigma)+p_1h_1s_{13}+p_2h_2s_{23}$$

The supply equations are:

$$p_1 = \frac{\Delta t}{1+t} + \frac{m_1}{(1+t)e_1} \qquad p_2 = \frac{m_2}{e_2} \qquad p_3 = \frac{m_3}{e_3}$$

And by substituting the supply equations into the demand equations to eliminate the p's, we obtain this set of equations:[9]

$$a_{11}m_1 + a_{12}m_2 + a_{13}m_3 = W_1$$

$$a_{21}m_1 + a_{22}m_2 + a_{23}m_3 = W_2$$

$$a_{31}m_1 + a_{32}m_2 + a_{33}m_3 = W_3$$

As before, we can solve these three equations for m_1, m_2, and m_3.

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[9]The coefficients are:

$$a_{11} = 1 + \frac{D_1+h_1(H_o\sigma)}{(1+t)e_1} \quad \text{where } D_1=h_2s_{12}+h_3s_{13}$$

$$a_{22} = 1 + \frac{D_2+h_2(H_o\sigma)}{(1+t)e_2} \qquad D_2=h_1s_{12}+h_3s_{23}$$

$$a_{33} = 1 + \frac{D_3+h_3(H_o\sigma)}{(1+t)e_3} \qquad D_3=h_1s_{13}+h_2s_{23}$$

G. Comparison with Other Models[10]

It is interesting to compare our model with the Dutch model of trade liberalization.[11] The model has been employed by others, including L. B. Krause in his recent book on European economic integration.[12]

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[9](Cont.)

$$a_{21} = \frac{-h_1\Phi_{12}}{(1+t)e_1} \qquad a_{12} = \frac{-h_2\Phi_{12}}{e_2} \qquad a_{13} = \frac{-h_3\Phi_{13}}{e_3}$$

$$a_{31} = \frac{-h_1\Phi_{13}}{(1+t)e_1} \qquad a_{32} = \frac{-h_2\Phi_{23}}{e_2} \qquad a_{23} = \frac{-h_3\Phi_{23}}{e_3}$$

where $\Phi_{ij} = s_{ij} - H_o\sigma$

$$W_1 = \frac{-\Delta t}{1+t}\,[D_1 + h_1(H_o\sigma)] \qquad W_2 = \frac{\Delta t}{1+t}\,(h_1\Phi_{12}) \qquad W_3 = \frac{\Delta t}{1+t}\,(h_1\Phi_{13})$$

[10]This section is not intended for lay readers.

[11]This model has been presented in several publications of P. J. Verdoorn. The one I employed is "The Intra-Bloc Trade of Benelux," pp. 291-329 in E. A. G. Robinson, ed., The Economic Consequences of the Size of Nations (New York: St. Martin's, 1960). The Dutch model has been ably presented and analyzed in L. H. Janssen, Free Trade, Protection and Customs Unions (Leiden, 1961).

[12]Lawrence B. Krause, European Economic Integration and the United States (Washington: The Brookings Institution, 1968).

Verdoorn deals as we do with the market for a particular commodity. He also assumes all supply curves to be flat. Thus when a country reduces tariffs on M_1 (the imports of a partner in a customs union) while retaining the tariff on nonmember imports (M_2), P_1 is the only price which changes. The elasticity of demand resulting from such a tariff change can be expressed as follows:

$$e_1 = q_1\Sigma + q_2\beta$$

where e_1 = the elasticity of demand for M_1

Σ = the import elasticity of demand

β = the elasticity of substitution between M_1 and M_2

q_1, q_2 = the shares of M_1 and M_2 in total imports. ($q_1 + q_2 = 1$)

(Verdoorn treated e_1, Σ, and β as negative numbers. I have treated them here as positive numbers.)

Since $e_1 = m_1/(-p_1)$, we can write

$$m_1 = -p_1q_1\Sigma - p_1q_2\beta. \qquad (5)$$

Verdoorn thought of this equation in this way: M_1 increases along with all imports (note that p_1q_1 is the weighted average reduction in the price of all imports), and M_1 also increases by being substituted for M_2. Verdoorn assumed that $\Sigma = .5$ and $\beta = 2.0$.

We shall try to reconcile the Dutch model with our own. Wherever possible, we shall use the same notation in the two models. First, let us see how our model looks when we assume, with Verdoorn, that all supply curves are flat. Our demand equation becomes

$$m_1 = -p_1(h_2s_{12} + h_3s_{13}) - p^*(H_o\sigma). \qquad (6)$$

(We are ignoring income effects because $(1-H_o)$ is assumed to be negligible.) We can immediately see a certain similarity between the two models. m_1 and p_1 have the same meaning in both (5) and (6). The term $-p_1q_2\beta$ from the Dutch model seems to correspond to our term $-p_1(h_2s_{12}+h_3s_{13})$, with β corresponding approximately to s_{12} and s_{13}. The term $-p_1q_1\Sigma$ in (5) seems to correspond to our term $-p^*(H_o\sigma)$, with both Σ and $H_o\sigma$ representing a demand elasticity and both p^* and p_1q_1 representing a weighted average of prices.

We can make the two models completely consistent by assuming, in our model, that $h_3=0$, or in other words, that there is no domestic production of the article competitive with imports. Such a model might apply, for example, to U.S. imports of arabica and robusta coffee. Both β and s_{12} would represent the elasticity of substitution between the two types of coffee and both Σ and $(H_o\sigma)$ would represent the elasticity of demand for coffee. With h_3 equal to zero in our model, $h_1+h_2 = 1$, and h_1 and h_2 would correspond exactly to q_1 and q_2. In our model, $p^*=h_1p_1$, and this corresponds exactly to p_1q_1. Thus, under the assumption that h_3 equals zero, all the terms in (5) have exact counterparts in (6), and the two models would give identical results. This interpretation of the Dutch model makes it a special case of our model, and a special case which would not seem applicable to most finished manufactures.

Verdoorn's model, however, is subject to another interpretation, which is probably closer to the thinking of Verdoorn and others who have employed his model. In comparing (5) and (6), we might consider the correspondence between β and s_{12}, and

between Σ and h_3s_{13}. Our term $p^*(H_o\sigma)$ would have no counterpart in the Dutch model under this interpretation. Let us assume in our model, then, that $\sigma=0$, i.e. that the substitution between the commodity in question (call it shoes) and all other goods is negligible. Making the same assumption in the Dutch model, we can interpret Σ as h_3s_{my} where s_{my} is the elasticity of substitution between imports and domestic production; both Σ and h_3s_{my} represent the import demand elasticity.

But even in this special case, the two models are still different. And the difference turns out to be a very fundamental one. Let us write down the two equations, using s_{12} in place of β since they represent the same concept.

$$m_1 = -p_1(q_2s_{12}) - p_1q_1(h_3s_{my}) \qquad (5a)$$

$$m_1 = -p_1(h_2s_{12}) - p_1(h_3s_{13}) \qquad (6a)$$

The terms q_2s_{12} and h_2s_{12} both represent substitution of M_1 against M_2, but the two models give different answers. Since $q_2 \geq h_2$, trade diversion in our model is smaller than or equal to diversion in the Dutch model. In general, trade creation will be different in the two models, too.

Thus the two models give different results, and this is because they represent two different views of consumer behavior. I think the Dutch model is probably more applicable in certain situations and our model is more applicable in others. An example where the Dutch model would be applicable is where M_1 and M_2, the two imported products, are two varieties of a certain type of shoe, say sandals. Y, domestic production, consists of other types of shoes. Consumers treat sandals as

a "bundle"; when P_1, the price of one variety of sandal, goes down, consumers substitute against M_2 according to the term $-p_1(q_2s_{12})$. Then they substitute all sandals against other types of shoes, according to the term $-p_m(h_3s_{my})$, where P_m refers to the price of all sandals. Since only P_1 is assumed to change, $p_m=p_1q_1$, and the term becomes $-p_1q_1(h_3s_{my})$.

Of course a model of consumer behavior doesn't imply anything about what goes on in the consumers' minds. But in the absence of empirical data, perhaps it will prove useful to fall back on introspection. I suggest that in the case of a good like sandals, consumers consciously compare different varieties of sandals, while they are much less likely to compare consciously a sandal with another type of shoe. This line of reasoning also suggests that s_{12} would be higher than s_{my}. (Recall that in Verdoorn's applications of the Dutch model, he sets $s_{12}=2.0$ and Σ, or h_3s_{my}, equal to 0.6.)

In the case where M_1, M_2, and M_3 are three different varieties of shoes which are considered together by the typical consumer, our model rather than the Dutch model might be more applicable. In our model, a decline in p_1 leads to substitution against M_2 (the term $-p_1h_2s_{12}$) and against M_3 (the term $-p_1h_3s_{13}$) in symmetrical fashion. It does not seem to be necessary, however, for s_{12} and s_{13} to be equal.

While the two models are conceptually different and give different results under most circumstances, there is a special case in which the two models give the same results for m_1. This case is the one in which $s_{12}=s_{13}$ and $s_{12}=s_{my}$. Under these

assumptions, we can write equations (5a) and (6a) as follows:

$$m_1 = -p_1(q_2+q_1h_3)s_{12} \qquad (5b)$$

$$m_2 = -p_1(h_2+h_3)s_{12} \qquad (6b)$$

It can be shown that $(q_2+q_1h_3)$ equals (h_2+h_3).
(Note first that $h_3 = 1 - (h_1+h_2)$.):

$$q_2 + q_1h_3 = \frac{h_2}{h_1+h_2} + \frac{h_1[1-(h_1+h_2)]}{h_1+h_2} = \frac{h_2+h_1-h_1(h_1+h_2)}{h_1+h_2}$$

$$= 1 - h_1, \text{ which equals } h_2+h_3.$$

Therefore m_1 has the same value in 5b and 6b.

Even in this case of $s_{12}=s_{13}=s_{my}$, however, the two models give quite different estimates of trade creation and trade diversion. The trade diversion and trade creation for illustrative values of imports shares are shown in the table below:

Value of $(m_1/-p_1)$

		Total	Dutch Model		Our Model	
q_1	q_2		Diversion	Creation	Diversion	Creation
.1	.9	5.88	5.40	.48	1.08	4.80
.4	.6	5.52	3.60	1.92	.72	4.80
.9	.1	4.92	.60	4.32	.12	4.80

Note: $s_{12}=s_{13}=s_{my}=6$. $h_3=.8$

The Dutch model gives higher estimates of trade diversion and lower estimates of trade creation than our model.

We have two models of consumer behavior--we must decide which to use.

I have opted for our model rather than the Dutch model, but without a convincing justification for the choice. I'm rather attracted to the "bundle" model as a explanation of consumer behavior, but casual observation suggests to me that one cannot identify our imports in given commodity categories as bundles. That is, for bundles such as sandals, men's sport shirts, motorcycles, toys for 3-year-olds, carpets, and tennis rackets, part of domestic consumption is imported and part is produced domestically. I suggest this is the case for most bundles. Since the bundle model doesn't seem to apply, I use our model.

H. The Five-Good Model; Sensitivity to Parameters

The five-good model is exactly analagous to the three-good model. This is the model we shall employ in section V to estimate the effects of preferences. We use a model with as many as five goods because it is desirable to separate the following types of suppliers: less developed countries not now receiving preferences, less developed countries now enjoying preferences (these countries of course face possible losses of exports as the preferential tariffs they receive are extended to competitive suppliers), low-wage developed countries whose products are especially competitive with those of LDC's (in these categories we include Japan, Spain, and Portugal), other developed countries, and domestic suppliers in the country granting preferences.

The demand equations, the supply equations, and the solution are very similar to those in the three-good model and

are not repeated here. What we shall do in this section is to show the sensitivity of the model to changes in the parameters.

Below is a list of the variables employed in the model.

h_1, h_2, h_3, h_4 = the shares of shoe imports from (1) less developed countries not now receiving preferences, (2) less developed countries now enjoying preferences, (3) Portugal, Spain, and Japan, and (4) other developed countries in total (U.S.) consumption of shoes.

h_5= the share of domestic suppliers in U.S. consumption of shoes.

M_1, M_2, M_3, M_4, M_5= the quantities of imports and of domestic production.

s_{ij}= the elasticity of substitution between M_i and M_j.

σ= the elasticity of substitution between shoes and all other goods.

e_1, e_2, e_3, e_4 = the elasticity of export supply

e_5= the elasticity of supply of domestic production.

m_1, m_2, m_3, m_4, m_5= the percentage change in M_1, M_2, M_3, M_4, and M_5.

Trade diversion is the total loss of exports by sectors 2, 3, and 4, or $\Delta M_2 + \Delta M_3 + \Delta M_4$, which equals $M_2m_2 + M_3m_3 + M_4m_4$. Trade creation is the increase in M_1 minus the trade diversion, or M_1m_1-(trade diversion). (Trade creation slightly exceeds the decline in domestic production, M_5m_5, because there is some substitution of shoes for all other goods.) The trade creation ratio (TCR) and the trade diversion ratio (TDR) are defined respectively as the trade creation and trade diversion each divided by the initial level of M_i. From this it follows that m_1=TCR+TDR.

Table 6 shows m_1, TCR, and TDR under alternative sets of parameters. Throughout, we assume an initial tariff level of 25% which is cut in half for preference-receivers. For the moment we assume no supply constraint in the less developed countries. This assumption, which will be relaxed in the next section, enables us to ignore the effects of U.S. preferences on LDC trade with other countries.

In Table 6, a blank space indicates that the value of the parameter has not changed from the previous observation. The "standard assumption" for finished manufactures is given in observation 2. All s's are 6.16, $\sigma = .5$, $e_5 = 4$, and the other parameters are as shown in the table. Observations 1-3 show that m_1 is not very sensitive to variations in e_5 between 2 and 100. The comparison of observation 4 with observation 2 shows that m_1 is very insensitive to σ. Observation 5 shows the insensitivity of m_1 to e_2, e_3, and e_4. In each of the above cases, TDR shows considerable sensitivity to the parameter changes. Observations 6 and 7 show that m_1 is indeed sensitive to the s's.

The "standard assumption" for semi-manufactures is given in observation 22. Observations 21 to 27 show that m_1 for semi-manufactures is not very sensitive to changes in e_5, σ, and e_2, e_3, and e_4, but it is sensitive to the s's.

To summarize this section, we can say that m_1 is sensitive only to the s's, but that trade creation and trade diversion are sensitive to the other parameters as well.

TABLE 6

Tariff Preferences: Sensitivity of Results to Changes in Parameters

Observation	Parameters													Calculated Results		
	h_1	h_2	h_3	h_4	h_5	s_{12}	All Other s's	σ	e_1	e_2	e_3	e_4	e_5	m_1	TCR	TDR
1	.02	.01	.05	.12	.80	6.16	6.16	.5	1000	6	6	6	2	.581	.440	.141
2													4	.588	.480	.108
3													100	.599	.542	.058
4								.2					4	.586	.465	.121
5								.5		4	4	4		.587	.498	.089
6						12.32	6.16			6	6	6		.623	.494	.129
7						12.32	12.32							1.140	.908	.232
21	.03	.01	.08	.15	.73	6.16	6.16	.2	1000	1.5	1.5	1.5	.30	.479	.267	.213
22													.59	.503	.329	.174
23													.80	.515	.360	.156
24								.5					.59	.530	.398	.132
25								.2		3	3	3		.521	.277	.244
26										1	1	1		.493	.358	.136
27						12.32	12.32			1.5	1.5	1.5		.850	.522	.328

Symbols defined in text. A blank space indicates that the value of the parameter has not changed from the previous observation.

I. The Model with Supply Constraints in the LDC's

U.S. preferences to LDC's will, if export supply curves are upward sloping, raise the price of their exports and thereby affect LDC trade with other countries. Similarly, the trade effects of U.S. preferences will be affected by the simultaneous granting of preferences by other developed countries.

We shall now develop a model that will handle these complications. The model of the previous section can be illustrated graphically by the horizontal supply curves in Fig. 2. The preference shifts the supply curve from S_1 to S_1'. The model of the present section redraws the supply curves to look like S_2 and S_2'.

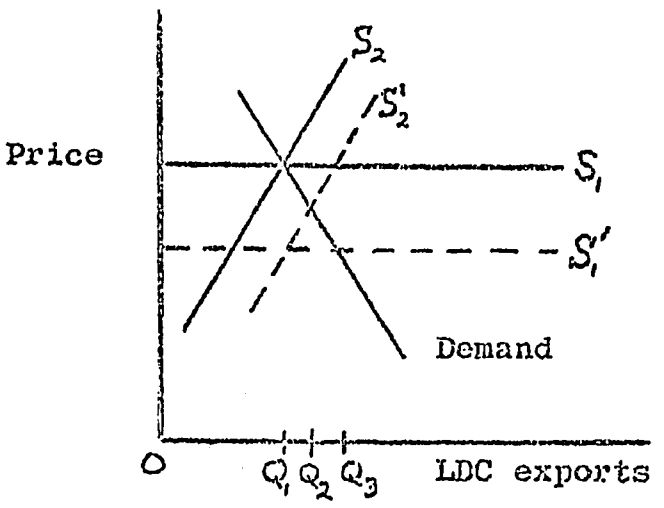

FIG. 2

The demand curve of the preference-granting region for LDC exports allows the prices of competitive goods (P_2 through P_5) to change according to the supply elasticities. In the model of the previous section, we calculated Q_1Q_3, from which we can easily derive the elasticity of the demand curve E_1. Specifically,

$$E_1 = \frac{\Delta Q}{Q} \quad \frac{P}{-\Delta P} = \frac{Q_1Q_3}{OQ_1} \quad \frac{1+t}{-\Delta t} .$$

We shall refer to Q_1Q_3 as ΔQ^*, or the increased exports under the assumption of no supply constraints in the LDC's.

Now in constructing our more general model, which incorporates supply constraints in the LDC's, we first calculate E_1 and ΔQ^* for each preference-granting region. We aggregate the ΔQ^* for all preference-granting regions and we calculate a weighted average ($\bar{E}_1$) of the E_1's, where the weights are the initial imports from LDC's of each preference-granting region.

Then from the formula

$$\Sigma \Delta Q^* = (\Sigma Q)\bar{E}_1 \cdot (-\tau)$$

where the summation runs over preference-granting regions, we calculate τ, the implicit average tariff reduction.[13] Then we can draw a graph analagous to Fig. 2 for all regions combined. Given the elasticity of export supply in the LDC's (e_1), we can calculate the actual increase in exports, which we shall call ΔQ_a (in Fig. 2, ΔQ_a equals Q_1Q_2).

In Fig. 3 below, S_2 is the supply curve including the tariff. S_2' is the supply curve including half the tariff, or the supply curve under preferences. The new equilibrium is determined by the intersection of S_2' and the demand curve. Alternatively, equilibrium can be found by drawing the supply curve excluding the tariff (S_2'') and finding the quantity at which the vertical distance between the D curve and the S_2'' curve is one half of the tariff. This is the method we shall employ below.

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[13] In general, τ will not be equal to the weighted average tariff cut. If, however, E_1 and the tariff cut ($\Delta t/(1+t)$) are the same for all markets (strictly, all that is required is that they be uncorrelated), then τ as calculated in the text will be equal to the uniform tariff cut $\Delta t/(1+t)$.

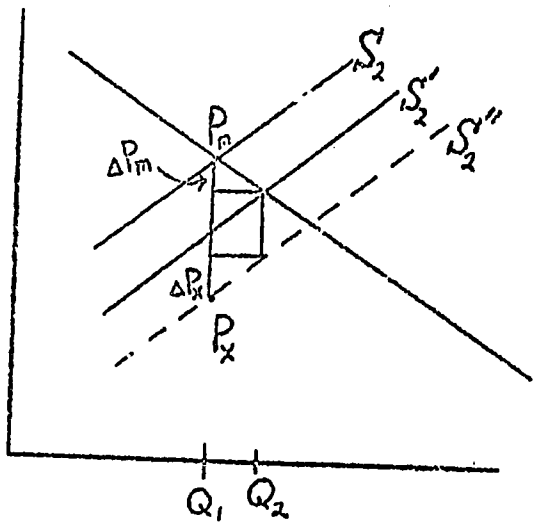

FIG. 3

On page 13 above, we showed that with this type of graph, we can write

$$pm = \frac{\Delta t}{1+t} + \frac{m}{(1+t)e_m}$$

where pm is the percentage change in the import price and m is the percentage change in the quantity imported, as a result of the preferential tariff cut. In terms of our notation here,

$$p_1 = \frac{\Delta t}{1+t} + \frac{\Delta Q_a}{Q} \frac{1}{(1+t)e_1}$$

where t is the implicit average tariff rate derived from τ and ΔQ_a is Q_1Q_2 in Fig. 3.

But $\Delta Q_a/Q = -p_1E_1$. Hence

$$p_1 = \frac{\Delta t}{1+t} - p_1 \frac{E_1}{(1+t)e_1}$$

$$p_1\left[1 + \frac{E_1}{(1+t)e_1}\right] = \frac{\Delta t}{1+t}$$

$$p_1 = \frac{\Delta t}{1+t}\left[\frac{1}{1 + \frac{E_1}{(1+t)e_1}}\right] = \frac{\Delta t}{1+t}(\beta). \qquad (7.)$$

We define β as the term in brackets.

Now $\Delta Q_a/Q = -p_1 E_1$. Substituting (7) into this, we have

$$\Delta Q_a/Q = -\frac{\Delta t}{1+t}[\rho E_1].$$

This is the increase in exports under the assumption of supply constraints. If there are no supply constraints, the increase in exports is, as we showed earlier,

$$\Delta Q^*/Q = -\frac{\Delta t}{1+t}[E_1]$$

Hence $\Delta Q_a = \Delta Q^*(\rho)$ (8)

In other words, to take account of supply constraints in the LDC's, we should multiply the results of the model of the previous section (ΔQ^*) by the "correction factor" ρ.

If there are importing regions not granting preferences, we should estimate E_1 for such regions and our weighted average E_1 would be affected. In other respects, however, the analysis would proceed as before. The implicit average tariff cut, τ, would be smaller. But the crucial formula (8) would not be affected.

One could then calculate the effects of preferences on exports to each region by calculating the rise in the export price in LDC's and by adding to the new export price the tariff applicable in each region. The change in landed price multiplied by the region's E_1 would give the change in imports. One implication of the model is that exports to non-preference-granting regions would decline. Another is that a given preference-granting region's imports would increase less if other regions grant preferences than if they do not.

Summary. In this section we have developed a model for calculating the effects of preferences under conditions of supply constraint in LDC's. The important conclusion is that the export increases estimated under the assumption of no supply constraint (ΔQ^*) should be scaled down by a factor which we have called β, where

$$\beta = \frac{1}{1 + \frac{E_1}{(1+t)e_1}}$$

e_1, the export supply elasticity in the LDC's is a crucial parameter for the determination of β and hence for the estimation of the effects of trade preferences. But since I am not able to give any general estimate of the size of e_1, the empirical results to be given in section V were calculated on the assumption of e_1 = infinity, i.e. no supply constraints. I leave it to the reader to pick his own e_1 and to calculate his own β. I will, however, offer the following suggested values.

For finished manufactures, E_1 is usually about 5 or 6. With $E_1 = 5$, $t = .25$ (this of course varies with the commodity), and $e_1 = 4$, $\beta = .5$ and the estimates of the next section should be cut in half. (The higher is e_1, the larger is β.)

For semi-manufactures, E_1 will usually be a little lower than for finished, but still around 5. With $E_1 = 5$, $t = .25$, and $e_1 = 1.5$, $\beta = .193$, and the estimates in section V should be divided by five.

J. The Model with Economies of Scale in the LDC's

In the previous section we considered the case of rising supply curves in LDC's. Supply curves may be falling, however, because of economies of scale in production or marketing or both. There are two cases to consider: (a) where the industry cost curves are U-shaped and (b) where costs continue to decline as exports expand. Let us assume for the moment that the exports of a given product from different LDC's are perfect substitutes. Then in case (a), current exporters would normally have reached the low point on the industry cost curve. Preferences would increase production, raising costs and probably inducing additional countries to become exporters. The export supply curve for LDC's taken together would still be upward sloping.

In case (b) on our assumptions there would be only one LDC exporting the product. Preferences would enable this country to expand production and lower its costs. Potential exporters would find the export market for this product even less attractive under preferences than it was without them.

If we relax the assumption that the products of different LDC's are perfect substitutes, then no clear conclusions emerge in case (a).[14] Some countries may be on the falling portion of their cost curves and others may be on the rising portion. Exports from each country would normally rise and what happens to the weighted average of costs is indeterminate.

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[14] Strictly speaking, product heterogeneity within the sector of LDC goods is incompatible with our five-good model, in which LDC goods are homogeneous.

In case (b), under the product differentiation assumption, there may be several countries currently exporting the product. All will normally increase production under preferences and costs for all will decline.

Whether costs are rising or falling, the model developed in the previous section is applicable to the present case. If costs are falling, e_1 will be negative. Again, the reader is invited to plug into the model whatever values of e_1 he feels are appropriate in particular cases.

K. Brief Summary of the Essential Features of the Model

We started from the assumption that the import demand elasticity for the United States was 4.12 for finished manufactures. After adding a few more assumptions, we then concluded that the average elasticity of substitution between imports and domestic production was about 6.16 for finished manufactures. We further assumed that 6.16 was the elasticity of substitution between different groups of imports.

The sensitivity analysis of sections H and I revealed that there are only two parameters to which m_1, the total increase in LDC exports, is very sensitive, the elasticity of substitution (s) and the export supply elasticity in the LDC's (e_1). We assumed e_1 to be infinity, i.e. the LDC export supply curve is flat.

The significance of the assumption that all elasticities of substitution are 6.16 can be appreciated if the following approximate relationship is accepted: the elasticity of demand for LDC exports equals the (common) elasticity of

substitution times one minus the LDC share in the total DC market. Since the LDC share in the total DC market is usually small (under 10 per cent), we have in effect assumed an elasticity of demand for LDC exports of around 5.8 or 6.0. In fact, the empirical results of section V would be only slightly altered if this simple assumption were made. (Of course this simple assumption would not enable us to estimate trade creation and trade diversion, but only total expansion in LDC exports.)

In the case of semi-manufactures, we simply assumed that the elasticity of substitution was the same as for finished manufactures, 6.16. Because of some different assumptions about elasticities of supply in the developed countries, the implied elasticity of demand for LDC exports of semi-manufactures works out to about 5.0.

IV. Nonferrous Metals

We have treated nonferrous metals separately from the other commodities, partly because of their quantitative importance and partly because the product homogeneity assumption seems to apply to them. There are probably other commodities to which the homogeneity assumption applies, but I did not find any others of sufficient importance to merit the detailed analysis that we give to nonferrous metals.

We shall consider here the possible effects of a preference scheme on the <u>form</u> of nonferrous metal exports, that is, whether exports are in the form of ore or metal. We shall not consider

the possible effects of preferences on the mining of ore itself. I think these effects are likely to be small because the elasticity of supply of ore in LDC's (and in DC's) is probably fairly low and the nominal tariffs involved are generally low.

But a small tariff change may have quite a dramatic effect on the form of nonferrous metal exports. In the first place, a small nominal tariff change is likely to imply a sizeable change in the rate of effective protection. The cost curve of converting ore into metal generally has a downward-sloping portion and then is likely to be flat up to very large outputs. If LDC exports are perfect substitutes for both DC exports and for domestic DC production, the demand curve for LDC exports will have an extremely high elasticity. In fact, with constant costs and product homogeneity, a simple supply-demand model implies that all the refining of LDC ore should take place either in the LDC itself or in the importing country. This simple model does seem to accord fairly well with reality, for only rarely does an LDC export metal in both ore form and metal form. I am not familiar enough with the mineral operations of LDC's to be able to explain why these rare cases do occur, but some possible explanations come to mind. First, a country may have ore mines in quite distant locations, and it may happen that it pays to refine the ore from one mine but not from another. Second, the country may be in the process of expanding its refining capacity; in this case the ore exports may eventually disappear. Third, an American company

operating mines in both the United States and abroad may want to maintain refining capacity in both locations in order to confront a strike or strike threat more effectively.

Thus in most cases the refining of ore is an all-or-nothing proposition for an LDC. Where all the exports are currently in ore form, a preference might be enough to tip the balance and make economic the conversion of all ore into metal. Similarly, where part of the exports are in metal form, the perference might cause the conversion of the rest of the ore into metal, although this would seem unlikely if the motivation of LDC refining capacity were to meet a strike threat. Of course the preference might cause only part of the ore exports to be converted, either because there are different mines involved or because part of the motivation for installing refining capacity is to meet a strike threat.

There seems to be no way, short of acquiring detailed knowledge of particular mining operations, of ascertaining whether a given preference will tip the balance and result in conversion of ore exports into metal exports. All we can do here is to show possible outcomes under fairly extreme assumptions. Unfortunately the magnitudes are large and hence so is our uncertainty as to the effects of preferences on nonferrous metal exports.

Table 7 gives an over-all picture in 1965 of ore and metal exports from LDC's to the U.S., U.K., E.E.C., and Japan. Table 8 gives the tariff rates, both pre-Kennedy Round and post-Kennedy Round. (Almost all the ore tariffs are zero.

TABLE 7

LDC Exports to DC's of Nonferrous Ores and Metals, 1965

(Millions of Dollars)

	Importing Country				Total of Four Countries
	U.S.	U.K.	EEC	Japan	
Ore					
Copper	18.7	0	28.3	76.9	123.9
Bauxite	148.0	4.7	9.1	13.1	174.9
Lead	9.2	0.4	33.3	6.2	49.1
Zinc	27.8	2.2	27.2	31.3	88.5
Tin	12.8	45.7	81.7	1.0	141.2
Total					577.6
Metal					
Copper	231.7	276.1	552.0	62.9	1122.7
Aluminum	5.9	0.2	15.8	0.2	22.1
Lead	25.3	2.5	22.2	4.5	54.5
Zinc	9.1	5.0	10.2	0.2	24.5
Tin	157.3	31.1	40.9	52.5	281.8
Total					1505.6

Sources: UN, Statistical Office, Commodity Imports, 1965 (Statistical Papers, Series L, No. 1).

TABLE 8

Tariff Rates on Nonferrous Metals
Selected Developed Countries

	U. S.	U. K.	E.E.C.	Japan
	Pre-KR - Post-KR[1/]	Pre - Post	Pre - Post	Pre - Post
Copper, smelter	.0538 - .0253	0 - 0	0 - 0	.100 - .085
Copper, refined	.0485 - .0228	0 - 0	0 - 0	.133 - .106
Aluminum, refined	.051 - .048	.01 - .005	.09 - .09	.13 - .09
Lead, refined	.0703 - .0703	.007- 0	.062 - .062	.206 - .157
Zinc, refined	.0483 - .0483	.02 - .02	.051 - .051	.15 - .10
Tin, unwrought	0 - 0	0 - 0	0 - 0	0 - 0

Sources: For U.S., Tariff Schedules of the U. S., Annotated, 1965, Tariff Commission, TC Publication 163; GATT 1964-67 Trade Conference: Report on U. S. Negotiations, Vol. II, Office of Special Trade Representative for Trade Negotiations. For other countries, worksheets of International Trade Analysis Division, Department of Commerce.

1/ Pre-Kennedy Round, Post-Kennedy Round tariff rates.

The United States imposed quotas on the imports of lead and zinc from 1958 to 1965, but these are no longer in force.)

For reasons given above, we shall concentrate on the ore exports and their possible conversion into metal. The analysis is conducted in Table 9, where we list in column 1 the total ore exports. We can eliminate tin ore from consideration because none of the four importing countries impose tariffs on tin metal. In column 5 of Table 9, we list the ore exports of countries which export a given metal in both ore and metal form. The countries involved are Peru (copper, lead, and zinc), Chile (copper), Mexico (zinc), and the Congo (zinc). These exports total $108.9 million. We calculate the metal exports if all these ores were converted to metal; this calculation makes use of the ratios of metal value to ore value, which were obtained for the United States from the 1963 Census of Manufactures. These potential metal exports are $203.2 million, and the value added is $203.2 - $108.9 = $94.3 million, as shown in the bottom half of the table.

Column (4) of Table 9 shows the ore exports of countries not exporting these ores in metal form. These ores total $327.5 million, and their conversion would yield metal exports of $786.2 million, and a value added of $458.7 million. If we add the $458.7 to the $94.3, we get a combined total of $553 million.

We can make another calculation based on the assumption that the LDC metal exports are not really perfect substitutes for the metal produced by the developed countries. I will

TABLE 9

Ore Exports from LDC's and Potential Metal Exports Obtainable from Refining Ores

Ore	Total	Zero Duty	(4)+(5)	Non-Metal Exporters	Metal Exporters	Ratio of Metal Value to Ore Value
	(1)	(2)	(3)	(4)	(5)	(6)
Copper	123.9		123.9	90.5	33.4	1.773
Bauxite	174.9		174.9	174.9	0	2.841
Lead	49.1		49.1	34.3	14.8	2.283
Zinc	88.5		88.5	27.8	60.7	1.815
Tin	141.2	141.2	0	0	0	0
Total	577.6	141.2	436.4	327.5	108.9	

Exports of Metal if above ore exports were refined

Copper	219.7	160.5	59.2	
Aluminum	496.9	496.9	0	
Lead	112.1	78.3	33.8	
Zinc	160.7	50.5	110.2	
Tin	0	0	0	
Total	989.4	786.2	203.2	
Value of Metal Minus Value of Ore	553.0	458.7	94.3	

assume an elasticity of demand for LDC metal exports of 10, which, on the assumption of constant costs in the DC's, implies an elasticity of substitution of slightly above 10 (perhaps 11). We apply the formula $10 \cdot \Delta t/(1+t)$ to the existing metal exports of Peru, Chile, Mexico, and the Congo. If the calculated increase would use up more ore than the country currently exports, I limited the increase in metal exports to that permitted by current ore exports. This procedure gives increased metal exports of $38.6 million, or $17.7 value added.

This estimate has the defect that it neglects the possibility of metal exports from countries not now exporting metal. But it has the virtue of representing in some way the size of the tariff. The first two estimates assumed that a 50% tariff preference, whether the tariff was 2.5% or 15%, would result in the conversion of all the ore into metal.[15] One could recalculate these two estimates, reducing them in the process, by using a probabilistic approach. The probability that a given ore export would be converted to metal would be related to the height of the tariff. I have not made any such calculations.

The above figures have left out possible additional earnings from the refining, in LDC's, of smelter products.

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[15] In Table 8, the British tariffs on aluminum, lead, and zinc are 2% or less and it may be considered quite improbable that preferences would affect ore exports in those cases. Since the exports of these ores are small in the total picture, however, little is to be gained by removing them from the calculations.

Unfortunately I could not obtain data on imports of smelter products and refined metals for countries other than the United States. The refining of smelter products exported to the U.S. could be of some significance. In 1965 the U.S. imported $172.4 million of copper smelter products from LDC's (Chile 114, Peru 46, and other countries 12). Refined metal imports are 4 from Chile and 18 from Peru. On the three alternative assumptions we employed before, we obtain additional value added in exports of $42.0, $35.9 and $0.4 million. (The post KR tariff on refined copper is only 2.28%; hence on the assumption of a demand elasticity of 10, we get only $0.4 million.)

This is about as far as we can take the analysis. The effects of preferences would probably lie somewhere between $17.7 and $553 million, and quite probably closer to the smaller than to the larger figure. Admittedly this is not a very helpful conclusion. Perhaps some mineral experts in the Tariff Commission and the Commerce Department could, with the aid of industry contacts, estimate the effects of preferences on certain large mining operations. Estimation of the effects of preferences in a handful of countries would narrow the range of uncertainty considerably. For example, Jamaica alone exports $94 million of bauxite to the U.S. That accounts for 22% of the ore exports for which preferences might make a difference.

V. The Estimated Effects of Preferences

A. Effects under Our Model

The model described in section III, with the parameters given there, was employed with import data for 1965. A 50-per cent preference was assumed, with post-Kennedy Round tariff rates. (These rates, which were calculated by the Commerce Department in early 1968, were based on the assumption that the ASP package would be accepted by the U.S. Congress.)

The same model was employed to estimate the effects of the Kennedy Round itself. In this calculation, a three-good model was employed. All the countries receiving Kennedy-Round cuts were in sector 1 and domestic production was in sector 3. The countries not benefiting from Kennedy Round cuts were in sector 2. These were the Associated African and Malagasy States, French Colonies, and French imports from Algeria, Tunisia, and Morocco for the Common Market, the Commonwealth countries for the U.K., the Philippines for the U.S. (since the Philippines' preferential entry into the U.S. market is scheduled to disappear by 1974, the tariff on Philippine goods will actually increase during the Kennedy Round), and none for Japan. These countries now receiving preferences of course stand to lose from the decline in their preference margins as a result of the Kennedy Round. The parameters were the same as those listed earlier, except that all export supply elasticities (including those of LDC's) were taken to be 6.0 for finished manufactures and 1.5 for semi-manufactures.

Thus a comparative statics calculation of the effects of the Kennedy Round was applied to 1965 trade. To these estimated trade flows, the preferential cuts were applied. If one were to use our results to make projections of trade flows under preferences, he should estimate the growth in trade flows for reasons other than tariff changes, and he should allow a reasonable period of time after the implementation of preferences (perhaps five years) for the preferences to have something approaching their full effect.

Table 10 shows the estimated effects on LDC manufactured exports of the Kennedy Round cuts and a 50-per cent tariff preference. The highlights of the table are (1) the total effects of preferences are 395 million, as compared to 140 million for the Kennedy Round, (2) the great bulk of the preference effects are in finished manufactures (332 million), and (3) the U.S. accounts for 273 million out of the total of 395 million.

The 395 million includes two categories which perhaps should be excluded. The first is textiles (SITC 65), 66 million, a large portion of which is already subject to quantitative restrictions. The second is machinery and transport equipment (SITC 7), 24 million, in which a substantial fraction of the reported LDC exports are alleged to be machinery sent back to the industrial countries for repair.[16]

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[16]See "OECD Countries' Imports of Manufactures from the Less Developed Countries," OECD Special Group on Trade with Less-Developed Countries, TD/LDC/41, March 1967, p. 13.

TABLE 10

Estimated Effects of Kennedy Round and Preferences on LDC Exports of Finished and Semi-Manufactures

(figures in millions of U.S. dollars)

Finished Manufactures		Increase in Imports as a Result of:	
Importing Country	1965 Imports	Kennedy Round	Preferences
U. S.	788.0	74.4	234.2
U. K.	117.9	4.9	12.8
E.E.C.	427.7	34.6	79.6
Japan	63.9	5.4	5.6
Total, Finished	1397.4	119.2	332.2
Semi-Manufactures (excluding nonferrous metals)			
U. S.	289.8	14.7	38.7
U. K.	69.3	1.7	4.7
E.E.C.	273.4	2.6	15.7
Japan	66.2	2.0	4.0
Total, Semis	698.7	21.0	63.0
Finished plus Semi-Manufactures (excluding nonferrous)			
U. S.	1077.7	89.1	272.9
U. K.	187.2	6.6	17.5
E.E.C.	701.1	37.2	95.3
Japan	130.1	7.4	9.6
Total	2096.1	140.2	395.2

Detail may not add to total because of rounding.

If these two categories are excluded, there remain 306 million. It is interesting to note that 188 million of this is in SITC 8, miscellaneous manufactured articles.

We should subtract from the figures given above the loss of exports by less developed countries now receiving preferences. We shall call these countries the "Associated LDC's." These losses are given in Table 11. The losses from the Kennedy Round cuts greatly exceed the losses from preferences, because the Kennedy Round cuts apply to a much larger bloc of competitive trade than do the preferences. The extremely small trade diversion suffered by the "Associated LDC's" under preferences, however, results from two features of our model which may be invalid. We have employed the same elasticity of substitution between "Associated" and other LDC's, and we have employed a "non-bundle" model; these matters were discussed in section III.D.

B. An Alternative Approach

A basic assumption of our model is that the items affected by preferences will be those which LDC's already export. Our model underestimates the effects of preferences to the extent that preferences will enable LDC's to break into entirely new export products. It may also be true that a number of items currently exported in small volume have great potential for expansion under preferences, and here also our model would underestimate the effects of preferences.

Part of the reason why LDC's may break into new markets or greatly expand their share in old ones is that export industries may make dramatic technological or managerial

TABLE 11

Estimated Losses of Exports by
Countries Now Receiving Preferences

Finished Manufactures [1]		Loss in Exports as a Result of:	
Importing Country	1965 Imports	Kennedy Round	Preferences
U. S.	33.4	14.3	.17
U. K.	237.1	4.9	.15
E.E.C.	18.4	N.A.	N.A.
Total	288.9		
Semi-Manufactures [1]			
U. S.	42.5	2.1	.31
U. K.	116.3	3.2	.37
E.E.C.	71.6	N.A.	N.A.
Total	230.4		

N.A. = not available

[1] The countries now receiving preferences are:

U.S. - Philippines
U.K. - Commonwealth Countries
E.E.C. - Associated African and Malagasy States p
French colonies plus French imports
Algeria, Tunisia, and Morocco.

progress and thereby lower their cost curves. Conceivably this could take place as a result of preferences. Of course our model does not take into account possible changes in cost curves.

Another possibility which is left out of our model is that the granting of preferences may open the eyes of LDC governments to the benefits of export promotion policies. Merely correcting overvalued exchange rates might do more for manufactured exports in some LDC's than preferences.

Unfortunately there doesn't seem to be any general way of estimating these sorts of effects of preferences. Just to give some alternative estimates to those obtained from our model, I have performed a calculation designed to pick out the "sleepers," that is, the products for which our model might seriously underestimate the effects of preferences, because the products are either not exported at all or are exported in a volume which underestimates their potential for expansion.

I start from the proposition that the "sleepers" are probably currently being exported by the low-wage developed countries--Portugal, Spain, and Japan (PSJ). I have limited the calculation to finished manufactures imported by the United States. First I calculated the PSJ exports to the U.S. after the Kennedy Round. Then I assumed that LDC exports under preferences would bear a relation x to PSJ exports, where x depends on the margin of preference.

The selection of x is a matter of judgment and we have nothing to go on. I set x equal to four times the margin of

preference. Thus, for example, if the tariff rate is 10% and the margin of preference is 5%, LDC exports under preferences would equal 20% of post-Kennedy PSJ exports.

This PSJ calculation is not meant to provide an estimate of the substitution of LDC goods for PSJ goods. I do not assume or assert that PSJ exports will decline by the amount LDC exports increase. If one were to estimate the substitution of LDC goods for PSJ goods, he should start from the existing ratio of LDC to PSJ exports and estimate how that ratio would change under preferences. But since I am interested in picking up "sleepers," I do not make use of the existing ratio of LDC to PSJ exports.

The results of the "PSJ calculation" are shown in Table 12. This procedure gives an estimate of the effects of preferences of 293 million, compared with 170 million under our regular model. In some cases of course, the PSJ calculation yielded a smaller figure than our model. If the larger of the two estimates for each item is employed, we get the totals shown in column (3) of the table, or 332 million.

I then looked through the products thus identified as "sleepers" to see if LDC's might reasonably be expected to export them. Certain products seemed out of the question and these were eliminated: all machinery and transport equipment (SITC 7, not shown in Table 12), iron and steel (67), wire products (693), and nails, tacks, etc., (694). Elimination of 67, 693, and 694 reduces the total from 332 to 314 million.

TABLE 12

Estimated Effects of Preferences on LDC Exports -
A Calculation Based on PSJ Exports of Finished Manufactures to the U.S.

(figures in millions of U. S. dollars)

SITC Group	Effects of Preferences Under Previous Model (1)	Effects of Preferences Under PSJ Calculation (2)	Effects of Preferences, Taking for Each Item the Higher of (1) and (2) (3)
2	6	2	7
6 (exc.textiles)	18	90	96
8	146	201	229
Total	170	293	332
Excluding 67 (iron and steel), 693 (wire products), and 694 (nails, tacks, etc.)			
Group 6	18	72	78
Total	170	275	314

The list of the more important products identified as "sleepers" might be of interest. These are the products for which the PSJ calculation yielded a substantially larger estimate than our regular model: ceramic tile (662.4); household articles--porcelain (666.4), earthenware (666.5); domestic utensils of base metal (697.2); cutlery (696.0); hand tools (695.2); hardware (698.1); unworked glass (664.3); ground glass (664.4).

No claim of accuracy is made for the PSJ calculation, which is obviously based on very arbitrary assumptions. It is interesting, though, that this completely different procedure yielded a result that is of the same order of magnitude as that obtained from the regular model.

C. Summary

We have estimated the effects of preferences for nonferrous metals, finished manufactures, and semi-manufactures. The range for nonferrous metals was $17.7 million to $553 million additional value added in exports, with the expected value nearer the lower than the higher figure. On the assumption of no supply constraints, preferences were estimated to expand LDC exports of finished manufactures by $332 million and of semi-manufactures by $63 million. These figures for finished and semi-manufactures are gross exports; no subtraction has been made for imported raw materials, reductions in exports of raw materials, or foreign company profits out of export sales.

Finally, our import data included only $2.1 billion out of eligible imports of manufactures of $3.16 billion, and only $1.5 billion out of eligible imports of nonferrous metals of $1.8 billion.

Data Appendix

1. Tariff Data. The tariff averages at the four-digit level for the U.K., the E.E.C., and Japan were calculated by hand by the Office of International Trade Analysis of the Department of Commerce under the direction of Frances Hall. She was kind enough to make the worksheets available to my research assistant. The U.S. tariff averages, calculated by computer at the Census Bureau for the Office of International Trade Analysis, were unfortunately available only at the three-digit level. We applied the model to U.S. trade at the four-digit level and employed the three-digit tariff averages to each four-digit category falling within a three-digit category. All tariff averages were implicitly weighted by "own" imports, that is, they were the duty collected divided by the volume of imports.

2. Calculation of Import Shares. A major share of my time was involved in the calculation of these import shares. There are difficulties of both an empirical and conceptual nature.

First it was necessary to calculate an average import share for finished manufactures and another for semi-manufactures. These import shares were employed in Section III B to derive an estimate of s_{my} from assumed values of n_m and e_y. The import share (α) appropriate for this calculation is the weighted average of the import shares (α_i) in the different

categories, where the weights are the imports in the different categories (M_i). That is,[17]

$$\alpha = \frac{\Sigma M_i \alpha_i}{\Sigma M_i}$$

But with this formula, the value of α depends on how detailed the import categories are. The more detailed the categories, the higher is α.[18] This raises the question as

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[17] The reason why α should be calculated this way is as follows. The overall import demand elasticity (n) can be expressed as a weighted average of the import demand elasticities (n_i) in the different categories. That is,

$$n = \frac{\Sigma n_i M_i}{\Sigma M_i}$$

In section III B above, we assumed there was for all import categories a common elasticity of substitution (s) between imports and domestic consumption. On this assumption

$$n_i = (1-\alpha_i)s$$

Hence $n = \frac{s\Sigma(1-\alpha_i)M_i}{\Sigma M_i} = s(1-\alpha)$

In summary, since n is a weighted average of the n_i with the M_i as weights, α should be a weighted average of the α_i with the M_i as weights.

[18] This statement can be proved as follows: Consider a category of imports for which we can distinguish several subcategories. The weighted average import share would be

$$\alpha = \frac{\Sigma M_i \alpha_i}{\Sigma M_i}$$

Now suppose we can no longer distinguish the subcategories; all we can observe is total imports and total consumption in the whole category. The aggregate import share (α^*) that we

to what is the appropriate level of disaggregation. Theoretically we would want the categories to be small enough so that consumers regard imports and domestic consumption as different varieties of the same article. Probably most of the four-digit SITC categories are too large by this test. For example, 894.2 includes children's toys, indoor games, Christmas decorations, and entertainment articles, and 894.4 includes equipment for fishing, hunting (except guns), sports, and outdoor games. Surely a baseball is not the same article as a ski. (On the other hand, certain 4-digit categories may split up highly substitutable articles, especially in SITC 6, where commodities are classified by material. For example, fabrics of cotton, wool, jute, and manmade fiber are in separate categories.)

The procedure I followed was to calculate α from the most detailed import categories available in U.S. Commodity Exports and Imports as Related to Output, 1965 and 1964, U.S. Bureau of the Census, 1967. These categories based on an SIC

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[18] (Cont.) observe can be thought of as

$$\alpha^* = \frac{\Sigma M_i}{\Sigma(M_i+Y_i)}$$

where Y_i is domestic production in category i. Since $M_i = \alpha_i(M_i+Y_i)$, we can write

$$\alpha^* = \frac{\Sigma\alpha_i(M_i+Y_i)}{\Sigma(M_i+Y_i)}$$

Thus α^* can be represented as a weighted average of the α_i, where the weights are domestic consumption (M_i+Y_i). α, on the other hand, is a weighted average of the α_i, where the weights are the M_i. α^* must be smaller than α, because α^* gives a greater weight than α does to products with a high Y_i or a low α_i.

classification are generally more detailed than the SITC 4-digit categories. In addition, the matching of imports and domestic production has been very carefully done by the Census Bureau.

I had to allocate the SIC categories into finished and semi-finished manufactures. This had to be done on an approximate basis because the definitions of finished and semi-finished manufactures are based on an SITC classification. The errors involved here are not serious because at this stage we are only interested in calculating the average import shares for all finished and all semi-finished manufactures. These came out .201 for finished and .27 for semi-finished; the .201 figure was employed to obtain the 6.16 estimate for the elasticity of substitution between imports and domestic production.

In a later stage, when the model was applied to the four-digit SITC categories, we needed estimates of the import shares by these categories. For this purpose I made use of the work of Hal Lary in Imports of Labor-Intensive Manufactures from Less Developed Countries.