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INDICATORS OF PROTECTION AND OF OTHER INCENTIVE MEASURES*

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This paper reports on research by the authors in deriving indicators of protection and of other incentive measures in Latin American countries. It describes methods of estimation by the use of computers and presents the major results obtained so far. It further examines possible future developments in using simulation models and in evolving "policy packages" for the developing countries.

1.

Following earlier efforts (Barber, 1955), the concept of effective protection received considerable attention after the publication of papers by Balassa (1965), Corden (1966), and Johnson (1965). These contributions reflect a dissatisfaction with models of international trade and protection which do not allow for trade in intermediate products. Thus, it has been pointed out that resource allocation and the protection of particular activities is affected not only by the nominal rate of protection on the product itself, but also by nominal rates on traded inputs and by the share of value added in the product price. The effective rate of protection captures these influences as it involves estimating the margin of protection on value added.

The effective rate of protection is conventionally estimated in a partial equilibrium framework under the following assumptions: zero substitution elasticity between material inputs and primary factors, constant returns to scale, infinite foreign elasticities of demand (for exports) and supply (of imports), absence of distortion in product and in factor markets, and no transportation costs. If substitution elasticities are zero, effective rates are expressed as the percentage excess of domestic over foreign value added.

$$Z' = T'(I - A)(I - \widehat{1'A})^{-1} = T'(I - A)\hat{V}^{-1}, \tag{1}$$

where Z = column vector of effective rates of protection;
T = column vector of nominal tariffs;
A = matrix of direct input output coefficients for domestic and imported inputs at world prices; and
$I - \widehat{1'A} = \hat{V}$ = diagonalized matrix of value-added coefficients at world prices.

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Since effective rates are always greater (smaller) than nominal rates on the product itself if the latter exceed (fall short of) average nominal rates on intermediate inputs, the variability of effective rates always exceeds that of nominal rates. It also follows that the greater are the differences in nominal rates of protection on products and their inputs and in the share of value added among industries, the greater will be variations in effective rates of protection as compared to nominal rates.

The additional information provided by the effective protection concept, and hence its practical usefulness, thus depends on the extent of interindustry differences in nominal rates and in value-added shares. This explains the importance of the use of effective rates in developing countries and, particularly, in the countries of Latin America where nominal rates vary to a substantial extent. In several of these countries, nominal rates range from less than zero (this will be the case for commodities subject to export taxes) to 150 to 200 percent.

We have assumed so far that transportation costs are nil. Under this assumption, all goods would be traded so that only production costs at the last stage of fabrication would be relevant, and effective rates could be calculated by utilizing (1). However, in reality, a variety of goods are not traded because the cost of transportation makes this prohibitive. Such "nontraded" goods generally include electricity, gas, water, banking, insurance, domestic trade and transportation, and other services. They are used as inputs in the production of traded goods.

The treatment of nontraded inputs will depend on the objective of calculating the effective rate of protection. If this is designed as a measure of the incentives provided to particular industries, we need to estimate the increase in the cost of nontraded goods to the producer that results from protection. In turn, if the effective rate of protection is used to estimate the cost of protection, the cost of nontraded inputs to the national economy should be included with the direct cost of processing. The former objective is served by applying the so-called Balassa method; and the latter, by employing what has come to be called the Corden method.

The Balassa method assumes infinite elasticity of supply of nontraded goods, so that protection-induced increases in the prices of traded commodities used directly and indirectly in producing nontraded goods are assumed to be shifted forward. The Corden method, too, assumes forward shifting of increases in these prices, while including direct and indirect value added in the production of nontraded goods with value added in processing.

In the practical application of the two methods, the input-output coefficients for nontraded inputs are divided into two parts: (a) material goods used directly and indirectly in producing nontraded goods and (b) value added expended directly and indirectly in the production of nontraded goods. This calculation is effected by using a semi-input-output method which involves utilizing elements of the matrix of direct and indirect value added and material input coefficients for nontraded inputs, without further partitioning the material inputs used in the production of nontraded goods. It is apparent that the difference in the formulas used for estimating the effective rate of protection under the Balassa and Corden methods is that the former includes, and the latter excludes, in the denominator of the equation, the cumulated value-added elements of nontraded inputs.

$$Z'^{B} = T'[I - A_t - RA_{nt}][I - \widehat{1'A_t} - \widehat{1'A_{nt}}]^{-1}, \tag{2}$$

$$Z'^{C} = T[I - A_t - RA_{nt}][I - \widehat{1'A_t} - \widehat{1'A_{nt}} - \widehat{1'R_wA_{nt}}]^{-1}, \tag{3}$$

where the superscripts indicate the Balassa and Corden methods respectively,

A_t = direct coefficient matrix for traded inputs;
A_{nt} = direct coefficient matrix for nontraded inputs into traded commodities;
R = total coefficient matrix of material inputs into nontraded goods; and
R_w = total coefficient matrix of domestic value-added inputs into nontraded goods.

The effective rate of protection calculated by using the Corden method can be reinterpreted as measuring the direct domestic costs of earning and saving foreign exchange. In turn, the so-called Bruno ratio shows the total (direct plus indirect) domestic cost of earning and saving foreign exchange by combining the cost of domestic fabrication at all stages of processing (Bruno, 1965). It is calculated by dividing the sum of direct and indirect domestic value added by net savings in foreign exchange, which latter is defined as the difference between the world-market price of the product and the world-market value of imported inputs used directly and indirectly in domestic fabrication.

$$B' = W'[I - A]^{-1}[\hat{P} - \widehat{N'(I - A)^{-1}}]^{-1}, \tag{4}$$

where V = column vector of value added per unit of output at world prices.
W = column vector of domestic value added per unit of production at domestic prices;
P = column vector of international prices per unit of production; and
N = column vector of imported inputs per unit of production.

Thus, while the effective rate of protection is estimated by the use of the semi-input-output method, the estimation of the Bruno ratio involves using a full input-output method. It can easily be shown (Balassa-Schydlowsky, 1968) that the latter is equivalent to the weighted average of effective rates at various stages of fabrication, the weights being world-market value added at the different stages.

$$B = 1 + V'Z[I - A]^{-1}[V'(I - A)^{-1}]^{-1}, \tag{5}$$

where V = column vector of value added per unit output at world prices.

Calculations of effective rates of protection and the Bruno ratio are customarily made at the existing exchange rate. However, this rate reflects the structure of protection itself and, in order to estimate net rates of protection and the cost of protection to the domestic economy, calculations need to be made at the exchange rate that would obtain under free trade. In practice, this involves adjusting the results obtained at the existing exchange rate for the difference between this and the free-trade rate.

2.

In the research project on "The Structure of Protection in Developing Countries," calculations of effective protection and the cost of protection were made, among others, for Brazil, Chile, and Mexico (Balassa, 1971). In the following, we briefly report on these results; in all cases, estimates adjusted for the difference between the existing and the free-trade exchange rates are shown.

The system of protection in all three countries is characterized by discrimination in favor of the manufacturing sector and against primary activities. However, the extent of this discrimination is substantially greater in Chile and in Brazil than in Mexico. This is shown by the fact that net effective rates of protection on manufacturing activities averaged 68 percent in both Brazil and Chile, as against 16 percent in Mexico.

Brazil and Chile also show much variability in effective rates of protection, indicating that the incentives provided to individual industries differ to a considerable extent. Nevertheless, a definite pattern emerges in the two countries; we observe an escalation in the level of protection from lower to higher levels of fabrication. Nominal and effective rates tend to be the lowest on construction materials, followed by intermediate products at lower levels of fabrication, machinery, intermediate products at higher levels of fabrication, and consumer goods (Table 1).

TABLE 1
NET NOMINAL AND EFFECTIVE RATES OF PROTECTION IN MANUFACTURING INDUSTRIES
[percent]

	Brazil (1966)		Chile (1961)		Mexico (1960)	
	Nominal Rates	Effective Rates	Nominal Rates	Effective Rates	Nominal Rates	Effective Rates
Construction materials	41	47	−1	−2	−12	−7
Intermediate products I	52	66	−9	1	12	26
Intermediate products II	[1]	[1]	30	54	15	27
Nondurable consumer goods	89	115	81	124	15	19
Durable consumer goods	64	98	10	30	37	77
Machinery	48	58	14	18	18	27
Transport equipment	[2]	[2]	[2]	[2]	16	26
Manufacturing total[3]	55	68	26	68	14	16

SOURCE: Bela Balassa, *The Structure of Protection in Developing Countries* (Baltimore: Johns Hopkins University Press, 1971), p. 56.

[1] Included with intermediate products I.

[2] Included with consumer durables.

[3] Includes processed feed.

The escalation in the structure of protection also explains the fact that in both Brazil and Chile effective rates tend to exceed nominal rates by a substantial margin. These differences, in turn, are relatively small in Mexico, where the extent of escalation of nominal rates of protection is small. Moreover, in part because of competition from smuggling, nominal rates on nondurable consumer goods do not exceed those on their inputs, and effective rates are, in fact, lower than nominal rates.

While protection encourages import substitution, export industries are penalized by export taxes, tariffs on their inputs, and the overvaluation of the exchange rate, as compared to the free-trade situation. The extent of discrimination against export industries is again substantial in Brazil and Chile, while it is small in Mexico; net rates of effective protection of export industries averaged −36 and −27 percent in the first two countries, and −5 percent in the third. Apart from discrimination against export industries, the system of protection in the three countries also involves a bias against exporting in import-substitution industries. This is because, until recently, the protection of sales in domestic markets did not have its counterpart in subsidies to exports, and thus domestic sales were more profitable than export sales.

The extent of the bias against exporting is measured by calculating the percentage excess of domestic value added in import substitution over that obtainable in exporting. In Brazil and Chile, this ratio exceeded 100 percent in most manufacturing industries; i.e. to compete in export markets, producers would have had to operate with a value added less than one-half of that obtainable in producing for domestic markets. In turn, relatively low tariffs on imports limited the extent of the bias against exporting in Mexico.

Discrimination among economic activities involves a cost to the national economy, since resources are reallocated from low-cost to high-cost industries. In Brazil and Chile, there are even instances when protection makes the domestic production of commodities profitable in industries where value added at world-market prices is negative; i.e. the world-market value of intermediate inputs exceeds that of the product itself. This may be due to the monopolistic position of the seller of parts and components, their high transportation costs, the waste of materials, the unsuitability of the countries' resource endowment for the production of the commodity in question, or may simply be the result of the allocation of resources brought about by protection, as shown by Guisinger (1969).

Negative value added at world-market prices provides extreme cases of the cost of protection. On the national-economy level, this cost was estimated following a method developed by Bergsman (1971): by separating protected industries into two groups, depending on whether they can be expected to disappear or to continue under free trade. The saving in costs in the first group of industries was considered an improvement in static (allocative) efficiency; in the second group, production costs were assumed to decline to competitive levels under free trade. In the latter case, the estimates are presumed to represent the dynamic costs of protection resulting from the use of backward and small-scale methods in the confines of protected domestic markets. In addition to the static and dynamic costs of protection, its consumption effects, terms-of-trade effects, and the increased costs of exports under free trade were also estimated. The resulting net cost of protection is shown in Table 2 as a percentage of the gross national product. It appears that this cost was the greatest in Brazil (9.6 percent) and in Chile (6.2 percent), and was relatively small in Mexico (2.5 percent).

These results are useful in indicating the extent and the cost of protection in the three Latin American countries. They were further utilized to show the relationship between the structure of protection and economic growth in these countries. The comparisons are favorable to Mexico where relatively low levels of protection and the low extent of discrimination against exports seem to have favored economic growth, while high protection and discrimination against exports hampered growth in Brazil and Chile (Balassa, 1971, Chap. 4).

While estimates of effective protection, adjusted for the difference between the existing and the free-trade exchange rate, indicate the increased costs of processing allowed by protection in Latin American countries, the total cost of

TABLE 2
THE "COST" OF PROTECTION IN INDIVIDUAL COUNTRIES
[percent of GNP]

	Brazil (1966)	Chile (1961)	Mexico (1960)
Static (allocative) cost of protection of import substitutes[1]	0.6	1.4	0.6
Dynamic cost of protection of import substitutes[2]	9.5	9.6	2.2
Consumption effect[3]	0.1	0.6	0.1
Terms-of-trade effect[4]	−0.5	3.5	−0.3
Cost of increased exports under free trade[5]	−0.2	1.9	−0.1
Net cost of protection	9.5	6.2	2.5

SOURCE: Bela Balassa, *The Structure of Protection in Developing Countries* (Baltimore: Johns Hopkins University Press, 1971), p. 82.

[1] Excess costs plus above-normal profits and wages in industries that would not survive under free trade.

[2] Excess costs plus above-normal profits in industries that would become competitive under free trade.

[3] Consumer surplus on the increased consumption of imports.

[4] Reductions in export prices in the event of free trade.

[5] The rise of the cost of exports under free trade under the assumption that export industries are subject to increasing costs.

production in Latin America has also been raised by the high cost of intermediate inputs due to the application of protective measures. Comparing total costs or prices at the existing exchange rate, in turn, has given rise to what can be termed the "inefficiency illusion" of Latin American industry (Schydlowsky, 1971a).

Comparisons of domestic and foreign prices, made by translating the former into dollars at the existing exchange rate, are often used as evidence for the inefficiency of Latin American industry. But such comparisons are inappropriate for the problem at hand, since domestic prices are raised by tariffs and other protective measures on intermediate inputs, as well as by the overestimation of domestic value added at the existing exchange rate. Indeed, a substantial part of the observed price difference is due to the improper valuation of intermediate inputs and productive factors, so that after appropriate adjustments, inefficiencies in Latin American industries will appear to be much smaller than price comparisons at the existing exchange rate would indicate.

3.

Estimates of nominal and effective rates of protection show the impact on relative prices and value added of measures of protection. These include "price" measures such as ad valorem and specific tariffs, import surcharges, advance deposits for imports, export taxes and subsidies, and multiple exchange rates, as well as "nonprice" measures such as quotas, licensing, and exchange controls. In the study referred to above, all price measures were expressed in terms of ad valorem tariffs that are levied as a percentage of import value. In turn, in the case where imports are limited by quantitative restrictions, we calculated the tariff equivalent of these restrictions as the excess of domestic over foreign prices. Price comparisons were also made wherever tariffs are prohibitive.

Measures of protection are the principal incentives affecting the allocation of resources in Latin American countries. But other types of incentives including credit, tax, and expenditure preferences may also be applied and, for the producer, the combined effects of all incentive measures will be relevant. Correspondingly, in the research project on "Development Strategies in Semi-Industrial Countries," all quantifiable incentive measures are being considered. In the framework of this project, directed by Bela Balassa, studies dealing with two Latin American countries, Argentina and Colombia, are being carried out by Daniel M. Schydlowsky jointly with several associates.

Credit preferences may take the form of loans at preferential rates granted to particular industries for exports and import substitution, for domestic and foreign investment, and for investment in selected regions. The government may also establish interest ceilings for bank loans and may interfere with the allocation of credits by the banks. In turn, in the presence of interest-rate ceilings and credit rationing, unofficial ("gray," "black," or "street") credit markets may develop, with higher interest rates. The difference between the rates actually paid and that obtainable in the absence of governmental intervention, then, will express the extent of credit incentives in a particular situation.

In turn, a nondiscriminatory tax system would entail applying a value-added tax that is rebated on exports and imposed on imports. Such a tax could not, however, be taken as a norm for making comparisons with the actual tax system, since this would negate the government's prerogatives to fashion the tax system to serve income-distributional objectives. It appears more appropriate, therefore, to consider each tax individually and to calculate the extent of incentives due to the differential treatment of various activities, in the form of deviations from the average in tax rates, tax exemptions, depreciation provisions, and loan carry-forward regulations applying to particular activities. Indirect taxes on imports and wage taxes, too, will have differential effects.

Incentives to individual industries may also be provided through government-expenditure preferences. Some of these, such as preferential railroad and electricity rates, export-promotion efforts, or the financing of research in a particular industry, are relatively easy to quantify. Others may, however, benefit several industries and necessitate a division of the relevant expenditures among them. Yet others are general in character, and it will rarely be possible to calculate their incidence to particular activities. This conclusion also applies to the general economic "climate," including the efficiency of government administration, the prevalence of competition, and political and social conditions, in general. Taking account of quantifiable credit, tax, and governmental-expenditure measures makes it necessary to reformulate the effective rate of protection concept. This is replaced by effective rate of subsidy, which will indicate the net incentives provided to value-added activities. Similarly, the cost of protection concept needs to be reformulated to express the cost of all incentive measures to the national economy.

Just like the effective rate of protection, effective rate of subsidy calculations express the net effect of incentive measures as a proportion of value added. This will be the appropriate procedure as long as the productive factors, whose remuneration is included in value added, are available in fixed supply. In turn, if we abstract land and assume that capital is mobile internationally, effective protection should be calculated with respect to labor (Basevi, 1966). If, on the other hand, the labor supply is infinitely elastic in the relevant range, entrepreneurs can obtain labor at a constant wage rate, and the relevant indicator of net incentives will be the effective rate of subsidy to cash flow (Schydlowsky, 1967).

While the assumption of the infinite elasticity of supply of capital does not appear realistic in developing countries, the labor supply is often rather elastic. To take account of this possibility, in the research project referred to above, the effective rate of subsidy is calculated with respect both to value added and to cash flow.

Further considerations are introduced in the event of factor-market imperfections. The effective rate of subsidy will now be calculated differently, depending on whether it is to indicate the extent of incentives for the entrepreneur or the cost of incentives to the national economy. In the first case, we will calculate a private effective rate using market prices; and in the second, a social effective rate using shadow prices.

4.

Effective rate of protection analysis has direct application to the construction of systems of protection. In the absence of infant industry and optimal tariff arguments, externalities, and factor-market distortions not compensable by other policy measures, optimal allocation of resources requires equal and uniform effective protection for all productive activities, whether they be export producers or import substituters. Such a situation is achieved either by free trade and an exchange rate that equilibrates the market, or by its equivalent combination of exchange rate with uniform import duties and export subsidies.

A different policy problem arises when inelasticity of foreign demand or systematic differences in factor costs make it desirable to discriminate between different types of producers, say, traditional exporters and others. Tax/subsidy rates and the exchange rate should now be set so as to maximize foreign-exchange earnings from traditional exports, and to provide uniform effective protection to all other activities. In this case, the required nominal rates can be derived from the following formula:

$$T = (I - A_1')^{-1} V_1 z, \tag{6}$$

where T = column vector of nominal rates;

z = uniform desired effective protection, a scalar;

A_1 = matrix of input-output coefficients excluding inputs of traditional export commodities, i.e. $A_1 + M = A$;

M = matrix of inputs of traditional export commodities; and

V_1 = column vector of value-added coefficients for activities other than traditional export ones.

If some group of activities yield external economies or are infant industries, it may be desirable to provide them with higher effective protection in order to bring private benefits into line with social benefits. In this case, the construction of the nominal tariff proceeds by defining a vector of desired effective protections,

Z, and then applying the following formula:

$$T = (1 - A')^{-1}(\hat{V}Z), \tag{7}$$

where A = input coefficients of all activities;
V = value-added vector for all activities; and
$\hat{}$ = diagonalization.

Combining optimal tariff arguments with infant-industry protection or external economies requires taking into account differentiation or the tariff due to desired differences in effective protection and due to differential input intensity in inputs of traditional export commodities. The general formula applicable then becomes a combination of (6) and (7), as follows:

$$T = (I - A_1')^{-1}\hat{V}_1 Z. \tag{8}$$

A more complex tariff construction problem ensues if the market prices of factors of production diverge from their shadow prices. Optimal allocation would now require equalizing the social effective rate of protection, i.e. the ratio of domestic value added at shadow prices to the value added at world prices. In the absence of other policy measures to offset the divergence between social and private prices, uniform effective protection at market prices will imply differential social effective rates of protection. Hence, optimal allocation requirements under these conditions require incorporating into the nominal tariff structure appropriate subsidy elements to cover the divergence between social and private costs. The nominal tariff structure incorporating the subsidy elements under the assumption of fixed factor proportions can be calculated as:

$$T = (I - A')^{-1}[V'z + Ls_L + Ks_K + (1 - L - K)s_{1-L-K}], \tag{9}$$

where L = column vector of labor input coefficients;
K = column vector of capital input coefficients;
$1 - K - L$ = column vector of primary factor input coefficients of other than capital and labor; and
$s_L, K, 1 - L - K$ = scalars of subsidy or tax needed to equalize social and private factor costs.

Taking into account simultaneously optimal tariff arguments, infant-industry considerations, externalities, and subsidies to cover divergences between social and private costs, nominal tariffs should be constructed according to the following formula:

$$T = (I - A_1')^{-1}[\hat{V}Z + Ls_L + Ks_K + (1 - L - K)s_{1-L-K}]. \tag{10}$$

It should be pointed out that the discussion so far has assumed that tariffs are used exclusively for the purpose of optimizing the production structure, and the inclusion of considerations relating to the structure of demand complicates the analysis still further. On the other hand, the inclusion of noncompetitive imports subject to a revenue tariff can easily be accommodated by the addition of a term NT_n in the bracket on the right-hand side of equation (10), where N is defined as the matrix of coefficients of noncompetitive imports, provided A_1 is replaced by A_2, defined to exclude noncompetitive import coefficients from the matrix, i.e. $A_2 + N = A_1$.

It is very important to note that apart from the trivial case when uniform tariffs and export subsidies apply to all commodities, none of the tariff structures developed above yield a uniform nominal tariff, thus disproving the intuitively plausible notion that a uniform nominal tariff provides the desirable uniform effective protection. Uniform nominal protection will offer uniform effective protection only under the restrictive condition that there are no inputs of traditional export commodities into protected industries. For uniform effective protection (at market prices) to be optimal, however, it is also required that: (i) the desired infant-industry protection be uniform; (ii) external economies be uniform; and (iii) the subsidy required to equate market to social costs either be uniform or be provided through policy measures other than the tariff.

5.

Export promotion can also be analyzed in the context of an effective rate of protection framework. The antiexport bias in the tariff system arises usually from protection on inputs which is not compensated by an appropriate subsidy on the exports of the particular commodities, while such a subsidy is forthcoming for sales to the domestic market through the tariff on the output.

In the absence of export subsidies, the taxation of potential exports implicit in this situation can be derived directly from (1) by dividing effective protection into its two components: (i) increased revenue on sales due to the output tariff; and (ii) increased cost for inputs due to the tariffs on the inputs.

(11) $$Z' = Z'T'V^{-1} - T'AV^{-1}.$$

The implicit taxation on potential exports is given by the second term alone. The discrimination in favor of sales to the domestic market is given in absolute size by the first element.

It naturally follows that a drawback system designed to put export producers on an equal footing with their foreign competitors should refund to producers the total implicit tax to which they have been subject, i.e. $T'AV^{-1}$. Traditional drawback systems, however, only refund the duties actually paid, not refunding any excess cost of domestically purchased inputs. Thus, if the input-output matrix is disaggregated into a matrix of domestic coefficients A_d, and a matrix of coefficients of imports A_m, we have:

(12) $$Z' = T'\hat{V}^{-1} - T'A_d\hat{V}^{-1} - T'A_m\hat{V}^{-1}.$$

Traditional drawback systems refund only $T'A_m\hat{V}^{-1}$ insofar as determinable. They still leave exporters subject to the implicit tax of $T'A_d\hat{V}^{-1}$ arising from excess cost of domestic inputs.

It should also be noted that neither a traditional drawback system, nor a generalized one refunding all implicit taxation, equalizes incentives between sales to the domestic market and to export markets. Even in the presence of such systems, a discrimination against export sales equal to exactly Z' will then remain.

In order to equalize the incentive to produce for the export market in comparison to the domestic market, net export subsidies for nontraditional products are necessary. These should be set equal to the rate of nominal protection in industries operating at full utilization of capacity. If exports would take place on the margin out of unused capacity or making use of economies of scale, subsidies covering marginal cost would suffice. In the latter case, however, a reduction of nominal import protection would be necessary to equalize the subsidization offered to domestic and foreign sales, but contraction of firms may then ensue as a result of total revenue falling below total cost.

The export subsidies involved are usually regarded as having a fiscal cost. In many developing economies where the raising of taxes is a difficult matter, such a fiscal cost is seen as a well-nigh unsurmountable barrier to the adoption of an export subsidy program. If domestic installed capacity is not fully used, however, export sales will generate an increase in the level of domestic income via the foreign-trade multiplier. In turn, a higher level of income implies an expanded tax base, which at constant levels of ex post tax incidence will yield additional fiscal revenue. Such new revenue may pay for part or all of the subsidy program, depending on the macroeconomic interactions involved (Schydlowsky, 1971).

The net fiscal cost of export subsidies in the presence of excess capacity in domestic industry has been worked out for Argentina in Schydlowsky (1971) on the basis of the following macromodel:

$$P = P_0 + pV'X, \tag{13}$$

$$M = \hat{m}X, \tag{14}$$

$$E = E_0, \tag{15}$$

$$G = G_0, \tag{16}$$

$$X = AX + P + G + E, \tag{17}$$

and

$$T = a'M + (t_d + t_i)'X, \tag{18}$$

where all symbols refer to column vectors; a prime denotes transposition; a circumflex denotes diagonalization; and where P = private total expenditure on goods of the different sectors at market prices; P_0 = autonomous private expenditure on goods of the different sectors; p = marginal propensity of the private sector to spend on the goods of the different sectors; V = gross value added at factor cost less direct taxes in the different sectors; X = output of the different sectors at market prices; M = imports of goods similar to those of the different sectors at CIF prices; m = import requirements at CIF prices of the different sectors per unit of output at market prices; E = export of the different sectors at FOB prices; A = matrix of domestic input-output coefficient; G = total government expenditure on products of the different sectors; T = fiscal revenue generated in the different sectors; a = ad valorem rates of import duty on the products of the different sectors; t_d = rate of direct taxation as a proportion of gross output in the different sectors; and t_i = rate of indirect taxation as a proportion of gross output in the different sectors.

Substituting equations (13), (14), (15), and (16) in (17), we obtain the equilibrium levels of output and income:

(19) $$X = (I - A - pV')^{-1}(P_0 + G_0 + E_0),$$

and

(20) $$Y = V'X = V'(I - A - pV^{-1}(P_0 + G_0 + E_0),$$

as well as total new fiscal revenue:

(21) $$dT = (a'\hat{m} + t_d' + t_i')(I - A - pV')^{-1}dE.$$

Introducing the export subsidies, we obtain:

(22) $$dTn = (a'\hat{m} + t_d' + t_i')(I - A - pV')^{-1}dE^* - \lambda' dE^*,$$

where Tn is the vector of net fiscal revenue; λ is the vector of subsidies, as a proportion of private sector revenue from exports plus subsidy; and E^* is the vector of private-sector income from exports and export subsidies.

TABLE 3
FISCAL EFFECT OF SECTORAL INCREASES IN EXPORTS

		Revenue per Peso of New Exports	Maximum Allowable Subsidy Unchanged Fiscal Balance (% FOB value)
1	Agriculture	0.713	248
2	Livestock	0.712	247
3	Forestry, hunting, and fishing	0.696	229
4	Mining	0.691	224
5	Fuel and electricity	0.632	172
6	Foodstuffs and beverages	0.704	238
7	Meat	0.716	252
8	Tobacco	0.883	755
9	Textiles	0.714	250
10	Clothing	0.698	231
11	Wood	0.678	211
12	Paper and cardboard	0.671	204
13	Printing and publishing	0.653	188
14	Chemicals	0.687	219
15	Rubber	0.634	173
16	Leather	0.725	263
17	Stone, glass, and ceramics	0.691	224
18	Metals	0.615	160
19	Steel	0.607	154
20	Vehicles and machinery	0.642	179
21	Automobiles	0.632	172
22	Machinery and electrical equipment	0.630	170
23	Other industries	0.689	222
24	Recovery materials	0.713	248
25	Construction	0.694	227
26	Commerce	0.736	279
27	Transport	0.650	186
28	Other services	0.720	257

SOURCE: D. M. Schydlowsky, "Short-Run Policy in Semi-Industrialized Economies," *Economic Development and Cultural Change*, April 1971, Table 9.

Table 3 shows the total resulting fiscal revenues per peso of new earnings from exports in different sectors of the Argentinian economy, as well as the corresponding maximum sectoral subsidy levels which can be paid without generating a net fiscal deficit.

An optimal export subsidy program can be derived by the use of a linear programming framework which maximizes income subject to constraints representing installed capacity, the balance of payments, and the fiscal balance. The latter two should be independent constraints in the system, since domestic demand is assumed to come from existing internal excess demand as well as from new exports. Indeed, new exports are determined in part by the needs arising out of domestic demand. In symbols, the linear program is to maximize ΔY subject to:

$$(I - A)X + (I + d)M - IE - p\Delta Y = 0, \tag{23}$$

$$X \leq K, \tag{24}$$

$$-m'M - 1'M + e'E \geq 0, \tag{25}$$

and

$$1'X + a'M - g'E \geq 0, \tag{26}$$

where ΔY is a scalar denoting the increase in income; A, X, p, E, a, and m are as defined previously; M is a vector of competitive import activities; d is a vector of ratios of market to CIF prices; K is a vector of potential additional output through 100 percent capacity use; e is a vector of marginal revenue in export markets (i.e., price FOB export point); and g is a vector of export subsidies (covering total or marginal cost according to the purpose of the calculation).

The solution to this linear program will give: (i) the maximum level of income obtainable; (ii) the commodities exported and, hence, the marginal export subsidy required to achieve the optimum;[1] (iii) competitive imports required to overcome sectoral bottlenecks; and (iv) the net change in the fiscal situation originating in the move to full capacity utilization.

6.

Virtually the totality of empirical work in the effective protection area has been done in the partial-equilibrium context discussed so far. At the same time, it has been recognized from the outset (e.g. Corden 1966) that the analysis of protection requires a general-equilibrium framework. This section (based largely on Balassa 1971a) examines recent attempts to investigate the theoretical validity of the effective protection construct in a general-equilibrium framework.

The consequences of allowing for substitution between different primary factors and between primary factors and intermediate goods has been a particular subject taken up in the context of one-country, three-commodity general-equilibrium models. Furthermore, general-equilibrium models incorporate the effects on realized protection of changes in factor prices, and, hence, nominal

[1] In this model it is implicitly assumed that commodities will be differentiated for subsidy purposes to the same extent that a differentiation exists for tariffs or quotas on the import side. The discussion of the relative advantages of this and other alternatives in terms of allocation and administration would carry us beyond the scope of this paper.

protection will affect particular activities not only through changes in product prices but also through changes in factor prices. In turn, factor price effects are accentuated if we admit the possibility of input substitution (Tan, 1970), and certain definitional problems will also result (Ethier, 1970).

It is easy to show that in a three-commodity model the effects of protection on particular industries may not be appropriately indicated by the effective protection measure, even if substitution elasticities among inputs are zero. Thus, industry A, having a lower effective rate of protection than industry B, may still enjoy greater protection if it is complementary in factor use with unprotected industry C and thus benefits from a protection-induced decline in the prices of the factors of production it uses intensively.

The error possibilities due to the neglect of protection-induced changes in factor prices will depend on the magnitude of these changes relative to changes in the prices of products, including material inputs. In the simple two-country, two-commodity, two-factor model, the protection-induced changes in relative factor prices are greater in magnitude than the changes in relative product prices.

By contrast, apart from Corden's two-product model (1969) where factor-price effects cannot reverse the effects of protection of product prices, the practitioners of effective protection have implicitly or explicitly emphasized international differences in efficiency that fit the Ricardian framework. This would mean that, rather than protecting factors of production, countries tend to protect industries that have high costs because of the use of small-scale production methods (due to differences in scale), the application of inferior technology and organization (due to differences in technical and organizational knowledge), and the prevalence of X-inefficiencies (due to the failure to minimize costs for the technology applied).

Given the present state of knowledge (or rather ignorance) as regards the effects of protection on factor prices, it is fair to suggest that—other things being equal—the relative importance of factor-price effects will be the greater, the more uniform are levels of protection. With the wide variety of nominal rates of protection observed in most countries, it may be surmised then that the effects of protection on output and input prices tend to outweigh its effects on factor prices.

On the basis of available evidence on substitution elasticities among inputs, it would seem that this conclusion is not materially affected if we introduce the possibility of input substitution. But we now face the problem of defining value added and the effective rate of protection. Ethier (1970) suggests that the relevant definition will have to be couched in terms of marginal value added, leading to a rather complicated formula that might be difficult to measure empirically. However, Jones (1970) has shown that the value-added concept has a meaning even with substitution, and the usual definition can be applied.

Efforts to analyze the effects of protection in a multiproduct and perhaps multicountry world require, under the present state of the arts, a mathematical programming framework. If the production conditions can be specified and the demand structure written in functional form, the inclusion of tariff-collection activities with the corresponding expenditure vectors for government revenue allows the complete specification of a programming problem.

An early effort of this kind was undertaken by Schydlowsky (1966), in which the general-equilibrium effects of tariffs in a three-country, nine-commodity, three-factor world were explored. Production conditions in each country were assumed to be of the Leontief kind, in input-output table form; demand conditions were specified as being of constant elasticity in all prices and income in order to allow for adequate consumer substitution between commodities, while additivity of demand conditions was assured by an explicit constraint to that effect. Appropriate tariff-collection activities and government-expenditure proportions were specified. Finally, home and foreign goods were assumed to be imperfect substitutes, thus preventing complete specialization through the demand side. The problem was solved by nonlinear programming with a variant of the gradient method on data specified to represent three different kinds of countries in terms of factor endowments and production functions. The policy situations simulated included unilateral changes in tariff, multilateral reductions, and customs union.

A more recent effort by Evans (1968, 1970) applied linear programming to a growth model for Australia specifically including the effect of tariffs in the specification of the economy. Upper and lower bounds were imposed on some activities in the model, and expansion and contraction of sectors was not allowed to proceed instantaneously. Demand conditions were specified as linear expenditure functions, with limited substitution between commodities. Production conditions were linear.

Evans compared the result of his model with the prediction from effective rate of protection analysis and found a rank correlation of 0.63 between the effective rates thus measured and the estimated changes in resource flows (this result pertains to the model without growth constraints for particular industries). In turn, the rank correlation coefficient between effective rates measured, respectively, in a general-equilibrium, and in a partial-equilibrium, model was found to be 0.52.

These results cannot be used, however, to derive conclusions on the inappropriateness of effective rates as an indicator of resource allocation, or on the existence of substantial differences between estimates of effective rates measured in a general- and in a partial-equilibrium framework. To begin with, effective rates are supposed to indicate the resource-pull and resource-push effects of protection in Marshallian long-run, under ceteris paribus assumptions after all adjustments in capacity have been made. By contrast, Evans has used a medium-term model that permits the expansion of capacity but does not accommodate reductions in it. Correspondingly, industries which can cover variable costs under free trade would continue to operate at existing output levels. Indeed, there is no change in activity levels in nearly one-half of the industries in the model; and this, in turn, reduces correlation between effective protection and changes in activity levels. The correlation would presumably increase if the time span of the model were long enough to permit the depreciation of equipment; in which case, several of the industries in question would show a decline in output.

The correlation between effective protection measured in a general-equilibrium model and resource flows, as well as that between effective rates estimated in a general- and in a partial-equilibrium framework, are further affected by the assumptions made on maximization behavior, the form of the consumption and investment functions, the supply and productivity of labor, and prospective export demand. While such assumptions are necessary for the ten-year projection Evans made by the use of his medium-term model, such a model cannot answer the question about the effects of eliminating protection under ceteris paribus assumptions.

In a policy-analysis context, the use of general-equilibrium models with adjustments over time is promising but not yet operational. Major improvements are needed in the specification of production conditions, where efficient and inexpensive algorithms need to be developed to handle decreasing, as well as increasing, costs. On the demand side, functional forms must be found which satisfy the integratability conditions while allowing more variability in the own and cross price elasticities than currently available forms. Finally, a specification of the factor markets that allows for unemployment and stickiness in factor prices, in lieu of the now common but unrealistic assumption of a fixed factor supply and full employment, needs to be undertaken. With these innovations introduced and an ever increasing computational capacity, the level of disaggregation can gradually be increased to the point where policy analysis can be brought to bear on specific policies in tariff setting.

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