THE INCIDENCE OF PROTECTION:
THEORY AND MEASUREMENT

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particularly so-called nontraditional exports - than is generally perceived by producers in that sector.

2. Factor Oriented Approaches to Protection.

The most well-known approach to the analysis of the effects of protection on factor incomes is the two-sector Heckscher-Ohlin-Samuelson (HOS) model. In this section we give a brief outline of that model and then consider extensions for home goods and international capital mobility.

The HOS Model

The country has a fixed endowment of labor and capital which is used in the production of importables and exportables. The two sectors have independent production functions which exhibit constant returns to scale; the production of importables is labor intensive, while exportables is capital intensive. Finally, in relation to the foreign country, the home country is labor scarce and capital abundant.

Prior to the opening of trade the home country produces the good intensive in the abundant factor (exportables) at a lower cost than does the foreign country. Accordingly, when the two countries trade the world price of exportables in terms of importables will be higher, causing production of exportables to expand and demand to contract, with the excess supply being exported. The opening of trade causes the domestic production of importables to contract as part of demand is now satisfied by imports. As exportables are capital intensive and importables labor intensive, after the opening of trade at the pre-trade factor prices there is an excess demand for capital which causes the return to capital to rise and wages to fall. Hence trade benefits the abundant factor. It follows that an import duty takes the economy towards the pre-trade equilibrium, which benefits labor, the scarce factor. This is known as the Stolper-Samuelson result.

Extensions of the HOS Model: Home Goods and Internationally Mobile Capital

The Stolper-Samuelson result is, however, very sensitive to the rather special structure of the model. Two modest extensions of the model can both lead to the exact opposite result. First, Rodriguez (1981) considers
the situation when there is an additional sector which produces home goods (services, etc.). Then under plausible assumptions about some empirical magnitudes, the effect of the tariff is to unambiguously hurt labor.

The second extension is when capital is sufficiently mobile internationally so that capital owned by domestic residents always earns the world rate of return. Accordingly, any policy which induces an incipient reduction in the return at home causes capital to leave the country, so that it becomes an exporter of capital services. Capital will leave until the domestic and world returns are equalized. This means that the dollar income of domestic owners of capital is always constant. In contrast to Rodriguez' contribution, this extension involves only traded goods.

It is convenient to develop the argument by considering three related models: (i) Two sectors, exportables and importables with linear homogeneous production functions. (ii) Three sectors, traditional exportables (agriculture, mining, etc.), nontraditional exportables (manufactures) and importables with linear homogeneous production functions. (iii) The three sectors in (ii) with the production of traditional exportables subject to diminishing returns to scale due to land or some other natural resource being a fixed factor, and with the two other production functions linear homogeneous.

(i) Exportables and Importables with Linear Homogeneity

We start from a nondistorted equilibrium with all goods traded. With imports labor-intensive, imposition of the tariff discriminates against the abundant factor capital, the HOS result. This, however, causes capital to leave the country to earn the higher world return, but the factor price ratio remains constant as the domestic commodity price ratio is constant. This means that the economy experiences a Rybczynski effect, with the loss of capital causing production of exportables to contract and that of importables to expand even more. The loss of capital does not cause the domestic return to capital to rise as long as there is nonspecialization in production, because
nonspecialization implies a one-for-one relationship between commodity and factor prices, so that factor prices remain unchanged. It follows that the exit of capital ceases only when the exportables sector goes out of existence with all labor and the remaining capital being employed in the importable sector. That is, the economy becomes completely specialized in producing importables.

The amount of capital which remains in the country will be such that its return in producing importables equals the world return. As this return has to rise, the capital intensity in importables will be lower than that prevailing with the tariff but with no capital mobility, which means that wages in terms of importables will be lower. To analyse what happens to wages in relation to the free trade situation, we need to specify the trading pattern which emerges with the tariff and capital mobility. Note that specialization does not wipe out trade because, at a minimum, the country still has the export receipts from capital services which it can spend on imports. There are two possible trading patterns.

(a) The first is when there is an excess demand for importables in the new equilibrium, so that the country continues to import them. In this situation the tariff is binding, and the value of the marginal product of capital in importables has to equal the world return both before and after the tariff, it follows that its marginal product must fall as the domestic price of importables has risen. This implies a higher capital intensity relative to that with free trade and, accordingly, wages in terms of importables have risen. As the price of exportables is unchanged, wages in terms of these goods also rise. Hence labor unambiguously gains in this case.

As production of exportables ceases to satisfy home demand, these goods must now also be imported. Importables will continue to be imported if the income of capital abroad is sufficiently large to finance these imports as well as the imports of what was previously the exportable. This will be the case if the income of capital abroad is larger than the country's expenditure on exportables.
It is difficult to say a great deal about whether this condition is likely to be satisfied as we do not know how much capital goes abroad. However, it is the case that only a fraction of the capital goes abroad and that only a fraction of income goes to capital. Thus the income of capital abroad is only a fraction of a fraction of total income, and as such is likely to be less than the share of income devoted to expenditure on exportables. On these grounds it seems unlikely that this trading pattern will emerge.

(b) The second case is when there is an excess supply of importables in the new equilibrium so that there is a complete trade reversal. The country exports the good previously imported and it imports the other good. In this case the tariff is redundant (as it is on the commodity no longer imported) and internal and world prices will be equal; factor proportions and factor prices will be the same as with free trade. Clearly, no one gains from the tariff.

(ii) Traditional Exportables, Nontraditional Exportables and Importables with Linear Homogeneity

We assume that the nontraditional exportables and importables sectors produce similar goods, so that they have identical factor intensities; traditional exportables are capital intensive relative to importables and nontraditional exportables. In (i) above the import tariff is identical to an export tax and it is convenient to consider the effects of such a tax for the current case. There are two possible types of export tax systems.

(a) A tax on nontraditional exports causes this sector to disappear and all its resources be absorbed by importables. As factor intensities are the same in the two sectors, the closure of nontraditional exportables does not require any change in factor proportions, implying that factor prices remain unchanged and no factor gains from the trade restriction.

(b) A tax on both traditional and nontraditional exports has the effect of causing nontraditional exportables to disappear, as above. There are now two sectors remaining and the price of importables in terms of traditional
exportables has risen. This situation is exactly the same as an import duty and the results of (i) above apply. Hence it is unlikely that any factor gains from the trade restriction.

(iii) As for (ii) with Traditional Exportables having a Fixed Factor

We again consider the two types of export tax systems. First, a tax on nontraditional exports gives the results of (ii)(a) above. Second, a tax on all exports (or an import duty) causes the nontraditional sector to disappear, with its resources being absorbed by importables. Also traditional exportables contracts, part of the released capital goes abroad to leave a composite factor with an intensity equal to that of importables and this goes into importables. As traditional exportables contracts it becomes more intensive in the fixed factor, causing wages and the return to capital to go back to their pre-tax levels. Production is now inefficient as there is excessive intensity in the fixed factor in traditional exportables. All the tax and inefficiency cost is borne by the fixed factor.

The conclusion which emerges from this analysis is that trade liberalization is unlikely to harm labor (or capital) when capital is sufficiently mobile internationally.

3. Effective Protection

The discussion of the HOS model assumed that inputs comprise only of the primary factors labor and capital; intermediate inputs (materials) were not mentioned. It follows that the products of the HOS model are interpreted as value-added, gross output less material inputs. The concept of effective protection provides a link between the factor oriented approach of the HOS model and the sector (or product) approach. This concept is concerned with how primary factors move across sectors in response to the tariff structure.
A duty $t_i$ on imports of good $i$ benefits the domestic industry producing $i$, but hurts other industries which use $i$ as an input. Thus a tariff on an imported input simultaneously acts as a subsidy and a tax. A sector's effective rate of protection summarises its net position regarding the subsidy and tax elements of the tariff structure and is defined as the proportional increase in value-added. With $a_{ij}$ the share of input $j$ in the cost of a unit of $i$ ($i, j = 1, \ldots, n$), the free trade value-added is $v_i = 1 - \sum_{j=1}^{n} a_{ij}$. With a set of nominal tariff rates $t_1, \ldots, t_n$, value-added becomes $v_i' = (1 + t_1) - \sum_{j} a_{ij}(1 + t_j)$, so that the effective protective rate for sector $i$ is

$$
t_{i}^{e} = \frac{v_i' - v_i}{v_i} = \frac{t_i - \sum_{j} a_{ij} t_j}{1 - \sum_{j} a_{ij}}.
$$

Sectors with the highest $t_{i}^{e}$'s are those receiving the greatest protection for their value-added and there is a presumption that the tariff structure causes resources to move into those activities. We shall return to the effective protective rate in the next section.

4. Sector Approaches to Protection

In the HOS model it is possible to say which factor loses from the tariff. But, as factors are employed in both sectors, it is not possible to say which sector loses. It is only when we introduce a home goods sector that it becomes possible to devise a simple measure of the incidence (in public finance terms) of the tariff. With home goods we can determine whether the tariff incidence is borne primarily by exporters (in which case it operates like an export tax) or is shared between producers of home goods and exporters.

If importables and home goods are close substitutes in demand and production, then the relative price between them will tend to be fixed. The tariff then lowers the price of exportables in terms of both importables and
home goods; these two relative prices fall by about the same amount. The real income generated in exportables falls in terms of both importables and home goods. The tariff is then fully equivalent to an export tax in that the incidence falls fully on exporters.

Alternatively, if exportables and home goods are close substitutes, then the price of both these goods in terms of importables falls. In this case the incidence is shared between producers of home goods and exporters.

To consider an intermediate case lying between these two extremes, let there be a 35 per cent tariff which causes the price of home goods to rise by 25 per cent. The price of importables in terms of exportables rises by the full amount of the tariff. However, in terms of home goods, the price of importables rises by only about 10 per cent, while the price of exportables falls by about 25 per cent. Exactly the same pattern of relative prices would emerge with a 10 per cent tariff and 25 per cent export tax; a 35 per cent export tax and no tariff would also generate the same relative price structure.

Although the tariff is nominally paid by importers, the resulting change in relative prices is such that about 70 per cent of the tariff is an implicit tax on producers of exportables, with the remaining 30 per cent an implicit subsidy to domestic producers of importables. Seventy per cent of the tariff is perceived by exporters as a reduction in their purchasing power over home goods; the real income of the import-competing sector in terms of home goods rises by only 10 per cent.

It can be seen that the response of the price of home goods in terms of exportables provides a convenient measure of the tariff incidence. When the tariff causes this relative price to rise substantially, exporters bear most of the incidence. As the above example illustrates, the elasticity of the price of home goods with respect to the domestic price of importables is the proportion of the tariff paid by exportables; one minus the elasticity is the proportion which is a subsidy to importables.
The response of the price of home goods to that of importables can be simply derived as follows. We write \( q^s \) and \( q^d \) for the quantity supplied and demanded of home goods and \( p_i \) for the nominal price of good \( i \) (\( i = e \) for exportables, \( m \) for importables and \( h \) for home goods). Taking real income and the economy's factor endowment to be fixed and using a \(^\hat{\cdot}\) to denote proportional change (\( x = dx/x \)), the change in the supply and demand of home goods is

\[
q^s = \eta^s_e p^e + \eta^s_m p^m + \eta^s_h p^h
\]

\[
q^d = \eta^d_e p^e + \eta^d_m p^m + \eta^d_h p^h
\]

where the \( \eta^s_i \) 's and \( \eta^d_i \) 's are compensated supply and demand price elasticities for home goods. These elasticities are subject to the homogeneity constraint

\[
\sum_i \eta^s_i = \sum_i \eta^d_i = 0.
\]

Equilibrium in the home goods market requires \( q^s = q^d \), so that from (2), (3) and (4) we obtain

\[
\hat{p}_h - \hat{p}_e = \omega(\hat{p}_m - \hat{p}_e)
\]

where

\[
\omega = \frac{\eta^d_m - \eta^d_h}{\eta^s_m - \eta^s_h}
\]

is the elasticity of \( p_h/p_e \) with respect to \( p_m/p_e \). Since \( \eta^s_h > 0 \) and \( \eta^d_h < 0 \), it follows that the sign of \( \omega \) depends on that of the numerator in (6). At this level of aggregation it seems reasonable to rule out complementarity, so that \( \eta^d_m > 0 \) and \( \eta^s_m < 0 \). This means that \( \omega > 0 \), implying that the price of home goods never falls with the tariff. As indicated above, \( \omega \) is

1. For alternative ways of deriving the same result, see Dornbusch (1974), Rodriguez and Sjaastad (1979) and Sjaastad (1980a,b).
the proportion of the tariff that is an implicit tax on the export sector.

We shall thus refer to $w$ as the incidence parameter.¹

The expression for $w$ can be further analysed by defining

$$\omega^d = -\frac{\eta_m^d}{\eta_h^d}.$$  

Substitutability means that $\omega^d > 0$. From (4) $\eta_m^d$ takes a maximum value of $-\eta_h^d > 0$ when $\eta_e^d = 0$ (home goods and exportables unrelated in demand). Hence $\omega^d$ takes a maximum value of unity, so that it is a positive fraction. The coefficient $\omega^d$ is an index of the degree of substitutability between home goods and importables in demand, with $\omega^d = 0$ corresponding to zero substitution. Similarly defining $\omega^s = -\frac{\eta_m^s}{\eta_h^s}$ with $0 \leq \omega^s \leq 1$, eq. (6) can be rewritten as

$$\omega = \beta \omega^s + (1 - \beta) \omega^d,$$

where $\beta = \frac{\eta_h^s}{(\eta_h^s - \eta_h^d)} > 0$ is the fraction of the sum of the absolute values of the supply and demand elasticities $(\eta_h^s - \eta_h^d)$ accounted for by the supply side. Thus $\omega$ is a weighted average of the degree of substitutability between home goods and importables on the supply side ($\omega^s$) and that on the demand side ($\omega^d$).

1. Equation (5) is derived on the basis of substitution effects between home and traded goods. It might be objected that, when one estimates equation (5), he will obtain a positive coefficient on the independent variable even though those substitution effects do not exist, simply because the price of exportables appears on both sides of the regression equation, giving rise to the possibility of a spurious correlation. To deal with this, consider the following alternative model.

Letting $P$, $H$, $M$, and $X$ be the natural logarithms of the price level, the price of home goods, the internal price of importables, and the internal price of exportables, respectively, define the price level as a weighted average of the three prices:

$$P = \alpha H + b M + c X, \ c = 1 - \alpha - b.$$  

Letting $t$ represent the tariff-equivalent barriers of all elements of commercial policy, we have:

$$M = X + \ln(1+t) = X + t, \text{ for } t \text{ "small"}.$$  

Thus:

$$P = \alpha H + (1-\alpha)X + bt.$$  

(continued)
Eq. (7) is a convenient and elegant way of summarizing the structure of relative prices. The two special cases mentioned at the start of this section were (i) importables and home goods close substitutes in demand and production, which implies $a^s = a^d = \omega = 1$ and the relative price of home goods rises equiproportionally with the tariff; and (ii) these goods poor substitutes, so that $a^s = a^d = \omega = 0$ and the price of home goods remains unchanged. Since $\omega$ is a weighted average of two positive fractions, it follows that $0 < \omega < 1$, implying that the price of nontraded goods rises with the tariff, but less than proportionally.

Eq. (7) is a general result, one which does not depend on the substitutability assumption. However, only when complementarity is ruled out are $a^s$ and $a^d$ positive fractions; the result in the previous paragraph that $\omega$ is a positive fraction thus depends on the substitutability assumption.

Footnote 1, page 10, continued:

Assume further that the system is homogenous up to a stochastic term:

$$H = P + u,$$

where $u$ has zero mean and is assumed to be uncorrelated with $t$. Thus the tariff affects the price of home goods only through its effect on the price level. Combining the above, we obtain an equation similar to (5):

$$H - X = A(M - X) + v, \quad A = b/(1-a), \quad v = u/(1-a).$$

Looking at the systematic effect of $t$ on $H$, we have:

$$\frac{dH}{dt} = \frac{dX}{dt} + A.$$

i. Suppose that exchange rate policy holds the price of exportables constant; i.e. $\frac{dX}{dt} = 0$. Then $\frac{d(H-X)}{dt} = A$.

ii. Suppose that exchange rate policy is conducted to stabilize the price of importables; i.e. $\frac{dM}{dt} = 0$ and $\frac{dX}{dt} = -1$. In that case, $\frac{d(H-X)}{dt} = \frac{dH}{dt} + 1 = 1$.

Note that $A$ is the weight of imports, relative to tradeables, in the general price index, and has no direct connection with substitution effects; nevertheless, $A$ captures the effect of commercial policy on price of home goods. Thus $A$ has the same interpretation as does $\omega$ — it is the portion of a tariff that is in fact an implicit tax on the export sector.
It may well be the case that there is very little information available about price elasticities, while it is possible to have at least some intuitive ideas of income elasticities based on the luxury/necessity classification. In this situation we can generate price elasticities from income elasticities by applying separability theory. This requires further structure on the consumer's preferences by postulating that the utility function can be written in the additive form \( u(q^d, q^m, q^h) = \sum_i u_i(q^d_i) \). The utility function is the sum of three sub-utility functions, one for each good; it is thus clear that there is no interaction between goods. Such a specification of preferences is restrictive, but it is probably acceptable for our application as the goods are broad aggregates.

It can be shown that the additive utility function implies price elasticities of demand for home goods of the form

\[
\eta^d_m = \frac{\phi^d}{\epsilon^d_h} \frac{w^d_m}{w^d_h},
\]

\[
\eta^d_h = \phi^d \epsilon^d_h (1 - \frac{w^d_m}{w^d_h}),
\]

where \( \phi^d < 0 \) is the income flexibility (the reciprocal of the income elasticity of the marginal utility of income), \( \epsilon^d_i \) is the income elasticity of the demand for good \( i \) and \( w^d_i \) is the share of \( i \) in total expenditure; see the Appendix for derivations. Eqs. (8) and (9) imply that we can generate price elasticities from knowledge of the budget shares, income elasticities and the value of \( \phi^d \). Using (8) and (9) gives

\[
\alpha^d = \frac{-\eta^d_m/\eta^d_h}{w^d_m/\epsilon^d_h} = w^d_m \epsilon^d_m/(1 - w^d_h/\epsilon^d_h).
\]

Proceeding in the same manner for the supply side and assuming that the transformation function can be written in the additive form

\[
f(q^S_e, q^S_m, q^S_h) = \sum_i f_i(q^S_i),
\]

we obtain results analogous to (8), (9) and (10),

\[
\eta^S_m = \frac{\phi^S}{\epsilon^S_h} \frac{w^S_m}{w^S_h} \epsilon^S_m.
\]


(12) \[ \eta^S_h = \phi^S \epsilon^S_h (1 - w^S_h \epsilon^S_h) \]

(13) \[ \alpha^S = -\frac{\eta^S_m}{\eta^S_h} = \frac{w^S_m \epsilon^S_m}{(1 - w^S_h \epsilon^S_h)} \]

where \( \phi^S > 0 \) is minus the reciprocal of the elasticity of the shadow price of the aggregate resource endowment with respect to the endowment; and the other notation is as above with the substitution of 'supply' for 'demand' (see Appendix).

Using (10) and (13) in (7) gives

(14) \[ \omega = \beta \frac{s^m \epsilon^m_m}{1 - w^S_h \epsilon^S_h} \left( 1 - \frac{d^d \epsilon^d}{1 - w^d_h \epsilon^d_h} \right) \]

If we make the further simplifying assumption that for home goods the income elasticity of demand is equal to the scale elasticity on the supply side for home goods, then \( \epsilon^S_h (1 - w^S_h \epsilon^S_h) = \epsilon^d_h (1 - w^d_h \epsilon^d_h) \), since in equilibrium the home goods market clears implying that \( w^S_h = w^d_h \). Using this result gives

\[ \beta = \eta^S_m / (\eta^S_h - \eta^d_h) = \phi^S / (\phi^S + |\phi^d|) \]

which when substituted in (14) yields

(15) \[ \omega = \frac{\phi^S}{\phi^S + |\phi^d|} \frac{s^m \epsilon^m_m}{1 - w^S_h \epsilon^S_h} \left( 1 - \frac{d^d \epsilon^d}{1 - w^d_h \epsilon^d_h} \right) \]

We shall return to this way of expressing the incidence parameter in the next section when we discuss measurement.

To the extent that the tariff increases the price of home goods, its protective effect for the importables sector is less than otherwise. This is because the income generated in importables is lower in terms of its purchasing power over home goods. In effect, the tariff is a subsidy for domestic production of importables, while the higher price of home goods is a tax. We can use the change in the domestic price of importables relative to home goods to measure the net effect of the tariff in protecting the importables sector. Assuming for convenience that the only trade distortion
is a uniform tariff on all imports and taking the relative price to be unity under free trade, we have

\[
\tau = \Delta(p_m/p_h) = (1 + t)/(1 + \omega t) - 1 = (1 - \omega) t/(1 + \omega t),
\]

where \( t \) is the tariff rate. The quantity \( \tau \) is called the true tariff (Sjaastad, 1980a) and is obviously closely related to effective protection. The numerator on the far right of (16) is made up of the difference between two components. The first is the direct subsidy to the output of importables \( t \); the second is the tax on the real income of producers of import-competing goods due to the rise in the price of home goods \( \omega t \). The difference between these two components determines the net effect of the tariff on the importables sector. It should be noted that under substitutability \( \omega \) rises less than proportionally with the tariff \( 0 < \omega < 1 \), implying that on balance importables gain \( \tau > 0 \).

The true export subsidy is similarly defined as the change in the domestic price of exportables relative to nontraded goods,

\[
\sigma = \Delta(p_e/p_h) = 1/(1 + \omega t) - 1 = -\omega t/(1 + \omega t) < 0.
\]

This is simply interpreted as the implicit tax borne by exporters due to the tariff pushing up the price of home goods.

The true tariff and export subsidy are the hypothetical tariff and subsidy rates that would replicate the relative price structure induced by the actual tariff, while keeping the nominal price of home goods unchanged. In terms of the earlier example of a 35 per cent tariff causing \( p_h \) to rise by 25 per cent, the incidence parameter \( \omega = 25/35 = .71 \), the true tariff \( \tau = .08 \) and the true subsidy \( \sigma = -.20 \).

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1. The analysis can be easily extended to nonuniform tariffs and export subsidies and taxes; see Sjaastad (1980a).
In a world of many types of importables we define the $i^{th}$ true tariff as

$$\tau_i = \Delta\left(\frac{p_i^m}{p_i^h}\right) = \frac{(1 + \tau_i)/(1 + \omega - t)}{1} - 1 = \frac{(t_i - \omega \tau_i)/(1 + \omega \tau_i)}{1}$$

where $t_i$ is the nominal tariff rate on the $i^{th}$ import and $\tau$ is an appropriate weighted average of all rates. If we then replace $t_i$ in (18) with the effective rate $t_i^*$ defined in (1) we obtain the true effective rate

$$\tau_i^* = \frac{(t_i^* - \omega \tau_i)/(1 + \omega \tau_i)}{1}$$

This expression has the desirable property that it can also be obtained directly from eq. (1) by replacing $t_i$ with $\tau_i$, i.e.

$$\tau_i^* = \frac{\tau_i - \sum_j a_{ij} \tau_j}{1 - \sum_j a_{ij}}$$

It can be easily seen from (19) that for $\omega, \tau > 0$, the true effective rates are smaller than the effective rates. However, the ranking of activities according to the amount of protection each receives remains unchanged.

5. Tariffs and the Exchange Rate

The distinction between true effective protection and effective protection arises solely because of the increase in the price of home goods induced by the tariff. With substitution, the higher price of importables causes an increase in the demand for home goods and a reduction in their supply. To eliminate the excess demand for home goods, their nominal price must rise. An alternative way for this market to clear is for the prices of traded goods (exportables and importables) to fall relative to home goods, i.e. by an appreciation of the exchange rate. In the extreme case of the nominal price of home goods remaining fixed, the appreciation is such that the change in the price of importables relative to home goods is equal to the true tariff $\tau$ given in (16). With nominal prices and the exchange rate unity under free trade, the change in this relative price when we impose the tariff
at rate $t$ and let the exchange rate appreciate by $r$ be $(1 + t)(1 - r) - 1.$

Equating this to $(1 - \omega)t/(1 + wt)$ [$= r$, from (16)] we obtain

(20) \[ r = \frac{wt}{1 + wt}. \]

For $\omega, t > 0$, it follows from (20) that $r > 0$, implying that the exchange rate does indeed need to appreciate when we impose a tariff.

Of course in general it is possible to have any linear combination of the change in the price of home goods and exchange rate appreciation. Allowing for an unspecified degree of price flexibility and appreciation, we have $\Delta(p_m/p_h) = (1 + t)(1 - r)/(1 + \Delta p_h) - 1$. Equating this with the known change in this relative price $\tau = (1 + t)/(1 + wt) - 1$ and solving for $\Delta p_h$ gives

(21) \[ \Delta p_h = wt - r(1 + wt). \]

The workings of this equation are illustrated in Fig. 1 which clearly shows the sense in which an appreciation of the rate substitutes for an increase in the price of home goods. When the exchange rate is fixed $(r = 0)$, the increase in the price of home goods is a maximum, being equal to $\omega t$. When $p_h$ rises by less than $\omega t$, some appreciation is required to clear the market for home goods. In the case of complete rigidity of $p_h$, the rate appreciates by $\omega t/(1 + wt)$ as in eq. (20).

Corden (1971, Ch. 5) and Balassa (1971a, b) introduced the concept of the "net protective rate" which is the tariff rate less the exchange rate appreciation. Interpreting this as the change in the price of importables with the price of home goods constant, this concept is exactly $\Delta(p_m/p_h) = (1 + t)(1 - r) - 1 = (1 - \omega)t/(1 + wt)$ when we substitute (20) for the

1. Sjaastad (1973) also independently introduced a very similar measure, the "compensated rate of protection".
appreciation required with $\Delta p_h = 0$. Hence, the net protective rate coincides with the true tariff. The advantage of the true tariff analysis is that it makes explicit the required appreciation (or change in the price of home goods, as the case may be).

In concluding this section, it is stressed that the relationship between the tariff and the exchange rate discussed above hinges entirely on the assumption that the nominal price of home goods is sticky, or even fixed, an assumption that may be acceptable in the short run (especially if the analysis relates to the lowering of the tariff) but is untenable in the long run when all prices would tend to be fully flexible. In such a world, the relative price change required to clear the home goods market following the imposition of a tariff must take place by a change in the nominal prices of traded goods, and only an exchange rate appreciation can bring that about. This analysis, however, treats the exchange rate as a relative price rather than a monetary variable, and hence ignores all monetary adjustments attendant to a change in the exchange rate.
6. The Measurement of The Incidence of Protection

In this section we present estimates of the tariff incidence for a number of countries. First we summarize studies which have estimated the incidence parameter \( \omega \) directly. Then we provide some evidence regarding the magnitude of \( \omega \) from structural form general equilibrium models.

Direct Estimates of \( \omega \)

Eq. (5) expresses the proportional change in the price of home goods relative to exportables as a linear function of the change in the relative price of importables, with coefficient \( \omega \). Taking \( \omega \) to be constant and adding a disturbance term, (5) is a linear regression equation which can be estimated with time series data for a given country. This procedure, in essence, has been used by the studies which estimate \( \omega \) directly. Direct estimates of \( \omega \) are now available for Chile, Uruguay, Argentina, El Salvador and Australia.

(i) Chile

The Chilean data are monthly for the period January 1959-June 1971 (150 observations).\(^1\) For exportables we use the mining products sub-index of the Wholesale Price Index which measures the internal price of these products; \( P_m \) is the imports sub-index of the WPI. The price of home goods is the CPI with food removed, constructed as a weighted average of the three non-food sub-indexes housing, clothing and other. In general two different weighting patterns are used to construct \( P_h \), the first derived from the 1969 Survey of Consumer Expenditure and the second from the 1978 Survey.

---

1. All data are from the Instituto Nacional de Estadisticas (INE).
The estimation results are given in Table 1 where the trade balance (export registrations minus payments for imports) has also been included as an additional independent variable to capture the effects of departures of income from absorption on \( p_{e} / p_{n} \). As indicated in Sjaastad (1980a) the appropriate weights to be used in the construction of the price indexes are relative substitution effects. As these are unknown, a certain amount of experimentation was undertaken to see if the results were sensitive to changes in the weights for the home goods price index.\(^1\)

As can be seen from Table 1 with a wide variety of alternative specifications for the weights, \( \hat{\omega} \) always lies in the narrow range .53 to .59. This indicates that about 50 to 60 per cent of the tariff incidence is borne by producers of exportables. The stability of \( \hat{\omega} \) is impressive and means that the results are highly robust. Moreover, \( \omega \) is always estimated very precisely, with \( t \)-values in excess of 10.

As a check on the functional form, we added a squared price variable to the equation. As indicated in the last two lines of Table 1, its coefficient is insignificant and \( \hat{\omega} \) is almost unchanged. We conclude that the parameterization with \( \omega \) constant is satisfactory for the Chilean data.

(ii) Uruguay

The data for Uruguay are monthly for the period January 1966-October 1979 (166 observations).\(^2\) The price of exportables is constructed on the basis of the internal prices of the principal export products of Uruguay. The price of importables is constructed from the wholesale price

---

1. Due to the lack of data, it is not possible to carry out the same sensitivity analysis for \( p_{e} \) and \( p_{m} \).

2. The data sources are (i) the wholesale price index for national products (IPN), prepared by the Economic Research Department of the Central Bank of Uruguay and (ii) the wholesale price index for imported products (IPM), published by the Office of Statistics and Census. These data were originally constructed and analysed by Sjaastad (1980c).
### TABLE 1

**REGRESSION RESULTS: CHILE, JULY 1959–DECEMBER 1970**

\[ \log(p_h/p_e) = \alpha + w\log(p_m/p_e) + \beta[\log(p_m/p_e)]^2 + \gamma(\text{trade balance}) \]

(Cochrane-Orcutt estimates; t-values in parentheses)

<table>
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<tr>
<th>Weight in home goods price index given to</th>
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<th>( \hat{\beta} )</th>
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<td>('78+'69)/2</td>
<td>('78+'69)/2</td>
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</table>

The price of home goods is constructed as \( \log p_h = \omega_h \log(\text{price of housing}) + \omega_c \log(\text{price of clothing}) + (1-\omega_h-\omega_c) \log(\text{price of other consumption}) \), where the \( \omega \)'s are weights whose values are specified in columns 1-3; 1978 refers to the weights derived from the 1978 Survey of Consumer Expenditure and 1969 refers to the 1969 Survey weights. Although we do not report its coefficient, the trade balance is included in all equations; and similarly for the constant term.
data before January 1972 and is the import price index thereafter. The home goods price is the index of wholesale prices of national goods excluding (i) meat and meat products (ii) miscellaneous food products (iii) petroleum and alcohol products and (iv) animal products. For further details of these data, see Sjaastad (1980c).

The estimation results are given in Table 2. In some equations we have added a lagged dependent variable to allow for slow adjustment of the relative prices. This gives rise to a distinction between a short-run value of the incidence parameter \( \omega' \) and a long-run value \( \omega = \omega'/(1-\lambda) \), where \( \lambda \) is the coefficient of the lagged dependent variable; estimates of both \( \omega' \) and \( \omega \) are given in the table. Looking at equations 1, 2, 4-6 and 8, the estimates of \( \omega \) (long-run) lie in the range .51 to .57, which is similar to the range for Chile. The estimates of \( \omega \) from equations 3 and 7 (OLS with lagged dependent) are somewhat higher but these results are not entirely satisfactory as the implied speed of adjustment is implausibly low (1-\( \lambda \approx .07 \), implying that about 7 per cent of the gap between equilibrium and actual is eliminated each month). Also, there is some evidence that the residuals of these equations are autocorrelated.

In contrast to the Chilean results, in Table 2 the squared relative price variable is significant (equations 9-12). The squared term means that the incidence parameter is no longer a constant, but now varies with \( \log(p_m/p_e) \). Furthermore, there is now a distinction between the average and marginal values of omega (\( \omega_A \) and \( \omega_M \), respectively). The former indicates to what extent the tariff barriers constitute an implicit tax on exports, while the latter tells us how an increment to existing protection is distributed between an increment to the implicit tax on exports and an increment to true protection for import-competing activities. Clearly it is \( \omega_A \) that is relevant to estimating the net effects of existing protection and for predicting the consequences of a major reduction in protection.
### TABLE 2

REGRESSION RESULTS: URUGUAY, JANUARY 1966-OCTOBER 1979

\[
\log(p_n/p_e) = \alpha + \omega' \log(p_m/p_e) + \lambda \log(p_n/p_e) - 1 + \beta [\log(p_m/p_e)]^2
\]

(t-values in parentheses)

<table>
<thead>
<tr>
<th>Estimation technique(^a)</th>
<th>(\hat{\omega}')</th>
<th>(\hat{\lambda})</th>
<th>(\hat{\beta})</th>
<th>(\hat{\omega}'/(1-\hat{\lambda}))</th>
<th>(\hat{R}^2)</th>
<th>D.W.</th>
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<td>-</td>
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<td>.42</td>
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<td>-</td>
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<td>.55</td>
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<td>.71</td>
<td>.94</td>
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<td>.1060 (2.00)</td>
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<td>.57</td>
<td>.56</td>
<td>1.96</td>
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<td>.42</td>
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<td>-</td>
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<td>.54</td>
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<td>.55</td>
<td>2.05</td>
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<table>
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<tr>
<th>Long-run (\hat{\omega}_A)^b</th>
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<th>(\hat{\lambda})</th>
<th>(\hat{\beta})</th>
<th>(\hat{\omega}'/(1-\hat{\lambda}))</th>
<th>(\hat{R}^2)</th>
<th>D.W.</th>
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<tbody>
<tr>
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<td>1.107 (9.90)</td>
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<td>11. OLS</td>
<td>.117 (2.55)</td>
<td>.920 (36.46)</td>
<td>-.1046 (1.77)</td>
<td>.94</td>
<td>.95</td>
<td>1.50</td>
</tr>
<tr>
<td>12. CORC</td>
<td>.417 (7.45)</td>
<td>.0786 (1.47)</td>
<td>.1786 (2.06)</td>
<td>.53</td>
<td>.56</td>
<td>2.05</td>
</tr>
</tbody>
</table>

---

\(^a\) OLS = ordinary least squares; CORC = Cochrane-Orcutt estimation procedure which adjusts for residual autocorrelation.

\(^b\) Long-run average omega \(\hat{\omega}_A = (\hat{\omega}' + .4\hat{\beta})/(1-\hat{\lambda})\); see text for explanation. The associated marginal omegas are given in Table 3.
To estimate $\omega$, we need to make further assumptions about the structure of protection and also transform the variable $\frac{p_m}{p_e}$; see Sjaastad (1980b) for details. Applying this procedure to the estimates gives the four long-run average omegas given in Table 2. The Cochrane-Orcutt estimates (equations 10 and 12) agree well with the previous values of $\hat{\omega}$, while the ordinary least squares estimates are higher. However, note again that as the OLS residuals are autocorrelated, these estimates are not satisfactory.

We can estimate the long-run value of $\omega_M$ from the equations of Table 2 as $\frac{3\log(p_m/p_e)}{3\log(p_m/p_e)} \equiv \omega_M = \frac{[\omega' + 2\beta \log(p_m/p_e)](1-\lambda)}{1-A}$. In equation 10, for example, $\hat{\beta} = .175$, so that $\omega_M$ is an increasing function of the level of protection. In Table 3 we tabulate the implied long-run values of the marginal omegas at the beginning, middle and end of the sample period. For the reason given in the previous paragraph, we concentrate on the CORC estimates, equations 10 and 12. Both increase moderately with protection and are not too far away from the corresponding average omegas. This means that although there is some nonlinearity, it is not all that important.

**TABLE 3**

<table>
<thead>
<tr>
<th>Table 2 Long-run $\omega_M$ implied by equations 9-12 of Table 2: URUGUAY, JANUARY 1966-OCTOBER 1979 (t-values in parentheses)</th>
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<tr>
<td></td>
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<tr>
<td>9. OLS</td>
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<td>10. CORC</td>
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</tr>
<tr>
<td>11. OLS</td>
</tr>
<tr>
<td>12. CORC</td>
</tr>
</tbody>
</table>

a. The long-run marginal $\omega$ is evaluated at the mean of $\log(p_m/p_e)$ over the 12 months in each of the three years, .033, .136 and .413, respectively.
(iii) Argentina

The Argentine data are annual for the period 1935-79 (45 observations), with \( p_e \) an index of wholesale prices of agricultural goods (PMA), \( p_m \) an index of wholesale prices of imported goods (PMI) and \( p_h \) an index of wholesale prices of nationally-produced goods (PMA).

The estimation results, from Sjaastad (1980b), are given in Table 4. The long-run estimates of \( \omega \) in the linear form of the equation range from .38 to .48 and are thus a little lower than those for Chile and Uruguay. There is again evidence of nonlinearity as the coefficient of the squared relative price term is significant. This coefficient is always negative, indicating that \( \omega \) declines with increasing protection.

In upper panel of Table 5 we tabulate the long-run average and marginal values of omega associated with equations 4-6 of Table 4. The estimates of \( \omega_A \) for eqs. 4-6 all lie well above those of eqs. 1-3, where no distinction is made being marginal and average values. The obvious conclusion is that to neglect the nonlinearity results in an underestimate of the average omega.

The effects of nonlinearity were also captured by a second technique. The greater is protection, the larger is the share in total imports of intermediate and capital goods. Thus the variable \( f \cdot \log(p_m/p_e) \) was included in equations 7-9 of Table 4, with \( f \) the percentage of total imports accounted for by intermediate and capital goods. For 1935-39, \( f = 47.5 \) per cent, while by 1970-76 that fraction had grown to 74.1 per cent. As can be seen from Table 4, the coefficient of this variable is negative and highly significant. The negative coefficient again indicates that \( \omega \) declines as protection increases.

The lower panel of Table 5 gives the long-run omegas corresponding to these equations. For 1935-39 the estimates of \( \omega \) based on eqs. 7-9 are quite similar to those for \( \omega_A \) and \( \omega_M \) from eqs. 4-6. During the 1970s, however, the former estimates are much lower than the latter estimates of \( \omega_A \), but quite similar to those of \( \omega_M \).
25.

**TABLE 4**

REGRESSION RESULTS: ARGENTINA, 1935-79

\[ \log \left( \frac{p_h}{p_e} \right) = \alpha + \omega' \log \left( \frac{p_m}{p_e} \right) + \lambda \log \left( \frac{p_h}{p_e} \right)^{-1} + \gamma \text{trade balance terms} + \beta \left[ \log \left( \frac{p_m}{p_e} \right) \right]^2 + \text{GDP} \]

and trade balance terms

t-values in parentheses

<table>
<thead>
<tr>
<th>Estimation technique</th>
<th>( \hat{\omega} )</th>
<th>( \hat{\lambda} )</th>
<th>( \hat{\beta} )</th>
<th>( \hat{\gamma} )</th>
<th>( \hat{\omega} = \hat{\omega} / (1-\lambda) )</th>
<th>( R^2 )</th>
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* See Table 5.

\( f \) = the percentage in total imports of intermediate and capital goods.

**OLS** = ordinary least squares; **CORC** = Cochrane-Orcutt estimation procedure which adjusts for residual autocorrelation.
As an illustrative application, we consider the estimation of the true tariff and export subsidy rates in Argentina. Sjaastad (1980b) estimated the equivalent uniform tariff for 1970-79 in Argentina to be \( t = 98 \) per cent.

Using this and \( \omega = .48 \) (one of the lower estimates of \( \omega \)) in eqs. (16) and (17), we obtain estimates of the true tariff and export subsidy equivalents,

\[
\hat{\tau} = (1-\hat{\omega}) \frac{t}{(1+\hat{\omega} t)} = (0.52)(0.98)/1.47 = 35 \text{ per cent}
\]

\[
\hat{\sigma} = -\frac{\hat{\omega} t}{(1+\hat{\omega} t)} = -(0.48)(0.98)/1.47 = -32 \text{ per cent}.
\]

These estimates indicate that the same volume of trade would have prevailed in the 1970s had the then-existing trade barriers been replaced with a uniform import duty of 35 per cent and a uniform export tax of 32 per cent. An implication is that if Argentina were to adopt a policy of free trade, the price of exportables would rise, relative to home goods, by 47 per cent (from an index of 68/100 to unity), and relative to importables by nearly 100 per cent (from 68/135 = .504 to unity). Furthermore, if it were desired that the price of home goods remain constant in the process, the trade liberalization could be accompanied by a devaluation of 47 per cent [from an index of 68 to 100; see eq. (20)]. That is, all tariffs could be eliminated, and the peso devalued by 47 per cent without causing inflation; for a proof, see Sjaastad (1980a).

### Table 5

<table>
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<th>Table 4 equation number/Estimation technique</th>
<th>1935-39</th>
<th>1970-79</th>
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<tr>
<td>5. OLS</td>
<td>.81</td>
<td>.38</td>
</tr>
<tr>
<td>6. CORC</td>
<td>.69</td>
<td>.39</td>
</tr>
<tr>
<td>( \hat{\omega}_M = \hat{\omega}_A )</td>
<td></td>
<td>(1970-76)</td>
</tr>
<tr>
<td>7. OLS</td>
<td>.58</td>
<td>.29</td>
</tr>
<tr>
<td>8. OLS</td>
<td>.67</td>
<td>.33</td>
</tr>
<tr>
<td>9. CORC</td>
<td>.69</td>
<td>.35</td>
</tr>
</tbody>
</table>
(iv) El Salvador

The data for El Salvador are from Diaz (1980) and are monthly for the period 1966-1976 (132 observations) and quarterly for 1962-1977 (64 observations). The price of exportables is measured by the index of the internal prices of the principal export products of El Salvador (coffee, cotton, sugar, shrimp and other), which is published by the Banco Central de Reserva of El Salvador. The price of importables is constructed as a weighted average of indexes of the domestic prices of the major imports (food, raw materials, manufactures, chemicals and machinery and transport). The wholesale price index, published by the Banco Central de Reserva, is used for the price of home goods.

The estimates of omega, from Diaz (1980), are given in Table 6 for the two sets of data. In all cases, $\omega$ is estimated quite precisely. From these and other results reported by Diaz, the preferred value of $\omega$ for El Salvador is .70. In comparison with the other three countries, this value is somewhat higher and it indicates that for El Salvador home goods and importables are quite close substitutes.

(v) Australia

Our data for Australia are quarterly from March 1950-June 1980 (122 observations). We use the export price index for the price of exportables, the import price index for importables and the wholesale price index for home goods.

The results are given in Table 7, and, as before, omega is estimated with much precision. The CORC estimates indicate that the long run value of the incidence parameter is around .7 for Australia.

1. We are indebted to Jenny Gippel, Reserve Bank of Australia, for her help with the Australian data.

2. These data are from Australian Bureau of Statistics and Reserve Bank of Australia publications. After 1969 the WPI was discontinued and for this period we use the price index of home produced materials used in manufacturing industry, which is published by the ABS.

3. We also included GDP and the trade balance as additional explanatory variables; in general, these were insignificant.
TABLE 6
REGRESSION RESULTS: EL SALVADOR, FIRST QUARTER, 1962 - FOURTH QUARTER, 1977
AND JANUARY 1966 - DECEMBER 1976

\[ \log(p_h/p_e) = a + \omega \log(p_m/p_e) + \lambda \log(p_h/p_e) \]

(t-values in parentheses)

<table>
<thead>
<tr>
<th>Estimation technique</th>
<th>( \hat{\omega}' )</th>
<th>( \hat{\lambda} )</th>
<th>( \hat{\omega} = \hat{\omega}'/(1-\hat{\lambda}) )</th>
<th>( R^2 )</th>
<th>D.W.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarterly data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. OLS</td>
<td>.50</td>
<td>-</td>
<td>.50</td>
<td>.54</td>
<td>.51</td>
</tr>
<tr>
<td></td>
<td>(8.25)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. CORC</td>
<td>.44</td>
<td>-</td>
<td>.44</td>
<td>.77</td>
<td>2.26</td>
</tr>
<tr>
<td></td>
<td>(7.85)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. OLS</td>
<td>.36</td>
<td>.48</td>
<td>.69</td>
<td>.69</td>
<td>1.55</td>
</tr>
<tr>
<td></td>
<td>(6.40)</td>
<td>(5.34)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. OLS</td>
<td>.56</td>
<td>-</td>
<td>.56</td>
<td>.55</td>
<td>.12</td>
</tr>
<tr>
<td></td>
<td>(12.02)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. CORC</td>
<td>.75</td>
<td>-</td>
<td>.75</td>
<td>.95</td>
<td>1.98</td>
</tr>
<tr>
<td></td>
<td>(19.49)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. OLS</td>
<td>.17</td>
<td>.75</td>
<td>.68</td>
<td>.82</td>
<td>1.52</td>
</tr>
<tr>
<td></td>
<td>(11.22)</td>
<td>(13.42)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

OLS = ordinary least squares; CORC = Cochrane-Orcutt procedure which adjusts for residual autocorrelation.
TABLE 7

REGRESSION RESULTS: AUSTRALIA, MARCH 1950 - JUNE 1980

\[ \Delta \log(p_h/p_e) = \omega + \omega' \Delta \log(p_m/p_e) + \lambda \Delta \log(p_h/p_e)_{-1} \]

+ seasonal dummies
(t-values in parentheses)

<table>
<thead>
<tr>
<th>Estimation technique</th>
<th>( \hat{\omega}' )</th>
<th>( \hat{\lambda} )</th>
<th>Long-run ( \hat{\omega} = \hat{\omega}'/(1-\hat{\lambda}) )</th>
<th>( R^2 )</th>
<th>D.W.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. OLS</td>
<td>.685</td>
<td></td>
<td>.69</td>
<td>.59</td>
<td>1.10</td>
</tr>
<tr>
<td></td>
<td>(12.69)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. CORC</td>
<td>.689</td>
<td></td>
<td>.69</td>
<td>.67</td>
<td>1.95</td>
</tr>
<tr>
<td></td>
<td>(13.00)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. OLS</td>
<td>.638</td>
<td>.213</td>
<td>.81</td>
<td>.63</td>
<td>1.50</td>
</tr>
<tr>
<td></td>
<td>(12.04)</td>
<td>(3.61)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. CORC</td>
<td>.690</td>
<td>.032</td>
<td>.71</td>
<td>.67</td>
<td>1.96</td>
</tr>
<tr>
<td></td>
<td>(13.02)</td>
<td>(.45)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( \Delta = \) first difference; OLS = ordinary least squares; CORC = Cochrane-Orcutt estimation procedure which adjusts for residual autocorrelation.

We conclude this sub-section on the direct estimation of omega by summarizing the results for the five countries. For Chile the estimates of \( \omega \) lie in the range .5 - .6. There is no indication of significant nonlinearity (in the logs) in the response of the relative price of home goods to that of importables. Most of the estimates for Uruguay (all of the satisfactory estimates) also lie in the same range. For this country there is evidence of modest nonlinearity which creates a distinction between the average and marginal values of omega.

1. Here and elsewhere we refer to the long-run values of omega.
In the linear form of the equation for Argentina, estimates of omega lie in the range .4 - .5. There is again evidence of nonlinearity; in this case it is more important and indicates that omega declines significantly with increasing protection. A comparison of the results with and without the nonlinear term indicates that to neglect nonlinearity results in an underestimate of the average omega. The implication is that those studies with $\omega$ constant give estimates which are to be interpreted as lower bounds to the "true" average values of omega. In the 1970s for Argentina the marginal and average values of omega lie in the range .3 - .4 and .5 - .6, respectively.

The estimates of omega for El Salvador lie in the range .45 - .75, with the preferred value being .70. For Australia, omega is also about .7.

All in all, there is remarkable uniformity of the estimates in the five countries. The results are strengthened by the fact that in most cases omega is estimated very precisely. For Chile, the results were shown to be highly robust in that the estimates do not depend on the particular weighting scheme adopted for the home goods price index. The results in most cases show that half or more of the burden of protection is shifted onto the exportables sector.

Estimates of $\omega$ from Two General Equilibrium Models

In this sub-section we report the values of the incidence parameter implied by two general equilibrium models, for the U.S. and for Australia.

(i) U.S.

Clements (1980b) estimated econometrically a small-scale GE model with three sectors, exportables, importables and home goods. Prices of the two traded goods are exogenous, while that of home goods is endogenous, which is

1. Diaz (1980) shows that this is also the case for the El Salvador results.
consistent with the theory developed in this paper. The data are annual U.S. for the postwar period.

We use eq. (6) to convert the structural form price elasticities for home goods into $\omega$. The required values of the elasticities are:

- Elasticity of demand for home goods with respect to $p_m$: $\hat{\eta}_d = .044$
- Elasticity of supply of home goods with respect to $p_m$: $\hat{\eta}_s = -.532$
- Elasticity of supply of home goods with respect to $p_h$: $\hat{\eta}_h = .598$
- Elasticity of demand for home goods with respect to $p_h$: $\hat{\eta}_d = -.054$

Using these in eq. (6) gives

$$\omega = \frac{.044 + .532}{.598 + .054} = .88$$

This value is larger than the others, which leads to the question why? Although the comparison involves countries which are obviously very different, there are no strong a priori reasons to expect these differences to affect $\omega$ in a systematic way. One reason for the difference may be the difficulty in estimating precisely the structural form price elasticities with time-series data, which typically have a low information content. Hence, it is useful to compute an alternative set of price elasticities based on the separability theory developed at the end of Section 4.

According to eqs. (8) and (9) when we postulate that the utility function is additive, price elasticities can be generated from knowledge of the income elasticities, budget shares and the value of the income flexibility. The values of the income elasticities and budget shares, from Clements (1980b), are:

- Income elasticity of demand for importables: $\hat{\varepsilon}_d = .994$
- Income elasticity of demand for home goods: $\hat{\varepsilon}_h = 1.093$
- Budget share of importables: $\hat{\omega}_m = .300$
- Budget share of home goods: $\hat{\omega}_h = .582$. 
Finally for the income flexibility, we use $\phi^d = -0.7$, a value consistent with a good deal of econometric evidence from many countries. Using these values in (8) and (9) gives

$$\hat{n}_m^d = 0.7 \times (1.093)(0.3)(0.994) = 0.228$$

$$\hat{n}_h^d = -0.7 \times (1.093)[1-(0.582)(1.093)] = -0.278.$$  

As can be seen, these are rather different from the previous values. Because we can have more faith in the estimates of the income elasticities, budget shares and $\phi^d$, these price elasticities are preferable.

For the supply elasticities, we use the following values from Clements (1980a):

- GDP elasticity of supply of importables $\phi^S_m = 1.550$
- GDP elasticity of supply of home goods $\phi^S_h = 0.670$
- GDP share of importables $\psi^S_m = 0.211$
- GDP share of home goods $\psi^S_h = 0.579$

There is very little evidence available on the value of the other supply parameter $\phi^S$, so we take the "neutral" value of $\phi^S = 1$. Using these in eqs. (11) and (12) gives

$$\hat{n}_m^S = -(0.670)(0.211)(1.550) = -0.219$$

$$\hat{n}_h^S = 0.670[1-(0.579)(0.670)] = 0.410.$$  

Using (22) - (25) in eq. (6) gives the new value of omega,

$$\hat{\omega} = \frac{0.228 + 0.219}{0.410 + 0.278} = 0.65.$$ 

Although this value is still relatively large, it is now more in line with the values of omega for the other countries.

We simulate the effects of a tariff increase using ORANI, a sophisticated large-scale GE model of Australia. The simulations are from Dixon et. al. (1979), which uses the ORANI 78 version of the model described in Dixon (1979).

There are 112 sectors in the model which we aggregate into exportables, importables and home goods using the shares in total value-added as weights. The classification of sectors is given in Dixon (1980, Table 4). We consider the effects of an equiproportional increase in all tariffs such that \( (\text{new } t_i) = (1+k) \cdot (\text{old } t_i) \), where \( k > 0 \) and \( t_i \) is the \( i \)th nominal tariff rate. We choose the coefficient \( k \) such that the domestic price of importables rises by 5 per cent.

The effect of the increase in tariffs is to increase the domestic price of exportables by 1.12 per cent, on account of a terms of trade improvement. The price of home goods rises by 4.35 per cent. These imply an omega of \( (4.35-1.12)/(5-1.12) = .83 \). This indicates that for Australia more than 80 per cent of the tariff is a tax on exporters. Although this is relatively large, it is still broadly consistent with the time series estimates of omega for Australia.

This high value of \( \omega \) reflects the type of products which represent exportables in Australia. To a large extent these are natural resource-based or agricultural products (more than 70 per cent of total exports), which are in quite inelastic supply. This means that these industries absorb a good part of the tariff incidence in the form of reduced rents to the natural resource or land.

These two estimates of omega from structural general equilibrium models serve to strengthen and complement the previous results. The direct (or reduced form) estimates of omega from the four Latin American countries and Australia were on the whole consistent with the values implied by the GE models.

1. We are indebted to Peter Dixon, Brian Parmenter and Alan Powell for their help with the ORANI results reported in this sub-section.
7. Concluding Comments

In this paper we have surveyed the factor and sector oriented approaches to protection. A simple extension of the conventional Heckscher-Ohlin-Samuelson model to incorporate internationally mobile capital led to the conclusion that trade liberalization was unlikely to harm the scarce factor labor. This of course is opposite to the usual Stolper-Samuelson result. The sector approach focuses on the key role of home goods to devise a simple measure of the incidence (in public finance terms) of the tariff. With a home goods sector we can determine whether the tariff incidence is borne primarily by exporters (in which case it operates like an export tax) or is shared between producers of home goods and exporters. We showed that the response of the price of home goods in terms of exportables provides a convenient measure of the tariff incidence. When the tariff causes this relative price to rise substantially, exporters bear most of the incidence. The elasticity of the price of home goods with respect to the domestic price of importables is the proportion of the tariff paid by exporters; this elasticity is known as the incidence parameter.

The analysis of the tariff incidence leads to the true tariff concept, which is the change in the domestic price of importables relative to home goods. In the situation where the nominal price of home goods is sticky, the true tariff analysis can be directly related to the Corden-Balassa "net protective rate." We showed that in this case the effect of the tariff on the exchange rate can be easily analysed.

We estimated the incidence parameter directly for five countries. In most cases the parameter is estimated very precisely and the estimates indicate that half or more of the burden of protection is shifted onto exporters. Finally, the values of the parameter derived from two general equilibrium models were on the whole consistent with the direct estimates.

The implication of these results is straightforward. Suppose we have a tariff structure whose uniform equivalent (i.e. generates the same
volume of trade) is 35 per cent. With an incidence parameter of \(25/35 \approx 0.7\), the tariff pushes up the price of home goods relative to exportables by 25 per cent. In the aggregate, the real income of the import-competing sector in terms of home goods rises by only \(35 - 25 = 10\) per cent. Those import-competing activities receiving tariff protection of less than 25 per cent in fact have negative true protection. Similarly, any export activity without a subsidy has an implicit tax of at least 25 per cent.\(^1\)

In many developing countries, the industrialized sector at least potentially comprises of nontraditional exportables and importables, which have similar factor intensities. Thus the effect of tariff protection is to tax one part of the industrialized sector and to subsidize the other. The clear implication is that the nontraditional exportables will fail to emerge (or grow less rapidly), so that protection leads to a concentration of traditional exports. Hence the objective of export diversification is clearly inconsistent with protection (i.e. import substitution). Not only does protection reduce the volume of trade, but it has this adverse effect on export composition. Specialization in traditional exports gives rise to the well-known problems of price instability and the consequent demands to reduce it (e.g. UNCTAD commodity agreements).

Another manifestation of protection is the widespread use of export subsidies for nontraditional exports. At best, these have the effect of neutralizing the negative protection for that sector due to import duties. The end result is one which is qualitatively similar to free trade but with taxes on traditional exports. This may or may not be desirable, but flies in the face of GATT rules.

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1. Export activities which use import competing goods as inputs clearly pay more than the 25 per cent tax. Exports which only use other exportables have a 25 per cent tax on their value-added.
APPENDIX

Derivations of Price Elasticities under Additivity

To simplify the notation, we drop the d superscript for demand. Let $p_i, q_i$ be the price and quantity demanded of good $i$ and let $p, q$ be the corresponding vectors. The consumer chooses $q$ to maximize the utility function $u(q)$ subject to the budget constraint $p'q = M$, where $M$ is total expenditure ("income" for short). The first-order conditions are the budget constraint and $3u/3q = \lambda p$, where $\lambda$ is the marginal utility of income. Differentiating these conditions with respect to $p$ and $M$ gives Barten's (1964) fundamental matrix equation,

$$
\begin{bmatrix}
U & p \\
p' & 0
\end{bmatrix}
\begin{bmatrix}
3q/3M \\
-3q/3M
\end{bmatrix}
= \begin{bmatrix}
0 & \lambda I \\
1 & -q'
\end{bmatrix},
$$

where $U = 3^2u / 3q3q'$ and $3q/3M$ and $3q/3p'$ are the income and price derivatives of the demand functions. Solving (A1) gives

$$
\frac{3q}{3p'} + \frac{3q}{3M}q' = \lambda U^{-1} - \frac{\lambda}{3\lambda/3M} \frac{3q}{3M} \frac{3q'}{3M}
$$

for the income-compensated price derivatives and

$$
3q/3M = (3\lambda/3M)U^{-1}p
$$

for the income derivatives.

When the utility function is additive the Hessian $U$ and its inverse are both diagonal. Then, the right-hand side of (A2) in scalar form becomes

$$
\lambda \delta_{ij} u_{ii} - \frac{\lambda}{3\lambda/3M} \frac{3q_i}{3M} \frac{3q_i}{3M},
$$

where $\delta_{ij}$ is the Kronecker delta and $u_{ii}$ is the $(i,i)^{th}$ element of $U^{-1}$. Converting this to an elasticity by multiplying by $p_j/q_i$ gives
The first term on the right of (A4) can be written as

\[
\frac{\partial \log q_i}{\partial \log p_j} = \lambda \delta_{ij} u_{ipj} q_i - \frac{\lambda}{\partial \lambda/\partial M} \frac{M}{q_i} \frac{\partial q_i}{\partial M} \frac{\partial q_i}{\partial M}.
\]

where the first step is based on (A3) and \( \phi = \frac{\lambda}{\partial \lambda/\partial M} \) is the income flexibility and \( \varepsilon_i = \frac{M}{q_i} \frac{\partial q_i}{\partial M} \) is the income elasticity for good \( i \). The second term on the right of (A4) can be expressed as \(-\phi \varepsilon_i w_j \varepsilon_j\), where \( w_j = p_j q_j / M \) is the \( j \)th budget share. We can hence write (A4) as

\[
\frac{\partial \log q_i}{\partial \log p_j} = \phi \varepsilon_i (\delta_{ij} - w_j \varepsilon_j),
\]

which is eq. (8) for \( i = \) home goods, \( j = \) importables and eq. (9) for \( i, j = \) home goods.

The derivation of eqs. (11) and (12) is similar to the above and is contained in Clements and Izan (1980).
REFERENCES


