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NON-TRADED INPUTS AND EFFECTIVE PROTECTION: A GENERAL EQUILIBRIUM ANALYSIS*

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1. Introduction

The theory of effective protection was originally developed under the simplifying assumptions of a small country, fixed intermediate input coefficients and the absence of non-traded intermediate inputs. The general equilibrium implications of relaxing the fixed coefficients assumption have been studied in a large number of recent papers.[1] In contrast, no rigorous general equilibrium analysis of the question of non-traded inputs in connection with the theory of effective protection has appeared so far.[2]

In this paper, we shall investigate, in terms of a simple general equilibrium model, the resource allocation implications of a number of alternative measures of effective protection that have been (or could have been) suggested in the literature to cope with non-traded inputs. We shall adhere to the assumptions of fixed intermediate input coefficients (though primary factor coefficients will be variable), two domestically-produced tradeables[3] and small country to keep our basic issue of non-traded inputs in sharp focus.

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[1] See, for example, Jones (1971), Ethier (1970, 1971), Bhagwati and Srinivasan(1971), Ruffin (1970).

[2] Of the partial equilibrium or at best quasi-general equilibrium studies, mention may be made of the papers by Leith (1968) and Humphrey (1969a, 1969b). Corden's analysis (1966, 1971) of the problem, though it runs along general equilibrium lines, is far from rigorous.

[3] It has been demonstrated in the literature that with variable intermediate input coefficients no usual value added concept of effective protection is appropriate for predicting output movements even in a simple two-commodity–two-factor model with no non-traded inputs. See, for example, Jones (1971).

Throughout the paper, the effective protective rate for industry j (EPR_j) will be defined as the proportionate change in value added per unit output of industry j. Corden (1966) treated non-traded inputs like primary factors and argued for the inclusion of the value of non-traded inputs in value added. On the other hand, Balassa (1965) treated non-traded inputs just like ordinary traded inputs with zero tariffs (and hence unchanged prices for a small country) for computing the change in value added. However, the prices of non-traded commodities change, in general, when tariffs are imposed on traded commodities in a general equilibrium framework. Therefore, if one likes to treat non-traded inputs in exactly the same way as traded inputs he should ideally take into account the changes in the prices of non-traded inputs (since that is what he does for traded inputs) resulting from the setting up of a particular protective structure in computing *EPR*'s. Thus, we get at least three alternative measures of effective protection in the face of non-traded inputs. The measure which treats non-traded inputs just like primary factors will be called the Corden measure. The Balassa measure will be the one which treats non-traded inputs like traded inputs with unchanged prices. The third measure will be called the Scott measure.[4] It is different from the Balassa measure in that the changes in the prices of non-traded commodities as a result of changes in the prices of traded commodities will be taken into account.

It will be shown that the Balassa measure does not carry any resource allocation significance. The Corden measure correctly predicts the output movements of tradeables as well as the direct-plus-indirect primary factor movements and value added shifts as between the two traded-good activities so long as the non-traded commodities (whatever be their number) are 'pure' intermediate commodites. With two non-tradeables solely used as inputs the Corden measure of (relative) protection to the traded-good industries also provides a correct indicator of the degree of (relative) indirect protection to the non-tradeable industries. The Scott measure, on the other hand, assumes the same significance as the Corden measure if and only if the ranking of the traded-good industries in terms of direct primary factor coefficients is the same as that in terms of direct-plus-indirect coefficients.

[4] This is because Corden has suggested to me (in personal correspondence) that Scott used measure, which, in the ultimate analysis, comes very close to the present one.

2. Model

Let us consider an economy where four commodities 1, 2, N and M are being produced locally in four industries 1, 2, N and M respectively. Of these, commodities 1 and 2 are internationally traded and commodities N and M are non-tradeables or home-goods.[5] There are two primary factors labor and capital – being fully employed and in fixed supply (L,K). Both primary factors are used in the production of all four commodities. In addition, industry 1 uses commodities N, M and S (which is being entirely imported from abroad with no domestic production thereof) and industry 2 uses commodities N and M as intermediate inputs. Production functions in all industries are linear homogeneous in labor, capital and intermediate inputs, where any. Primary factor coefficients per unit of output are variable, in general, but intermediate input coefficients per unit of output are assumed fixed. The country is a small country and there is perfect competition in all markets.

Let us use P_j for the domestic price of commodity j, w for the wage of labor, r for the rental of capital, x_j for the gross output of commodity j and a_{ij} for the amount of input i used directly per unit of commodity j. Our model then consists of six basic equations, viz. four zero-profit conditions for the four industries and two full employment conditions for the two primary factors. Thus we have

$$a_{L1} w + a_{K1} r + a_{N1} P_N + a_{M1} P_M + a_{S1} P_S = P_1 \tag{1}$$

$$a_{L2} w + a_{K2} r + a_{N2} P_N + a_{M2} P_M = P_2 \tag{2}$$

$$a_{LN} w + a_{KN} r = P_N \tag{3}$$

$$a_{LM} w + a_{KM} r = P_M \tag{4}$$

$$a_{L1} x_1 + a_{L2} x_2 + a_{LN} x_N + a_{LM} x_M = L \tag{5}$$

$$a_{K1} x_1 + a_{K2} x_2 + a_{KN} x_N + a_{KM} x_M = K . \tag{6}$$

By writing the competitive profit equations (1) through (4) in strict equality form we are implying that given some set of prices P_1, P_2 and P_s for the tradeables (determined by world demand and supply conditions) w, r, P_N and P_M adjust in such a way that all four industries

[5] The necessity of having two non-traded commodities will be apparent in the later part of the paper when we consider indirect protection to the non-tradeable industries.

produce non-zero outputs. This may not be possible, in general, unless commodities N and M are non-tradeables whose prices, unlike P_1, P_2 and P_s are not set arbitrarily from outside the system. If commodities N and M were tradeables, we get four equations to determine only two variables w and r, given P_1, P_2, P_s, P_N and P_M from outside. Inconsistency could well arise and the country must then cease to produce some of the commodities, thereby dropping the corresponding equations from the system. This consideration provides a justification for labelling commodities N and M as non-tradeables in our model. Eqs. (5) and (6) provide the full employment conditions for the two primary factors labor and capital.

Let A and A' represent the matrices formed by the direct and direct-plus-indirect primary factor coefficients in industries 1 and 2 so that

$$A = \begin{pmatrix} a_{L1} & a_{L2} \\ a_{K1} & a_{K2} \end{pmatrix} \quad \text{and} \quad A' = \begin{pmatrix} A_{L1} & A_{L2} \\ A_{K1} & A_{K2} \end{pmatrix}$$

where $A_{Lj} = a_{Lj} + a_{LN}a_{Nj} + a_{LM}a_{Mj}$ and $A_{Kj} = a_{Kj} + a_{KN}a_{Nj} + a_{KM}a_{Mj}$; $j = 1,2$. By direct-plus-indirect labor (capital) coefficient in industry j we mean the amount of labor (capital) used directly plus the amount of labor (capital) used indirectly through the use of non-traded inputs in industry j.

Under our assumptions of constant returns to scale and fixed intermediate input coefficients the prices of intermediate inputs should not affect the cost-minimizing values of a_{Lj} and a_{Kj} and hence of A_{Lj} and A_{Kj} which will depend only upon w/r. Thus

$$A_{Lj} = A_{Lj}(w/r) \tag{7}$$

$$A_{Kj} = A_{Kj}(w/r)\,. \tag{8}$$

Let us now define θ_{ij} as the direct distributive share of input i in industry j and λ_{ij} as the proportion of input i used directly in industry j. Thus, for example, $\theta_{L1} \equiv a_{L1}w/P_1$, $\theta_{N1} \equiv a_{N1}P_N/P_1$, $\lambda_{L1} \equiv a_{L1}x_1/L$ and $\lambda_{N1} \equiv a_{N1}x_1/x_N$. It is now possible to define four other matrices as follows:

$$\lambda = \begin{pmatrix} \lambda_{L1} & \lambda_{L2} \\ \lambda_{K1} & \lambda_{K2} \end{pmatrix} \quad \text{and} \quad \lambda' = \begin{pmatrix} \lambda'_{L1} & \lambda'_{L2} \\ \lambda'_{K1} & \lambda'_{K2} \end{pmatrix}$$

$$\theta = \begin{pmatrix} \theta_{L1} & \theta_{K1} \\ \theta_{L2} & \theta_{K2} \end{pmatrix} \quad \text{and} \quad \theta' = \begin{pmatrix} \theta'_{L1} & \theta'_{K1} \\ \theta'_{L2} & \theta'_{K2} \end{pmatrix}$$

where $\lambda'_{ij} = \lambda_{ij} + \lambda_{iN}\lambda_{Nj} + \lambda_{iM}\lambda_{Mj}$ and $\theta'_{ij} = \theta_{ij} + \theta_{iN}\theta_{Nj} + \theta_{iM}\theta_{Mj}$, $i = L,K, j = 1,2$.

Denoting the determinants of the above matrices as $|A|$, $|\lambda|$, $|\theta|$, etc., it can be verified that the following relationships hold:

$$\begin{aligned} \operatorname{sign}|A| &= \operatorname{sign}|\lambda| = \operatorname{sign}|\theta| \\ \operatorname{sign}|A'| &= \operatorname{sign}|\lambda'| = \operatorname{sign}|\theta'| . \end{aligned} \tag{9}$$

Note, further, that $|A| > 0$ if and only if commodity 1 is labor-intensive in terms of direct coefficients and that $|A'| > 0$ if and only if commodity 1 is labor-intensive in terms of direct-plus-indirect coefficients. Since $|\theta|$ and $|\theta'|$ may well differ in sign commodity 1 may be labor-intensive in terms of direct coefficients but capital-intensive in terms of direct-plus-indirect coefficients.

Now, let ^ ('hat') over a variable represent the proportionate change in that variable so that $\hat{P}_1 \equiv dP_1/P_1$, etc. The competitive profit equations (1) through (4) can be written, in terms of rates of change, as

$$\theta_{L1}\hat{w} + \theta_{K1}\hat{r} + \theta_{N1}\hat{P}_N + \theta_{M1}\hat{P}_M + \theta_{S1}\hat{P}_S = \hat{P}_1 \tag{1.1}$$

$$\theta_{L2}\hat{w} + \theta_{K2}\hat{r} + \theta_{N2}\hat{P}_N + \theta_{M2}\hat{P}_M = \hat{P}_2 \tag{2.1}$$

$$\theta_{LN}\hat{w} + \theta_{KN}\hat{r} = \hat{P}_N \tag{3.1}$$

$$\theta_{LM}\hat{w} + \theta_{KM}\hat{r} = \hat{P}_M . \tag{4.1}$$

In deriving (1.1) through (4.1) we have simply made use of the first order cost-minimization conditions[6] (since $da_{N1} = da_{M1} = da_{N2} = da_{M2} = 0$ by assumption) $\theta_{Lj}\hat{a}_{Lj} + \theta_{Kj}\hat{a}_{Kj} = 0$, $j = 1,2,N,M$.

In our present model EPR_1 is $(P_1 - \theta_{S1}\hat{P}_S)/(1-\theta_{S1})$ by the Corden measure, $(\hat{P}_1 - \theta_{S1}\hat{P}_S)/(1-\theta_{S1}-\theta_{N1}-\theta_{M1})$ by the Balassa measure and $(\hat{P}_1 - \theta_{S1}\hat{P}_S - \theta_{N1}\hat{P}_N - \theta_{M1}\hat{P}_M)/(1-\theta_{S1}-\theta_{N1}-\theta_{M1})$ by the Scott measure. Similarly, EPR_2 is $\hat{P}_2$ by the Corden measure, $\hat{P}_2/(1-\theta_{N2}-\theta_{M2})$ by the

[6] See Jones (1965, 1971) and Kemp (1969) for applications of the same technique.

Balassa measure and $(\hat{P}_2-\theta_{N2}\hat{P}_N-\theta_{M2}\hat{P}_M)/(1-\theta_{N2}-\theta_{M2})$ by the modified Balassa measure.[7] By substituting for $\hat{P}_N$ from (3.1) and $\hat{P}_M$ from (4.1) into (1.1) and then dividing through by $1-\theta_{S1}$ one gets

$$\frac{\theta'_{L1}}{1-\theta_{S1}}\hat{w}+\frac{\theta'_{K1}}{1-\theta_{S1}}\hat{r} = \frac{\hat{P}_1-\theta_{S1}\hat{P}_S}{1-\theta_{S1}}. \tag{1.2}$$

Similarly, substituting for $\hat{P}_N$ from (3.1) and $\hat{P}_M$ from (4.1) into (2.1)

$$\theta'_{L2}\hat{w}+\theta'_{K2}\hat{r} = \hat{P}_2 . \tag{2.2}$$

Solving (1.2) and (2.2) together[8]

$$(\hat{w}-\hat{r}) = \frac{1-\theta_{S1}}{|\theta'|}\left[\frac{\hat{P}_1-\theta_{S1}\hat{P}_S}{1-\theta_{S1}}-\hat{P}_2\right]. \tag{10}$$

On the other hand, dividing through (1.1) by $(1-\theta_{S1}-\theta_{N1}-\theta_{M1})$ and (2.1) by $1-\theta_{N2}-\theta_{M2}$ and then solving them simultaneously

$$(\hat{w}-\hat{r}) = \frac{(1-\theta_{S1}-\theta_{N1}-\theta_{M1})(1-\theta_{N2}-\theta_{M2})}{|\theta|}\times \tag{11}$$
$$\left[\frac{\hat{P}_1-\theta_{S1}\hat{P}_S-\theta_{N1}\hat{P}_N-\theta_{M1}\hat{P}_M}{1-\theta_{S1}-\theta_{N1}-\theta_{M1}}-\frac{\hat{P}_2-\theta_{N2}\hat{P}_N-\theta_{M2}\hat{P}_M}{1-\theta_{N2}-\theta_{M2}}\right]$$

(10) and (11), in turn, imply

[7] Though we are assuming fixed intermediate input coefficients in this paper, the *EPR*-measure as adopted here need not necessarily be restricted to fixed coefficients only. This is because for infinitesimal changes it does not matter whether the pre-change or the post-change a_{ij}'s (and correspondingly θ_{ij}'s) are used as the base. For example, Jones (1971) uses the same kind of *EPR* measure while specifically considering the variable coefficients case.

[8] The following type of solution will appear whenever each row sum of the coefficients matrix formed by the simultaneous equations is unity.

$$\left[\frac{\hat{P}_1-\theta_{S1}\hat{P}_S}{1-\theta_{S1}}-\hat{P}_2\right]\Big/\left[\frac{\hat{P}_1-\theta_{S1}\hat{P}_S-\theta_{N1}\hat{P}_N-\theta_{M1}\hat{P}_M}{1-\theta_{S1}-\theta_{N1}-\theta_{M1}}-\right. \tag{12}$$

$$\left.-\frac{\hat{P}_2-\theta_{N2}\hat{P}_N-\theta_{M2}\hat{P}_M}{1-\theta_{N2}-\theta_{M2}}\right]=\frac{|\theta'|(1-\theta_{S1}-\theta_{N1}-\theta_{M1})(1-\theta_{N2}-\theta_{M2})}{|\theta|(1-\theta_{S1})}$$

Since $(1-\theta_{S1}-\theta_{N1}-\theta_{M1})/(1-\theta_{S1})>0$ the Corden measure and the Scott measure yield two different ranking of industries 1 and 2 in terms of *EPR*'s if and only if $|\theta|$ and $|\theta'|$ differ in sign. In other words, it is possible to have $EPR_1 > EPR_2$ in Corden sense and at the same time $EPR_2 > EPR_1$ in Scott sense if and only if the direct factor intensity rankings of the two industries are different from direct-plus-indirect factor intensity rankings.[9]

3. Implications of alternative measures

Since we have two full employment equations to determine four output levels x_1, x_2, x_N and x_M it is obvious that we need some additional restrictions to get determinate results. To circumvent this indeterminacy problem we shall assume henceforth that commodities N and M are pure intermediate commodities (i.e., with zero final demand).

From (7) and (8)

$$\hat{A}_{Lj} = -\sigma_{Lj}(\hat{w}-\hat{r}) \qquad j = 1,2 \tag{7.1}$$

$$\hat{A}_{Kj} = \sigma_{Kj}(\hat{w}-\hat{r}) \qquad j = 1,2 \tag{7.2}$$

where σ_{Lj} and σ_{Kj} are defined as $-\hat{A}_{Lj}/(\hat{w}-\hat{r})$ and $\hat{A}_{Kj}/(\hat{w}-\hat{r})$ respectively. Clearly,

$$\sigma_{Lj}>0, \qquad \sigma_{Kj}>0\,.^{10} \tag{13}$$

With $x_N = a_{N1}x_1 + a_{N2}x_2$ and $x_M = a_{M1}x_1 + a_{M2}x_2$ the full employment equations, in terms of rates of change, reduce to

[9] The relationship between factor prices, commodity prices and alternative *EPR* measures in such a model has been more extensively discussed in Ray (1971).

[10] Since, for example, $A_{L1} = a_{L1} + a_{LN}a_{N1} + a_{LM}a_{M1}$ must go down when w/r rises in as much as a_{L1}, a_{LN} and a_{LM} must all go down and a_{N1} and a_{M1} are fixed by assumption.

$$\lambda'_{L1}\hat{x}_1 + \lambda'_{L2}\hat{x}_2 = -(\lambda'_{L1}\hat{A}_{L1} + \lambda'_{L2}\hat{A}_{L2}) \tag{5.1}$$

$$\lambda'_{K1}\hat{x}_1 + \lambda'_{K2}\hat{x}_2 = -(\lambda'_{K1}\hat{A}_{K1} + \lambda'_{K2}\hat{A}_{K2})\,. \tag{6.1}$$

Since each row sum of the coefficients matrix of the above two equations is unity, their simultaneous solution, after using (7.1) and (7.2), gives

$$|\lambda'|(\hat{x}_1 - \hat{x}_2) = \alpha(\hat{w} - \hat{r})$$

where $\alpha = \sum_j \lambda'_{Lj}\sigma_{Lj} + \sum_j \lambda'_{Kj}\sigma_{Kj} > 0 \qquad j = 1,2\,.$ (14)

Now, by substituting for $(\hat{w}-\hat{r})$ from (10) and (11) respectively, (14) can be expressed in two alternative forms:

$$(\hat{x}_1 - \hat{x}_2) = \frac{\alpha(1-\theta_{S1})}{|\lambda'|\,|\theta'|}\left[\frac{\hat{P}_1 - \theta_{S1}\hat{P}_S}{1-\theta_{S1}} - \hat{P}_2\right] \tag{14.1}$$

$$(\hat{x}_1 - \hat{x}_2) = \frac{\alpha(1-\theta_{S1}-\theta_{N1}-\theta_{M1})(1-\theta_{N2}-\theta_{M2})}{|\lambda'|\,|\theta|}\times$$

$$\left[\frac{\hat{P}_1 - \theta_{S1}\hat{P}_S - \theta_{N1}\hat{P}_N - \theta_{M1}\hat{P}_M}{1-\theta_{S1}-\theta_{N1}-\theta_{M1}} - \frac{\hat{P}_2 - \theta_{N2}\hat{P}_N - \theta_{M2}\hat{P}_M}{1-\theta_{N2}-\theta_{M2}}\right]. \tag{14.2}$$

Since $|\lambda'|$ and $|\theta'|$ must have the same sign but $|\lambda'|$ and $|\theta|$ need not have, it follows from (14.1) and (14.2) that the Corden measure correctly predicts the output movements of tradeables but the Scott measure may not in the present case. In so far as $[(\hat{P}_1 - \theta_{S1}\hat{P}_S)/(1-\theta_{S1}-\theta_{N1}-\theta_{M1}) - \hat{P}_2/(1-\theta_{N2}-\theta_{M2})]$ may differ in sign from $[(\hat{P}_1 - \theta_{S1}\hat{P}_S)/(1-\theta_{S1}) - \hat{P}_2]$ the Balassa measure may also be misleading. It is obvious that these results will be valid whatever be the number of non-traded goods so long as they are 'pure' intermediate commodities.

An intuitive explanation of the above results may be as follows. In the present case where commodities N and M are pure intermediate commodities the entire output space is reduced essentially to two dimensions involving two composite commodities. For instance, one unit of x_1, a_{N1} units of x_N and a_{M1} units of x_M constitute one unit of the first composite commodity. Clearly one unit of the composite commodity uses labor and capital given by our direct-plus-indirect coefficients. The Corden measure measures the protection accorded to the direct-plus-indirect (rather than direct) value added and thus correctly predicts the output movements of the composite commodities. Since x_1 and x_2 must be proportional to the output levels of the composite commodities (under fixed intermediate input coefficients assumption) the Corden measure is a correct indicator of the output movements of the traded-good industries. The Scott measure, by measuring protection accorded to direct value added, will fail to yield a correct prediction about the output movements of the composite commodities and hence of the traded-good industries if and only if the direct coefficients ranking of the traded-good industries is different from direct-plus-indirect coefficients ranking. The Balassa measure does not measure correctly the protection given to direct-plus-indirect value added (nor to direct value added either) and hence may be misleading also.

Humphrey (1969a, 1969b) suggests that if somehow the changes in the prices of non-tradeables (in other words, the tariff-equivalents for non-tradeables) resulting from a particular protective structure for tradeables could be known, the *EPR*'s computed on the basis of the nominal tariff rates and the tariff-equivalents will be the appropriate ones to use. But these *EPR*'s are really nothing but what we have called *EPR*'s in terms of the Scott measure. However, we have already shown above that this measure may not correctly predict the output movements of tradeables in a general equilibrium framework in situations where the Corden measure is the correct indicator of output movements. Corden (1971, pp. 162–163) on the other hand, conjectures that the Scott measure is the appropriate one if there is only one non-traded commodity or if the price-relationships among non-tradeables remain unchanged. But it can be checked very easily that our result that the Corden measure is the appropriate one and the Scott measure may not be so long as the non-tradeables are 'pure' intermediate commodities will hold even when there is only one non-tradeable in the model. Thus, Corden's conjecture is not valid in general.

Another interesting point is that whenever industry 1 is protected relative to industry 2 in the Corden sense, the output of the non-tradeable used intensively in industry 1 must increase relative to that of the other non-traded commodity. In other words, the Corden measure correctly measures the degree of indirect (relative) protection accorded to the non-traded industries supplying inputs to the traded-good industries.

The proof is simple. Define two more matrices such that

$$\bar{A} = \begin{pmatrix} a_{N1} & a_{N2} \\ a_{M1} & a_{M2} \end{pmatrix} \quad \text{and} \quad \bar{\lambda} = \begin{pmatrix} \lambda_{N1} & \lambda_{N2} \\ \lambda_{M1} & \lambda_{M2} \end{pmatrix}$$

and note that sign $|\bar{A}|$ = sign $|\bar{\lambda}|$. Clearly $|\bar{A}| > 0$ if and only if industry 1 is N-intensive (rather than M-intensive).

Now, $\hat{x}_N = \lambda_{N1}\hat{x}_1 + \lambda_{N2}\hat{x}_2$ and $\hat{x}_M = \lambda_{M1}\hat{x}_1 + \lambda_{M2}\hat{x}_2$.
Therefore,

$$(\hat{x}_N - \hat{x}_M) = (\lambda_{N1} - \lambda_{M1})\hat{x}_1 - (\lambda_{M2} - \lambda_{N2})\hat{x}_2 \, . \tag{15}$$

Since each row sum of $|\bar{\lambda}|$ is unity

$$|\bar{\lambda}| = \lambda_{N1} - \lambda_{M1} = \lambda_{M2} - \lambda_{N2} \tag{16}$$

and hence (15) can be written as

$$(\hat{x}_N - \hat{x}_M) = |\bar{\lambda}|(\hat{x}_1 - \hat{x}_2) \, . \tag{17}$$

Substituting for $(\hat{x}_1 - \hat{x}_2)$ from (14.1) into (17)

$$(\hat{x}_N - \hat{x}_M) = \frac{\alpha(1-\theta_{S1})|\bar{\lambda}|}{|\lambda'|\,|\theta'|} \left[\frac{\hat{P}_1 - \theta_{S1}\hat{P}_S}{1-\theta_{S1}} - \hat{P}_2\right] \, . \tag{18}$$

Since $\alpha(1-\theta_{S1})/|\lambda'| \cdot |\theta'| > 0$, $(\hat{x}_N - \hat{x}_M) > 0$ if and only if $|\bar{\lambda}| > 0$ whenever $[(\hat{P}_1 - \theta_{S1}\hat{P}_S)/(1-\theta_{S1}) - \hat{P}_2] > 0$. It readily follows that if industry 1 is protected relative to industry 2 in Corden sense, the output of the non-traded commodity used intensively in industry 1 will expand relative to that of the other non-traded commodity. Since the Balassa measure and the Scott measure may still yield rankings of industries 1 and 2 that are different from that in terms of the Corden measure, none of these two measures will possess that significance.

So far we have confined ourselves to output movements only. Let us now indicate rather briefly the implications of the alternative *EPR* measures with regard to domestic resource movements and value added shifts as between the two traded-good industries in our model. It can be proved that if $EPR_1 > EPR_2$ in Corden sense the amounts of direct-plus-indirect labor and capital used in industry 1 will go up and those in industry 2 will go down. To save space we merely give here the expression for the proportionate change in direct-plus-indirect labor used in industry 1:

$$\widehat{(A_{L1} \cdot x_1)} = \hat{A}_{L1} + \hat{x}_1 = \frac{(1-\theta_{S1})}{|\theta'|} \times \left[\frac{\hat{P}_1 - \theta_{S1}\hat{P}_S}{1-\theta_{S1}} - \hat{P}_2\right] \left\{-\sigma_{L1} + \frac{\beta}{|\lambda'|}\right\} \tag{19}$$

where $\beta = \lambda'_{K2}(\sigma_{L1}\lambda'_{L1} + \sigma_{L2}\lambda'_{L2}) + \lambda'_{L2}(\sigma_{K1}\lambda'_{K1} + \sigma_{K2}\lambda'_{K2}) > 0$.

With $(\hat{P}_1 - \theta_{S1}\hat{P}_S)/(1-\theta_{S1}) > \hat{P}_2$, the expression in (19) is clearly positive if $|\theta'|$ and $|\lambda'|$ are both negative.[11] It can also be checked that $\beta > \sigma_{L1}|\lambda'|$ so that $\{-\sigma_{L1} + \beta/|\lambda'|\}$ is positive whenever $|\lambda'|$ is positive. Thus, the expression in (19) must be positive if and only if $EPR_1 > EPR_2$ in Corden sense. Needless to say, neither the Scott nor the Balassa measure will necessarily have this property.

It cannot be proved (without imposing additional restrictions), however, that direct labor and capital will go up in industry 1 and go down in industry 2 if $EPR_1 > EPR_2$ in terms of any of the three measures.

Turning now to shifts in values added one can prove that the direct-plus-indirect value added in industry 1 will go up and that in industry 2 will go down if $EPR_1 > EPR_2$ in the Corden sense and, in addition, $EPR_1 > 0$ and $EPR_2 < 0$. Again, we give here only the expression for the proportionate change in the direct-plus-indirect value added in industry 1:

$$\widehat{(v_1 x_1)} = \hat{v}_1 + \hat{x}_1 = \frac{\hat{P}_1 - \theta_{S1}\hat{P}_S}{1-\theta_{S1}} + \frac{\beta(1-\theta_{S1})}{|\theta'|\,|\lambda'|} \times \left[\frac{\hat{P}_1 - \theta_{S1}\hat{P}_S}{1-\theta_{S1}} - \hat{P}_2\right] \tag{20}$$

where $v_1 = P_1 - a_{S1}P_S$ is the direct value added per unit output in

[11] Recall $|\lambda'|$ and $|\theta'|$ must have the same sign.

industry 1. The expression in (20) is clearly positive if $(\hat{P}_1 - \theta_{S1}\hat{P}_S)/(1-\theta_{S1}) > \hat{P}_2$ and $(\hat{P}_1 - \theta_{S1}\hat{P}_S)/(1-\theta_{S1}) > 0$. Thus an output tariff for industry 1 (i.e., $\hat{P}_1 > 0$, $\hat{P}_2 = \hat{P}_S = 0$) or an input subsidy foı industry 1 (i.e., $\hat{P}_S < 0$, $\hat{P}_1 = \hat{P}_2 = 0$) will definitely increase the amount of direct-plus-indirect value added in industry 1.[12]

It is also true that direct value added will go up in industry 1 and go down in industry 2 if $EPR_1 > EPR_2$ in Corden sense and, in addition, direct value added per unit output in industry 1 goes up and that in industry 2 goes down. However, a priori there are no simple tariff combinations which will definitely bring this about. For example, an output tariff for industry 1 with no other tariffs in the system (i.e., $\hat{P}_1 > 0$, $\hat{P}_2 = \hat{P}_S = 0$) certainly makes $EPR_1 > EPR_2$ in Corden sense but does not guarantee that the direct value added per unit output in industry 1 goes up in as much as the prices of non-tradeables might change in such a way as to reduce the direct value added per unit output in industry 1.

It is obvious that if we allow commodities N and M to be used also for final consumption no EPR measure can predict correctly the output, resource or value added movements as between the two traded-good industries in our model.

Note, finally, that the Scott measure cannot be applied even for a small country without first solving the whole system. In contrast, both the Corden measure and the Balassa measure are applicable without there being any need to solve the system if the country is a small country. Since, as we have already noted, the Balassa measure does not carry any resource allocation significance, this leaves the Corden measure as the only measure which is operational and at the same time has some (limited) resource allocation significance.

[12] If direct-plus-indirect values added are measured at (fixed) world prices instead of domestic prices (as done above) direct-plus-indirect value added in industry 1 must go up and that in industry 2 must go down if and only if $EPR_1 > EPR_2$ in Corden sense. This is because the direct-plus-indirect values added at world prices per unit output in industries 1 and 2 are constants by the small country and fixed intermediate input coefficients assumptions. Thus whenever $\hat{x}_1 > 0$ and $\hat{x}_2 < 0$ (which happens if and only if $EPR_1 > EPR_2$ in Corden sense) the direct-plus-indirect value added at world prices must increase in industry 1 and decrease in industry 2.

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